12th International HCH and Pesticides Forum
6-8 November, 2013, Kiev, Ukraine

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12th International HCH and Pesticides Forum

12th Forum 10 years after the 7th forum in Kiev: what has been achieved in a decade in Ukraine – what is Ukraine's role for the other EECCA countries

6-8 November, 2013, Kiev, Ukraine

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- Ministry of Agrarian Policy and Food of Ukraine
- Institute of Geochemistry of Environment (National Academy of Science of Ukraine)
- ECOINTOX (Medved Institute), Ukraine
- S.I. Group Consort, Israel
- FAO
- Federal Environment Agency of Germany (UBA)
- Free University of Berlin, Germany
- Green Cross, Switzerland
- GreenTox, Switzerland
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- GEF-UNEP-WHO Project “Demonstrating and Scaling-up of Sustainable Alternatives to DDT in Vector Management Global Programme“
- SI Group Consort Ltd., Israel
- FAO
- Federal Environment Agency of Germany (UBA)
- FREE University of Berlin, Germany
- GreenTox, Switzerland
- SAVA, Germany
- TREDI, France
- Veolia, United Kingdom
- POLYECO S.A., Greece
- PortService, Poland

Introduction

This booklet summarizes the outcomes of the 12th International HCH and Pesticides Forum held in Kiev, Ukraine, 6-8th November 2013.

It presents the background for the Forum and the Forum Declaration, which was read out and fully endorsed by all participants.

Furthermore, the booklet contains important statements from the Minister of Ecology and Natural Resources of the Ukraine, Mr. Oleg Proskuryakov, the Minister of Environment of the Republic of Moldova Mr. Gheorghe Șalaru, the European Commissioner to the Environment Mr. Janez Potočnik , and the State Secretary on Health Protection of Slovenia, Ms. Brigita Čokl, who all addressed the Forum and emphasised the urgency of finding proper solutions to the elimination of obsolete pesticides in the region.

We trust that this report can contribute to the efforts of the authorities to develop better policies and strategies to the obsolete pesticides issues, their impacts on public health, the ecosystem and the National Economies and to promote continued and accelerated action.

For more information on the subject, please visit our website on www.ihpa.info.

Forum Sponsors

The International HCH and Pesticides Forum in Kiev was sponsored by:

the European Union through the project “Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union”, FAO, the GEF-UNEP- WHO Project “Demonstrating and Scaling-up of Sustainable Alternatives to DDT in Vector Management Global Programme”, GreenTox, Switzerland, SI Group Consort Ltd., Israel

EDL, New Zealand, Federal Environment Agency of Germany (UBA), Free University of Berlin, Germany, POLYECO S.A., Greece, PortService, Poland, SAVA, Germany, TREDI, France, Veolia, United Kingdom.

IHPA is grateful for the support given from all companies and organisations. Your support facilitated the 12th Forum in Kiev. This enabled easy access for Regional experts to travel to Kiev and to particpate in the discussions. Thank you all.

The 12th International HCH and Pesticides Forum created a platform for discussing the national and regional strategies, action plans and financial resources for elimination of obsolete pesticides with a special focus on the need for accelerated action. Valuable scientific results and best practices were exchanged; and the progress in the Ukraine was showcased, emphasizing the importance of Government determination and focus.

On November 6 – 8th the 12th Forum on HCH and Pesticides Forum was held in Kiev, Ukraine with participation of more than 220 experts from more than 40 countries.

The 12th Forum brought together governments, international financing institutions, UN agencies, representatives from EU institutions, IGOs, NGOs, academia and the private sector for further exchange of information and possible cooperation among countries, experts, institutions and donors. The Forum was initiated and enabled by the International HCH and Pesticides Association (IHPA) in order to follow up on the progress since the 11th Forum in Gabala, Republic of Azerbaijan in 2011.

The Forum was hosted by the Ministry of Ecology & Natural Resources of the Ukraine, and the participants expressed their gratitude to the Ministry for its hospitality and generous contribution in organizing this Forum.

The sessions during the Forum were launched by high-level discussions on framework conditions and followed by various thematic technical sessions. At the high level session three panel discussions were organised; a political panel discussion, a panel discussion with industry and private investors representatives; and a panel discussion with representatives of the most important International Financing Institutions (IFIs).

High-level discussions

The political session included a statement by the Minister of Environment of the Republic of Moldova, Mr. Gheorghe Șalaru, as well as positions from the EU Delegation in Ukraine, Mr. Jean-Francois Moret and the Vice-Chair of the Committee on the Environment, Public Health and Food Safety of the European Parliament, Mr. Dan Jørgensen. They all expressed their political commitment and stated their support for further action.

In the industrial session, the representatives included Mr. Ilya Marchewsky from SI Group Israel, Chairman, Mr. Thomas Vandenbrouque from Tredi International, Mr. Jean-Francois Nogrette, Veolia and CEO of SARP Industries group. The participants discussed barriers and potentials. They expressed their willingness for investment in regional facilities and clean up technologies and stressed the need for a clear legal framework and political will to ensure a regulated and transparent market for obsolete pesticides (and other hazardous waste) treatment and elimination.

The last panel discussion focussed on the role of the major IFIs. Their representatives included Mr. Ibrahima Sow from the GEF, Dr. Kevin Helps from FAO and Dr. David Piper from UNEP. All representatives ensured the availability of support to well-prepared and Government supported projects.

The High-level discussion was followed by thematic technical sessions including all key issues related to Persistent Organic Pollutants and their impact on human health, the ecosystem and economy, including the consequences of non-action. Among others, IHPA launched a new approach to quantifying the socio-economic damages and losses, and will with this approach work for a more comprehensive assessment of the impacts from obsolete pesticides. It is expected that the outcomes of this approach will also make the international community better aware of the huge economic effects and will lead to both acceleration and a higher level of ambition to eradicate obsolete pesticides.

It is time to accelerate action

By John Vijgen, Director IHPA

For decades obsolete pesticides have contaminated the soil and water destroying natural resources with large consequences for human health, ecosystems and national economies.
The adoption of the Stockholm Convention in 2001 was an important step in the direction towards a pesticide free future. However, after more than ten years with the Stockholm convention, initiatives to eliminate stocks in EECCA-region have turned out to develop slowly, amongst other due to lack of technical capacity and funding.

Non-action is too expensive

Our collective effort has proven to be too slim and too uncoordinated to mitigate the growing pollution caused by obsolete pesticides.

Today we still see persistent organic pollutants migrating into the environment, and that problems we thought were contained, have grown 20-30 times or more of the original extent. Economic losses of an export ban caused by pesticide residuals in food are measured in billions of euros. It is obvious that clean up is more cost-effective.

Signs of improvements in EECCA-region

However, important initiatives in obsolete pesticides elimination have been taken.

When looking at the region, Ukraine, Belarus and Moldova stand out in their determination to advance. But also other countries make progress. Russia has recently ratified the Stockholm Convention, technical capacities have been built in Azerbaijan and collection and long-term storage of obsolete pesticides have taken place in Turkmenistan. Moldova and Azerbaijan have started to conduct detailed mapping of obsolete pesticides in soil and water in areas where pesticides previously have been stored.

Much more should be done to combat further spreading of persistent organic pollutants into the environment.

Damages and Losses

To support national governments, IHPA proposes a new approach that combines identification of damages and quantification of the economic losses of non-action.

The ‘damages and losses’ methodology assesses the cost of different types of damages, including increased illness, loss of life, failing ecosystem services and polluted agricultural products.

This new approach ensures transparency in decision-making, and will enable benchmarking and accelerate private sector investment in the required environmental infrastructure.

Outlook - upcoming tasks

Building on the 12th Forum declaration there is a crucial need in the years to come for all EECCA-governments to prioritize obsolete pesticides at national level and to prepare clear plans for obsolete pesticides elimination, including appropriate policies and legal enforcement.

The ongoing EU financed FAO project on 'Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union' is a new milestone as it addresses as well management of obsolete pesticides as sustainable agriculture production practices. This project is a beacon and its implementation should be ensured and followed up in all countries.

Only by building destruction capacities in the Region, the countries will be able to manage the elimination of obsolete pesticides themselves. This is therefore an important priority – a MUST!

The European Union, international agencies and financing institutions therefore also play a pivotal role in supporting, assisting and accelerating clean up initiatives planned and taken by national governments.
And continuation of awareness raising and capacity building is a pre-condition for success.
The next Forum is planned to take place in Aragon (Spain) in 2015.
I am looking forward to seeing you there.

It is simply time to accelerate action!

8 November 2013

FORUM DECLARATION

12th International HCH and Pesticides Forum Kiev, Ukraine
6-8 November 2013

The International HCH and Pesticides Forum having met at Kiev from 6-8 November 2013, has taken note of the overall slow progress of elimination of obsolete pesticides, its negative impact on countries socio-economic performance, its severe adverse effects on health and quality of life, as well as its far- reaching consequences to neighbours and shared water resources.

The 12th Forum gathered more than 220 experts, who shared their knowledge and experience and expressed their continuous commitment to awareness raising and cleanup of obsolete pesticides in the EECCA-region.

Accordingly, the 12th Forum decided to call upon Governments in the region, the European Union, the international organizations, financial institutions, the local NGO's and the civil society to recognize the existence of approx. 240.000 tonnes of obsolete pesticides in the region, and the need to accelerate action and create the required policies and infrastructure to support the objectives of the Stockholm Convention on Persistent Organic Pollutants.

The following is drawn up based on the discussion and recommendations from the Forum participants.

Call upon all *National Governments* to

1. Establish an open and transparent dialogue on all levels of society, i.e. political, scientific and public level in order to recognise the damages and required actions needed for elimination of obsolete pesticides wastes.
2. Based on the above, develop and implement the required policies and legal enforcement including action plans to eliminate obsolete pesticides wastes in a sustainable manner.
3. Understand the increasing negative socio-economic and human health impacts of non-action and the associated damages and losses, and explain the urgency of the issues in international fora and in bilateral negotiation.
4. Allocate funds for awareness raising through media and education as well as to advance sustainable technologies for elimination of obsolete pesticides wastes in an environmental sound manner (SBC guideline).

5. Work with FAO to ensure the adoption of sustainable agriculture production practices in order to avoid accumulation of obsolete pesticides in the future and to ensure that natural resources such as soil and water are preserved for future generations
6. Strengthen the national environmental institutions, build capacity through training programs and ensure that existing capacities are maintained.

Calls upon the *European Union* to recognise that non-action has immediate and long-term negative consequences to the European Community and the European economy, and specifically call upon

7. The European Parliament to assist the Parliamentarians in the EECCA region in developing and implementing policies to eliminate obsolete pesticides wastes in an environmental sound manner, and to request the European Commission to make the necessary funding available.
8. The European Commission to build on the project 'Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union (FAO/GCP /RER/040/EC')' and lead a regional action plan for elimination of obsolete pesticides wastes in partnership with the EU member states and the private sector; and to prevent new obsolete pesticides wastes.
9. ToallocatefundsforbuildingawarenessinsupportofNGOs,othercitizensorganisationsand related institutions.

Call upon the *International Organisations and Financial Institutions* to

10. Enhance the capacities of the countries through coordinated technical assistance
11. Facilitate the Governments action planning especially within harmonisation for a regional approach and cooperation
12. Assist countries in assessing the damages and losses in economic terms base on an agreed methodology and in financing urgent projects
13. Allocate funds for implementation of action plans and related projects, and to question countries that are not implementing their approved national implementation plans (NIP)

Specifically call upon,

14. The GEF to continue support the elimination of Obsolete and POPs pesticides by co-funding a regional facility for the treatment of Obsolete and POPs pesticides

Call upon local NGOs and the civil society to

15. Continue their large effort in creating political pressure and raise awareness of the importance to eliminate obsolete pesticides in the environment, food cycle and human bodies and to follow-up on Government policies and assist in their implementation.

The 12th Forum recognised the effort of IHPA as an important contributor in building awareness at governments and civil society in the EECCA region, and urged the organisation to continue working towards the fulfilment of the objectives of Stockholm Convention and in bringing together scientists, industry and policy-makers of the Region.

After this declaration had been read out, the Forum participants spontaneously confirmed their dedication to the eradication of obsolete pesticides and requested IHPA to ask the addressees of this declaration to join their acts of commitment.

Kiev, 8th November 2013

Message from the Minister of Environment and Natural Resources of Ukraine O.A. Proskuryakov

SPEECH OF THE MINISTER OF ENVIRONMENT AND NATURAL RESOURCES OF UKRAINE O.A. Proskuryakov

AT THE PLENARY SESSION OF THE 12th CONFERENCE OF THE INTERNATIONAL ASSOCIATION FOR PESTICIDES AND CHLORINATED ORGANICS

On behalf of the Government of Ukraine I welcome all the participants and guests of the 12th Forum of International Association for Pesticides and Chlorinated Organics in Kyiv!

Waste management is one of the most pressing environmental challenges. This issue is also under special control of the Government of Ukraine. Therefore, finding ways of solving the problem of accumulation of obsolete pesticides and other persistent organic pollutants in Central and Eastern Europe, and other countries, is now extremely urgent for the international community and nation states.

The Ministry of Ecology and Natural Resources of Ukraine considers cooperation with international organizations, institutions and other partners in this area to be one of the preferred directions in its activity. Our absolute priority is fulfilling obligations under:

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;
Rotterdam Convention on the Prior Informed Consent on Certain Hazardous Chemicals and Pesticides in International Trade.
Stockholm Convention on Persistent Organic Pollutants.

Given the urgency of solving the problems in this area, the Ministry developed a draft National Waste Management Programme for the years of 2013-2020, which will soon be introduced by the Government to the Parliament of Ukraine.

The Ministry also actively works towards practical measures aimed at clearing the state territory off the places of hazardous wastes storage. The main attention is paid to the most resonant and environmentally dangerous places.

Let’s see some examples and figures. Over the past three years the following was removed from Ukraine:

- mixture «Premix», which was illegally imported to the territory of Zakarpattya Region, – 1300 tons;
- obsolete pesticides – over 26 thousand tons;
- hexachlorobenzene wastes from the landfill of toxic industrial wastes in Kalush District of Ivano-Frankivsk Region – over 21 thousand tons;
- mononitrochlorobenzene wastes from the territory of the State Enterprise “Gorlovskij Chemical Plant” – over 2700 tons.
- Beryllium containing wastes from the territory of the State Scientific and Production Enterprise “Zahid” (Kyiv) – 320 tons

Implementation of these measures significantly improved the ecological status of the territories and allowed to relieve social tension among the population.

Ministry will subsequently continue carrying out these important works with wide involvement of private business.
For proper legal regulation and creation of conditions for the application of best practices in this field, we now carry out a series of activities under National Programme of Adaptation of Ukraine’s Legislation to EU Laws.

For proper legal regulation and creation of conditions for the application of best practices in this field, we now carry out a series of activities under National Programme of Adaptation of Ukraine’s Legislation to EU Laws.

Several draft resolutions of the Government on the implementation of the relevant European directives concerning the treatment of various types of wastes were prepared.

We also welcome the initiatives of enterprises, which impact the environment in their activity, on reducing emissions, waste generation.

The national system of governance in the field of chemical safety is based on the principles of preventive response and “polluter pays full price.” This will prevent environmental degradation and reduce the negative impact of hazardous chemical contaminants on the health of the citizens of our country.

Dear Colleagues!
I am strongly convinced that only by working together and with the widest participation of representatives of academia, business and the public we can minimize the impact of modern technological civilization upon the environment and preserve our planet for future generations.

Once again I want to emphasize that our Ministry is open for new initiatives and ready to give every assistance possible.

Thank you for your attention and wish you fruitful work!

Message from the Minister of Environment of the Republic of Moldova, Gheorghe Șalaru

12th International HCH and Pesticides Forum 6-8 November 2013, Kiev, Ukraine
Gheorghe Șalaru Minister of Environment Republic of Moldova

Gheorghe Șalaru
Minister of Environment Republic of Moldova

Opening speech

Dear Colleagues,

Let me greet you, participants in the 12th International HCH and Pesticides Forum and wish you success in your noble mission to reduce and eliminate the danger faced by our countries in the last decades, due to the accumulated stocks of obsolete pesticides and other hazardous chemicals and wastes.

The 12th Forum is remarkable also for the fact that after 10 years he again is held in Kiev, and this is another important point to summarize what has been done during this time in this area and outline the prospects for the coming years.

The problem of obsolete pesticides in Moldova started to manifest itself, as in other former soviet republics, in the 70-80s of last century, in the period of intense chemicalization of agriculture. In our country, with a predominantly agricultural industry, a relatively small area and high population density (34 thousand square km and about 4 million people), this problem has taken a very large proportion. At that time Moldova imported annually up to 40 thousand tons of pesticides, unutilized balances of which were accumulating from year to year. The first attempt to solve this problem was made in the 70s, when in the south of Moldova was built a special landfill for pesticides wastes. During 12 years, until 1987, there had been buried about 4,000 tons of pesticides, including DDT and HCH. Currently, this object is guarded and under constant monitoring.

Especially acute the problem of obsolete pesticides has become in the 1990s, when as a result of changes in property relationship that have occurred in society, including in agriculture, most pesticides warehouses ownerless and began to decay. In many of them obsolete pesticides were stored. By 2000, these objects left about 350 and the quantities of pesticide waste kept in them were estimated at 1,770 tons.

To solve this problem, since 1997 several attempts have been made by the Government of Moldova, but only after special decision (No 1543), adopted in November 2002, actions began. Several ministries (Ministry of Agriculture and Food Industry, Ministry of Environment, Ministry of Defense, Emergency Situations Service) and all regional and local authorities have been involved in this work. Funds for repackaging and centralized storage of obsolete pesticides have been allocated from the state budget and from the National Environmental Fund.

At the same time, the Republic of Moldova acceded to the Stockholm Convention on Persistent Organic Pollutants, committing themselves to reduce and remove the risks associated with POPs. This fact opened up opportunities for support in addressing these issues by the international funds. Thus, all subsequent steps in this direction have been carried out on the basis of funds allocated by the government and with significant support from abroad (World Bank and the Global Environment Fund, NATO, UNEP, OSCE, the Governments of Canada, the Netherlands, the Czech Republic etc.).

By 2008, all known stocks of obsolete pesticides were repackaged and temporarily stored in secure conditions. In 37 warehouses were stored about 3,350 tons of pesticides waste.

Simultaneously began the process of their export abroad and destruction. From 2007 to 2013, in the framework of two projects implemented by the Ministry of Environment about 1,500 tons of pesticides have been eliminated. This process continues within the five projects started this year, funded by the Czech Government, NATO, OSCE, FAO and the National Environmental Fund. As estimated, by the end of 2015 all stocks of obsolete pesticides stored in warehouses will have been removed.

These results have been made possible thanks to the constant attention drawn by the Government to address these problems, continuing support of the international organizations and governments of some developed countries, as well as to active participation in this process of involved ministries, local authorities and civil society.

At the same time, despite significant progress in addressing issues related to obsolete pesticides, there are still a lot of problems both in the region as a whole and in each country separately. Some of them require immediate actions, the other can be resolved gradually, spreading efforts and resources depending on the seriousness of the problems and priorities of each country.

For Moldova it is, first of all, the removal of stocks of pesticides stored in warehouses, and we have all the chances to complete this process by the end of 2015. After that the removal of 4,000 tons of pesticides buried in the south of the country, near the borders with Ukraine and Romania should be followed. Here we intend to work closely with our neighbors.

In parallel an extensive work on updating, development and implementation of national legislation in the field of chemical products and bring it in line with European and international standards are being conducted.

We should develop and implement a series of national programs to clean up areas contaminated by pesticides, including POP pesticides. These are mostly the former warehouses of chemicals and other objects used in the past in agriculture. Their number is about 1,600.

There are still many problems associated with other hazardous chemicals and wastes, particularly PCBs, chemical waste in scientific and university laboratories, industrial plants, etc. All these issues also need to be assessed and solved in a single package of measures on reducing the negative impact of chemicals on the environment and human health.

In this sense, the Government of the Republic of Moldova, and in particular the Ministry of Environment, will continue to make substantial efforts to achieve the goals set out in this area, and are counting on the continued support of the international community and on enhancing the regional cooperation. Also, we consider the continuation of cooperation with our partners in the country, and primarily with the central executive authorities concerned and involved in these processes – the Ministry of Agriculture, Ministry of Defense, the Ministry of Economy, as well as with district and local authorities, and civil society.

Message from the State Secretary of the Ministry of Health of the Republic of Slovenia Mrs. Brigita Čokl

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Number: 510-94/2013/33
Date: 25. 10. 2013

Subject: **STATE SECRETARY'S SPEECH AT THE 12TH MEETING OF THE HCH FORUM, 6 - 8 NOVEMBER 2013**

Dear participants of the 12th meeting of the HCH Forum,

I regret not being able to be with you in person, but I ensure you that my colleagues and I follow all your activities in this very important field of work.

Slovenia has been supporting the disposal of obsolete pesticides since the Intergovernmental Forum on Chemical Safety. Among its other tasks, the Forum, established in Stockholm in 1994, also strove for the disposal of obsolete chemicals and reduction of pesticide risks[1]. In the years thereafter, Slovenia followed and actively participated in activities in this field. Thus in 2000, we participated at the OECD and partners' Workshop on Obsolete Pesticides in Alexandria, Virginia[2]. The workshop discussed obsolete pesticides and other obsolete chemicals on the global level. At the workshop, Slovenia presented its efforts to manage the problem of obsolete pesticides at the national level and also established contacts with the International HCH and Pesticides Association (IHPA) and its director John Vijgen. The work of this non-governmental organization is very important, and I thus sincerely congratulate the IHPA on its persistence and current achievements.

Slovenia actively cooperates with the HCH Forum, and we also contributed two ambassadors to promote the issue of obsolete pesticides and other obsolete chemicals.

Although Slovenia succeeded in eliminating obsolete pesticides, we are aware that the problem will not be resolved merely with their disposal. On the contrary, we must strive to prevent the accumulation of such stock in the future. We are also aware that the issue has not yet been resolved in our region or globally.

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[1] http://www.iisd.ca/process/chemical_management-ifcsintro.html

[2] http://www.oecd.org/chemicalsafety/pesticides-biocides/2076941.pdf

At a time when we are witnessing climate change and are faced with its consequences, such as extensive flooding, and fires due to drought, and when floods and droughts are becoming more frequent, the danger of these old burdens is even greater. Hazardous substances and their metabolites are spread over greater areas during floods and fires. These also include substances which are known to have dreadful consequences for human health and also for future generations. The endocrine disrupting chemicals to which I am referring may already be poisonous in extreme small quantities.
And what can be done? Our task is to recognize these threats, acknowledge them and speedily address their resolution. Slovenia welcomes the role of the European Commission, FAO, UNEP and others who have approached the great project in this field.

I would also like to say that Slovenia participated at the first briefing related to this issue in the European Parliament on 29 June 2010, when we presented the then new Resolution on improvement of health through sound management of obsolete pesticides and other obsolete chemicals. At a Slovenian initiative, the Resolution was adopted at the 63rd meeting of the General Assembly of the World Health Organization, on 10 May 2010 in Geneva. This Resolution serves as the foundation for the active cooperation of all relevant stakeholders, such as governments, the European Commission, WHO, UNEP and others. The Resolution also realized one of the main recommendations adopted at the aforementioned OECD-FAO-UNEP Workshop in 2000, i.e. "more active participation of the medical community and the World Health Organization".

Furthermore, the issue of obsolete pesticides and particularly hazardous chemicals was included in the EU Danube Strategy (Chapters IV and VI) at a Slovenian initiative.

Dear ladies and gentlemen, esteemed participants of the HCH Forum,

it is our responsibility to suitably define the issue of obsolete pesticides and other obsolete chemicals and to ensure the implementation of all the documents already adopted.

To conclude, I wish to stress again that the issue of obsolete pesticides and other obsolete chemicals is extremely important to Slovenia, although the country is not affected by these issues at the moment.

We are nevertheless aware that this problem affects us all, and we will do our best to further support measures in order to eliminate this problem permanently.

We were planning to hold the meeting now being held in Kiev, in Slovenia, but this unfortunately was not possible.

Therefore, I sincerely thank Ukraine, the host of the meeting, and wish much inspiration for the participants and the best possible outcome of the meeting.

With Regards,

Brigita ČOKL
State Secretary

Message from the Environment Commissioner Janez Potočnik

JANEZ POTOČNIK
Member of the European Commission

Brussels, 18. 10. 2013
Ref. Ares(2013)

Message from Environment Commissioner Janez Potočnik to participants at the 12th International HCH and Pesticides Forum, 6-8 November 2013, Kyiv

Dear participants,

I regret that I am not able to attend this gathering to discuss and reflect on the major problem of obsolete pesticides due to institutional obligations that require my participation. That does not mean that I do not put attention to this issue.

Dealing with dangers posed to the health of people and the environment by obsolete pesticides is an enormous challenge for many countries, especially in Eastern parts of Europe and Central Asia.

Many activities have been launched to better understand the problem, to address the causes and to engage the relevant parties in cleaning up sites where obsolete pesticides and other dangerous chemicals are stored. But much remains to be done. This requires co-operation between governments, who are responsible for the well-being of their citizens; the agricultural sector, which is the main user of pesticides, and thirdly the pesticides industry, which has the knowledge and means to promote better alternatives.

I would particularly like to express my appreciation to the International HCH and Pesticides Association for their persistent efforts to solve the problem. Together with FAO, UNEP, UNDP, UNIDO, World Bank and many other organisations, the Association has managed to make people aware of the dangers posed by obsolete pesticides, initiating actions that have brought tangible results. I encourage you to continue your work.

The European Commission is in regular dialogue with partner countries to promote solutions to this problem. We are encouraging legislative reforms to address issues related to the management of obsolete pesticides stocks – the causes that have led to their accumulation – and preventing the problem from recurring in the future. In this context, we are supporting an international project in Eastern Europe and Central Asia to enhance the countries' capacity to eliminate obsolete pesticides stocks. We hope that this project, by bringing together donors and stimulating investment to phase out stocks of obsolete pesticides, will have a snowball effect in the future.

As the title of this project reminds us, "prevention" and "elimination" are both equally important. Preventing waste, including hazardous waste, is the first principle of any sound waste policy, and it applies to pesticides production and usage as well. Adopting legislation and policies that aim at achieving sustainable management practices covering the entire pesticide life-cycle is therefore crucial.

I hope you have a fruitful discussion and that your deliberations over the coming days will pave the way for successful measures to phase out obsolete pesticides right across Europe and Central Asia.

Yours sincerely,

About the International HCH and Pesticides Forum

The International HCH and Pesticides Forum represents a platform for discussion between stakeholders of all kinds, working on implementation of projects related to POPs, obsolete pesticides and hazardous chemical waste. It acts as a catalyst in the exchange of information for the implementation of the Stockholm Convention and other chemicals- related multilateral environmental agreements, and the environmentally sound management of pesticides, pesticide waste and other chemicals, and has today developed into an important event for national as well as international decision-makers and stakeholders

History of the International HCH and Pesticides Forum
The first International HCH and Pesticides Forum took place in 1992 in Provincie Overijssel - Zwolle in The Netherlands. Since 1992 the Forum has been organised 12 times and creates a platform for discussing the national and regional strategies, action plans and financial resources for elimination of obsolete pesticides with a special focus on the need for action.

Forum Mission Statement
Obsolete pesticides are not only an environmental problem. Much more it stands in the way of socio-economic development, impacts both the quality of life resulting in human health problems and economic losses. The vision of the International HCH and Pesticides Forum is a world free of obsolete pesticides.

The Forum mission is therefore continuously to ensure that the elimination of obsolete pesticides is on the global agenda by having bi- annual meetings for exchange of information and review of results.

About IHPA
The International HCH & Pesticides Association (IHPA) is an independent and non- political network of committed individuals that wants to draw international attention to the worldwide problems stemming from the production and use of HCH and other obsolete pesticides and its dangers for human health and the environment.

Visit our website www.ihpa.info or contact IHPA, director John Vijgen john.vijgen@ihpa.info for more information

EDUCATION AND WARENESS RAISING: A NEED AND A MUST

FIELD TRIP

WORKSHOP: BIOAVAILABILITY

GEF/UNEP PROJECTS DEMONSTRATING AND SCALING UP OF SUSTAINABLE ALTERNATIVES TO DDT FOR THE CONTOL OF VECTOR BORNE DISEASES IN SOUTHERN CAUCASUS AND CENTRAL ASIA

FAO SESSION: PESTICIDE MANAGEMENT: MORE FOOD LESS RISK

STATE OF THE ART AND LATEST DEVELOPMENT IN FORMER SU STATES AND CENTRAL EUROPEAN REGION

GLOBAL EXPERIENCE ON POPS AND OBSOLETE PESTICIDES WASTE MANAGEMENT

HEALTH PROBLEMS AT OBSOLETE PESTICIDES SITES (EXPOSURE AND TOXICITY OF PESTICIDES)

INVENTORY, MONITORING AND RISK ASSESMENT

NEWLY LISTED POPS AND OTHER STOCKHOLM CONVENTION ISSUES

PCB TREATMENT

EDUCATION AND AWARENESS RAISING: A NEED AND A MUST

In 2010 a group of 98 people from Tashbulak fell ill after the consumption of the meat of poisoned cows that reportedly drank standing water from pits on the site. 58 of these persons were seriously sick and 35 were hospitalized, among them 15 children.

In 2013 130 sheep pasturing in the neighborhood of Suzak A. died. Today a fence has been built around the site. At the same time, the open pits are covered and a guard house has been built for the guard that keeps a close watch over the site.

GROUPS AT RISK FROM OBSOLETE PESTICIDES IN KYRGYZSTAN

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Abstract

Stocks of obsolete pesticides pose a threat to public health and the environmental in Kyrgyzstan. Exposure to the Persistent Organic Pollutants (POPs), which many of these stocks contain, can lead to serious health effects. Unusable stocks piled up in the Soviet-time Kyrgyzstan due to over-ambitious planning and mismanagement of pesticides.

As a signatory to the Stockholm Convention, Kyrgyzstan aims to eliminate the obsolete stocks and reduce the release of POPs into the atmosphere. Large international projects will be needed for the final disposal of the stocks and it will take time to find enough support to develop and implement these projects. Today, however, the health and environmental risks remain a significant concern and something needs to be done about it.

Suzak A. Burial Site in Jalalabad Oblast is one of the Kyrgyz hot-spots that need direct intervention. The fencing material that once isolated the site from its surrounding has been taken away by locals. Illegal 'waste miners' come to the burial site to dig out the pesticides and sell these on the local market. They spill the pesticides, and pollution of the soil has been observed as a consequence of these activities.

Two years ago, 98 people fell ill and 35 were hospitalised after the consumption of the meat of poisoned cows that reportedly drank standing water from pits on the site. This year, a herd of 130 sheep died after drinking from the same pits. Milieukontakt is convinced that the combination of active stakeholder involvement and short-term risk reduction is the most appropriate way to avoid further accidents from happening at Suzak.

Milieukontakt, Tauw, Green Cross Switzerland, together with the Kyrgyz NGOs Ekois and Green Light joined forces to tackle the problems around the burial site. Cost effective and low tech measures to protect the environment and the villages close to the site are the key technical ingredients for this project. Awareness raising activities and a social medical intervention to support the village of the people who were poisoned will play an important role too. The initiative is financed by the GEF/UNDP Small Grants Programme in Kyrgyzstan, Green Cross Switzerland, OSCE and the Milieukontakt Private Donations Fund.

Keywords

Risk reduction around pesticides hot-spots; protection of vulnerable groups.

ARTICLE:

Obsolete pesticides in kyrgyzstan

Obsolete pesticides (OPs) pose a significant environmental and health threat in the Central Asian region, stemming from the overuse and mismanagement of pesticides during the Soviet era. Many of the chemicals of concern are now either deregistered locally, banned internationally because of their massive impacts on public health or found unusable because of their long-term storage leading to degradation. It is estimated that around half of the world's quantities of obsolete pesticides can be found in the former Soviet Union, and a large portion of it again in Central Asia because of the massive use in agriculture and cotton production.

It has been estimated that at least 250,000 tonnes of obsolete pesticides to date remain at tens of thousands of locations in the countries of the former Soviet Union[1]. In recent years, unprotected stocks of Persistent Organic Pollutants (POPs) have started to enter into the environment and will finally end up in the food chain. This process is globally well underway; scientists have found traces of POPs in the fat tissue of polar bears and Inuit in arctic regions where pesticides have never been used. Laboratory studies show that pesticides can cause health problems, such as birth defects, nerve damage, cancer, and other effects like infertility or genetic damages that might occur over a long period of time. This process is enhanced by the waste mining at the former depots of obsolete and POP pesticides, by people taking advantage of poor farmers buying these obsolete and POP pesticides for a lower price than the price of pesticides in the official market.

1 This number will probably grow massively in the years to come because of the addition of lindane to the chemicals forbidden by the Stockholm Convention, but also the search for illegally buried pesticides in the 60s and 70s.

Safer handling of hazardous substances and efforts to clean up past pollution will have important health and environmental benefits and contribute to a green economy that should be considered as a vital part of economic development of Kyrgyzstan and, therefore, a key long-term aim for the country. Sick population cannot contribute to a healthy economy.

The Kyrgyz government is aware of the serious health and environmental risks posed by obsolete pesticides and other unused hazardous chemicals, but as one of the less developed countries of Central Asia it lacks the legal, institutional and financial capacity to address the issue. Nevertheless, the country has signed all relevant international conventions addressing the issues of wastes management like the Stockholm, Basel and Rotterdam Convention.

To really tackle the problem, large projects financed by international donors are needed for collection, repackaging and disposal of the stocks in state of the art destruction facilities such as high temperature incineration plants in Western countries. To date, safe disposal facilities are not available in the region and until a modern disposal capacity has been established it will be necessary to export the hazardous stocks to Western Europe. Other proven disposal options but incineration are currently not available, though research is ongoing to have ultimately a larger "toolbox" available for disposal.

International initiatives to tackle the problem

Milieukontakt has been active in obsolete pesticides repackaging projects since 2005 when the Netherlands Ministry of Foreign Affairs and the Dutch Doen Foundation financed a project to repackage a total of around 400 tonnes of obsolete pesticides in Moldova, Georgia and Kyrgyzstan[2].

2. For the Kyrgyz part of this project Milieukontakt's representative office was responsible for the local management of the project. Today the former Milieukontakt office is operating as an independent NGO under the name Ekois. Together Milieukontakt and Ekois are involved in the implementation of several pesticides projects in Kyrgyzstan.

More recently, Milieukontakt has been involved as expert in a consortium with Tauw – European Consultants and Engineers, Witteveen+Bos – Consulting Engineers, the International HCH and Pesticides Association (IHPA) and Green Cross Switzerland. The consortium works (in different constitutions) on assignments of GEF/UNEP, The World Bank, UNDP and FAO in Egypt, in former Soviet Countries and on the Balkans, in Egypt and in Vietnam. Currently, the consortium (in different constitutions) is working in pesticides projects in Georgia, Vietnam (UNDP) and Armenia (OCSE).

Green Cross Switzerland has been active since 2008 on obsolete pesticides and is currently the Executing Agency of two GEF/UNEP-funded projects on capacity building on obsolete pesticides in the former Soviet Union and West Africa. Milieukontakt is one of the technical experts working in these projects in former Soviet republics. In recent years, policy makers working at international donor organisations have become more and more aware of the problem and a series of projects addressing the issue have been developed and are currently being implemented. Kyrgyz examples of such projects are as follows:

1.Obsolete Pesticides Technical Study *in the Kyrgyz Republic, the Republic of Tajikistan, and the Republic of Uzbekistan, 2009-2010,* Implemented by a consortium of Tauw, Witteveen+Bos. The International HCH and Pesticides Association (IHPA), Green Cross Switzerland and Milieukontakt International, Financed by the World Bank;

2. *Initiative for Pesticides and Pest Management in Central Asia and Turkey, 2010-1012,* Implemented by FAO, Financed by the FAO Turkish Partnership Programme;

3. *Demonstrating and Scaling Up Sustainable Alternatives to DDT for the Control of Vector Borne Diseases in Southern Caucasus and Central Asia* (Georgia, Kyrgyzstan, Tajikistan), Implemented by Green Cross Switzerland, WHO and Milieukontakt International, Financed by the GEF through UNEP;

4. *Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union.* Implemented by FAO, with partners IHPA, Green Cross Switzerland and Milieukontakt International, Financed by the EC.

The World Bank project mentioned above served as a preparatory study for the formulation of a large scale remediation project to dispose of, amongst others, the stocks collected at Suzak burial site in the Jalalabad District in Kyrgyzstan. Unfortunately, until now, the Kyrgyz government and partners from international donor organisations have not been able to agree on how to finance such a project.

The FAO Turkish project completed a full country obsolete pesticides inventory in Kyrgyzstan.

Within the frame of the GEF/ UNEP project, 60 tonnes of DDT will be repackaged and safeguarded in an intermediate collection centre.

The FAO EC project is an example of one of the largest projects that plans disposal of the collected stocks by means of destruction.

As mentioned above, larger international projects will be needed to really solve this pressing issue, and such projects will be formulated and implemented in the future. However, at the same time, there are people at risk today. Some of them are living close to hot spots of obsolete and POPs pesticides. Houses are built on top of buried stocks, former stores are privatised and used as food stores, market warehouses or living facilities, children are playing at broken down former storage sites and many of the vulnerable people (women and children) are exposed to unacceptable health risks.

Suzak burial site

Suzak burial site in Jalalabad province is one of the Kyrgyz hot-spots that needed direct intervention. There are two Suzak burial sites: Suzak A and Suzak B. Suzak B is fenced and more or less looked after by the local community that lives very near this site. But Suzak A, that reportedly contains 3000 tonnes of obsolete pesticides, is a real environmental and health hazard. The fencing material that once isolated the site from its surrounding has been taken away by locals and illegal "waste miners" come on a regular basis to the burial site and dig out the pesticides, in order to sell these on the local market as *Dust* (DDT). They spill the pesticides and pollution of the soil has been observed as a consequence of these activities. Another problem is local herds of sheep and cattle passing by the site. Two years ago, 98 people fell ill, and 35 were hospitalised after the consumption of the meat of poisoned cows that reportedly drank standing water from pits on the site.

Milieukontakt International, Tauw, Green Cross Switzerland, together with the Kyrgyz NGOs Ekois and Green Light joined forces for risk reducing remediation of the site in early 2013. Awareness raising activities and a social medical intervention to support the village of the people who were poisoned will play an important role in planned activities. The initiative is financed by the GEF/UNDP Small Grants Programme in Kyrgyzstan, Green Cross Switzerland, OSCE and the Milieukontakt Private Donations Fund.

In the frame of the above mentioned World Bank project, an inventory of the Suzak A site was made. Furthermore, a strategy was developed to eliminate the direct risks on the short term and contain the remaining risks on the mid and long term. In the Goups at Risk Project, the aim is to build on this strategy, and mainly focus on the elimination of the direct risks on the short term. Awareness rising among the groups at risk residing in the villages around the site will be a key intervention to avoid future poisoning of herds and people. Assistance to the medical facilities in the village where people fell ill as a result of eating the poisoned meat is planned.

A strong benefit from public participation and stakeholder involvement

During a first mission in July 2013, it turned out that there is strong commitment to solve the health and environmental problems from the burial site in Jalal Abad Oblast. A Memorandum of Understanding, designed as a Go / No Go decision making instrument to measure the commitment of local government, was signed by all relevant stakeholders even before the mission. Moreover, the first steps of technical implementation were already taken. In September, a new fence was build around the site. At the same time, the open pits were covered and a guard house was build. In exchange for the right to farm almond nuts neighboring the site, a guard that lives there with his family and keeps a close watch on everything that happens around Suzak A.These early results give a good perspective for further project implementation, and high hopes that the project results will be reached in efficient cooperation with local government and NGOs.

Public participation and active stakeholder involvement is highly welcomed by international funding organizations. In many projects, implementing partners incorporate elements of participation and stakeholder involvement in the project design. Real implementation, however, can be difficult because of many reasons. In the Central Asian region it is not always clear to local authorities that they might benefit from participation and stakeholder involvement for instance. Furthermore, a strong focus on the technical side of problem resolution can be encountered. Last but not least, there is no strong tradition of public disclosure and participation to build on.

The start of this small project (with a modest budget of 100.000 USD), right from the start, shows exceptional results. Key factors for achieving these results can be found in the following circumstances:

1. There was an urgent need to solve pressing problems (people and animals were poisoned)

2. Public administration is active and really willing to solve the problems (a new dynamic generation of local governmental officials and politicians took over from the older more bureaucratic generation);

3. Different organizations with different expertise are able to cooperate in a multidisciplinary project;

4. Finances were secured by a well-organized lobby to advocate the need for urgent action; and

5. All stakeholders agreed to compromise and carry out a kind of postponed maintenance of the burial site instead of implementing the final long-term solution for the problem.

There are more sites in the region where there is an urgent need to solve pressing problems, and there are more groups at risk from obsolete pesticides in Central Asia. Based on the experience of this project, Milieukontakt and consortium partners Tauw and Green Cross Switzerland are planning to form alliances with local NGOs, the government and funding agencies to lower the risks around these hot spots in the short term.

The larger international projects will then be able to provide a final solution in the middle or longer term and take the pesticides away for disposal.

PESTICIDES AND GENERAL PUBLIC IN CIS

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Abstract

The world is becoming more complicated each year. The number of people grows, just as their needs and demands surge. High technology creates new materials that enter everyday life. However, high-tech solutions demand high level of culture both from manufacturers and consumers. But how can it be achieved? The former Soviet Union countries now go through transitional processes. High technologies compete with primitive ones, collective farms - with private, quality – with low price. Active and, at times, aggressive advertising confuses people. Eventually, general public, i.e. consumers, are more than perplexed. How to figure out this complicated world on your own?

There exist different approaches to public awareness: TV and radio programs, newspaper articles, information brochures distributed at public places, etc. Green Cross Belarus has been working for 20 years with raising public awareness in the field of health and safety. The most effective, from our point of view, is targeted work with population that preferably starts with children and families. Firstly, because young people are more open to new knowledge as well as more flexible. Secondly, children easily introduce new information into family life and spread it among their peers and neighbors. On the other hand, parents are more cautious and pay more attention to the issues of safety. Over the last few years, we have prepared and published 8 issues of a brochure "How to raise a healthy child", a brochure on healthy and safe nutrition, introductory school course "Me and Pesticides" and a range of other materials. At the moment, in partnership with the Food and Agricultural Organization of the UN, we are preparing an adapted for the post-Soviet area Russian-language version of the guidelines "Schoolgarden". This whole kit of educational materials should help to gradually involve all population categories: from infants to schoolchildren, from students to adults. Also, it is very important how the process of knowledge transmission goes. From our point of view, it is best implemented through a combination of theoretical and practical activities.

This way, participants will not only get but also secure their new knowledge.

Keywords

Pesticides, obsolete pesticides, POP, DDT, public awareness raising, health, risk, safety, garden, danger, education, training, Belarus, former Soviet Union, children, parents, families.

Introduction

Pesticide usage in agriculture is becoming more and more widespread. It is clear that this tendency is connected with further urbanization of the population and, as a consequence, with increasing demand for cheap food production by means of intensive agricultural technologies. Nowadays, chemical corporations are actively working on new generations of safer pesticides, which do not have long-term implications. However, any such chemicals cannot be absolutely safe and demand adequate culture of usage. Furthermore, nobody knows all potential consequences of newly developed pesticides on health state and environment, which could appear in many years.

Public awareness in CIS region

Any technologies, either nuclear or chemical, demand appropriate culture among specialists as well as among general public. Otherwise, consequences may have grave implications on local, regional or international scale. As an example to this may serve the Chernobyl catastrophe, the tragedy in Bhopal, tens of thousands of tons of chemical weapons at the bottom of the Baltic Sea or the latest accident in Fukushima. The consequences of the last one are (and will be) much more significant than it was foreseen in 2011.

Therefore, actively participating in this process developed countries create a new consumer culture for the direct users working in agriculture as well as for the general public who consume a wide range of food, produced by means of new technologies. As experience shows, it allows to considerably decrease risks though still does not guarantee full security.

After the collapse of the Soviet Union, a range of new countries, which have to individually create their own system of technologies and their security, emerged. Though new countries have a certain technological heritage from the previous system, they most often do not have as strong science and technology base as their predecessor's. Moreover, the majority of these countries are in a lingering economic crisis, which does not allow spending adequate funds on safety assurance. The crisis stimulates interest in cheap technologies and cheap products.

Vital problem for CIS and other developing countries is associated with the quality of food, which is rapidly going from worse to bad. The majority of supermarkets seduce wide public with not expensive and cheap food, which is not natural and/or not healthy. Lack of knowledge and experience in healthy and safe nutrition among ordinary people causes serious problems for their health state and even more long term consequences for their children and grandchildren.

MODULE 1: international drawing contest "man on the land"

The Contest rules and conditions will be distributed among the project countries through different ways of communication. As soon as all the interested parties are informed of the Contest, its terms and conditions, they will work on the drawings respecting those conditions and send them in for the evaluation. All the works submitted to the Contest will be registered, sorted and prepared for consideration by professional jury. It can be expected that around 6,000 works will be submitted to the Contest. The international jury board consisting of art educators and experts will evaluate all the submitted works and choose the best ones for awarding and exhibition. All the Contest winners will, in person, through their schools/studious or by post, receive diplomas purposefully developed for the contest. A number of winners selected by Jury will get special awards to stimulate them for further self-development. A special award ceremony with performance, where winners will get their awards and meet each other, is being planned. Their teachers, parents, guests, diplomats and mass media will be invited to the ceremony. An art exposition, which will be exhibited in Minsk and further on used as a transportable exposition in other project countries and various public events (including Steering Committee Meetings of the GCP/RER/040/EC program), will be formed from the winning works. All the winning works will be digitized in high resolution so that the Program will benefit from produced visual materials. The following products will be developed and, as a result of the Contest run, produced the following:

1. A video film, representing the Contest "Man on the Land" and addressing topics and issues of the Program;
2. Winning works image data base, which will be used for the purposes of the visualisation of the Program.
3. Transportable exposition that will be presented in project countries as well as at various public events;
4. Desk and wall calendars for 2014 and 2015, which will be based on the Contest drawings and will have and the English and Russian versions; postcards that can be used for the communication purposes of the Program (e.g. sending out holiday greetings, networking, informing about planned events and keeping close connections with stakeholders);
5. A presentation CD of the Contest that will have the electronic database of drawings and the Contest video film on it.

MODULE 2: pilot education course for schoolchildren

Nowadays, there are 6,500 tons of obsolete pesticides in burial sites in Belarus. Thousands tones of new pesticides, which are being actively used in agriculture are being bought each year.

To increase public awareness of the general public, "Green Cross Belarus" developed a pilot course "Pesticides and me" for schoolchildren. The course consists of 7 lessons with senior schoolchildren and is oriented at ecology, chemistry, biology and geography teachers. For it was developed a methodological kit:

7 PowerPoint presentations, a manual with an attachment, tests and questionnaires.

The material is divided into 4 sections:

1. Pesticides – allies and enemies: a historical overview of chemical means usage alongside with the definition of POPs and important normative documents and modern standards for pesticide production and storage.
2. Pesticide classification: a flow chart of the most widespread types of pesticide classifications on the basis of their purpose, dates, action mechanisms, etc.
3. Pesticides in the environment: different ways of pesticide penetration into the environment, migration schemes and pesticide influence on the organic world, alternatives to pesticide usage.
4. The influence of pesticides on human health. In this chapter, attention is given to bioaccumulation of pesticides in human body, influence of pesticides on human beings (direct and indirect), study of pesticide substances, major factors of pathologic changes under the influence of minor pesticide doses, preventive measures and reduction of pesticide negative influence on health.

Why have we chosen schoolchildren as our target group? This was done because they are most open to new information and also try to apply new knowledge. Out of all existing systems of spreading knowledge, school is undoubtedly the best one. On the other hand, this course teaches youth to think and act independently, which is very important in the modern situation, especially in the CIS countries. Schoolchildren also bring their knowledge to the families and try to embed them their usually trying to overcome conservatism of their parents. In fact, the older a person gets, the more conservative he becomes.

Also the idea of the course is to include students of the major universities into active awareness raising process. New knowledge comes into existence very rapidly, and it is necessary to be able to reform your self and take it to practical application.

Before approbation, an inception workshop, in which lecturers from universities, school teachers and a group of senior schoolchildren took part, was held. During the workshop, several open lessons were held and reviewed by all participating parties. After that, the course went through approbation in 4 schools of Belarus during one school year as a part of extracurricular activities. The children spread questionnaires among adult population of their localities. The results showed that unfortunately the knowledge of adults, including specialists, is extremely low in this field. Moreover, concern about the pesticide usage among regular people is also low and exists in people's mind rather than in everyday life. With the help of this course, we managed to increase awareness in localities where the course was used for approbation. Moreover, extremely important issues of people's motivation to ensure their safety and health protection of their families were raised. It is interesting that the majority of population believe that their health condition depends fully on the sate of national health care system: clinics, hospitals, doctors, medicine, but not a bit on their own behavior, level of knowledge and culture of life, nutrition and life style.

MODULE 3: education course for schoolchildren "schoolgarden"

"Schoolgarden" education course for schoolchildren was developed by the Food and Agriculture Organisation of the United Nations for developing countries with the focus on Africa. At the same time, it contains basic knowledge and helpful information, which could be successfully used in CIS countries. Thus, Green Cross Belarus will arrange translation of available education kit into Russian and arrange its adaptation for CIS region. The work is planned in the framework of FAO-EC Project entitled "Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union" for 2014. Then, the results will be spread out among all project partners in CIS.

MODULE 4: preliminary education of young parents "How to raise a healthy child"

Food is one of key factors influencing human organism. Coming from outside, the food is transformed into a number of internal ingredients taking part in all vital life processes. Food serves as a means to support life, growth, development and workability of human beings. Rational nutrition is the nutrition which fits the needs of human organism and is adequate to its energy consumption. The main principles of rational nutrition combine balancing of needs and effective regime. To develop and realize rational nutrition, we have to determine needs of organism in main food substances taking into account age, profession and climate as well as social and living conditions. The man usually needs

7 main food components (arranged by significance): water, proteins, carbohydrates, fat, cellulose, vitamins and microelements. The world statistics calculated that 70% of deaths are caused by cardio-vascular disorders, cancer and insults; 50% of those happening as a result of poor nutrition. There are many harmful and unnecessary substances in our organisms while there is lack of many needed substances.

Nutrition style is coming from family. Thus, Green Cross Belarus has developed a set of education brochures on "How to raise a healthy child". One of the most important of those brochures is focused on "Healthy nutrition". It provides young parents with basic knowledge about nutrition and gives advice on how to arrange healthy nutrition in the ordinary life conditions.

Conclusion

New technologies and materials are the sign and reality of our time. Nowadays, almost every inhabitant of our planet is their consumer. Modern materials and food, technologies and rules of usage demand a competent and careful attitude to reach the desired outcome and not to inflict any harm, i.e. they require high consumer culture. While in developed countries, much effort is devoted to creating consumer culture, the process of such education in developing countries is usually happening on its own through trial and error of consumers. Such approach has the potential to be dangerous to the population of these countries. Unfortunately, the majority of foods nowadays are being produced with the aid of intensive agricultural technologies, i.e. with the active application of chemicals. For the majority of population, the decisive factor is the price, not the quality.

The question of human safety in this case for environment and food production becomes more and more acute especially for the population of developing countries. Those who develop, and those who produce and spread pesticides and other new chemicals need to carry not only moral but also practical responsibility through active participation in the consumer culture dissemination.

With these several ideas, we attempt to step by step raise human awareness of the issue of food security, pesticides and their safe application among the wide public. We suggest spreading such knowledge through an existing system of school education and extra education of parents, primarily, mothers. An emphasis is given to the link between generations: parents – children as well as between teachers – schoolchildren – families. They should become an important path along which awareness and new culture (first of all the culture of rational nutrition and safety) will spread in the society.

EDUCATION AND AWARNESS RAISING: A NEED AND A MUST

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Organized by Milieukontakt International
and Green Cross Belarus

Aziz Umarbaev from the Kyrgyz NGO Green Light presenting the NGO initiative to remediate Suzak A. obsolete and POPs pesticide burial site in Jalal Abad district

During the 12th HCH & Pesticides Forum, a separate session on education and awareness raising in obsolete and POPs pesticides projects was organized by Milieukontakt International and Green Cross Belarus. Three presentations introduced education and awareness raising activities implemented within the international obsolete and POPs projects:

Green Cross Belarus does a lot to involve children and teachers in awareness raising activities in its projects and, in this way, spreads the message that people should stay away from the dangerous chemical stocks among the entire population. Vladimir Shevtsov, the director of the organization, showed some impressive results from an international contest of drawings and paintings that illustrate the health and environmental threats from obsolete and POPs pesticides.

Olga Tsygulyeva from the Ukrainian organization *Mama 86* drew attention to the fact that the organization was able to find extra stocks of unidentified obsolete stocks of (POPs) pesticides in a project completed in 2010 in cooperation with Milieukontakt through an intensive awareness raising campaign. By talking intensively to different groups of people in villages, some additional and previously unknown stocks of buried pesticides were uncovered in the project area.

Milieukontakt, along with the *Green Light* Kyrgyz organization, gave a presentation on a small project in Kyrgyzstan, where obsolete and POPs pesticides from a burial site recently poisoned people and cattle. In line with the agreements under the Stockholm Convention, Kyrgyzstan has to dispose of the estimated 3000 tonnes of obsolete and POPs pesticides at this burial site, but finding the resources to realize such a final solution will take years. Through active awareness raising, a consortium of international environmental NGOs and an environmental consultancy firm have been able to secure the modest project financing from different sources needed to minimize the immediate environmental and health risks from the burial site, leaving the task to dispose of the stocks a goal for longer term planning. The project is a good example of how to achieve important results with a very modest project budget.

As a reaction to the presentations, the participants concluded that awareness raising campaigns and stakeholder involvement efforts need to be organized very carefully. If awareness raising does not contain the right message formulated in the right way, it can even have a counterproductive effect. If organized and prepared properly, awareness raising is a vital part of any project on POPs and obsolete pesticides and ensures that problems do not occur again.

In the experience of the participants of the session, many international projects do have some elements of public participation, but often only as an obligatory part of the project. It was concluded that public participation, education and awareness raising are very important but need to be organized as a structural component of every project. There is, however, little tradition of public disclosure and participation in the region of former Soviet republics and implementation can be difficult and will require a lot of efforts and time.

FIELD TRIP EXPERIECE

FIELD TRIP ORGANIZED BY SI GROUP: IMPRESSIONS 2ND DAY

Photo 1: Group arrival at demonstration site
Photo 2: Close up of PPE
Photo 3: Preparation repackaging works

WORKSHOP: BIOAVAILABILITY

RESULTS OF BIOMEDIATION EXPERIMENTS FOR POPs POLLUTED SITES: (CASE STUDY: THE REPUBLIC OF MOLDOVA)

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Abstract

The important pollution sources for the environment in the Republic of Moldova are old pesticides storages. The inventory of pesticide polluted site showed a huge number of high polluted sites (near 250) and large pollution spectrum. The polluted sites with high risk for environment and public health need effective remediation actions. One of the perspective technologies is a bioremediation. Some demonstration projects on the bioremediation technologies of POPs polluted soils have been tested in the Republic of Moldova. DARAMEND technology and phytoremediation have been studied for the perspective implementation in practice. The aim of this article is to review the obtained results and recommend the elaboration for the implementation of bioremediation technology for old pesticide polluted sites.

Keywords

Soil pollution, POPs, bioremediation, phytoremediation.

Introduction

The inventory of old pesticide storages in Moldova executed by the Ministry of Environment and the World Bank showed that a large quantity of polluted sites (1589) remain after the repacking and evacuation project. Nearly 16 % of old storages have POPs pollution more 50,0 mg/kg in soil (254 sites) [2,3,4]. The pollution spectrum is complex and consists of five POPs groups (DDTs, HCHs, Toxaphene, Chlordane, and Heptachlor), Trifluraline, Triazines, PAHs, Metolachlor and industrial chemicals, such as PCBs. They are synthetic chemical substances with high toxic characteristics to wildlife and humans.

The remediation actions are needed for highly polluted sites for the mitigation of risks for the environment and human health. Two bioremediation technologies (phytoremediation and DARAMEND) were tested in the condition of the Republic of Moldova last time [2,5]. These technologies are bioremediation, which are relatively new and potentially cost-effective remediation options for the remediation of POP-contaminated sites [1,6-14]. In-situ options are more economically attractive compared with ex-situ options, which involve excavation and storage of excavated material before transporting the same to ex-situ remediation facilities. Every remediation project should to be designed to take into consideration such aspects like soil conditions, volume of polluted soil, pollution spectrum, construction remains, groundwater level, and soil filtration properties.

This article presents the evaluation of the results of the implementation of phyto- and bioremediation technologies for the remediation of POPs polluted sites in Moldova. Phytoremediation is the name given to a set of technologies that use different plants as a containment, destruction, or an extraction technique. Phytoremediation has been receiving attention as results from field trials indicate potential cost savings compared to conventional treatments that require soil excavation and transportation (USEPA, 2000). The general approaches of this technology were used for the design of the phytoremediation experiment. The phytoremediation study of POPs polluted sites showed good extraction of DDTs, HCHs, PCBs, and other chlororganic compounds from the soil by zucchini and pumpkin plants [1,8 and others]. The design of a phytoremediation system varies according to the contaminants, conditions at the site, level of cleanup required, and plants used. A thorough site characterization should provide the needed data to design any type of remediation system. The source of the pollution may need to be removed if phytoremediation is the chosen technology for remediation.

Another demonstration project is based on in-situ bioremediation by land farming with addition of amendments - The DARAMEND® process by ADVENTUS [6]. Sequential cycles of anaerobic (no oxygen, strongly reducing conditions) and aerobic (oxygen present) conditions enhance reductive dechlorination of chlorinated organics.

1.Materials and methods

Based on previous investigation of POPs polluted sites, two locations were selected for a more detailed investigation.

The site location is illustrated in Figure 1.

Figure 1: The locations of polluted sites where bioremediation study was carried out

Selected sites were sampled for more detailed investigation. Based on these results, one site (Balceana) was selected for the phytoremediation trial and other (Bujor) - for bioremediation. Soil samples were taken from top soil, 0 - 20 cm. The samples were air-dried under laboratory conditions of about 20°C, then sieved through a 1.0 mm screen, and homogenized. Plant samples were dried in a drying box at 60°C. Ten gram subsamples of soil and 1 – 2 g subsamples of plant tissue were extracted with duplicates using a Soxhlet system for 14 hours. The solvent was a mixture of hexane and dichloromethane in the proportion 1:1 with a total volume of 150 ml.

Extracts were concentrated to 1 ml and cleaned by silica column chromatography and by solid phase extraction silica cartridges. All analytical determinations of POPs content in soil, plants and other environmental media were made by gas chromatography Agilent 6890 equipped with micro-ECD detector and Agilent 6890 with mass detector 5793 (GC/MS) using USEPA method Method 8081A. The detection limit was 0.01 mg/kg for DDTs, aldrin, dieldrin, endrin, and chlordane. The detection limit was 0.005 mg/kg for HCHs, hexachlorbenzene, and heptachlor In this paper, DDTs refers to the sum of concentrations of all DDT metabolites (DDT, DDE, DDD), and HCHs refers to the sum of concentrations of HCH isomers (α-, β-, and γ-HCH). Each sample was extracted and analyzed twice (two chromatograms). A detailed methodology of both experiments was presented in earlier publication [2,3,5].

1.1 Phytoremediation

The Balceana site was selected for the phytoremediation field experiment based on two primary considerations: 1) a sufficiently large cultivatable area surrounding the site was polluted by obsolete pesticides, primarily by DDTs, and 2) there was a good potential for local community involvement in planning and conducting the study. Situated in the lower Lapusna River Valley, the soil at the Balceana site is classified as a "chernozem" with a pH of 7.6 and an organic carbon content of 3.2%. The depth to groundwater is 3.0 – 3.5 m.

The experimental plot was established using typical agricultural techniques for soil preparation and planting. No additional soil treatment or soil amendment were used. The field experiment was designed using five vegetation treatments on plots planted with the following plant species: maize (Zea mays L.), zucchini (Cucurbita pepo L. var. pepo), pumpkin (C. pepo L. var. pepo), carrot (Daucus carota L.), and sorghum (Sorghum bicolor L. Moench).

1.2 Bioremediation

This experiment was based on in-situ bioremediation by land farming with the addition of amendments - DARAMEND® process by ADVENTUS [6]. Sequential cycles of anaerobic (no oxygen, strongly reducing conditions) and aerobic (oxygen present) conditions enhance reductive dechlorination of chlorinated organics. This solid-phase bioremediation technology employs organic and inorganic amendments to stimulate the decomposition of organic contaminants by indigenous soil microorganisms.

The contaminated building waste and soil adjacent to the warehouse have been isolated in an on-site waste deposit with bottom and top protective liners (membrane), and secured by a surrounding protective bank and a top layer of clean soil. The total volume of waste amounted to 1.550 m^3. The remaining contaminated soil is treated by in-situ bioremediation by land farming with addition of amendments (nutrient organic material as a microbiological carbon source, and reduced iron – DARAMEND© process by ADVENTUS) [5,6].

5 - 10 cycles of treatment have been applied to the top soil at the demonstration site. The soil was allowed to rest for at least 5 days during the anaerobic (reductive) phase. Reducing condition need to be maintained during this period to induce reductive dechlorination of DDTs and HCHs. It can be achieved by ensuring that the moisture content is high by the covering the wet soil with black plastic sheeting. The soil was tilled during the anaerobic (reductive phase) to provide oxygen, and then allowed to rest without any covering or addition of water for at least two days during the aerobic phase. Two phases (anaerobic and aerobic) were repeated for each treatment cycle. Soil sampling was repeated after 5 and 7 cycles.

To document the treatment, a sampling and analytical program based on statistical tests using the "Duplicate Method" to quantify contaminant heterogeneity during soil sampling in soil was applied, and this method demonstrated a relatively large degree of soil contaminant heterogeneity within a short distance.

2. Results and discussion

2.1 Pollution level

Balceana site. The site plan and spatial distribution of DDTs and HCHs are illustrated in Figure 2.

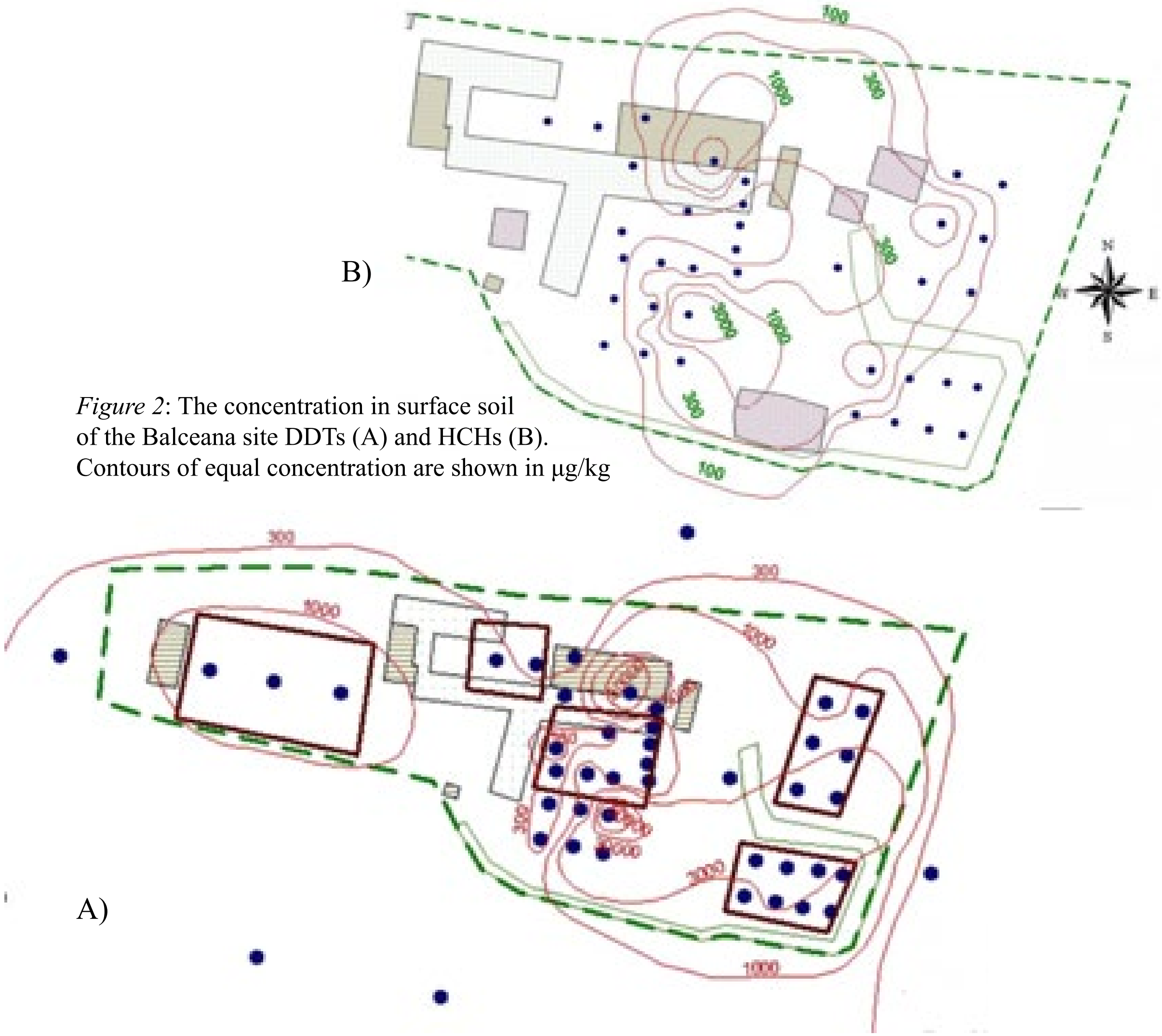

Figure 2: The concentration in surface soil of the Balceana site DDTs (A) and HCHs (B). Contours of equal concentration are shown in µg/kg

All territory surrounding the Balceana site is highly polluted by DDTs with concentrations more than 10 times exceeding the 0.10 mg/kg MAC. Two anomalous samples were identified with unusually high pesticide concentrations greater than 50,0 mg/kg. Higher soil concentrations of DDTs were observed in the lower part of the site. The pollution level of HCHs is lower in comparison with DDTs. In the two anomalous samples, high HCHs correlated with the DDTs results. The principal problem with this site is the contamination by DDTs.

The results, which provide the information to estimate the approximate area and volume of polluted soil, are illustrated in Table 1 below. The mass of contaminated soil with DDTs greater than 50,000 µg/kg is estimated at 41.3 tons. This soil would be considered toxic waste. The estimated mass of soil with the DDTs in the interval 30,000 – 50,000 µg/kg is 141.7 tons. Other intervals with lower concentrations have greater volume and are also dangerous for the environment and public health. The area at the Balceana site with a pollution level greater than the MAC for DDTs is larger than 15.2 hectares.

Table 1: Spatial distribution for concentrations of total DDTs and estimated volume of polluted soil at Balceana study area

DDTs pollution mg/kg	Area m^2	Area %	Polluted soil volume, m^3, 0.5 m depth	Weight, tons to 0.5 m depth*
0.1 – 0.3	14,982	9.8	7491	11986
0.3 – 1.0	114,320	75.0	57160	91456
1.0 – 3.0	16,994	11.2	8497	13595
3.0 – 10.0	4,857	329	2428	3885
10.0 – 30.0	1,054	079	527	843
30.0 – 50.0	177	0.1	89	141
> 50.0	52	0.03	26	41
Total	152,435	100.0		

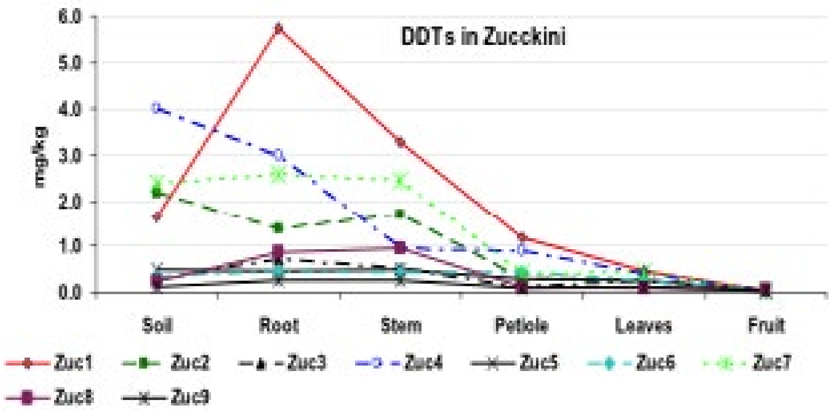

Figure 3: Accumulation of DDTs in zucchini by different plant parts. Each line represents one of nine zucchini plants that were harvested.

Bujor site. Bujor site showed a high pollution level of POPs in the central part of the storehouse territory. Soil samples had very high concentrations of DDTs, which exceed 50.0 mg/kg. The spatial distribution of pesticide contamination covers a smaller area in comparison with the Balceana site. The contaminated soil is primarily located within the foundation of the Bujor site, and all area surrounding the site is covered by natural vegetation that minimizes pesticide migration by movement of soil, water and air. This site potential for phytoremediation is limited since the principal pollution is located within the construction foundation in relatively high concentration.

This site was divided into 5 treatment areas and a control area. Areas 1 – 4 (total area of 210 m^2) and control area (total area of 25 m^2). Two complex soil samples were taken from each area (each complex sample was composed of 5 random soil samples from the depth of 10 – 20 cm.

2.2 Results of phytoremediation experiment

Only two plants showed a good extraction capacity for DDTs and HCHs: zucchini (C. pepo L. var. pepo) and pumpkin (C. pepo L. var. pepo). Zucchini plants were grown in three of the plots at studied site. Each plot had different initial soil pesticide concentrations with DDTs in the rhizosphere varying from 0.12 to 4.02 mg/kg. A total of nine zucchini plants were harvested.

Zucchini accumulated a high level of DDTs and the amount of accumulation depended on pesticide concentration in the soil near each plant (Figure 3). Harvested plants were divided into roots, stems, petioles, leaves and fruit.

Total accumulation of DDTs decreased from the roots to the fruit. Relatively high levels of accumulation were found in the roots and stems. Accumulation in the stem is the most important result for phytoremediation potential because it indicates translocation of DDTs from the roots to aboveground stems that are most easily harvested and removed from the site.

The Bioaccumulation Factor (BAF), an important indicator of phytoremediation potential, is calculated as the ratio of pesticide concentration in plant parts to pesticide concentration in the soil. BAF values for all zucchini plants fluctuated from 0.6 to 4.0 for roots and from 0.3 to 4.3 for stems (see Figure 4).

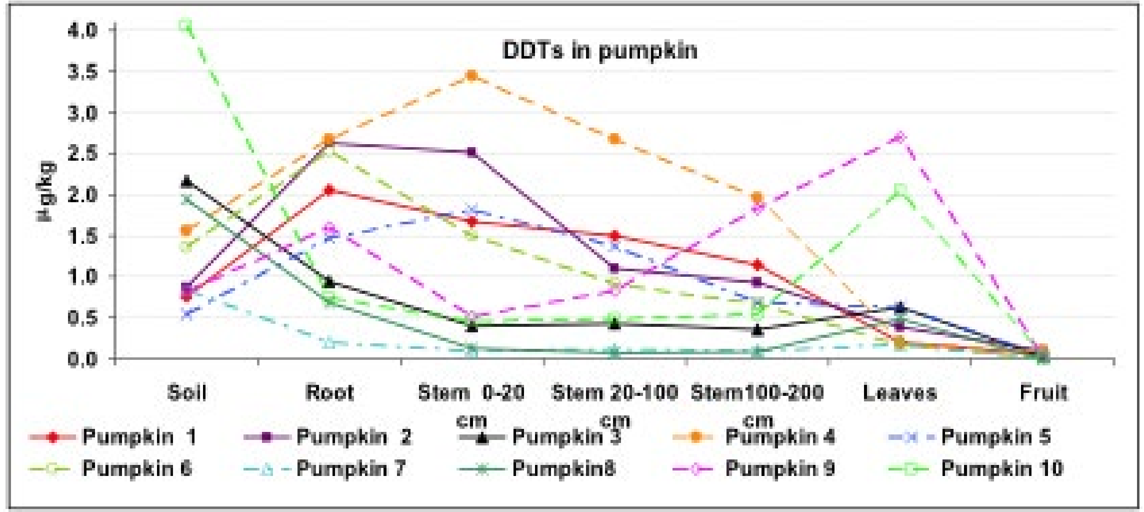

Figure 5: Accumulation of DDTs in different plant tissues of pumpkin. Each line represents results from one of ten harvested plants.

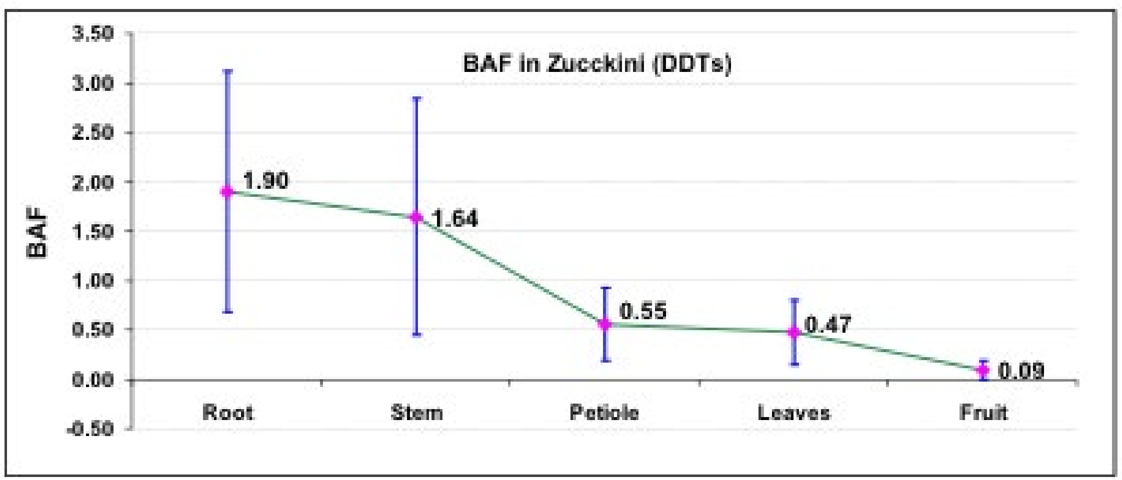

Figure 4: Bioaccumulation factor for DDTs for different tissues of zucchini plants: mean and standard deviation of BAF.

Other plant parts showed lower bioaccumulation potential. A BAF greater than 1.0 shows the evidence of accumulation potential since the concentration in plant tissue is greater than the concentration in soil. The BAF for roots and stems averaged over 1.0 with means of 1.90 and 1.64, respectively.

The pumpkin vegetation treatment also showed good phytoextraction capacity. Six plants showing higher pesticide concentrations in the roots and stems compared to the soil. Four plants showed lower DDTs concentrations in roots and stems

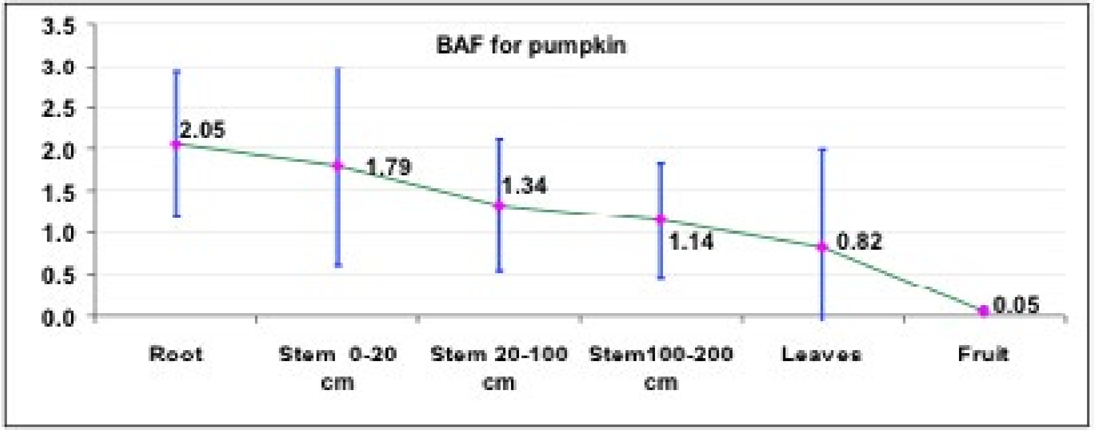

Figure 6: Mean and standard deviation of the bioaccumulation factor for DDTs in different plant tissues from ten pumpkin plants.

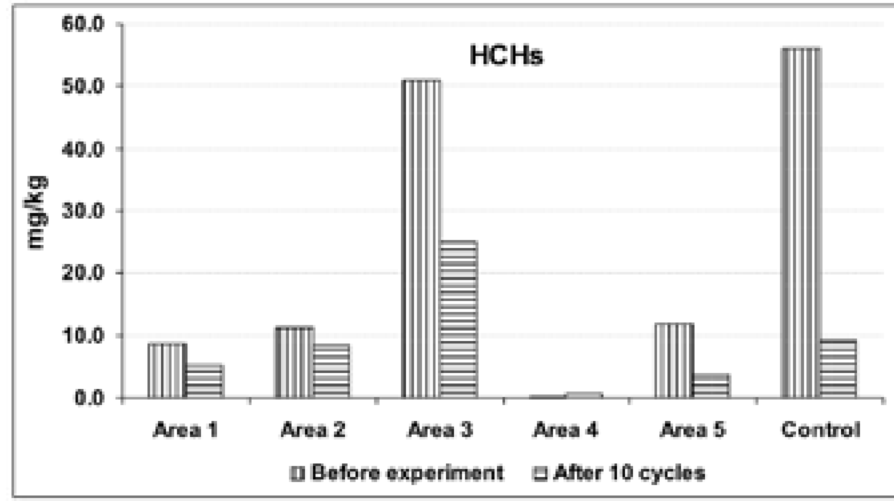

Figure 7: HCHs concentration in soil before and after bioremediation experiment

compared to soil (Figure 5). The pumpkin biomass was greater than zucchini biomass. Pumpkin stems reached up to 3 – 5 m in length. The stems were separated into groups by the distance from plant roots. The stems harvested near the plant roots showed higher concentrations of DDTs compared to stems farther from plant roots. Bioaccumulation factors for DDTs in plant tissues were very similar to observations for zucchini (Figure 6). The range of BAF for stem concentration varied from 0.45 to 3.01. The average decreased from 2.05 for roots to 0.82 for leaves. The fruit accumulate much lower amounts of DDTs with BAF 0.05. The weighted average value of BAF for zucchini was 1.10, and for pumpkin-1.42.

2.3 Results of bioremediation experiment

The principal soil pollution at this site is DDTs and HCHs isomers. The bioremediation of polluted soil leads to the decreasing of total POPs concentration in soil in the interval from 28 to 68% for HCHs and from 41 to 95 % for DDTs (Figures 7 and 8). The same decrease is indicated for Heptachlor (41 – 82 %). The principal isomer for DDTs group is p-p-DDE and beta-HCH for HCHs. The individual results for composite samples from each area show a large variation, which is attributable to the field sampling variation. The statistical analysis demonstrated that the sampling uncertainly due to contaminant

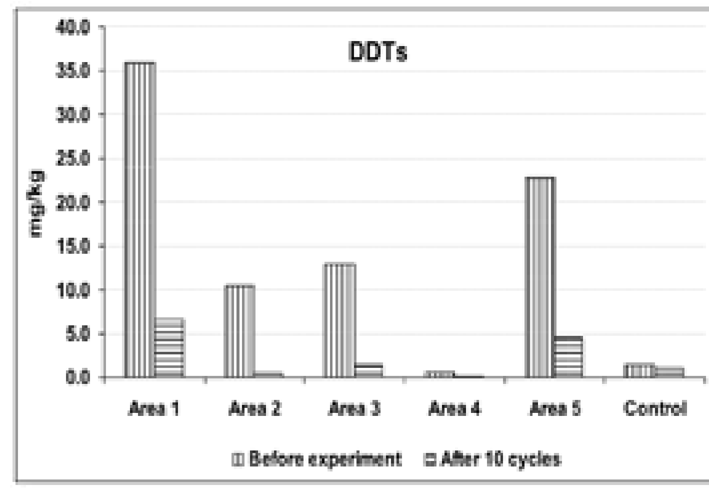

Figure 8: DDTs concentration in soil before and after bioremediation experiment

heterogeneity in the soil is much greater than the uncertainly due to analytical sampling and analysis.

The average POPs destruction after 10 cycles of treatment showed a higher level in comparison with 5 cycle treatment. The results after 10 cycles of treatment demonstrate appreciable reduction for DDTs (from 16,3 to 2,6 mg/kg, 82%), HCHc (from 16,7 to 9,7 mg/kg, 42%), and Heptachlor (from 6,3 to 1,5 mg/kg, 76%). The destruction of studied pesticides is indicated also for control area. The HCHs concentration is going down to 84 %, and for DDTs – to 34 %.

The microbiological parameters of soil community are growing by the experiment in all areas including and control site. The increase of the soil microbial activity is caused by the addition of organic substrates and can contribute to the degradation of POPs pollutant in some soils. This effect is a basic concept of DARAMEND biotechnology. This technology activates indigenous soil microorganisms for the acceleration of POPs destruction by co-metabolism. Sequential cycles of anaerobic (no oxygen, strongly reducing conditions) and aerobic (oxygen present) conditions enhance the degradation of chlorinated organics and are generated by mechanical tillage and application of DARAMEND® granulate followed by irrigation to regulate oxygen availability and moisture content.

The microbial biomass is raising up to 1,4 times, heterotrophic bacteria – 3,8 times, actinomycetes – 2,6 times, and fungi – 2,5 times in comparison with control plot. The microbiological indexes exceed regional values in local soils and were growing by the treatment process. We can simultaneously observe the acceleration of organic carbon value on test plot from 1.9 to 3,3 % in connection with DARAMEND application.

We can also indicate a relative high level of microbiological indexes in polluted soils from the investigated site, which demonstrates a presence of the active indigenous soil microorganisms. Thereby, we can explain a significant POPs destruction on control plot, without DARAMEND application: 85 % for HCHs and 34% for DDTs.

Conclusion

Phytoremediation can be used for the remediation of polluted sites; however, it needs to be designed based on local conditions. Investigators must take into consideration all advantages and limitations of this technology. This is important for plant selection, design of optimal plant density, and appropriate soil fertilization for the improvement of BAFs.

Time required for agricultural phytoremediation might be long and require utilization of complex approaches like biotechnology for the highest polluted soils.

The in-situ bioremediation by land farming could be implemented in Moldova and the results after 10 cycles of treatment demonstrate appreciable POPs reduction. Soil microbiological activity is growing by this bioremediation process, which can lead to the abovementioned destruction process. The soil contamination is still above the Moldovan soil quality criteria for agricultural land, but the risks associated with contaminated soil have been greatly reduced.

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REVISION OF THE GERMAN STANDARD DIN 19738, CHALLENGE AND FIRST RESULTS OF THE EXPERIMENTAL APPROACH

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Abstract
In Germany, an in vitro method simulating human gastrointestinal conditions was developed in 2004 in order to provide an estimate of contaminant bioaccessibility: DIN 19738 (2004-07). This existing DIN standard is currently under revision on behalf of the German Federal Environmental Agency (UBA) in order to harmonize and optimise the current standard procedure to provide conservative but reasonable estimates.

As the first step, the experimental key parameters were identified, which had mayor impact on the results of the method: the application (or replacement) of milk powder, use of enzymes and duration of the intestine phase. Soils contaminated with polycyclic aromatic hydrocarbons (PAHs), including Benzo[a]pyrene (BaP) as the relevant pollutant and soils contaminated with cadmium (Cd), lead (Pb) and arsenic (As) were used in the experimental phase.

Initial results of the research demonstrate the impact of the application of whole milk powder or concentrated milk as food surrogates on the bioaccessibility of contaminants. The use of enzymes turns out to be a further important factor for digesting of those food surrogates and thus, for the results of the experiments.

Keywords
Bioaccessibility, DIN 19738, in vitro method, polycyclic aromatic hydrocarbons, Benzo[a]pyrene, cadmium, lead, arsenic.

Introduction
Incidental soil ingestion is an important exposure pathway for assessing public health risks associated with contaminated soils. In Germany, an in vitro method simulating the human gastrointestinal conditions was developed in 2004 in order to provide an estimate of contaminant bioaccessibility: DIN 19738 (2004-07).

Within the revised German soil protection act, the investigation of the bioaccessibility of contaminants was added to get a more realistic exposure assessment. The respective lab method is supposed to provide robust and reliable data that can be used in human health risk assessments. For that reason, the existing German standard DIN 19738 is currently under revision on behalf of the German Federal Environmental Agency (UBA). The target is to harmonize and optimise the current standard procedure to provide conservative but reasonable estimates.

As the first step, the experimental key parameters were identified, which had mayor impact on the results of the method:

1. Duration of the intestine phase,

2. Use of enzymes, and

3. Application (or replacement) of milk powder.

These key parameters are modified separately within the experimental phase to determine their impact on the bioaccessibility data and to investigate the robustness of the method.

Methods

All experiments were carried out on the basis of the German standard DIN 19738 (2004-07). The existing in vitro method consists of a gastric phase (2 hours) and an intestinal phase (6 hours) simulating the human physiological digestive conditions. The saliva phase is optional (30 minutes) and was not included in the current investigations. All experiments were carried out with and without milk powder as food surrogate. The details of the methods are shown in Figure 1.

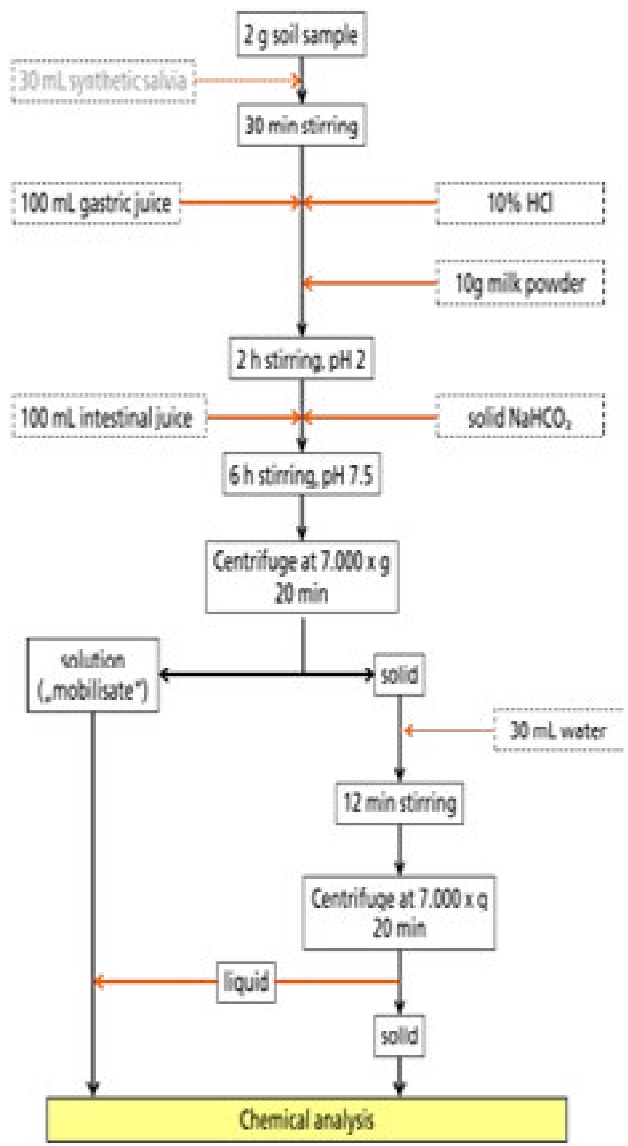

Figure 1: Procedure to investigate bioaccessibility simulating the human gastrointestinal conditions according to DIN 19738 (2004-07)

One soil contaminated with polycyclic aromatic hydrocarbons (PAHs) including Benzo[a]pyrene (BaP) as the relevant pollutant was used for the experiments with organic contaminants.

The soil was chosen due to its high concentration of PAHs (704 mg/kg soil dry weight) and BaP (56.6 mg/kg dry weight) in order to carry out all experiments without any additional clean-up or concentration steps before chemical analysis and, thus, to exclude possible further analytical variations. Chemical analysis was carried out using HPLC with fluorescence detection.

Regarding inorganic pollutants soils contaminated with cadmium (Cd), lead (Pb) and arsenic (As) were used in the experimental phase. Initial experiments were carried out using five different soils including BGS Guidance Material 102 of the British Geological Survey (BGS). Chemical analysis was performed using ICP-OES.

Results

Organic contaminants: Benzo[a]pyrene (BaP) as relevant pollutant for PAHs. The existing standard method was modified regarding the parameters (i) duration of intestinal phase, (ii) the use of enzymes and (iii) the application or replacement of milk powder as food surrogate. The results of these experiments are summarised in Table 1.

Table 1: Results of the bioaccessible fration of Benzo (a) pyrene (BaP) as % of the total BaP concentration as mean values of three replicates.

Modified parameter	Bioaccessible fraction of BP (% of total concentration) Without milk powder	Bioaccessible fraction of BP (% of total concentration) With milk powder
Existing standard procedure	3.6	18.8
Reduced intestinal phase	2.8	18.0
Preconditioning of enzymes	1.4	17.8
0.5 x enzymes	3.2	n.a.
no enzymes	4.5	2.7
Calv-milk powder		12.5
Condensed milk		13.5

*n.a. was not analysed due to a non-homogeneous mobilisate.

The duration of the intestinal phase is an essential factor for the work organisation. For this reason, the duration of the intestine phase was reduced from 6 hours to 3 hours. Using half the time for intestinal phase, the results for the bioaccessible fraction of BaP decreased slightly from 3.6 % to 2.8 % without milk powder or remained stable with milk powder compared to the standard procedure. The test system is very dynamic due the various components like proteins, fat and carbo-hydrates of the milk powder, soil, enzymes, bile and their interaction.

Furthermore, the conditions are varying continuously throughout the test duration due to digestion, solution, precipitation and complexing processes. Therefore, further experiments focused on the composition of the synthetic digestive juices especially on the amount and activity of the enzymes (pepsin, trypsin, pancreatin).

As the first step, preparation steps were tested to ensure a gently dissolution of enzymes and, thus, to assure a high enzymatic activity throughout the test. For this reason, preconditioning of enzymes overnight was compared to the use of enzymes as solids which was carried out during the standard procedure. Preconditioning resulted in a decreased bioaccesible fraction of 1.4 % without milk powder compared to 3.6 % when enzymes used as solids whereas the results with milk powder showed no impact of preconditioning (17.8 %).

As the second step, the concentration of enzymes was reduced: Experiments were carried out using half the concentration of enzymes and no enzymes. The results for the bioaccessible fraction of BaP were 3.2 % and 4.5 % without milk powder and, thus, in the range of the standard procedure (3.6 %) indicating that the concentration of enzymes does not have an impact on the test system without food surrogates. In the experiments with milk powder however, the mobilisate was found to be non-homogeneous (i.e. a fat phase was visible) and the results of the bioaccessible fraction of the pollutant were greatly reduced (2.7 %) compared to the standard procedure (18.8 %).

Milk is a food surrogate containing proteins, fat and carbohydrates as an emulsion and is currently used in the test system as a powder. To investigate the impact of this food surrogate, calv-milk powder and milk in a standardised liquid form (condensed milk) were used in the experiments. Bioaccessibility results of both calv-milk powder and condensed milk were reduced (12.5 % and 13.5 %, respectively) compared to the milk powder (18.8 %). Regarding calv-milk powder, the results may be caused by the lower fat content. Handling of all three options is similar, but the separation of the solid phase with condensed milk is more difficult, and an extension of the centrifugation step is, therefore, needed.

Further experiments with a reduced amount of milk powder and condensed milk and contemporaneously halved or doubled concentration of enzymes are ongoing.

Conclusion

The robustness of the in vitro method DIN 19738 was tested using Benzo[a]pyrene as a representative of lipophilic contaminants.

Samples with addition of milk powder turned out to be robust against variation of intestinal phase duration whereas samples without milk powder are probably more sensitive against variation of this phase.

The fat portion of the milk powder is an important factor for lipophilic contaminants during bioaccessibility testing.

Non-digested milk powder (e.g. a visible fat phase) resulted in a severe underestimation of the bioaccessible fraction. The fat may act like a surface coating of the soil and prevent the transfer into the aqueous mobilisate or the mobilisate is non-homogeneous resulting in non-reliable analytical results. In this context enzymes play an important role by digesting the milk powder (and not the soil) during the test.

A high variability of PAH results was found despite of the high contaminant concentration in the chosen soil, especially when the bioaccessible fraction was very low. The standard deviation was up to 57 % within 3 replicates.

Experiments with the inorganic contaminants cadmium, lead and arsenic confirmed the great impact of milk powder on heavy metal bioaccessibility, which is described in literature. Robustness is still under investigation.

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RISK REDUCTION OF SOIL CONTAMINATED BY OBSOLETE PESTICIDES IN AFRICA

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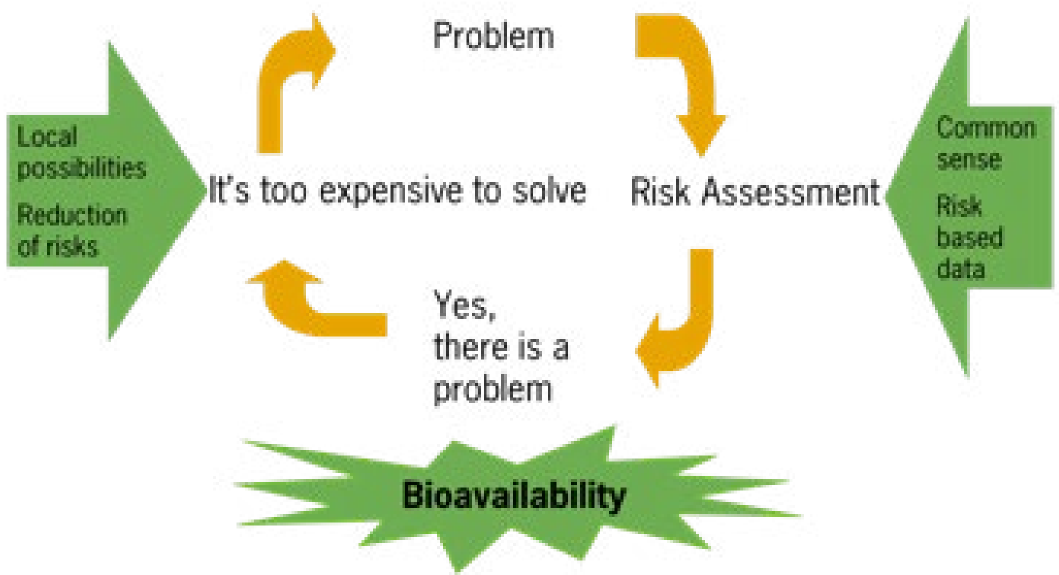
1. Introduction

The FAO Programme on the Prevention and Disposal of Obsolete Pesticides (FAO, 2013) is designed to get rid of stockpiles of obsolete pesticides and to ensure that new stockpiles do not accumulate. The Africa Stockpiles Programme (ASP), being a part of this program, had its focus on Africa. Most of the pesticides have been shipped to Africa for locust control but did not arrive at the proper place or proper time, thereby becoming obsolete. High concentrations of pesticides (e.g. dieldrin, parathion, malathion, chlorpyrifos) can be found in soils on the stockpiles.

The experience within ASP has shown that methods to assess the risks of contaminated soils are often too theoretical, difficult to complete in the African conditions, necessary laboratory facilities are lacking, and this all results in a wait and see attitude. This wait and see attitude becomes even stronger if the assessment procedure is followed by the recommendations based on too expensive or not realizable northern technology. The result is that no real actions to reduce risks are taken, nothing will happen till a new assessment will be started in future; an infinite circle (Figure 1).

This paper presents another entry: break this circle, assessment is not the primary goal, because for most suspect depots and sites, a visit and expert judgment is

Figure 1: Breaking the assessment circle (slightly modified from Harmsen and Naidu, 2013)



already sufficient to conclude that there is a potential risk for human health and environment. There is a strong need for immediate action and measures to reduce the risks of the pesticides. Regulations are mostly focused on these concentrations, but from a risk-based point of view, contaminations are only a risk if they are or may come available, a risk-based approach. This widens the range of options and, therefore, can facilitate more tailor-made solutions for individual sites. In a risk based approach, the stimulation of biodegradation of the pesticides and/or immobilization and isolation of the contaminant may play a role. The concept of bioavailability has shown to be a suitable tool in breaking the circle.

From a risk-based perspective, contaminations are only a risk if they are or may become available. This widens the range of options and, therefore, can facilitate more tailor-made solutions for individual sites (Harmsen et al., 2009). The following steps are necessary:

1. Investigation of the site (e.g. his torical use, hydrology, climate, transport).
2. Defining of the site specific risks.
3. Gathering of missing information, including local conditions and sampling.
4. Possibilities for site specific and sustainable remediation by risk reduction.
5. Implementation of the risk reduc tion measures.

2. Materials and methods

Three sites in Mali and three sites in Mauritania were investigated in 2007 following steps 1-3. Most important risks identified were as follows: a) inhalation of volatilized pesticides, b) transport to groundwater, c) physical contact by human and cattle d) run-off by rain (Mali) and e) wind erosion (Mauritania). Based on the results obtained and results of analysis of the samples taken, risk reduction proposals were made and discussed locally (step 4). All proposals are based on the use of local conditions to stimulate biodegradation and/or to prevent rain water to transport the pesticides both vertical as horizontal. In populated areas, a plan for future use was part of the solution to prevent that houses will be built on the isolated site. All plans have in common that they reduce the risks for the local population, are simple and cheap and can be implemented on a sustainable way, even under the difficult African conditions. First implementations (step 5) have been started in summer 2008 in Molodo (Mali) followed by activities on several other locations.

3. Results and Discussion

3.1 Results of monitoring and proposals for risk reduction

From all six sites, the following general conclusions could be drawn:

− On all locations, vegetated and biological active zones were present, in which biodegradation could occur.

− The amount of precipitation is limited, accounting from 20-200 mm/year in Nouakshott to 250-600 mm/year in Molodo. Most rainfall falls in the period from June to September. The evaporation is higher and if it is possible to use vegetation, all precipitation can be evaporated, thereby, preventing leaching to the groundwater.

− In Mali, transport of contaminants by surface run-off caused by heavy rains may occur.

– In Mauretania, polluted soils can be transported by wind.

– In Mauretania, the formation of sand dunes can be used to prevent the pollution. Vegetation can be used to stabilize these dunes and evaporate the small amount of rain.

For remediation, the following strategies has been followed:

– If possible, removal of the contamination in the source and spreaded contamination by biological treatment using landfarming (Harmsen et al., 2007). Landfarming is an easily applicable, simple and cheap technology.

– Isolation of the contaminant by evaporation of the precipitation using vegetation

– Isolation of the contamination by using natural covers (e.g. sand dunes in Mauretania).

– Increasing adsorption capacity of soil by adding local available black carbon (charcoal). Organic contaminants are strongly adsorbed by black carbon (Koelmans et al., 2006)

In the final situation, the areas used for landfarming and the final destination have to be vegetated using deep-rooting vegetation that can survive under local dry conditions and are not eaten by cattle (BOUMEDIANA, 2001). Vetiveria (Mafei, 2002) and Jatropha have been selected.

3.2 Implementation

The first implementation started in Molodo in June 2008. For logistical reasons, it was necessary to start with the excavation of the centre. One of the concrete construction present on the site has been used for temporary storage. Care was taken not to break the clay layer in the contaminated area to prevent direct contact with the groundwater. For refilling of the excavation, bioactive surface soil has been used. Doing this, biological activity was introduced at the contact layer of the contaminated soil left and the refilling soil. It is expected that this activity will slowly decrease the residual concentration. After filling, the soil has been enriched with local available compost and vegetated with vetiveria and jatropha to increase evaporation.

A small landfarm has been constructed, just beside the contaminated centre. This landfarm has been enriched with compost for further biological activation. The first charge of the contaminated soil has been spread on the landfarm. The results of this first charge are presented in Table 1 on next page. As expected, parathion-ethyl has been degraded and dieldrin not. Part of the soil on the landfarm has been transported to the final concrete depot. The soil on the bottom of this depot has been enriched with charcoal, to increase the adsorption capacity for dieldrin (Figure 2). A following charge has been brought to the landfarm from the temporary storage.

Figure 2: Application of charcoal to prevent leaching

Table 1	Pesticides concentration in soil on the landfarm					
	July 16, 2008			November 11, 2008		
	Parathion-ethyl g/kg d.m.	Dieldrin g/kg d.m.	Ratio	Parathion-ethyl g/kg d.m.	Dieldrin g/kg d.m.	Ratio
1	0.527	0.786	0.67	0.0095	0.442	0.021
2	1.497	0.518	2.89	0.021	0.745	0.028
3	1.615	0.869	1.86	0.011	2.775	0.004
4	3.085	1.081	2.85	0.01	0.775	0.013
5	0.868	0.459	1.89	< 0.003	0.118	<0.025
Average	**1.52**	**0.74**	**2.03**	**0.011**	**0.97**	**0.018**

Table 1: Pesticides concentration in soil on the landfarm

4. Conclusions

A lot of sites in Africa are polluted with obsolete pesticides, which are sent to Africa for locust control. In pilots in Mali and Mauretania, remediation strategies are developed that reduce risks and can be used under difficult African conditions. The remediation strategies are based on application of bioremediation using land-farming and/or isolation of the contamination. Implementation has been started in 2008 and turned out to be successful. This was followed by the implementation on the other sites in Mali and Mauretania.

The results of the project were shared with other African counties during a workshop in Bamako in 2010. This was followed by the implementation in Botswana, and in autumn 2013, activities were started to implement the approach in Benin.

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MEASUREMENT OF BIOAVAILABILITY, THE ROLE OF STANDARDIZATION

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1. Introduction

Contaminants only pose a risk if they are or become, available in a form that can have impact on human or ecosystem health. A risk-based approach that incorporates the bioavailability of contaminants for the identification of sites that require remediation and for setting priorities (NRC Committee, 2003), may be useful and more cost-effective than the approach based on total contaminant loading. A risk-based approach, rather than a total concentration approach, should result in the stimulation of the application of biodegradation and/or immobilisation and isolation of the contaminants as part of the solution. Local site-specific conditions may also play an important role and be taken into account by risk-based approaches (Harmsen and Naidu, 2013).

In the scientific community, it is already common knowledge that the total concentration of contaminants overestimates the risks and that risk assessment should be based on available concentrations. Although definitions are still being discussed, there is a common view on bioavailability. Moreover, a large number of methods that estimates the bioavailable fraction, has become available. On the level of regulation and administration, people also realize that risks are overestimated, but there is a long experience with total concentration. Total concentrations are measured with validated, and reliable methods are often described in both national and international standard procedures. From regulatory point of view, there is no direct drive to change their system. If they change, the system should 1) be easy explainable to the public, 2) make use of methods that others use, 3) provide clear results and no further discussion, and 4) be cheap and straightforward.

For the implementation of bioavailability, the regulation should like to have “THE” method to measure the bioavailable fraction. Science, however, offers a large number of methods, and developers of test have a lot of arguments to prove that their method is the best one. This causes confusion and hampers the implementation of bioavailability within the regulation. Standardization is a tool to close the gap between science and regulation. In this paper, we describe the way ISO working groups have worked on the standardization of methods to establish the bioavailable fraction. Scientific approaches had to be translated into standardized methods (Harmsen, 2007). Doing this in a proper way, standards will play an important role in the implementation of bioavailability in regulation, as shown for Germany by Kördel et al., 2013.

2. To standards on Bioavailability

2.1.Guidelines

The ISO working group on bioavailability started their work with the development of a guideline on bioavailability. This guideline had the function of a conceptual framework and gave direction for use and further development of methods.

The concept is presented in Figure 1. The upper part in the figure represents the soil, while the lower part- the organism, and both parts are separated by the cell membrane. Bioavailable compound will pass the cell membrane, and the amount can be predicted by chemical measurements in soil, or biological measurement using specific organisms. In soil, bioavailability can be distinguished as follows:

- The actual dissolved amount at ambient conditions, and

- The potentially-available amount, for example, the maximum amount that can be released under (pre-defined) worst-case conditions.

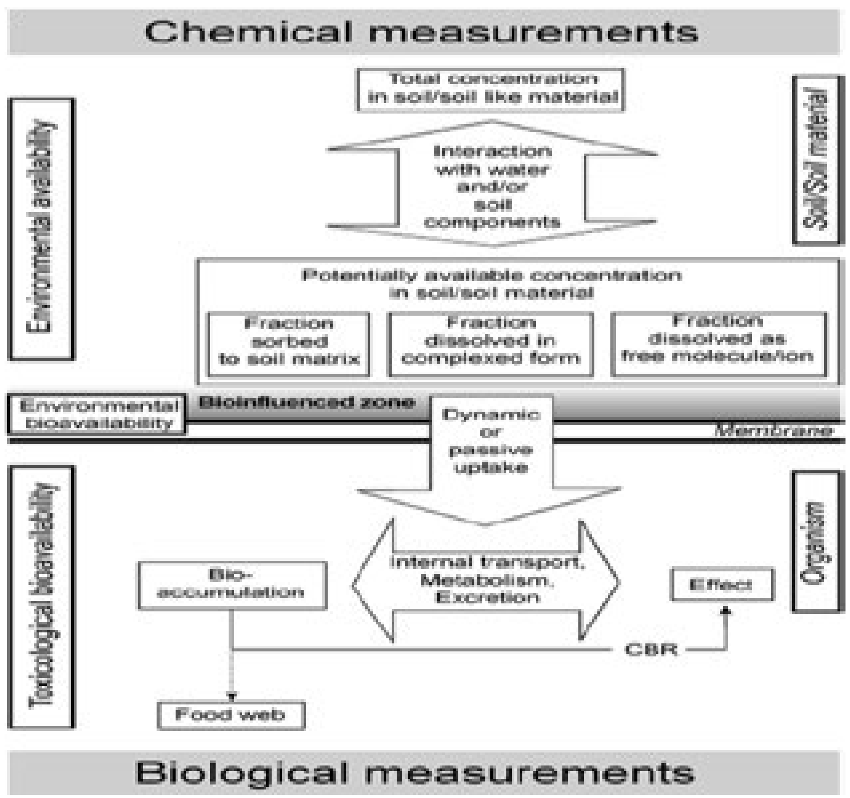

Figure 1: Concept of bioavailability, from total concentration in soil to effect (From: ISO 17402)

An important statement in the guidelines was that methods should have an understandable physical base. Empirical methods should not be the basis of a standard method. In 2008, ISO 17402:2008 Soil quality -- Requirements and Guidance for the Selection and Application of Methods for the Assessment of Bioavailability of Contaminants in Soil and Soil Materials, has been published.

2.2 Measurement of bioavailability

2.2.1. Trace elements

Following the publication of the guidelines, the development of specific standards to give an estimate of bioavailability has started. For trace elements (e.g. heavy metals), a method using 0.001 M CaCl2 was adopted to measure the actual availability. This method simulates the amount solved in the pore water. This method (ISO/TS 21268-part 1) is already used to predict leaching. The second method, ISO 19730, already in use for a longer period, uses 1 M NH4NO3, which physical base is less because of the high concentration. The method is used to predict the uptake by vegetation (Gryschko et al., 2005). To measure the potential available trace element, an extraction with diluted HNO3 is developed (ISO/DIS 17586).

As follows from Figure 1, bioavailability can also be estimated using the organism. In ISO 16198, a plant-based biotest is described to assess the environmental bioavailability of trace elements to plants in contaminated soils. Trace elements are transported through the water phase, and the accumulation using well-defined conditions is a measure for the availability.

For users of the standards, it is important to know what the meaning of the measured values is. Bioavailability has to be combined with the word "for". The size of the bioavailable fraction of a contaminant depends on the organism. Pathway (e.g. ingestion dermal contact inhalation) and exposure (e.g. contact time and binding to soil) are organism dependent parameters. It is necessary to calibrate a method (measured bioavailable fraction against the effect). Effects can be uptake and accumulation, but also toxicological parameters like mortality, growth, reproduction and behavioural responses. How to use the measured values and limitations of this use will be described in ISO/CD14858 Soil Quality — Environmental Availability in Soil — Use of Soil |Extracts for the Assessment of Trace Element Bioavailability.

2.2.2. Organic contaminants

For organic contaminants, ISO-standardisation is presently focused on the potentially available fraction using the TENAX/cyclodextrin method. In the near future, this will be followed by translation of the scientific developments on the measurement of actual availability (passive sampling) into an ISO-standard.

The standard (ISO 16751) for the potential available fraction specifies an extraction method using a 'receiver phase' for an organic contaminant with strong sorbing properties. This phase can be a complexing agent (cyclodextrin) or a strong adsorbent (Tenax), which maintains the mass transfer of available organic contaminants from a soil or soil-like material including (dredged) sediments to the aqueous phase. By abating solubility constraints, both methods give an estimation of the environmental availability of the organic contaminant, i.e. the amount of the contaminant with mass transfer potential to exchange from soil or soil like material into the aqueous phase and reflects the fraction of contaminant that can exert effects on biotic systems. The method is applicable for organic contaminants with a log Kow> 3.

Using this method, biodegradation and effects on organisms can be predicted (e.g. Cornelissen et al., Reid et al 2000, 1998, Hulcher et al, 2003, Hickman et al; 2008). All these "calibrations" will be described later, comparable to ISO/CD14858 for trace elements to give the users some guidance in application of the measured results.

3. Broader applications

Leaching of contaminants to groundwater, which can also be considered available, is an unwanted effect of use and reuse of soil and also building materials. This has been recognized in standardization and standards on leaching are in use. The first series was the ISO/TS 21268:2007 Soil quality -- Leaching Procedures for Subsequent Chemical and Ecotoxicological Testing of Soil and Soil Materials. Having more experience with this method, it became possible to predict leaching behaviour, using soil characteristics like pH, clay, iron- and aluminium oxides and thermodynamic properties. For this purpose, the ISO 12782 series has been developed.

In soil and site assessment, human take a specific position. Ingestion of soil, especially by children, is considered as an important risk. Bioaccesibility/bioavailability for human is described in ISO/TS 17924 (Assessment of human exposure from ingestion of soil and soil material -- Guidance on the application and selection of physiologically based extraction methods for the estimation of the human bioaccessibility/bioavailability of metals in soil). This standard from 2007 will be actualized in the coming period.

4. ISO standards on bioavailability or related to bioavailability

4.1. Bioavailability

The standards listed below are published or in development within ISO/TC190/Soil

Quality.
It represents the situation of December 2010

ISO 17402:2008 Soil quality -- Requirements and guidance for the selection and application of methods for the assessment of bioavailability of contaminants in soil and soil materials

ISO/DIS 16198 Soil quality -- Plant-based biotest to assess the environmental bioavailability of trace elements to plants

ISO/DIS 17586 Soil quality -- Extraction of trace elements using dilute nitric acid

ISO 19730:2008 Soil quality -- Extraction of trace elements from soil using ammonium nitrate solution

ISO/CD14858 Soil quality — Environmental availability in soil — Use of soil extracts for the assessment of trace element bioavailability

ISO/AWI 16751-1 Soil quality -- Environmental availability of non-polar organic compounds -- Part 1: Determination of potential availability using a strong absorbent or complexing agent

4.2 Leaching
ISO/TS 21268:2007 Soil quality -- Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil materials

• Part 1: Batch test using a liquid to solid ratio of 2 l/kg dry matter

• Part 2: Batch test using a liquid to solid ratio of 10 l/kg dry matter

• Part 3: Up-flow percolation test

• Part 4: Influence of pH on leaching with initial acid/base addition

ISO 12782:2012 Soil quality -- Parameters for geochemical modelling of leaching and speciation of constituents in soils and materials

• Part 1: Extraction of amorphous iron oxides and hydroxides with ascorbic acid

• Part 2: Extraction of crystalline iron oxides and hydroxides with dithionite

• Part 3: Extraction of aluminium oxides and hydroxides with ammonium oxalate/oxalic acid

• Part 4: Extraction of humic substances from solid samples

• Part 5: Extraction of humic substances from aqueous samples

These series will be completed with Part 6, Guidance for the application of ISO 12782, which describes the use of models.

4.3 Bioaccesibility/bioavailability
ISO/TS 17924:2007
Soil quality -- Assessment of human exposure from ingestion of soil and soil material -- Guidance on the application and selection of physiologically based extraction methods for the estimation of human bioaccessibility/bioavailability of metals in soil.

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REMEDIATION OF POP PESTICIDES POLLUTED AREAS IN THE CONDITIONS OF MOLDOVA

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Abstract

During the last decade, pollution due to POP pesticides has been recognized by the Moldovan authorities as a problem of national priority, which needs to be resolved in order to reduce/eliminate the impact of POPs on human health and the environment. As a result of national inventory carried out in 2008-2010, about 1600 contaminated sites were identified and described.

This study on remediation of POP pesticides polluted areas is complementary to the actions undertaken during last years in the field of sustainable POPs management and has as specific objectives: (i) to identify Best Available Technologies (BAT) for of POP pesticides polluted areas, taking into account technical, financial and economic aspects; (ii) to assess their potential environmental/health benefits and impacts; (iii) to implement appropriate remediation techniques at a few selected sites.

Based on the assessment which included aspects of practical and economic feasibility for implementation taking into account costs, performance, efficiency and potential impacts on the environment and human health, two techniques – isolation in controlled soil stockpiles and biological treatment with the Daramend technique have been selected and tested/validated at three pilot demonstration sites in order to identify methods most appropriate for Moldova with a view to recommendation of remediation strategies for other OP sites throughout the country pending the available financial resources.

Based on practical results, the Guidelines for local environmental authorities on how and when to carry out remediation measures on areas polluted with POP obsolete pesticides have been prepared.

Keywords

Persistent organic pollutants (POPs), obsolete pesticide (OP), contaminated sites, risk assessment, remediation, economic evaluation

Introduction

By the early 1990s, about 1000 warehouses for pesticide storage had been built in the collective farms. During the period from 1991 to 2003, most warehouses were destroyed or dismantled and only about 20% were maintained in a satisfactory condition. Significant amounts of obsolete pesticides were stored in the open inadequate containers and areas adjacent to warehouses were contaminated as a result of improper management of OP storage. As some storage facilities are situated close to residential areas and water courses, the risk of harmful effects on the environment and people's health is thereby greatly increased.

As a result of actions on repackaging and centralized storage of OP carried out in 2003-2008, about 340 warehouses have been fully emptied, ensuring the elimination of the most direct threats to human health and the environment. At the same time, these warehouses remain a significant pollution source because their walls, floors, and adjacent territories are contaminated.

Tackling this problem requires a detailed inventory and risk assessment of those sites, along with development of appropriate remediation measures. Such studies were conducted in parallel in 2008-2010 by the Ministry of Environment within two projects supported by the World Bank. As a result of the first study about 1600 contaminated sites were identified, described and included in an integrated database: http://pops.mediu.gov.md /1/.

The second study, presented below, was carried out to satisfy the urgent need for selecting suitable and affordable technical options for clean-up of obsolete pesticide residues and remediation of contaminated sites. It was conducted within the CIDA/WB Project "Remediation of POP pesticide polluted areas and inventory of PCB contaminated oil in power equipment" by the NIRAS Consulting Engineers and Planners A/S, and managed by POPs Sustainable Management Office (www.moldovapops.md).

The specific objectives of this study were as follows:

– To identify Best Available Technologies (BAT) for of POPs pesticides polluted areas, taking into account technical, financial and economic aspects;

– To assess their potential environmental/health benefits and impacts;

– To implement appropriate remediation techniques at a few selected sites.

The remediation techniques had to be tailored to best fit local characteristics like soil type, hydrogeology, contamination degree, and pesticide category. The identified techniques had to be tested/validated at selected pilot demonstration sites in order to identify methods most appropriate for Moldova with a view to recommendation of remediation strategies for other OP sites throughout the country pending the available financial resources.

1. Approach

To achieve the objectives set, addressing the issue included several stages: (i) classification of POP pesticides polluted sites; (ii) selection of demonstration sites; (iii) evaluation and selection of appropriate BATs for remediation; (iv) application of selected remediation techniques at the demonstration sites; (v) economic evaluation of the methods applied. More detailed description is presented in /2/.

Classification of pop pesticides polluted sites

During the initial project phase, data collection to identify site characteristics was initiated. Criteria for pre-selection and final selection of demonstration sites to test remediation technologies were defined based on the following considerations: site conditions affecting choice of remediation technique; and the need for remediation i.e. risk to human health and environment.

Based on the data available concerning the former OP warehouse, the main criteria for classifying the sites have been as follows: soil pollution levels and potential for pollution in floors and walls; physical state of warehouse; threat to human health dependent on the proximity to sensitive human and ecological targets; type of soil under and around the warehouse classified either as permeable to rain water.

Selection of demonstration sites

Based on above mentioned criteria, three contaminated sites for demonstration, of the 386 records for former OP warehouses, have been selected and proposed clean-up actions for each particular site as well as approximately amounts of soil to be treated are:

• *Bujor*: combination of bioremediation and isolation in cofferdam of demolished foundation. Amounts: bioremediation – 170 tons soil, cofferdam – 340 m^3 soil, demolition wastes – 449 m^3. Excavation and backfill the site with clean soil – 550 m^3. Cofferdam built on site.

• *Congaz*: demolition of building and cofferdam with both soil and demolition waste. Amounts: soil – 780 m^3; demolition waste – 1030 m^3. Excavation and backfill the site with clean soil – 1020 m^3. Cofferdam built 3 km south-west off site.

• *Step-Soci*: demolition of foundation and cofferdam with both soil and demolition waste. Amounts: contaminated soil – 30 m^3; demolition waste – 120 m^3. Excavation and backfill the site with clean soil – 150 m^3. Cofferdam built on site.

Evaluation and selection of appropriate BATs for remediation

The applicability of BAT Remediation Technologies for clean-up of sites polluted with pesticides (contaminated soil) was identified and assessed. The assessment included aspects such as practical and economic feasibility for implementation in Moldova and took into account costs, performance and efficiency as well as treatment time in full-scale field trials; and potential impacts on the environment and human health. The evaluation criteria included:

– *Risk management* based on ability of different kinds of remedial options to prevent risks in relation to the conceptual model describing the source of contamination and spreading to the environment and human targets;

– *Identification of available potential techniques* to clean-up soil contaminated by pesticides and POPs, already tested and approved by international organizations /3, 4, 5, 6/;

– *Economics*, based on techniques that are low cost, also for low volumes of soil to be treated;

– *Performance and efficiency* – it is important that the selected technique is not sensitive to variation in the type and nature of the contamination or require many fine adjustments of the process in order to achieve the required effect.

– *Time-frame and need for post clean-up monitoring* – the selected technique can complete clean-up to the required criteria within a reasonably time frame, and it is also desirable that there are no long-term requirements to monitor clean-up levels or control integrity of clean-up measures;

– *Environmental effects* – it is important that the selected technique does not produce residues, wastewater and gaseous emissions that can contaminate the environment and requiring special treatment.

Two remediation (BAT) techniques have been chosen for the three demonstration sites and tested with a view to possible further implementation in Moldova:

isolation in controlled soil stockpile (cofferdam) and bioremediation.

2. Remediation at the demonstration sites

Remediation activities at the demonstration site works have been preceded by a preparation process involving the development of the documentation legally required before starting the works.

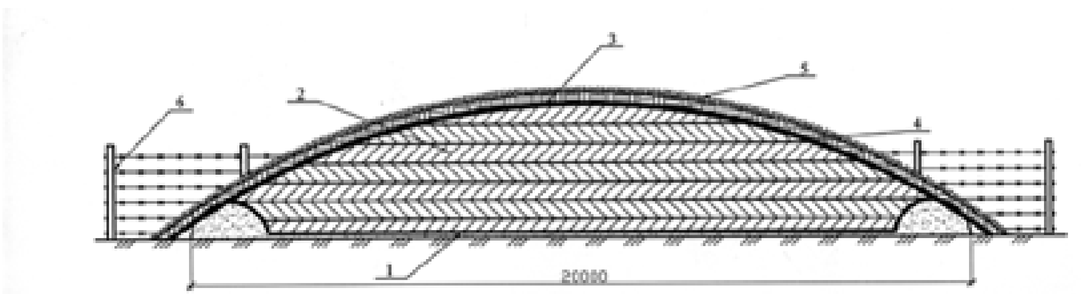

Figure 1: Constructive scheme of controlled POPs contaminated soil stockpile (cofferdam): 1 - polyethylene film covering the bed of cofferdam (buttom membrane), 2 - contaminated soil and rubble placed in layers and compacted, 3 - polyethylene film covering cofferdam (top membrane), 4 - layer of topsoil, 5 - sown grass, 6 - fence made of concrete pillars and barbed wire (mesh).

Controlled soil stockpile (cofferdam)

The scheme illustrating principle construction of a cofferdam is shown in Figure 1.

The cofferdam is a constructed controlled pile where contamination from the content stored inside it (in our case - contaminated soil and contaminated demolition wastes) to the ground water is secured by a bottom and top liner (membrane) and the soil is secured against surface water and rainwater by a bank around the pile and a top liner. The top liner is secured with a layer of clean soil topped with grass and a fence with warning signs are placed around the cofferdam.

Since the main function of a cofferdam is isolation the requirements toward this kind of construction consist of respecting/considering a number of factors which could affect its function/purpose: the right topographical location; the right design and its diligent execution in order; the content of the cofferdam; the access to cofferdam is denied /2/.

Bioremediation

Daramend is an advanced biological treatment technology for soil, sediment and solid wastes contaminated with recalcitrant organic compounds /7/.

The bioremediation test at the Bujor site included 10 cycles of Daramend application. The total surface of the test area was about 200 m2. The depth of tilling was 25-30 cm. The concentration of HCH, DDT and Heptaclor in the soil has been determined after 5 and after 10 cycles of treatment, and compared with data for the baseline analyses /2/.

As the mean concentrations after 5 cycles of treatment were still well above the Moldovan soil quality criterion of 0.1 mg/kg, the soil treatment in all areas has been extended to 10 cycles of treatment. The results after 10 cycles of treatment demonstrate appreciable reduction of up to 84% for sum of DDT, 42% for sum of HCH and 76% of Heptachlor.

The soil contamination is still above the Moldovan soil quality criteria for agricultural land (0.1 mg/kg), but the risks associated with contaminated soil have been greatly reduced. The contaminated area at

Bujor will not be used for agricultural or residential land use and the residual contamination is less than soil quality criteria for industrial land as defined in some EU countries. Furthermore, the site is usually covered by fairly dense vegetation, which prevents spreading of the low-level contamination in soil dust. No further actions are therefore recommended.

3. Economic evaluation

The economic evaluation of the BAT applicability – the direct and total costs as well as the unit price (efficiency) of both methods achieved during the remediation activities are presented in the table below (1 Euro = 16 Moldovan Leis).

Conclusions

The conclusions concerning the appropriate remediation techniques that can be implemented by local authorities in Moldova can be summarized as follows:

Priority for clean up activities: Risks should be reduced immediately as a top priority if there is risk to human health due to close proximity of the OP site to residential areas or vulnerable drinking water wells, and if the soil pollution and/or contaminated building materials are present at the OP site.

		Congaz	Bujor cofferdam	Step Soci	Bujor bioremediation
Amounts of soil and rubble treated,	m^3	4 942	1 545	440	98
Time to achieve cleanup	Day	23	10	8	>70
Man hours required to complete	hr	864	264	126	120
Training hours need to complete	hr	2	2	2	2
Cost of treatment/materials	Leis	39 212	20 662	7 892	112 612
Cost of hire for equipment	Leis	170 450	76 650	26 600	44 246
Cost of manpower	Leis	19 440	5 940	2 835	1 950
Daily Rate, manpower , man/days	Leis	150	150	150	130
Costs of hire equipment, average	Leis	350	350	350	350
Direct costs	Leis	229 102	103 252	37 327	158 808
Total cost including taxes	Leis	408 297	196 964	71 307	158 808
Cost of PPE		21 419	11 953	5 380	2 767

		Congaz	Bujor cofferdam	Step-Soci	Bujor bioremediation
TOTAL GENERAL		429 716	208 917	76 687	161 575
Price/ m^3	Lei/m^3	86,9	135,2	174,3	1 648,7
Achievement of clean-up goal		100%	100%	100%	50%
Need for maintenance		Yes	Yes	Yes	No
Need for follow up treatment		No	No	No	No
Applicability at other sites		Applicable	Applicable	Applicable	Applicable
Future maintenance		Needed	Needed	Needed	No
Need for future treatment		Yes	Yes	Yes	No
Future cost , treatment		Unknown	Unknown	Unknown	None

Table 1: Comparison of Economic Aspects

Good detailed site investigations: The site investigation is the basis for decisions on the need for remediation and on the extent of remediation required.

Start planning in good time: The planning process takes time, and the implementation is not possible in the winter months.

Getting Works Permit: The demonstration projects experienced a number of delays due to the need for clarification on a number of legislative aspects concerning permits to start the work. Some of these problems are solved by the descriptions provided in the guidelines and the template for the Technical Design of Works used for the demonstration projects.

Establish a local advisory facility: From the workshops and dissemination seminar, it is learned that the "site owners" needs a back up advisory facility from e.g. the PMT office or a local consultant attached to the PMT office. The Guidelines should be used by the "site owners", but anyhow some backup advisory is needed especially in the first remediation projects regarding; site investigations, planning, work permits, use of PPE and training of site supervision managers etc.

Use of PPE: Occupation health aspects involving use of Personal Protective Equipment (PPE) are easier to enforce if a short-term intensive construction project is initiated immediately after training in the use of PPE.

Recommended remediation method is a controlled soil stockpile (cofferdam): As many sites have both contaminated soil and building rubble, the method of choice is to excavate the contaminated soil and rubble to a controlled soil stockpile (Cofferdam). However this method is not a permanent method since the contamination is not treated, but isolated. Risks to human health are prevented, but maintenance is required to ensure the integrity of the protective isolation measures. If there are a number of smaller sites, there might be economical and management advantages to excavate the soil and waste materials and transport these to a local controlled soil stockpile site, so that maintenance costs can be reduced.

Enhanced biological degradation is not directly applicable: The biological method by land farming whereby excavation is avoided is assessed not to be directly applicable in Moldova at former OP warehouses due to uncertainty about the clean up levels that can be achieved for the investment involved and due to the presence of contaminated rubble. Permanent reduction of risk is however achieved, and the land is most probably suitable for industrial purposes especially if combined with an addition step to cover residual soil pollution with a clean soil layer.

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IMPACT OF BIOCHAR AND BIOCHAR SUBSTRATES AMENDMENT ON BIOAVAILABILITY AND DEGRADATION OF ORGANIC CONTAMINANTS AND PESTICIDES IN SOIL

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At the end of the last century, the famous Terra-Preta soils, which are very rich anthropogenic black earth with high contents of stable organic carbon, were rediscovered in the Amazon area. The Terra-Preta-soils provide high adsorption capacity, very effective microbial activity, excellent nutrient and water supply. The central element seems to be biochar or charcoal that was composted or fermented together with organic waste.

In the last 10 years, a lot of scientific work was done to decode the properties, impacts and possibilities of the amendment of biochar to soil. Concerning the reduction of negative impacts of contaminants in soil biochar provides to chances, especially polar organic substances have a huge potential to adsorb at the huge surface of biochar; on the other hand, site biochar improves the soil microbial activity including the ability to decompose organic pollutants.

New results concerning biochars influence on bioavailability and decomposing of pesticides summarizing the current status quo of scientific work will be presented as well as own results regarding to the impact of biochar on bioavailability and decomposing of organic pollutants in pot, lysimeter and field experiments.

EVALUATION OF POLLUTANTS IN SOIL BASED ON BIOACCESSIBILITY - PATHWAY SOIL - HUMAN BEING

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Abstract

In Germany, the evaluation of pollutants in soil is regulated. If measured concentrations of pollutants (total contents) in soil exceed the trigger values, detailed investigations are required. Therefore, an examination of the exposure conditions as well as of the mobile or mobilizable content of the pollutants might be useful. Since 2004, an in vitro method (DIN 19738), which is based on a physiological model of the digestive procedures in the upper digestive tract, has been applied. The results of these measurements allow the final assessment of pollutants in soil showing the most sensitive effects on human health after oral uptake. Meanwhile, in Germany, more than a thousand data sets are gained in practical appliance, assessing different cases and settings. In fact, the possibilities and limits of the method in practical use are known. Therefore, a review of the standards as well as a ring-test is being planned. Current scientific work has been started to prove the ruggedness of the standard. More specific results can be expected in 2014.

Keywords

Bioaccessibility, DIN 19738, in vitro, laboratory standard, oral route of exposure; detail investigation, Soil protection act.

Introduction

The investigation and evaluation of suspected sites, suspected contaminated sites, harmful soil changes and contaminated sites requires normative regulations. Therefore, in Germany, the Federal Soil Protection Act (BBodSchG) as well as the Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV) were adopted in 1998/1999. In the focus of these regulations, the objects of protection are the soil, the groundwater and the health of human beings. To describe potential risks, the regulations look at specific pathways, which are defined as routes from the source of pollution to the place of potential effect on a resource to be protected.
To look at environmental impacts on the health of human beings, it is indispensible to concentrate on possible exposure pathways and the routes of exposure (oral, inhalative, percutanous). The following contribution describes the background of soil evaluation of sensitive landuse with the focus on the protection of the health of human beings and on an applied method of detailed investigation in the process of the final evaluation.

Evaluation of harmful soil changes

In Germany, trigger values have been derived for inorganics (arsenic, lead, cadmium, chromim, cyanide, nickel, mercury) and some organic pollutants (PAH, PCB, HCH, DDT, aldrin, hexachlorobenzene, pentachlorophenol) considering their toxicological profile (toxic or carcinogenic)

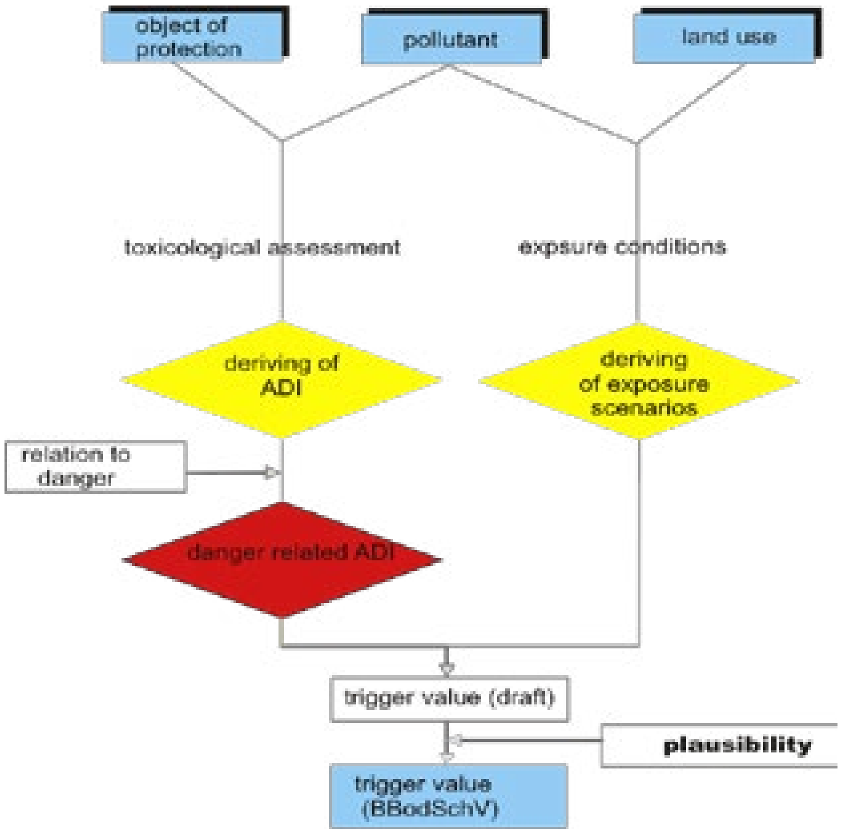

Figure 1: Procedure of deriving trigger values in Germany

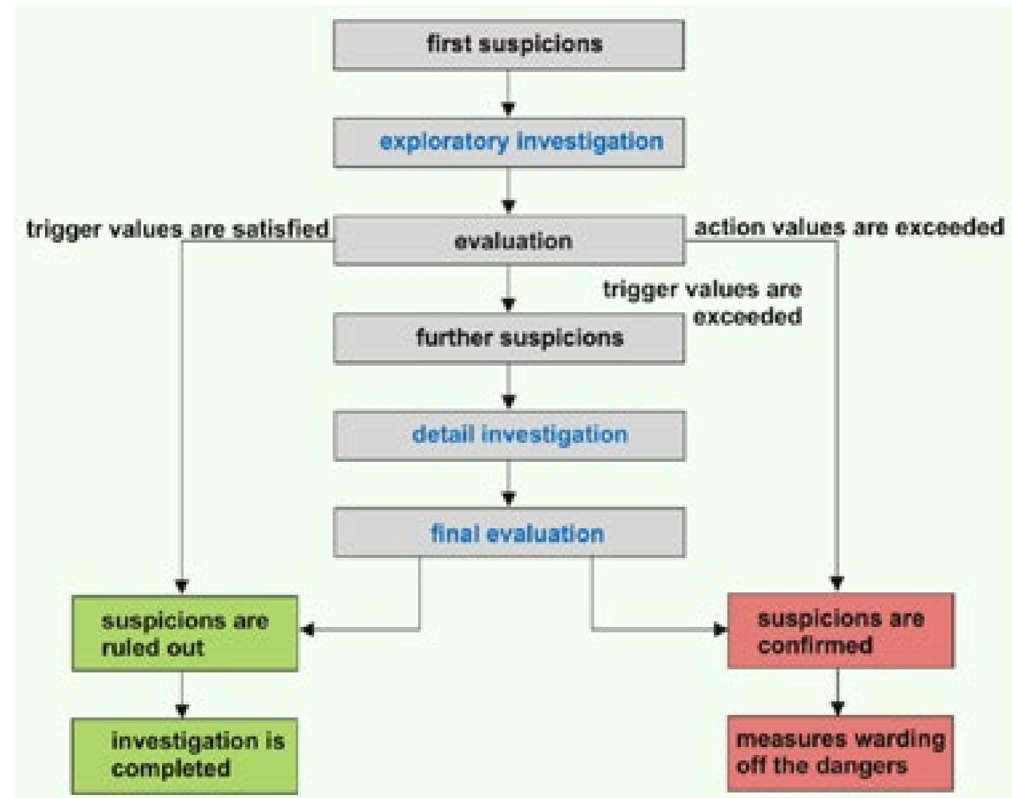

Figure 2: Procedures of investigation according to the Federal Soil Protection and Contaminated Sites Ordinance (Germany)

and their most sensitive mode of action as well as the possible conditions of exposure. The assessment of the toxicity of pollutants is based on toxicological studies and case reports and results in a proposed ADI (Acceptable Daily Intake) for humans. In the next step of the proce-dure, the ADI is combined with a factor (2-10) according to the defined level of protection (averting danger). The resulting so called "danger-related ADI" is used to assess the possible uptake of the pollutant assumed for defined exposure conditions. Standardised scenarios are defined for playgrounds, residential areas, back and small gardens, parks and recreational facilities and industrial and commercial real properties. After comparing the derived trigger value drafts with background contents or other information, epidemiological data (check of plausibility) the trigger values can be proposed (see Figure 1).

When a trigger value is exceeded at the sampling site, it shall be ascertained in the particular case whether the suspected danger resulting from the pollutant has to be confirmed. The flow chart (see Figure 2) gives an overview of the different steps in the procedures of investigation according to the Federal Soil Protection and Contaminated Sites Ordinance (Germany)

Detailed investigation (Assesment in particular cases)

As regulated in the ordinance, detailed investigation shall be the comprehensive further examination for the final hazard assessment which particularly serves the determination of amount on spatial distribution of pollutants, their mobile or mobilizable components, possibilities for their spreading in soil, water and air, as well as the posibility of their intake by human beings, animals and plants.

If humans (for example children who are playing on the ground) ingest pollutants bound to soil, it is not only the total contents that are of relevance to their health, but also the bioaccessibility of the pollutants in the gastrointestinal system. Although the bioaccessibilty and bioavailability can be determined by in vivo studies (for example, mini-pigs), the results cannot be extrapolated directly to humans.

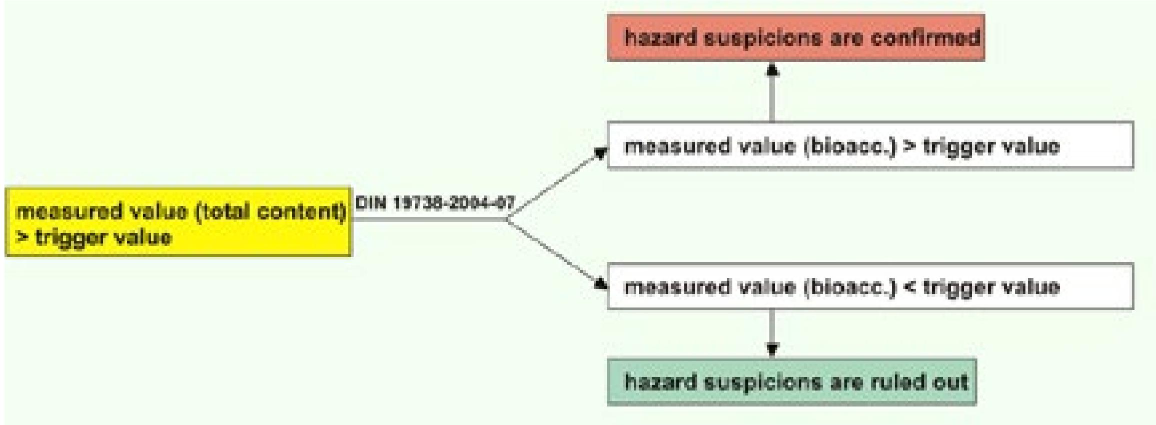

Figure 3: General evaluation of bioaccessible concentrations

A rapid and much less expensive method is to determine the amount of contaminants that can be released from contaminated soil by digestive juices of the upper

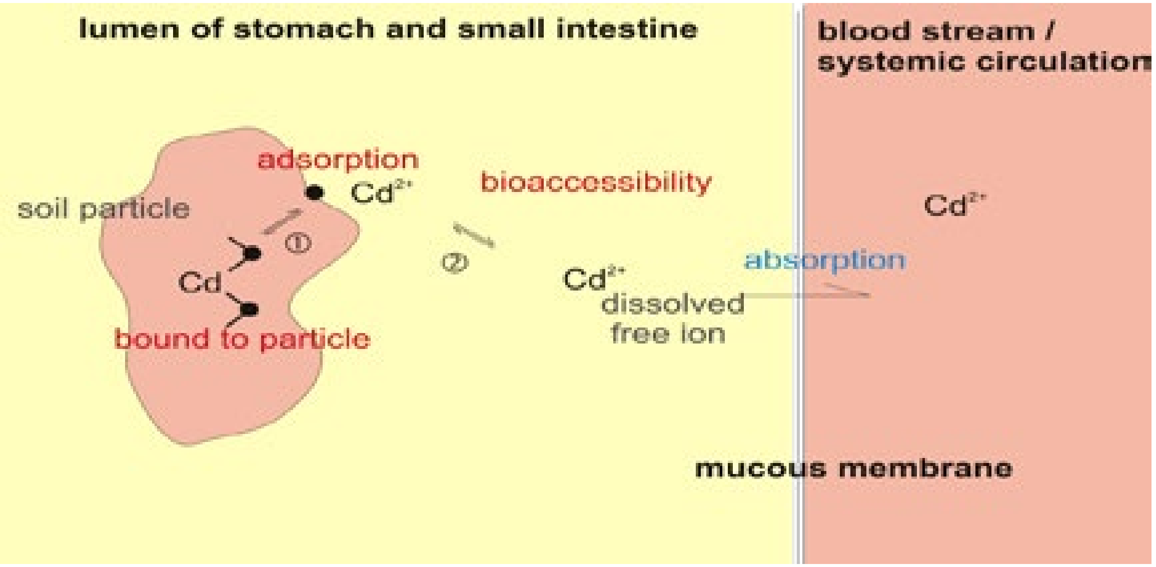

Figure 4: Bioaccessibility of substances bound to soil (oral pathway) – for example cadmium

digestive tract. For that, a standard (DIN 19738 (2004-07) has been developed, which provides the data for assessing the pathway soil-human being (see Figure 3). If the measured bioaccessible content exceed the trigger value, the hazard suspicions are confirmed, whereas hazard suspicions are ruled out when the trigger value i satisfied.

In vitro test system (DIN 19738)

Since it was thought that pollutants ingested with soil particles would become available to the gastrointestinal tract by 100 % (bioaccessibility = 100 %) regarding the analysed total content, DIN 19738 should verify this assumption. As far as is known, only a certain part of the pollutants adhering to soil particles can be set free by mobilization or desorption in the digestive tract. In case of release, these pollutants can be absorbed into the systemic circulation (see Figure 4).

This standard describes a test system for mobilizing contaminants from soil using synthetic digestive juices. Digestive juices are complex solutions of electrolytes, enzymes and digestion aids, whose compositions vary with type, quality and quantity amount depending on exogenous and endogenous factors, a major being the food. So, the experimental set-up and the composition of the synthetic digestive juices are described in detail. To take account of the influence of food components on the mobilization of contaminants, whole milk powder is proposed to be added to the test system.

The standardised model shall be suitable for testing the mobilization of PAH, PCBs, HCB, PCDs, PCDFs, HCH, DDT, endosulfan, propham, chloropham, aldrin, dieldrin, toxaphene and brominated and chlorinated diphenyl ethers. The mobilization capacity of inorganic substances as arsenic, lead, cadmium, chromium, mercury, thallium, antimony or radionuclides can also be examined.

Scope

For more than ten years, this method aimed at examining bioaccessibility by detailed analyses (DIN 19738 2004-07) has been applied in the laboratory successfully. In Germany, a few thousand data are available, especially for arsenic, antimony, lead, cadmium, thallium as well as for organic pollutants as PAH and, in some cases, PCB. In the course of the final risk, this method has been used to gain data basis for final assessments in different cases as former waste disposal sites, former industrial estates, large-area contaminations as a consequence of i.g. industrial emissions or flooding areas along rivers. However, in the daily routine it turned out that several methodological issues regarding reproducibility, conclusive results as well as the efficiency of the method came up. Therefore, it appears to be expedient and promising to streamline the introduced DIN within the scope of a multidisciplinary approach to work. To achieve this aim, the durability of the data basis for risk quantification techniques should be increased further.

Outlook

Currently, the workgroup “bioavailability” of the DIN-standards committee is reviewing DIN 19738. Objectives of this study are to verify the assumption described above and, therefore, DIN 19738 will be used to validate the hypothesis by several examinations. Furthermore, a complete revision and specification of DIN 19738 will be carried out.

The intention of this study is to operationalise the over-all scheme into five working aspects:

A1: Assessment of the shortcoming of the study technique and proposal for priority pollutants.

A2: Sampling and preparation of contaminated soils as well as testing the ruggedness of the technique.

A3: Preparation of the ring test to show the bioaccessibility.

A4: Execution and statistical evaluation of the ring test to display the bioaccessibility.

A5: Updating and presentation of DIN standard 19738.

Currently, the following examinations have been taken to gain further insights on the ruggedness:

• impact of food (milk powder , tinned milk, etc.);

• impact of synthetic digestive juices (amount and activity of enyzyms); and

• duration of the simulation of the intestinal phase.

As a result, a draft of the revised standard method shall be used for comparative interlaboratory tests as well as a basis for the ring test. There will be several examinations to attain more knowledge about ruggedness of the procedural steps, affecting the results distinctly and simultaneously affecting the additional work steps as well. More specific results can be expected in 2014.

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SUMMARY: WORKSHOP BIO AVAILABILITY

J. Harmsen & D. Hennecke
Chaired by Konstantin Terytze & Dieter Hennecke

In risk assessment it is already common knowledge that total concentrations measured in soil often over estimate risks. The available concentration is a better predictor of risks and can often be correlated with effects. Decreasing of the bioavailability is considered as a proper tool to reduce the risks on a contaminated site.

For the estimation of risks it is important to have suitable methods. In Germany incidental ingestion of soil is considered as an important pathway that affects human health. Since 2004 an in vitro method is in use that simulates the human gastrointestinal conditions (DIN 19738). This method is in revision in order to improve the experimental procedure to give more reliable results. Dieter Hennecke and Monica Machtold focussed on their presentation on the aspects that needed improvement. Well defining of additives in the tests (e.g. milkpowder), the use of enzymes and incubation time has been shown to have effect on the results.

The work in Germany will lead to a more robust method that can also be internationally applied.

Joop Harmsen summarized the developments in International Standardization (ISO) on the subject of bioavailability. Besides a guideline on the application of methods, specific methods become or are already available. All ISO-methods must have an understandable chemical-physical base, which is an important aspect for the acceptation of the concept of bioavailability within regulation.

The presentation of Oleg Bogdevich showed that using a remediation process based on biodegradation should be monitored by an experienced and accredited laboratory. For an assessment of the prospects it is necessary to identify the complete spectrum of contaminants and also get information on the geotechnical conditions of the site.

Ion Barbarasa showed that bioavailable pesticides are available for uptake by vegetation as a low tech approach which can easily applied in developing areas. However, to remove all pesticides from a contaminated site will need a long period, which was subject of the discussion after his presentation.

Contaminated sites can also be found in Africa. Joop Harmsen presented the African Approach to reduce the risks on the site. Important methods are stimulation of biodegradation using landfarming or reduction of the availability by isolation of the pesticides. This can be a physical isolation or using of adsorbing material (charcoal).

The use of adsorbing materials (biochar) was further explained by Ines Vogel. She also mentioned the effect on decomposition.

In the final discussion Konstantin Terytze focussed on the future of bioavailability. He stressed the necessity of possibilities to measure bioavailability and the importance of international standard methods. If we do it on the proper way it will become an important tool to better understand the risks on contaminated sites.

GEF/UNEP PROJECTS DEMONSTRATING AND SCALING UP OF SUSTAINABLE ALTERNATIVES FOR DDT FOR THE CONTROL OF VECTOR BORNE DISEASES IN SOUTHERN CAUCASUS AND CENTRAL ASIA

THE EXPERIENCE OF IMPLEMENTATION THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS AT THE REGIONAL LEVEL IN RUSSIA

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After Russian ratification of the Stockholm Convention on Persistent Organic Pollutants (POPs) made in 31.06.2011 Tomsk Public Organization “Siberian Environmental Agency” and Tomsk Green Cross initiated the work on the complete elimination of the pesticides use, which are banned but still exist in the Tomsk region. Our partners in this respect are the Russian Green Cross and Swiss Green Cross.

Figure 1: Location of the Tomsk Oblast in the Russian Federation

We started our work in 2012 from coaching the prospective specialists in the sphere of banned pesticides use according to the standards of FAO. The experts chosen for this purpose were experienced professionals from Georgia and Moldova who already dealt successfully with the pesticides problem in their regions. As a result, 10 experts were trained (e.g. government representatives, nonprofit institutions and enterprises dealing with waste management) according to the programme of banned pesticides use based on the FAO standards. There was also the project of regional level on implementation of the Stockholm Convention created and passed to the local Government of Tomsk region. The plan includes the preparation and implementation of a complete inventory of warehouses and burial banned for use and obsolete pesticides.

Figure 2: Inventory Work during training

During a training inventory of the pesticide DDT burial ground in Teguldet village of Tomsk region soil contamination of vegetable gardens was discovered. The vegetable gardens belonged to the residents of Teguldet village and were close to the pesticide burial ground. The level of contamination of cultivated soil comes up to 11 mg / kg or 110 MPC. Due to our requests, Government began to eliminate DDT burial ground in Teguldet, which approximately contains about 180 tons of DDT and about 14,000 tons of contaminated soil according to the estimation of Tomsk Polytechnic University.

Figure 3: The joint inventory with Green Cross Switzerland

In general, the implementation of the Stockholm Convention at the regional level is hampered by lack of the National Plan of Action for the implementation of the convention. Also obstacle is the strong differences in the approaches of the inventory and repackaging of toxic waste between national legislation and Russian standards FAO.

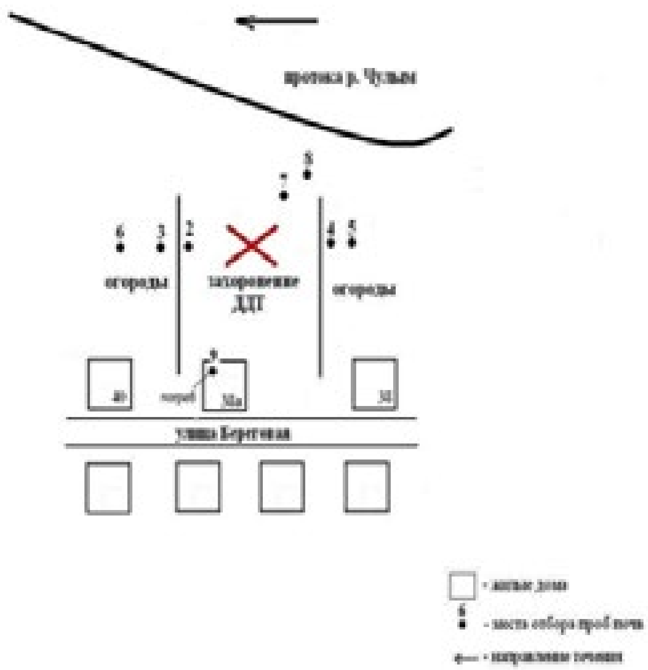

Figure 4: Overview of gardens where samples have been taken

Figure 5: Sampling works in the vegetable gardens belonging to the residents of Teguldet village close to the pesticide burial

SUBSTITUTING DDT IN FIGHTING AGAINST MALARIA

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The uses in disease vector control in accordance with the World Health Organization (WHO) recommendations and guidelines are the only acceptable purposes available for DDT under the Stockholm Convention. Except when locally safe, effective and affordable alternatives are not available for Parties, production and use of DDT be to eliminate. The Convention also invites, with the goal of reducing and ultimately eliminating, the Conference of the Parties to encourage Parties using DDT to develop and implement an action plan including the development of regulatory and other mechanisms to ensure that DDT use is restricted to disease vector control and implementation of suitable alternative products, methods and strategies, including resistance management strategies to ensure the continuing effectiveness of these alternatives. It also invites Parties to take measures to strengthen health care and to reduce the incidence of diseases.

Currently WHO recommends that in areas targeted for malaria vector control, all persons at risk should be protected by Insecticide Treated Nets (ITNs) or Indoor Residual Spray (IRS). The choice of ITNs or IRS depends on entomological, epidemiological, and operational factors including seasonality of transmission, vector survival and behavior, and insecticide susceptibility of anopheline vectors[1] . There are 14 insecticide formulations from four different chemical classes are recommended by the WHO for IRS. There are seven pyrethroid based insecticide formulations recommended for ITN.

Among major challenges in effective control of vector, accessibility to effective alternatives and capacity for their efficient implementation towards sustainable control are common in many developing countries. Safer and more efficient vector control interventions are generally associated with high operational cost to maintain the disease transmission. It is important that the decisions, both at national and local level, are taken on scientifically sound basis with adequate knowledge of the local data for efficient control and management of vector resistance. Assurance of desired standards in product quality and IRS operations are the key factors of successful vector control programmes found challenging in certain settings.

Substitution of DDT with another safer alternative product requires adjustments to the programme that entail the need for supplementary resources. It would include human and physical resources, knowledge, additional data and related technical and scientific information. Unless the vector in question has developed resistance to DDT, from the operational point of view, there is no immediate economic incentive to switch to a new product. Instead, it should be seen and implemented as an alternate management strategy of the vector for long term health and environmental benefits. Integrated Vector Management (IVM), is a *"rational decision-making for optimal*

1 World Malaria Report: 2012, World Health Organization.

use of resources" *(Source-WHO)*. Once adapted to the local situation, the IVM approach should provides a way forward for a sustainable solution to the programme managers. For successful implementation of IVM, among others, it requires an efficient inter agency coordination mechanism with a system in place for the collection of vital field data.

There are many new researches into testing and validation of the effectiveness and role of innovative new approaches as well as traditional pest control methods in vector control. While some are of bio and botanical origin, others range from molecular biology to environmental engineering. Some of the techniques and approaches currently being developed could potentially play an effective role within IVM approach. The limitations in deploying them under varying conditions, the demand of knowledge-intensive operations and poor statistical power of the existing results are some of the challenges to overcome. However, case studies from different parts of the world are available on successful employment of some of those techniques, along with conventional vector control interventions, both for the control of malaria as well as towards its elimination.

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PROBLEMS OF DDT IN AZERBAIJAN

Azerbaijan has always been an agricultural republic; it was supplying the country's population and big cities of the former Soviet Union with fresh vegetables, fruits, grapes, and other products. The country's strategic crop- cotton was grown on large areas, in more than 20 regions. The crops needed to be protected from pests and diseases, and many pesticides had to be used for that purpose.

Until 1958, to fight cotton pests, a product DDT was being imported to the Republic of Azerbaijan from different countries. After the start of the DDT production in Sumgait plant "Himprom", import from other countries stopped and it should be noted that Azerbaijan was sending DDT production to other regions of the former Soviet Union. Though the plant capacity was 60,000 tons per year, about 20,000-35,000 tons were produced annually.

In 1975, the usage of DDT in agriculture was forbidden; nevertheless, the product was used until 1990 as there were no alternative products against cotton pests.

In 1980, huge pesticides residues were formed in the Republic of Azerbaijan, which went out due to usage prohibition, ineffective purchase planning, products distribution, and pesticide demand reduction due to their ineffectiveness and large volumes of cheap products being delivered.

In 1985-1995, the remaining residues of pesticides, including DDT, were buried in Dzhangin landfills. During this period, about eight thousand tons of different chemical pesticides were buried in 183

№	Year	Tons produced	№	Year	Tons produced
1.	1958	1216		1970	25122
2.	1959	5412		1971	12496
3.	1960	19939		1972	14805
4.	1961	18874		1973	11133
5.	1962	25647		1974	21931
6.	1963	27061		1975	21133
7.	1964	36200		1976	22257
8.	1965	35093		1977	26221
9.	1966	29102		1978	23400
10.	1967	21823		1979	27428
11.	1968	27717		1980	5246
12.	1969	21293			
Total: **480549**					

Figur 1: DDT production in Sumgait Himprom (1958-1980) in tons

landfill bunkers; more than half of them was DDT. Prior to the reorganization of "Azerselhozhimii", the site was secured, and, from 1996 till 2005, due to the lack of protection, almost half of the products were taken out/stolen from the bunkers. In Azerbaijan, there is only one landfill (Dzhangin landfill) for pesticide disposal (there is also a landfill for hazardous waste of the Ministry of Ecology and a landfill of Emergency Situations Ministry, but neither of them contain pesticide waste).

In December 9th, 2003, the Republic of Azerbaijan ratified the Stockholm Convention "Persistent Organic Pollutants". To solve the problem arising from the Stockholm Convention, Presidential Decree of July 29th, 2004, the National Coordinating Center under the Ministry of Ecology and Natural Resources was established.

For the first time, in Azerbaijan, the inventory of obsolete, banned and unusable pesticides balances began in August 2006. Specialists of the State Phytosanitary Control Service together with the specialists from the Ministry of Ecology and Natural Resources in the framework of National Implementation Plan under the Stockholm Convention on Persistent Organic Pollutants, held a joint work to identify them.

Based on the monitors held, the original data was received. During the inventory, different residues of obsolete and POPs pesticides were found; many of them were mixed (DDT, granozan, izofen, dalapon, treflan, Zineb, hexachloran, hometsin, sulfur mixed with izofenom, etc.). Besided barrels of polidofen that contain 20% of DDT were detected in Salyan and Ganja. Large areas of land contaminated with pesticide residues were revealed.

By the end of the inventory, the National Implementation Plan under the Stockholm Convention was prepared and submitted to the Government for approval, but so far the plan has not been approved.

In September 2006, the problem of obsolete, banned and unusable pesticides by the Order of the President of the Republic of Azerbaijan "Comprehensive Action Plan for ecological improvement of the Republic of Azerbaijan in 2006-2010" was approved. Paragraph 5.11 of the Comprehensive Plan is entirely devoted to the inventory, collection and disposal of obsolete, banned from using toxic substances and the reconstruction of the landfill for pesticides. The realization of the targets of the Comprehensive Plan item was entrusted directly to the State Phytosanitary Control Service at the Ministry of Agriculture of the Republic of Azerbaijan.

The initial target of the Comprehensive Plan was Dzhalangin landfill transmission at use of the public service and its comprehensive reconstruction.

Currently, landfill acts as industrial structure, funded by the state, which has its director, chemists, workers and other personnel. The entire territory of the polygon perimeter is fenced with a metal lath; gates, water tank and fire safety system were installed. During the period 2008-2010, the landfill has been completely renovated, and more than 4,000 tons of solid residues of pesticide and contaminated soil from different regions of the country were transported and disposed of. Filled bunkers were tightly closed with concrete slabs. Up to date, the volume of buried pesticides at Dzhalangin landfill is about 9,000 tons of banned, obsolete pesticides and POPs and heavily contaminated soil.

In the framework of "Comprehensive Action Plan for ecological improvement of the Republic of Azerbaijan in 2006-2010", a warehouse for storage of liquid pesticides was built in 2010, 60 bins for solid pesticides were built, half of which had already been filled.

Besides DDT, a liquid preparation Polidofen 60 %, which contained 20% of DDT + 40 % of polychlorocamphene against pest of different crops was used in the Republic. This preparation had been lying in one of the warehouses in the city of Ganja until 2010. In 2010, after the allocation of funds from the "Comprehensive Action Plan for ecological improvement of the Republic of Azerbaijan in 2006-2010", around 1180 barrels of polidofen were repackaged and 200 pallets were transported to the Dzhalangin landfill (for storage of liquid pesticides a new warehouse was built in 2010) for storage until complete disposal.

The site in Salyan region is in a critical condition now. Liquid polidofen has leaked on the ground from old rusted barrels. It should be noted that close to it living quarters, warehouses for food storage are located; the warehouse is located within the district center. In this region, the groundwater is shallow, and the Kura River, which falls into the Caspian Sea, flows nearby.

At the site of Daykend Salyan district, polidofen residues were buried in the ground. During recent inventory, while excavating, rusty pesticides barrels were found.

There is a big problem with repackaging and disposal of the existing liquid pesticides at the landfill. Some barrels, which had been repackaged in Ganja in 2010, are already showing leaks.

INFORMATION ON DICHLORODIPHENYLTRICHLOROETHANE (DDT) IN RUSSIAN FEDERATION

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Currently, the use of DDT is banned in most countries. The sequence of introducing the ban was as follows: New Zealand, the USSR, Hungary, Sweden, Denmark, and Finland, followed by some other countries. However, the ban on the use of DDT does not exist in all countries. Besides, many countries have solid stocks of DDT.

In the USSR, active production and use of DDT began in 1946-1947, when the plants were built in Moscow, Dzerzhinsk and Cheboksary. During 1950-1970, about 20 tons of herbicide was used per year, resulting in a huge amount of contaminated land across the whole area of former Soviet Union.

Regions	Year	Use of DDT, tons
Belgorod	1982	28,9
Voronezh	1982	4,1
Kursk	1978 1982	14,5 19,9
Lipetsk	1978	8,4
Samara	1987	2,9
Tambov	1978 1979	36,6 23,4

Table 1: Amount of DDT used in different regions of Russia

The first country where DDT was banned was New Zealand, and the second - the USSR. However, this prohibition had some exceptions: the use of DDT was allowed in cases of malaria in the taiga regions, in the foci of tick-borne encephalitis, which can effectively be dealt with by means of DDT.

In 1969-1970, DDT was excluded from the official list of pesticides used in the USSR. Even then, the production and use of DDT has not stopped. Even in 1986, 16 years after the official ban, DDT production volume accounted for10 thousand tons per year. Until the late 80s, DDT was used "as an exception" in Uzbekistan and

in many regions of Russia.
As a result, about 20% of the fertile soils in the former USSR are contaminated for many years. With normal care for the soil, 0.5-1 ppm in 1960-70 and 0.1 ppm in 1981, respectively, in many places the amount of DDT in soils was 5-10 times higher, and in the cotton growing regions of Uzbekistan, the excessive amount of DDT reached 85 times.

DDT treatment of gardens and woodland many years ago led to the fact that its content in the soil in these areas is very high. Now, in many places, instead of fruit trees, other crops that can accumulate DDT from the soil are being grown, which causes it getting into the food of animals and humans.

In 1975, DDT was contained in 8% of meat samples, 5-10% of root crops and potato samples. In 1988, 30% of the samples of milk powder for baby food and, in 1989, 52% of dietary oil samples - the amount of DDT exceeded the permitted limit 5 times.

Officially, in the former USSR, the content of DDT in meat, butter, milk and eggs in general was "not allowed". However, some "temporary" rules have always been introduced. So, over a period of 15 years, after the ban of DDT, "temporary" MPC value (mg / kg) for milk in children's diet accounted for 0.05, 0.1- for eggs and meat and 0.2-for canned fish.

Although the use of DDT and other organochlorine pesticides was banned in Russia in the 1980s, they still remain in the environment and continue to accumulate in the food chains. Studies indicate that these chemicals are endocrine disruptors and can cause cancer. Some studies suggest that they are associated with an increased risk of lymphoma.

In early September 2013, an article about the effects of banned and obsolete pesticides on boys who live in Russia near the closed factories, which produce pesticides (Chapayevsk city, Samara region), or drink local milk. The article was published in Environmental Health News by the researchers from Russia and Harvard University in the USA. The aim of this study was to understand why the children's bodies contain extremely high concentration of such hazardous chemicals as DDE, hexachlorobenzene and beta-hexachlorocyclohexane.

In Chapaevsk, between 2003 and 2005, the blood of 350 boys aged 8 to 9 years was investigated. The average levels of pesticide concentrations in the blood of boys in Chapaevsk city happened to be 3 to 20 times higher than the similar levels of pesticides in the blood of their peers in America.

If boys drank milk of local production, the concentration of DDE, hexachlorobenzene and beta-hexachlorocyclohexane was 14 - 21 percent higher in the blood of boys who were breastfed for more than 13 weeks, the concentration of organochlorine pesticides was at 16-81% higher than that of boys who drank breast milk for less than 13 weeks. (Source: http://www.environmentalhealthnews.org/ehs/newscience/2013/09/russian-boys).

Considering the fact that about four children die from malaria every minute, mostly in sub-Saharan Africa, most of the doctors insisted that DDT remains the best weapon in the fight against this disease. However, there are a number of objections in this respect.

There are ongoing international initiatives to promote the development of alternative insecticidal compounds and technologies to use in the fight against malaria.

Only in those areas where alternative methods of malaria vector control are not widely available, the use of DDT may be justified. In some regions of India and

South America, mosquitoes are resistant to DDT. In some countries, impregnation insecticide-treated bed nets help in the fight against malaria.

The main objective for today is to eliminate the use of DDT in agriculture, keeping it as a reliable tool when fighting against malaria, which, however, can be used only under certain conditions until they become publicly available alternatives.

DDT was produced in the USSR, both in the form of technical product, and in a series of formulations, i.e. 5.5% and 10% of dry powder, 30% and 75% of wettable powders, mineral-oil emulsion," insecticidal" formulation, polidofen (mixture made of 20% to 40% of DDT and toxaphene) and several others.

Currently, the production of DDT in Russia (Dzerzhinsk) is inhibited, but one can make a product with the special permission for disease vector control.

Today and in the short term, DDT is used as a means of combating infectious diseases. This is explained by the danger of such natural focal diseases as plague and zoonotic cutaneous leishmaniasis. It should be noted that in the Russian Federation in the three regions of Southern Siberia, there are natural foci of plague (Transbaikalia, Tuva and Gorno-Altai foci). There is some data on other, smaller outbreaks in Russia (Southern Urals, south of the European part).

Upon the ratification of the Stockholm Convention, the Russian Federation in accordance with Part II of Annex B entered in the DDT Register maintained by the Secretariat and notified the World Health Organization about that.

Regulation of POPs Pesticides and DDT

1. The Federal Law "On the safe handling of pesticides and agrochemicals" (№ 109-FZ of 19.07.1997, as amended on 04.10.2010), approved by the Ministry of Agriculture, provides the legal framework for the safe handling of pesticides, including their storage, destruction and disposal. Under the Federal Law, any kind of treatment from pesticides and agrochemicals, which are not included in the "State catalogue of pesticides and agrochemicals".

2. Rospotrebnadzor Letter from 22.05.2009 № 01-6985-9-32 "On the burial of unusable and banned pesticides," reads as follows: recycle worn-out and (or) banned pesticides and agrochemicals (waste hazard classes 1-2), should be carried out at the sites of toxic waste by dumping or destruction by incineration at high temperature incinerators. Disposal practices must be carried out in accordance with the requirements of sanitary legislation, destruction technologies should be allowed in the prescribed manner.

3. The Federal Law "On Production and Consumption Waste" (№ 89-FZ of 24.06.1998, as amended on 30.12.2008); organization of activities in the field of waste management, including banned pesticides, the territories of municipalities formations carried out by the local government.

4. The FTP "National System of chemical and biological security of the Russian Federation (2009 - 2013)", approved by the Government of the Russian Federation on 27th October 2008, № 791. "Development of technologies for destruction (recycling) of PCBs stockpiles of pesticides and agro-not sought after in the industry and agro industry" project is being implemented. The development of technologies is to be completed in 2013 with the creation of a technological complex in technological development test center in Shihany city and testing a prototype plant.

5. The subjects of the Russian Federation

implement special programs or legislation acts so as to destroy obsolete and banned pesticides. The amount of funding for these programs in 2008 was estimated as 340 million rubles.

Activities on Inventory of POP pesticides

The priority objectives with regard to the solution of the POPs pesticides problem are as follows: conducting a full-scale detailed inventory and registration of stocks of pesticides, their locations, their containers and contaminated land. The inventory should be accompanied by efforts to identify unallocated drugs and mixtures.

Measures to ensure the security of stockpiles of POPs pesticides

Designated storage of obsolete pesticides, as well as their place of burial represent a potential danger to the environment and human health because of the migration of pesticide residues due to leaching, volatilization, and other processes beyond these locations and the subsequent circulation of toxicants in ecosystems and the food chain. These objects are a typical example of point sources (in some cases very intense) of the environmental pollution by obsolete and POPs pesticides.

Measures to ensure the disposal of stockpiles of POPs pesticides

SPP, including POPs-containing, are largely represented by multicomponential mixtures of organic and inorganic compounds. There are various methods of neutralization of SPP, including POPs pesticides. These include thermal methods (high temperature combustion in stationary and mobile applications, combustion in cement plants, plasma pyrolysis and others), physico-chemical methods (hydrolysis, ozonation, etc.) and some others.
It should be noted that so far there is no allowed for practical use method of pesticides elimination in the country.

Activities on Environmental Monitoring of storage and destruction of POPs pesticides

Monitoring of the technological state of burials, as well as periodic monitoring of ecological and toxicological areas adjacent to these graves is extremely important. Similar ecotoxicological monitoring is also needed in those facilities that store obsolete pesticides (warehouses, adapted premises, etc.). In the latter case, the area adjacent to such facilities, and often has a high level of contamination, even after the removal of these pesticide products, for a long time, can serve as a source of secondary pollution by pesticides.

In-depth inventory of the Project ACAP / ANO "CIP" on "Environmentally sound management of obsolete pesticides stockpiles in the Russian Federation"

Figure 1: Ruined warehouse on the territory of MUP DSOK "Taiga"

Figure 2: Contents of the iron container with pesticides in the former SUE "Krasnoyarsk"

Figure 3: Warehouse number 3 with an extension; village Beryozovka

Figure 4: Iron container in the Kiai village; inside view

The results of in-depth inventory of the Project ACAP / ANO "CIP" on
"Environmentally sound management of obsolete pesticides stockpiles in the Russian Federation"

Table 2
The status of stocks of obsolete pesticides (in tons) in the northern pilot regions of the Russian Federation in June 2012

Region	Total number of SPP		Total number of SPP exported to landfills	Number of remaining SPP on placements in June 2012
	Identified within the project	Identified in conjunction with the region		
Arkhangelsk region	62, 8	74,8	71,0 Krasny Bor Obninsk city, Kaluga region	1,5
Altai Republic	223,5			7,5
Altay region	4 972,0 on 11.09 500 tons liquid	5012,000 500 tons liquid	216 tons exported to Tomsk and Krasnoyarsk polygons	4 299,32
Komi Republic	23, 107		20 tons to the landfill Krasny Bor in 2005	4.8 tons (including newly discovered) in a renovated warehouse in Syktyvkar
Magadan region	23, 400			0

Omsk region	540, 038			
Sakha Republic (Yakutiya)	192, 000 liquid 1 505 m	360,74	SPP 1505 and 262.4 m3 polygons Krasny Bor and the Krasnoyarsk Territory. In 2012, planned removal of 30 tons	98,27 tons
Tomsk region	120, 509			
Tyumen region	314, 400	587,600	537,000 to the landfill "Red Forest" in 2007 49, 00 to the landfill "Green City" in 2010 3 burial liquidated in Tobolsk district	1,600 tons in the south of the Tyumen region

Krasnoyarsk region	280,000		90,000 on the ground "Green City"	About 300 tons in 14 eastern districts of the region
Murmansk region			4, 800 removed in 2008-2011	In 2011, the region of SPP and unauthorized storage areas have been identified
Kamchatka region and Chukotka Autonomous District		51, 280	In 2011, 51.280 exported by OAO "Polygon" of Tomsk region	0
Total (kg)	**6 752 647** liquid mixture **1 505 m³**			

This table has been prepared based on the information of the regional offices of the Federal Service for Veterinary and Phytosanitary Surveillance, the Ministry of Agriculture and Food Policy of the Republic of Sakha (Yakutia), the Committee of industrial development, ecology and nature of the Murmansk region in the ACAP project "Environmentally sound management of stocks of obsolete pesticides Russia " on 27.07.2012.

Preparation of SPP storage

Figure 5: The former hangar for Rockets Poplar, Altai region

Figure 6: Hangar equipped for storage of SPP, Altai region

Figure 7: Hangar filled repacked SPP, Altai region

Figure 8: Ruined central warehouse for the storage of pesticides in Syktyvkar

Figure 9: Warehouse Renovated

In the Baikal natural territory (BPT), the presence of residual amounts of obsolete POPs pesticides has also been noted. The soil contaminated by DDT was detected in all the surveyed areas of the Irkutsk region in 2011, which are located in the basin of the Angara River. The analysis results showed that the average content of total DDT in the soils studied all kinds of areas under crops was 0.15 and 0.14 in the spring of MPC autumn. Exceeding the maximum allowable concentration level of total DDT in the soils found in the territory of the Irkutsk region in the fields of "Khomutovskaya" and JSC "Shiryaevo" Where in the watershed of the river ("National Report on the State and the Environmental Protection of the Irkutsk region" in 2011).

Improvement of Legislation

One of the most convenient operating mechanisms is currently amending the relevant federal laws and regulations.

As a *basic principle* of the new system of regulation, *the transition to the best available technology* (BAT concept) must be implemented. To bring the legislation in line with the *Stockholm Convention on persistent organic pollutants*, the work should be is carried out taking into account the provisions laid down in the *Basel Convention (on the control of transboundary movements of hazardous wastes and their disposal) and the Rotterdam Convention (on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade*, which are interrelated.

In connection with the adoption of the Law on "On technical regulation", it seems that the prime direction of harmonization (unification) of national legislation, because of the ratification of the Stockholm Convention, is the development and adoption of appropriate technical regulations.

Prohibited and obsolete pesticides and waste generated during production or use, pose a significant threat to the environment, and their destruction is one of the most important tasks in terms of the environmental protection.

However, there is no generic method to solve this problem. The most common ways to dispose of hazardous waste, which can be rightly classified as pesticides, are burning and burial on specially engineered landfills. The biological, chemical and physical treatment methods are also used, which leads either to the complete destruction of toxic components, or to the substantial reduction of their hazards.

Unfortunately, the issues of environmental safety, when handling pesticides at the state level, have not received sufficient attention in the last few years. The Federal Law "On the safe handling of pesticides and agrochemicals" (Article 24) identified the need to recycle and dispose of pesticides, but bylaws provisions establishing the realization of this problem have not yet emerged. Until now, Russia does not have any existing plant for the destruction of POPs waste.

Even without a full analysis of the current situation, there is no reason to believe that it is necessary to urgently conduct an inventory of obsolete pesticides and their placement of objects, providing optimal storage conditions, increasing responsibility for the complete safety of all subsequent accounted range and deployment of the technologies, on the destruction of POPs pesticides, existing in Russia.

PROMOTING SUSTAINABLE ALTERNATIVES TO DDT FOR THE CONTROL OF VECTOR-BORNE DISEASES IN SOUTHERN CAUCASUS AND CENTRAL ASIA

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The "Demonstrating and Scaling up sustainable alternatives to DDT for the control of vector-borne diseases in Southern Caucasus and Central Asia" project, funded by GEF and executed by UNEP, WHO, Green Cross Switzerland and Milieukontakt International and participating countries is being presently implemented in Georgia, Kyrgyzstan and Tajikistan, and the WHO Regional Office for Europe is responsible for the health part of this Project.

The Project is built on the existing efforts of countries, WHO and other partners to promote cost-effective and environmentally sound national vector control policies and strategies aimed at reducing the reliance on persistent insecticides.

The main objectives of the health part of the Project is to demonstrate the viability, efficiency and cost-effectiveness of the sustainable alternatives to persistent insecticides, including DDT, in pilot areas of the participating countries, to build capacity to plan and implement vector control interventions based on principles of Integrated Vector Management (IVM) and to share the project lessons learnt and experience accumulated within and beyond the European Region.

During 2011-2013, different alternative vector control methods and techniques were monitored and evaluated in demonstration sites, and outcomes of these studies are being currently processed and analysed. Promoting such alternatives for vector control heavily depends upon active community participation and intersectoral collaboration. In recent years, a particular attention has been paid to strengthening of the national institutional and management capacities for planning and implementing vector control activities based on the IVM principles at central, intermediate and peripheral levels. A regional approach on IVM is extended within the countries of South Caucasus and Central Asia to involve non-project countries. It is expected that a final project report with conclusions and recommendations will be published by the middle of 2015.

SAFEGUARDING OF DDT AND ASSOCIATED WASTE IN GEORGIA, KYRGYZSTAN AND TAJIKISTAN

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FAO Consulatamt

Besides certain limitations, current POPs stocks dating from the Soviet times are unofficially still available to the general public through illegal repackaging of abandoned stocks and/or cross-border smuggling. Although official statistics do not show the use of DDT, environmental monitoring activities by the governmental institutions in some countries of the region show indiscriminate use of DDT, largely in the sector of agriculture, but also in disease control (typhus) resulting in increased health and environmental risks. In response to this challenge, the GEF-UNEP Project, entitled Demonstrating and Scaling up Sustainable Alternatives to DDT for the Control of Vector Borne Diseases in Southern Caucasus and Central Asia (in short: the DDT-project), aims to: (a) demonstrate the applicability and cost-effectiveness of alternatives to DDT for vector control in the selected demonstration sites (outcome 1); (b) develop national capacity for planning and implementation of vector control in the context of integrated vector management (IVM) (outcome 2); (c) identify and manage DDT stocks and waste (outcome 3), and (d) coordinate dissemination and sharing of country's experiences among the other countries and regions concerned (outcome 4).

In relation to outcome 3, the Project aims at:

• undertaking an integrated management approach for the participatory safeguarding of (on average) 60 tonnes of prioritised POPs stockpiles per country and the development of participatory disposal concepts (mainly DDT) as an example for similar projects in other countries of the region;

• presenting measures to safeguard stockpiles; and

• communicating on the hazards of DDT to specific target groups.

The Environmental part of the DDT project will assist participating countries with identification, inventory, priority setting, re-packaging, safe interim storage and development of plans for final disposal of DDT-containing stockpiles, taking into account respective country needs, availability of disposal facilities in the country and region, and more broad work in the area of obsolete pesticides and other relevant initiatives.

Georgia

In February 2011, the Inception Meeting for the DDT-project was organised in Tbilisi. The Ministry of Environmental Protection (MoEP) of Georgia was represented at this meeting by Khatuna Chikviladze, and the discussions about how to set up the Environmental Part of the Project in Georgia were initiated. Additional meetings took place during the HCH Forum in Gabala, Azerbaijan (September 2011) between MKI, Green Cross and a representative of the MoEP and the Ministry of Agriculture (MoA). At the Steering Committee meeting in Bishkek (Kyrgyzstan), in November 2011, the MoEP was not represented, but the

National Environmental Agency from Georgia participated in the meeting upon request of the MoEP. The last meeting then took place in June 2012 in Tbilisi with Ekaterine Imerlishvili, the successor to Khatuna Chikviladze. Despite the numerous discussions, no final joint view on the roles and responsibilities between the different project partners could be reached and as a result no activities have been carried out within the DDT-Project in Georgia so far.

During the SC meeting (September 2012) in Chisinau (Moldova) of the EU FAO Project on Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union, the UNEP representative Martin Murin, MKI, Green Cross and MoEP representative Ekaterine Imerlishvili had another meeting and decided on the following steps to be taken (see also the e-mail sent by UNEP representative Martin Marin on 25.09.2012 to Ekaterine Imerlishvili and Project partners):

1. The MoEP has several times expressed the wish to complete a nation-wide inventory in Georgia. Therefore, the MoEP will send a request to Green Cross (as Executing Agency of the DDT Project) to provide support to finalising a nation-wide inventory of obsolete pesticides in Georgia with the support by the DDT project;

2. Based on a positive response, MKI, in close cooperation with the MoEP, will prepare the scope of the inventory, Terms of References, a financial plan and a time plan;

3. These documents will, after review by GC/UNEP, be approved on the level of the Georgian National Steering Committee;

4. Execution of the inventory is planned for early 2013. The national inventory will include analytical laboratory identification of samples (especially for DDT, as the DDT project plans to repack DDT or associated waste);

5. Based on the inventory data and project results from the UNDP project at the Lagluja landfill, the priorities will be agreed upon between the DDT Project partners and the Georgian National Steering Committee on repackaging. These priorities should whenever possible allow the DDT-project to reach its goal of repackaging 60 tonnes of DDT or associated waste;

6. The awareness raising campaign, which is part of the DDT project, will be planned and agreed upon by MKI and the MoEP in consultation with GC/UNEP, and agreed at the national level.

For defining the scope of the inventory in Georgia, the MoEP needs to inform the DDT-Project about the inventories that already have been undertaken in the country, the amount inventoried as well as an estimation of how many sites still need to be inventoried. The Ministry of Agriculture has recently inventoried 15 sites within the FAO GEF project on Capacity Building on Obsolete and POPs Pesticides in Eastern European Caucasus and Central Asian Countries (EECCA project). It can be that no or few additional sites for inventory will be found. In that case, the scope for finalizing the national inventory in Georgia can focus on consolidation of existing inventory data (into PSMS), on checks of existing inventory data when deemed necessary and possibly research into smaller stocks of obsolete pesticides (establish if such smaller amounts exist and estimation of amounts). In the last case, it can be that such an inventory is a part of an NGO information campaign; individual farmers and citizens will have to be approached as often individuals own smaller amounts of obsolete pesticides. The people already trained on inventory and PSMS from previous projects (e.g. EECCA-project) are expected to be involved in the finalisation phase of a full nation-wide inventory.

As funds for POPs inventory and safeguarding are very limited, the DDT Project looks at coordinating efforts between projects (e.g. EU FAO, EECCA, FAO-TPP projects) and tries to support countries on issues that have not been or will not be addressed by the other projects. The idea is that projects will do follow-on steps and do not overlap. Persons trained in one project are involved in other projects where possible. When there is a need additional persons will be trained in the country in order to establish or broaden local capacity. For Georgia this means that the EECCA project has trained persons on inventory, PSMS, repackaging and awareness raising and supported the country in executing an inventory of 15 sites. The DDT project will - as discussed above - support the country with further inventory (with a special interest in DDT stocks and associated waste) and with a pilot project on repackaging (again of DDT or associated waste) of approximately 60 metric tonnes. Finally the above mentioned EU FAO project will support the country with disposal of these stocks. A schematic reflection of cooperation between projects in the case of Georgia is as follows:

Where possible cooperation will be established with the ongoing UNDP project at the Iagluja dumpsite in Georgia.

Kyrgyzstan

The DDT Project looks at establishing synergy between projects and tries to support countries on issues that have not been done or will not be done in other projects on obsolete pesticides. The idea is that projects will do follow-on steps and do not overlap. Persons trained in one project are involved in other projects where possible. When there is a need additional persons will be trained in the country in order to establish or broaden local capacity. The DDT project agreed to cooperate with the FAO/Turkey Partnership Programme Initiative for Pesticides and Pest Management in Central Asia and Turkey, 2010-1012 (FAO-TPP project), that is active in Kyrgyzstan as well. The overall objective of this project is to assist the countries of Central Asia, with a specific focus on Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan, to reduce risks to health and environment from obsolete pesticide stockpiles and from pesticides in current and future use. The project outputs will be: a) a detailed inventory of obsolete pesticides b) technical capacity building to strengthen pesticides management, and c) implementing proven methodologies for obsolete pesticide management and pesticide risk reduction.

Within the FAO TPP project, a training on inventory was held 19-29 June 2011 in Bishkek, Kyrgyzstan. Several participants from Kyrgyzstan attended this training:

1. Janybek Derbishaliev - Head of the Department of Chemicalisation and Plant Protection, Ministry of Agriculture;

2. Vladimir Pak – Deputy Head of Department of Chemicalisation and Plant Protection, Ministry of Agriculture;

3. Almaz Alakunov – Chief Specialist of Department of Chemicalisation and Plant Protection, Ministry of Agriculture;

4. Keneshbek Jumabekov - Senior Specialist, State Ecological Control Department, Ministry of Environment;

5. Gulnara Saryeva - Sanitary Inspector, State Sanitary Epidemiological Department, Ministry of Health;

6. Indira Zhakipova – NGO EKOIS and local MKI coordinator DDT project

After this training, between 11-16 March 2012, FAO consultant Khatuna Akhalaia guided the inventory team (in which all above mentioned persons took part) during the first phase of the inventory. Khatuna Akhalia visited Kyrgyzstan again between 17-23 September 2012 at the start of the second phase of inventory. The FAO TPP project conducted inventories at 119 sites in Ysyk-Kul Oblast, Narin Oblast, Talas Oblast and Batken Oblast. Jalalabad and Osh Oblasts were not inventoried in the frame work of the FAO TPP project because it was done already within a MKI project (2006-2008) and TAUW World Bank project (2008-2009). Currently a nation-wide inventory in Kyrgyzstan has been finalised.

In December 2012, a training on FAO's Pesticides Stock Management System is planned to be organised. This will provide the country with the tool to have all inventory data consolidated and to have an overview of which sites pose the largest risk with regard to pesticides and environment.

In early November 2012, MKI representative Wouter Pronk will visit both Tajikistan and Kyrgyzstan. One of the aims of this mission is to meet with the structures that can serve as the coming National Steering Committee for the DDT project and also other projects (such as the EU FAO-project Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union, that has started in Kyrgyzstan already and is expected to start in Tajikistan in the near future). UNEP representative Martin Murin has visited Kyrgyzstan in July 2012, amongst others to communicate the necessity of the NSC to the country and to discuss the set-up of such an NSC. After the PSMS data are clear, MKI will make a repackaging plan and budget plan and will look to repack 60 tonnes of DDT or DDT containing waste from priority sites. This plan will be sent to the NSC for endorsement.

Based on the FAO TPP project's finalisation of the nation-wide inventory in Tajikistan and the risk priorities endorsed by the NSC, the DDT project will then take the next step and use the inventory data to make a repackaging plan for approximately 60 tonnes of DDT or DDT containing waste. The EU FAO-project will follow up with disposal of the 60 tonnes of repacked DDT and DDT containing waste, and will also research possibilities of disposal of approximately 90 tonnes of repacked obsolete pesticides that is currently stored in Osh Oblast. A schematic reflection of cooperation between projects is as follows:

A point of concern at this moment for Kyrgyzstan is the fact that cross border transport of hazardous waste may be problematic and therefore it may take time before the repacked waste can be disposed of. This may mean that the DDT project will look into possibilities of supporting the country with interim storage of the repacked 60 tonnes of DDT and DDT containing waste. A preferred solution is however to repack only once it is clear that the repacked waste can be transported immediately within the EU FAO project.

Tajikistan

The DDT Project looks at establishing synergy between projects and tries to support countries on issues that have not been done or will not be done in other projects on obsolete pesticides. The idea is that projects will do follow-on steps and do not overlap. Persons trained in one project are involved in other projects where possible. When there is a need additional persons will be trained in the country in order to establish or broaden local capacity. The DDT project agreed to cooperate with the FAO/Turkey Partnership Programme Initiative for Pesticides and Pest Management in Central Asia and Turkey, 2010-1012 (FAO-TPP project), that is active in Tajikistan as well. The overall objective of this project is to assist the countries of Central Asia, with a specific focus on Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan, to reduce risks to health and environment from obsolete pesticide stockpiles and from pesticides in current and future use. The project outputs will be: a) a detailed inventory of obsolete pesticides b) technical capacity building to strengthen pesticides management, and c) implementing proven methodologies for obsolete pesticide management and pesticide risk reduction.

Within the FAO TPP project, a training on inventory was held on the 19-29th June 2011 in Bishkek, Kyrgyzstan. Several participants from Tajikistan attended this training:

1. Vohidov Abdumavlon - The Deputy Head of the State Institute on Plant Protection and Agricultural Chemicalisation, the Ministry of Agriculture;

2. Alimardonov Qayumars - The main specialist of the Department on Control of Land Use and Protection, the Ministry of Environment;

3. Alijonov Kholmurod - The Head of the Environmental Sanitation Department of the State Sanitary Epidemiological Services, the Ministry of Health;

After this training, between 8th and 11th May 2012, FAO consultant, Khatuna Akhalaia, led the inventory team (in which all above mentioned persons took part) during the first phase of the inventory. During this phase, the inventory team visited the Khatlonski Region and the Kurgantubinskaia Zone. In total, 22 sites were inventoried. It is planned that the second phase of the inventory will take place in

November 2012; the Sogdiiskii Region (7 rayons) and the Regions of the Republican Subordination (5 regions) will be inventoried. After the second phase is over, it is expected that the nation-wide inventory of the country is completed. The DDT plans to provide financial support to eventual lab analysis of the samples. In December 2012, a training on FAO's Pesticides Stock Management System will be organised. This will provide the country with the tool to have all inventory data consolidated and to have an overview of which sites pose the largest risk with regard to pesticides and the environment.

In early November 2012, MKI representative, Wouter Pronk, will visit both Tajikistan and Kyrgyzstan. One of the aims of this mission is to meet with the structures that can serve as National Steering Committees for the DDT project and also other projects (such as the EU FAO project Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union, which has already started in Kyrgyzstan, and is expected to start in Tajikistan in the near future). UNEP representative, Martin Murin, amongst others, visited Tajikistan in July 2012, to communicate the necessity of the NSC to the country and to discuss the set-up of such an NSC. After risk prioritisation has been done with the help of the PSMS, MKI will make a repackaging plan and associated budget to repack 60 tonnes of DDT or associated waste from priority sites. This plan will be sent to the NSC for endorsement.

One of the results of the FAO TPP project will be a nation-wide inventory in Tajikistan. The DDT project will then take the next step and use the inventory data to make a repackaging plan for approximately 60 tonnes of DDT or DDT containing waste. The EU FAO project will follow up with the disposal of the repacked obsolete pesticides. A schematic reflection of cooperation between the projects is as follows:

At this moment, a point of concern for Tajikistan is the fact that cross border transport of hazardous waste may be problematic; therefore, it may take time before the repacked waste can be disposed of. This may mean that the DDT project will look into possibilities of supporting the country with interim storage of the repacked 60 tonnes of DDT and DDT containing waste. A preferred solution is, however, to repack only once it is clear that the repacked waste can be transported immediately within the EU FAO project.

PROMOTING SUSTAINABLE LLIN DEPLOYMENT AND OTHER ALTERNATIVES TO DDT FOR THE CONTROL OF VECTOR-BORNE DISEASES IN SOUTHERN CAUCASUS AND CENTRAL ASIA

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Abstract

In the first years of the new millennium, applications of DDT (dichlorodiphenyl-trichloroethane) for all purposes ebbed to its lowest use-rate since World War II. The 3 nations in the Americas that reported continued use of the insecticide curtained their applications to almost zero by the year 2000 due to free trade agreements. In 2001, the Stockholm convention targeted DDT and 11 other persistent organic pollutants for severe restrictions. The provision was approved without dissent by all of the approximately 150 convention delegations. It appeared that the long life of the once ubiquitous pesticide had come to an end. In fact, this supposed demise may have been misleading, since the WHOPES database[1] showing a steady decline in global DDT use did not include the data from India and Sub-Saharan nations other than South Africa (Sadasivaiah 2007).

Although the Stockholm Convention effectively ended the use of DDT in agriculture, it did leave the door open for indoor uses for disease vector control. Five years later, the World Health Organization released a position statement advocating the use of DDT for indoor residual spraying (IRS) (Sadasivaiah 2007). The trigger for this recommendation appears to be that the world public health community was not making sufficient progress on the Roll Back Malaria Partnership's goal of Millennium Development Goal of achieving near zero deaths from malaria by the year 2015. By the middle of the first decade of the new century, it was clear that the goal would be difficult to achieve in less than ten years, especially in the southern tropical regions of Africa. By mortality impact, malaria was the 5th leading infectious disease worldwide. There were, and perhaps still are, approximately 270 million people, or 8% of the world's population, at risk from malaria. In 2012, there were 207 million diagnosed cases of malaria worldwide, but most (80%) of those were in Sub-Saharan Africa(Observatory 2012).

Thus, DDT gained favour for some of the reasons that the insecticide first attracted attention in the 1940's and 1950's:

- Broad spectrum of efficacy;
- Low mammalian toxicity;
- Wide spectrum of uses or applications;
- Low cost (a significant motivation);
- Long duration (persistence).

And of course, health officials felt that the public benefit of using DDT outweighed environmental concerns due to the fact that the DDT was not intended for outdoor use (Blankespoor 2012; Meiners 2014).

If the entire region of Central Asia, Transcaucasia and the Middle East are taken into consideration as a unit, the risky side of the equation is quite different from the human vulnerability in Sub-Saharan Africa. In these Mid Eastern, Caucasian, and Asian regions, there are approximately 56, 000 deaths annually, which accounts for

1WHO Pesticides Evaluation Scheme

only 3% of the global total. In this region, the Plasmodium vivax is the predominant malarial disease; however, there are occurrences of the more deadly Plasmodium falciparum found in Yemen, Saudi Arabia, Pakistan, Iran, Afghanistan, and southern Tajikistan (Dasgupta 2012, Observatory 2012). The disease risks are different in the Caucasusian-Asian region from those in Sub-Saharan Africa. The control strategies may also need different risk-benefit analyses.

In 2012, the team of Blankespoor, Dasgupta and Lagnoou developed tools to analyse these relative risks and benefits. They began with a detailed global malaria map (Oxford University), overlaid it with Global Population Data (Landscan) and estimated economic losses due to the prevalence of malaria in a population versus the increase disease caused by IRS DDT exposures. From a global perspective, and certainly from a Sub-Saharan Africa one, the use of DDT IRS does positively impact the $69 billion (2010 USD) in lost productivity of all afflicted populations. However, the IRS spray also adds $28 billion USD from the burden of new DDT spawned diseases and heath effects. This risk benefit equation seems more justified in Sub-Saharan Africa, where the negative impact of malaria is particularly great. In the regions outside of southern Africa, such as the Caucuses or Central Asia, where the number of cases and mortality subside, the societal costs of malaria will go down. But if IRS uses DDT, then the health costs from DDT spraying will remain constant (Blankespoor 2012)

Alternatives to DDT IRS

If DDT sprays for IRS are eliminated, there are still some alternatives that do not favour increased risks in either the biosphere or the humans living and working in close proximity to regions where there are some malaria risks. Alternative controls include:

- Physical controls;
- Other pesticide choices for IRS;
- Space sprays;
- Biological controls;
- Mosquito nets;
- Integrated vector management (IVM).

<u>Physical Controls</u>, the fundamental tools that eliminate habitat for breeding of mosquitos, should be the first control measure put in place. Unfortunately, pesticides are often used in lieu of sound physical pest management measures. Physical controls include:

- Empty any standing or stagnant water from old tires, pots, tarps and any other place where water accumulates;
- Change the water in animal troughs at least 2 times per week;
- Recycle any unused containers of any kind;
- Clear water from low places on roofs or gutters;
- Screen cisterns or water barrels;
- Improve drainage wherever there are low-lying places where water collects.

<u>Other pesticides</u> could be used for IRS. This is not always a good solution. The problem is that pyrethrum insecticides are the next logical choice, and although less persistent, insect resistance to pyrethroids is now well documented and this class of pesticide would better serve as the pesticide of choice in Long Lasting Insecticidal Nets (LLINs) for as long as possible. Other chemicals are not as desirable due to possible health effects.

Space sprays are non-residual pesticides, often sprayed in an outdoor environment. These applications are recommended for urban areas where people congregate outdoors. Space sprays are recommended for epidemic malarial outbreaks only.

Biological controls consist of using or enhancing any living organisms to control water borne larvae or disrupt the mating process of the mosquitos. Larvivorous fish have been successfully used to depress the numbers of maturing mosquitoes in aquatic environments. Two examples are Tilapia nilotica and Gambusa affinis. Cultured larvicides that are effective and the most widely used are:

Azadirachta indica (neem), Bacillus thuringiensis israelensis, and Bacillus sphaericus. More recently, public health officials have released sterile male mosquitos and have effectively disrupted a significant portion of the reproductive cycle (CEAGAfrica 2006, PANGermany undated).

Mosquito Nets alone or as a part of Integrated Vector Management where nets are used in conjunction with any of the other previously mentioned intervention measures are another alternative. Although developed some years earlier, affordable Long Lasting Insecticidal Nets (LLINs) are a product of the twenty-first century. These LLINs are a subset of the broad category of Insecticide Treated Nets (ITNs). Both the parent ITNs and the subset LLINs are treated with insecticides designed to kill or repel mosquitoes. LLIN manufacturers bind or incorporate synthetic pyrethrum insecticides by one of four technologies into or onto fibres woven from 3 types of resins. Impregnation or coating of the pyrethroid minimises the necessity for retreatment (Dobson 2011).

In a recent position statement, the WHO Global Malaria Programme (GMP) describes a shift in guidance for malaria prevention by recommending that *"national malaria control programmes and their partners purchase only LLINs designed to maintain their biological efficacy for at least against vector mosquitoes for at least three years in the field (and this is key) under recommended conditions of use, obviating the need for regular insecticide treatment."* The WHO GMP acknowledges that Interior Residual Spraying (IRS), combined with LLINs, may not be completely effective in areas of halo-endemic malaria infestations in for instance, sub-Saharan Africa.(GlobalMalariaProgamme undated) In low transmission areas where all age groups are vulnerable, e.g. the southern tier of the CIS nations, a populace may benefit from intervention schemes that target geographical distribution of LLINs addressing an uneven disease pattern.

There are advantages to using ITNs in general and LLINs in particular. Five studies show that ITNs reduced child mortality by 18% (GlobalMalariaProgamme undated). Clinical incidence of malaria in all age groups was reduced by 50%. The benefits of using bed nets is not limited to the incidence of malaria but show reductions to a range of other disease vectors: against nuisance mosquitoes, head lice and bed bugs. The use of LLINs have been found significantly less expensive than the use of ITNs (less than 50%) and 4-5 times less expensive than Indoor Residual Spraying (IRS) (GlobalMalariaProgamme undated).

The universal success of employing LLINs for Integrated Vector Management (IVM) is not assured, despite these hopeful statistical gains. Bednets are distributed globally by a number of mechanisms: mass campaigns, routine distributions at clinics, and subsidy vouchers allowing lower cost purchases at retail vendors. Recent studies have looked at the societal conditions that promote longevity in the intended use of LLINs. The studies show that if the value of the netting material is greater than the perceived risk for malaria, then adaptive uses for the LLINs/ITNs result: fish nets, garden barriers, privacy screens, and more. Impregnated nets have dossiers on acceptable risks only if employed for interior uses. There are few, if any, comprehensive studies to support low level leaching into the environment outdoors. Pyrethroids show acceptable exposure and risk assessment for humans, but are toxic in low levels to, for example: aquatic species. Recent sociological investigations have found that distribution techniques that utilize a cadre of trained health workers that go into the home and hang the nets for the first time and describe care and maintenance are the most likely methods to assure longevity for LLINs' intended purpose: sleep protection. The governments that employ these public health workers are also more likely to have a feedback system that identifies local taboos, sleeping patterns and other needs that impact longevity of use. Disease intervention efforts have been found less effective if the donors, and national public health agencies insisted in purchasing only one type or size of net, perhaps, in a colour that had a negative association (Study 2013).

As a part of deploying thousands of nets in a given area, consideration must be given to the End-of-Life management. Not only should most adaptive uses be discouraged, but also a managed disposal plan will benefit the environment. The physical condition of most LLINs reaches a critical stage usually long before the insecticide is depleted. The shards of often dirty, ripped net material, left in the open, may contribute to aquatic invertebrate suppression and the now documented resistance of anopheles mosquitoes to synthetic pyrethrums. Managed collection and recycling/ waste-to-energy are feasible as long as the controls are similar to those imposed on recovered pesticide containers (Dobson 2011) (Ng 2011).

Conclusion

Long Lasting Insecticidal Nets are one of the best tools available for Integrated Vector Management for the protection of lower risk populations from malaria. Coupled with physical and possibly biological controls, the LLIN based strategy could reduce the need to employ high-risk controls that include DDT interior spraying. Nets, like every other public heath intervention, are not without risks. For longevity of use and maximum protection for humans and the environment, proper planning, education of the users, and careful net selection and distribution can protect a local population as well as the environment.

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FAO SESSION: PESTICIDE MANAGEMENT: MORE FOOD LESS RISK

RESULTS FROM THE LEGAL ASSESSMENT OF PESTICIDES MANAGEMENT IN THE EASTERN EUROPE, CAUCASUS AND CENTRAL ASIA COUNTRIES

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Background and objective of the legal assignment

The current project is aimed at developing capacity for management of hazardous wastes through the example of obsolete pesticides and persistent organic pollutants (POPs). There is an estimated 200,000 tonnes of these materials known to be affecting the Russian Federation, EC near neighbour countries (such as Armenia, Azerbaijan, Belarus, Georgia, Moldova and the Ukraine) and the Central Asian Countries (CACs) - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Some previous work on disposal of waste from these countries was focused on exports of thousands of tones of pesticide stockpiles to high temperature incinerators operated commercially in EU Member States. Whilst this strategy meets all international environmental compliance requirements, at the same time it is prohibitively expensive. The vast distances involved for the transportation of waste from CACs to incineration facilities in Europe make that option very unattractive and urge finding a possible local solution. Under this project, a study of capacity to treat these hazardous materials is prescribed.

The idea of the Legal Component of this project is to review legal frameworks for pesticides and waste management for each of the 12 listed countries. This review was made by National Consultants (hereinafter referred as NC) and International Legal Consultant.

In order to ensure the uniform approach to the analyses of legislation, the International Legal Consultant carried out the following:
• coordinated and organized the work of the National Consultants;
• prepared guidelines and provided guidance in relation to what is expected by the ToR from the NC;
• revised, made comments on the National Reports with assessment of the legal frameworks for the management of pesticides and waste, including POPs and obsolete pesticides waste prepared by the NC.

The International Legal Expert also supported the identification, recruitment and briefing of the National Legal Consultants.

On the basis of the received National Country Reports, the International Legal Consultant will do the following:
• Prepare a Comprehensive Legal Report with the results of the reviews from 12 countries, including conclusions and recommendations to strengthen the national legal frameworks and meet the international requirements;
• Prepare a corresponding Comparative Matrix to illustrate the situation in relation to pesticides and waste management in 12 countries on the basis of the information provided from the National Legal Consultants.

Key activities completed so far with the legal component

The ToR of the FAO International Legal Consultant clearly indicated that the following activities should be organised:

• support in reviewing CVs of the candidates from the 12 countries and selection of the National Consultants;

• coordination of work of the recruited National Consultants;

• preparation of the Guidelines on relation to what is expected by the ToR from the NC;

• revision, making comments on the National Reports with assessment of the legal frameworks for the management of pesticides and waste, including POPs and obsolete pesticides waste prepared by the NC.

So far, only three National Consultants were recruited – from Armenia, Kyrgyzstan and Tajikistan. The following countries have been assessed by the International Legal Consultant: Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan and Uzbekistan (Matrix in Excel format was completed for each of these countries).

In relation to institutional frameworks established in these countries the following can be suggested in order to strengthen and improve the work of the governmental agencies / bodies:

For Azerbaijan:
• In order to bring together all the relevant actors, an establishment of the Pesticides Board or Commission;

• Involvement of other governmental units for assistance in the implementation and enforcement of the Law;

• Collection of information on pesticides incidents, assessment of data on the use of pesticides, etc.

For Kazakhstan:
Considering the multiplicity of various agencies:

• Identifying the primary competent authority to deal with the control of pesticides (to be the coordinator of all the activities in relation to pesticides management, including disposal);

• Assigning the head of that authority to take responsibility for implementing pesticides law;

• Authorizing the competent authority to call on other governmental units for assistance in the implementation and enforcement of the law;

• Charging the authority with collecting and sharing the information on pesticides management in general and pesticides incidents in particular;

• Ensure smooth information exchange across sectors, as well as regions (particularly, in the situation when such a number of agencies is involved in licensing various activities in relation to pesticides).

Kyrgyzstan:
It is clear that the major challenge of Kyrgyzstan in relation to pesticides is coordination of work of various agencies and departments. The first steps have been made and the Coordination Commission for the correct and proper management of chemicals has been established. It is too premature to evaluate the activities of the Coordination Commission, but there are hopes that it will bring together all the relevant actors and government units for assistance in the implementation and enforcement of the legal provisions on pesticides management as well as control functions.

Russia:
It should be noted that the issues of pesticides and waste management are within the joint jurisdiction of the Russian Fed-

eration and the subjects of the Russian Fderation. In accordance with Article 76(2) of the Constitution: "On the issues under the joint jurisdiction of the Russian Federation and subjects of the Russian Federation federal laws shall be issued and laws and other normative acts of the subjects of the Russian Federation shall be adopted according to them". So, legal framework is a combination of the Federal Laws, regulations and normative acts, as well as laws of the subjects of the Russian Federation (in total 83, consisting of republics, regions, oblasts, cities of federal significance, an autonomous oblast and autonomous okrugs, which have equal rights as constituent entities of the Russian Federation). So, for effective pesticides management, better coordination between the Federal and Regional (subjects of the Russian Federation) authorities is required.

Tajikistan:
In the light of the absence of information on the specially authorized state body for the production and safe handling of pesticides and agrochemicals in Tajikistan, it is not possible to provide legal analyses of the control functions of that body or any concrete recommendations.

Turkmenistan:
For Turkmenistan, it appears that there are no new legal acts regulating managements of pesticides and it looks that de facto SanPin of the former Soviet Union is still in force - Sanitary rules on storage, transportation and use of pesticides (insecticides) in agriculture, approved by the Chief Medical Officer of the USSR September 20, 1973 N 1123-73.

Ukraine:
In October 1993, the Cabinet of Ministers of Ukraine has established the State Interdepartmental Commission for the Testing and Registration of pesticides and agrochemicals ("Ukrgoskhimkomissiya"). In November 1993, this Commission has approved a temporary position on the procedure for state testing and registration of pesticides. This Commission has no controlling functions in relation to pesticides. According to statistics in the Ukraine, over the period from 1940-1980, crop losses due to pests and weeds have doubled, while the use of pesticides has increased by 10 times.

Uzbekistan:
It is clear that the Interdepartmental Commission of Uzbekistan does not carry out any controlling functions in relation to pesticides.

In the light of that, it can be recommended to:

• Identify the primary competent authority to deal with the control of pesticides (to be the coordinator of all the activities in relation to pesticides management, including disposal);

• Assign the head of that authority to take the responsibility for implementing pesticides law;

• Authorize the competent authority to call on other government units for assistance in the implementation and enforcement of the law;

• Charge the authority with collecting and sharing information on pesticides management in general and pesticides incidents in particular;

• Ensure smooth information exchange across sectors, as well as regions (particularly, in the situation when such a number of agencies is involved in licensing various activities in relation to pesticides).

The Final Phase of the project will be the completion of the remaining country reports and preparation of the Comprehensive Legal Report (with the results of the reviews from 12 countries, including conclusions and recommendations to strengthen the national legal frameworks and meet the international requirements), as well as Corresponding Comparative Matrix can only be completed on the basis of the National Reports as well as supporting information received from the National Consultants.

There is an apparent risk that recruitment of the National Consultants (for Moldova and Belarus) will be delayed and that will have a negative impact on the analyses and preparation of the Comprehensive Final Report by the International Legal Consultant in due time. However, at the moment, everything is being done to facilitate the timely commencement of the work and all the necessary preparations have been completed.

As part of the ToR, the FAO International Legal Expert took part in the Regional Workshop on 8th of October 2013 (originally planned to take place in Armenia, Yerevan and further moved to Kvarali – Georgia). The presentation on Legal Assessment of the Pesticides Management in the Eastern Europe, Caucasus and Central Asian countries has been made.

Major legal findings in relations to pesticides management

The Final Report will be prepared in line with the Terms of Reference and specific Guidelines for the Structure as requested by the FAO Legal Department. It presents in a concise manner all the work conducted by the International Legal Expert and National Experts of the countries during the execution of this project. The Final Report consists of four major parts:

1) Introduction with links to the International Context in relation to pesticides, participation of the counties under examination in international treaties;

2) Overview of Institutional and Legal Frameworks in relation to pesticides management prepared by the National Experts and International Legal Expert;

3) Comparative Analyses of National Legislation with major outcomes of the assessment, which briefly outlines the differences and similarities of legal aspects in pesticides management in ten countries (if there will be no National Experts for Moldova and Belarus), and provides recommendations and suggestions;

4) Recommendations and suggestions from the International Legal Expert in relation to improvement of regulatory framework of pesticide management in ten countries.

The situation in the Eastern Europe, Caucasus and Central Asia countries is not identical in relation to pesticides management, but certain common trends and similarities of particular problems have been identified during the legal analyses. This is why some recommendations and suggestions are given to particular countries – for example, in relation to Institutional Framework and Administrative Structures set up by the Governments. In relation to assessment of certain aspects of the national legislation, it was more appropriate to conduct analyses and provide comments referring to the substance of the provisions and deficiencies found in a number of countries.

The Final Recommendations of the Report will be presented in Section “Conclusions”. These recommendations concern general aspects of pesticides management in the reviewed countries and specific suggestions to particular countries in relation to the established legal frameworks.

The legal analyses of the national legislation form the bases for the following recommendations to improve the legal framework on pesticides management in the reviewed countries. It should be also highlighted that the major difficulty in the assessment of the national laws on pesticides management was in their multiplicity and overlapping scopes of various normative legal acts. Another typical feature for all 6 countries - to find fundamental and essential provisions and principles of safe use of pesticides not in the laws, but in secondary legislation: regulations, standards, rules, etc.

Structure of the national legal acts
The structure of the legal acts on pesticides depends on the general legal system, the legal context, the Constitution of the country and existing legislation, priorities of the Government, applicable policies and resources available for implementation. For this reason all 6 countries can be divided into 2 unequal categories – 5 countries of the former Soviet Union and 1 country, which closely followed in the past few years the EU model of food safety and controls and achieved considerable progress in pesticides management.

Scope and coverage of the national laws
It can be concluded that an important drawback of all the reviewed national legal acts is in the fact that although they cover various aspects of pesticides management, however, these acts do not mention that they have been developed in order to assist the country in meeting its international obligations. There is also no reference to the need of reduction of risks due to the pesticide use or the importance of reducing overall dependency on pesticides, as recommended by the Code of Conduct (Article 1.7).

Therefore, the recommendation in light of that will be to consider the importance of the international treaties and participation of the courtiers in these international instruments more seriously and actively and overall policy objective to reduction of the pesticides use and dependency on pesticides.

Definitions of the terms
It can be generally recommended in relation to definitions and interpretations of the terms used in the national legislation to align them with the international definitions and include all the terms in relation to pesticides management.

Registration of pesticides
In relation to registration of pesticides all countries under review have provided in their legislation for mandatory registration system, however, it is not clear what is the body responsible for registration in Tajikistan. In relation to all 6 countries it can be noted that it is not clear whether the designed systems encourage the use of fewer or less toxic pesticides, and discourage the contrary – at least no specific legal provisions are found during these legal analyses. The application and registration process is set out by national secondary legislation and therefore most of the details concerning particularities of registration were not assessed by these analyses (among them confidentiality of trade secrets, types of final decisions of the registration body, etc). At the same time, it is clear that registration is always based on the conclusion of the scientific results of trials.

Import / Export
All countries under review have similar provisions with requirements to import / export only those plant protection products and agrochemicals that have been registered. However, in case of Tajikistan it is not clear which Governmental Body conducts the registration. Moreover, considering that out of 6 reviewed countries only one ratified the Rotterdam Convention (Kyrgyzstan) there are no national provisions in relation to notification of the secretariat of the Convention on the imported chemicals. Also, it is not clear how the border inspection control is conducted to enforce the provisions of the national laws in relation to import and expert (however, the issue of controls will be addressed by the specific section of this Report).

Licensing of activities in relation to pesticides

• This sector seems to be the weakest point in the national legal systems. In Azerbaijan, the law does not require legal entities to have a license for production of pesticides or biological preparations. It is now clear if licensing of activities in relation to pesticides is covered by other legislation of Azerbaijan. If that is not the case, absence of licensing can be considered as a serious problem and a drawback in relation to management of pesticides in general in the country.

• It appears that not all the activities in relation to pesticides management are subject to licensing in Kazakhstan – for example, it is not clear whether storage, labelling, packing, re-packing and transportation of pesticides can be conducted without a licence.

• It appears that not all the activities in relation to pesticides management are subject to licensing in Kyrgyzstan – for example, it is not clear whether manufacturing, storage, packing, re-packing, labelling and transportation of pesticides can be conducted without a licence.

• It appears that not all the activities in relation to pesticides management are subject to licensing in Kyrgyzstan – for example, it is not clear whether manufacturing, storage, packing, re-packing, labelling and transportation of pesticides can be conducted without a licence.

• No secondary legislation of Tajikistan on licensing was found. It is also not clear who issues such licences.

• It appears that, first of all, no specific legislation in relation to licensing of activities in relation to plant protection products / pesticides exists in Uzbekistan. There is a Decree in relation to explosives and toxic substances, materials and products with their applications, which indirectly covers pesticides. However, not all the activities in relation to pesticides management are subject to licensing in Uzbekistan – for example, it is not clear whether packing, re-packing, labelling and transportation of pesticides can be conducted without a licence.

It seems that there are no provisions in the national legislation of the countries under review backing up the licensing scheme with inspections. This undermines the entire idea of licensing, as the competent authority should have the power to revoke a licence if inspections reveal that prerequisites are not met, if there is a violation of any conditions on which a licence was granted or if new facts come to light which would have led to the denial of the application in the first instance.

Transportation and distribution

General conclusion in relation to transportation and distribution of pesticides is that national legislation of most of the countries under review does not follow international standards for the transport of dangerous goods. There are no clear provisions that prohibit the transport of pesticides in the same vehicles as passengers, animals, food and animal feed. In Tajikistan, there is a principle of free circulation of pesticides (like any other goods) established and confirmed by the law. There are no licences required for transport activities with pesticides. The distribution of registered pesticides is also permitted without a licence (with the exception of Kazakhstan). So, it can be recommended to follow international standards for the transport of dangerous goods, set out requirements for vehicles and containers, introduce licensing and inspections of the vehicles and operators that conduct transport activities.

Labelling

The overall recommendations in relation to legal assessment of national provisions on labelling of pesticides can be summarized as follows:

•The national legislation should clearly state that labelling requirements apply equally to domestically manufactures or imported pesticides and be in the languages of the country and include pictoral representations adequate to the national literacy level.

• In addition, national technical norms should address the issue of physical requirements for the label and rules for affixing labels on packages.

• There should be requirements that labels are subject to pre-approval at the registration authority during the registration process.

• For countries, parties to the Rotterdam Convention (Kazakhstan, Kyrgyzstan and Tajikistan) requirements that labels include the appropriate WCO customs code should be adopted.

It is also appropriate to note that national legislation of the reviewed countries does not mention or refer to safety data sheets (SDS). An SDS is a specific form containing information on the hazard potential of the pesticide product. There are specific obligations in relation to contents of the SDS and in order to comply with the Rotterdam Convention, an SDS must be sent to each importer. So, it can be recommended to follow these international standards, too.

Packaging and re-packaging

In light of the above presented analyses of the national legal provisions in relation to packaging of pesticide products and evident gaps in safe management, the following can be recommended:

• Specific technical requirements for packaging and re-packaging should be adopted or clearly presented in the national legal framework in line with the detailed FAO International Guidelines for Packaging and Storage of Pesticides;

• Such technical requirements for packaging and re-packaging should be incorporated into the registration process;

• Specific national technical requirements for packaging and re-packaging should require packaging that is safe, will not degrade under normal conditions, does not resemble common packaging of consumable goods, has a child safety mechanism, prominently displays the approved label and is difficult or unattractive for re-use;

• Specific national technical requirements for packaging and re-packaging should prohibit the re-packaging or decanting of pesticide into food or drink containers;

• It can be considered to ban re-packing if effective controls are not possible and require that packaging or re-packaging only take place on licensed premises, where staff is adequately protected.

Storage

In the light of the above-mentioned general legal provisions in relation to storage of pesticides, it can be recommended to:

• Differentiate between private, end-user or home storage and bulk / commercial storage (no such differentiation is found in the assessed national provisions);

• Impose record-keeping requirements on those storing pesticides (again national provisions are too general and even this important principle of record-keeping is not mentioned);

• Prohibit the reuse of a pesticide container for any non-pesticide storage reason, unless authorized;

• Indicate the type of containers required and set out the rules for construction of storage buildings;

• Establish special requirements for storage of obsolete pesticide stocks.

Advertising

In the absence of any specific provisions on advertising of pesticides in Kazakhstan, it can be recommended to set out specific requirements for pesticides advertising in line with international guidelines and prohibit the advertising of unregistered and illegal pesticides, false or misleading advertising of pesticides or advertising contrary to approved uses or label instructions. National legislation of other countries in relation to advertising of pesticides can be also updated and amended in line with the WHO and FAO Guidelines on Pesticide Advertising (adopted in March 2010).

Disposal

National provisions in relation to disposal of pesticides contained in the presented above legal acts appear to be too general, not complete or fragmented. Assessment of specific provisions was not possible for Turkey, Tajikistan, and Azerbaijan. However, according to the FAO Contact Persons in these countries, the storage rules have been developed in line with the international requirements and the Code of Conduct. Situation with disposal in Uzbekistan appears to be not very clear – since manufacturers of plant protection products are responsible for developing methods of disposal, there are no controls foreseen over these activates and this does not follow international guidelines for disposal of empty pesticide containers, related waste and unused or obsolete pesticide stocks. It can be recommended to develop and adopt specific rules in relation to disposal obligations in line with the international guidelines.

Record-keeping and controls

It can be recommended very strongly to strengthen the system of controls in relation to management of pesticides in the reviewed countries.

Way forward – Suggestions from legal assesment

The role of the government and competent authorities in the management of pesticides is different in different countries, but needs to be strengthened in almost all the countries represented at this project. Intergovernmental / interagency cooperation is a key factor for achieving the sustainable use of pesticides and reduction of risk. The Final Report provides the following general suggestions in relation to management of pesticides at the national levels:

• The need for workshops to discuss the outcomes of the legal assessment with the national competent authorities responsible for registration and pesticides management (preferably with participation of the national representatives in the areas of health, agriculture, transport and the environment) for the development of policies, updating and modifying the legislation, strengthening registration process and control methods associated with pesticides.

• There should be increased trainings and education sessions for strengthening the political commitment to reduce the risks associated with pesticides and overall reduction of the use of pesticides.

• It is necessary to promote regional and sub-regional cooperation, exchange of information and experience in fields related to pesticides (including border inspection protection and overall control experience).

• Further support for capacity building in the field of rational use of pesticides at the national and regional levels, including the mobilization of financial resources.

• From the practical side, it can be recommended to provide support for the analysis of the country and the needs of the assessment programmes to strengthen the capacity to manage the use of pesticides on the basis of inter-sectoral and multi-stakeholder approaches.

• Crucial for safe pesticides management is monitoring of all steps after the registration of pesticides, including quality control and surveillance systems for counterfeiting and drug trafficking and use.

• Overall awareness raising in relation to the use of pesticides and possible adverse effects.

EXPERIENCES IN IMPLEMENTING INTEGRATED PEST MANAGEMENT PROJECTS IN CENTRAL ASIA

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Abstract

Many farmers do not have adequate knowledge of disease and pest control, crop and land management and also animal husbandry in Central Asia (CA) due to the specialisation during the Soviet times. FAO provides assistance in strengthening capacity of the National Plant Protection Organizations and strengthening national frameworks for pesticide management to respond to the challenges regarding pests and pesticide control in CA. FAO is promoting adoption of Integrated Pest Management (IPM) in the sub-region by implementing a number of projects and using the tool of Farmer Field Schools (FFS), which is a comparative advantage of FAO being implemented in different countries around the world. The projects under implementation by FAO in CA related to IPM are as follows: TCP/TUR/3301- Promotion of Integrated Crop and Pest Management in vegetables, fruit orchards and grapes, TCP/KYR/3403 - Development of FFS to promote modern crop management and pest control technologies, TCP/KYR/3305 and TCP/TAJ/3401 - Assistance for Capacity Development in Locust Control and GCP/INT/193/IFA - Reducing risks of wheat rusts threatening livelihood of resource-poor farmers through monitoring and early warning. In addition to the projects, activities such as technical assistance in conducting monitoring and surveillance of cereals pests and diseases is provided in the sub-region including Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. Regional Training Workshop on the Methods of Pest Surveillance, Survey and Control, Regional Expert Consultation on Cereals Diseases, Pests, Weeds Monitoring and Cereals Disease Resistance Breeding, Regional Workshop on Save and Grow: Promotion of Conservation Agriculture and Modern Plant Protection Methods and National Conference on Promotion of IPM in Turkey were conducted.

Keywords

FAO, FFS, IPM, Pest Control, Central Asia.

Introduction

Trends on population growth in the countries of SEC sub-region demonstrate that the sub-regional challenges compared to the global one are more serious. During the last 50 years, the population increased 2.5 times, and birth rate in the most of the countries still remains high. With the purpose of responding to the food demand, the intensive land reclamation has been taking place, which resulted in the expansion of irrigated area up to 3 times and led to environmental problems. However, the area is limited, further expansion of irrigated lands is not possible and the area under arable land per capita is declining, competition and conflicts for land and water are raising.

Based on the official statistics report, crop production in general, but let's focus on production of wheat that is slowly growing. Wheat is the main staple crop in all countries in the sub-region; thus, its consumption rate is the highest in the world – over 200 kg/year/capita. On the other hand, the production of wheat per capita is slightly declining, and wheat yields are remaining very low.

In addition, the serious infestation of quarantine and transboundary pests and diseases severely damage crop yields. Every year, the farmers observe damages caused by locust, wheat rusts, nematodes, gypsy mouth, American white fly and other dangerous pests and diseases.

To control pests and diseases, the farmers apply the pesticides, but the registration and quality control system of pesticides and pesticide applying equipment is not in place that put the environment and human health under serious risks. Thus, very often illegal and low quality pesticides are used. Another problem is obsolete pesticides. The countries in the sub-region mostly inherited from the Soviet Union a huge amount of obsolete pesticides – about 200,000 tones or 40% of world reserves that requires proper management and elimination.

Current and emerging challenges in SEC

After collapse of the Soviet Union, farmers faced with the knowledge deficiency and access problem on training in crop and land management, disease and pest control as well as animal husbandry. The extension services, credit and markets are also poor. Therefore, capacity improvement is prerequisite for further development of agriculture and improving livelihood of rural population. The current main challenges in CA can be summarized as follows:

- Rising prices of inputs (fuel, fertilizer, seed, pesticides, etc.)

- Yield of main crops is declining due to climate change and lack of superior varieties

- Lack of institution capacity and legislation

- Generation gap and lack of qualified experts

- Lack of modern knowledge and technology

FAO response to the challenges in Central Asia

To respond to the global challenges, the FAO has developed a paradigm Save & Grow (FAO, 2011) promoting growing more with less spending. This book serves as a guideline for policymakers using a holistic approach for solving the problems, efficient and sustainable utilization of ecosystem services and inputs with conserving and enhancing natural resources that reduced environmental pollution. Save & Grow provides the systems that are adaptable to specific conditions, locations and scales.

With the purpose of responding to the challenges on crop production and protection in the sub-region, Save & Grow is translated in four priority areas, two of which are focusing on pests and pesticide management;

- Strengthening capacity of the National Plant Protection Organizations

FAO is promoting adoption of Integrated Pest Management (IPM) to reduce pesticide usage by developing Farmer Field Schools (FFS), which is being implemented in different countries around the world. FAO cooperates with the countries and provides support in strengthening policies on plant protection, implementation of international conventions and standards (e.g. ISPM) and harmonization of regional phytosanitary legislations. FAO provides support in improving capacities to control transboundary pests and diseases (locust, wheat rusts) and carrying out the monitoring, surveillance and control of wheat rusts (e.g. SMS monitoring) and supports training of young researchers from the region on plant.

- Strengthening national frameworks for pesticide management

Cooperation and support in this area covers improving registration of pesticides and pesticide applying equipment, providing the guidelines/manuals on pesticide registration, specification and quality control, improving pesticide and obsolete pesticide management, ratification and implementation of Rotterdam Convention to assure safeguard of pesticide use.

Adoption and Promotion of IPM in SEC countries

Due to being a strategic crop for CA, IPM research was started on cotton in 1980's and focused specifically on mass rearing and release of bio-control agents by a network of insectaries. However, there were neither any other special IPM programs nor conservation of natural enemies and biodiversity in the agricultural landscape. Thus, in recent years, FAO has been promoting the adoption and implementation of IPM programs by projects, workshops, conferences and studies. FAO-SEC, in cooperation with CIMMYT and ICARDA, conducted a study on the status of plant protection and conservation of agriculture in Central Asian countries. The study defined the gaps and bottlenecks for promotion of modern plant protection techniques and crop management in the countries of the sub-region. On that basis, the guidelines for policymakers and strategies on promotion of IPM techniques through FFS approach are to be developed.

Projects on adoption and promotion of IPM in CA

The Central Asia Regional Integrated Pest Management Project, funded by the United States Department of Agriculture, was initiated through IPM Collaborative Research Support Program by Michigan State University in collaboration with the University of California-Davis, International Center for Dry Areas and other institutions in CA. Components of the projects are enhancing the efficiency and product lines of bio laboratories, enhancing biological control of pests through landscape ecology/habitat management and capacity building (development of guidelines, trainings on IPM, introduction of FFS, etc.). The outputs of the project are as follows: development of experts' data base (Entomologists, Plant pathologists, Pesticide management, Soil, Plant immunity, Bio-methods), introduction of entomophages, landscaping development, guidelines for trainers, brochures, pocket books, posters and agro Entomological cartogram, promotion of IPM on wheat (Tajikistan), tomato (Uzbekistan) and potato (Tajikistan) and training abroad (MSc, PhD and season long term courses) (Maredia and Baributsa 2007).

To ensure the supply of reliable and healthy foods from farm to table in Turkey, the project TCP/TUR/3301 on Promotion of Integrated Crop and Pest Management in vegetables, fruit orchards and grapes is under implementation.

The outputs of the projects are as follows:

- Review of the problems on pests and possibilities of using safe biological agents.

- Review of the national legislation on plant protection and certification system and developing proposals for improvement of legislation.

- Review of the procedures on pesticide residue analysis and control, enforcement of certification and introduction of Blue Flag.

- Capacity building on application of IPM (ToT, FFS, Technical Days, Study Tour, etc.)

- Publication of project results, information dissemination.

- Formulation of a five-year project on IPM and ICM for Turkey financed by the government and/or donor.

- National Conference on IPM.

In Kyrgyzstan, the promotion of IPM is supported by the project TCP/KYR/3403 on Development of FFS to promote modern crop management and pest control technologies. The objective of the project is to improve farmers' capacity in adoption and promotion of modern crop and pest management techniques and the outputs are as follows:

- Development of appropriate technical co-operation between researchers, extension specialists, NGOs and farmers.

- Providing technical assistance in formulation of the national strategies on adoption of IPM and development of FFS.

- Review the dangerous pest and diseases of main crops.

- Establish per three FFS in three project sites.

- Conduct an economic analysis of introducing IPM.

- Develop training modules and materials for FFS on IPM.

- Carry out a set of a season long ToTs for facilitators on IPM FFS.

- Organize Field Days and farmers' exchange visits.

- Create IPM data base and information network.

- Publish guidelines and brochures for farmers.

In Tajikistan and Kyrgyzstan, to protect the plants from locusts in a sustainable and environmentally safe manner the projects TCP/KYR/3305 and TCP/TAJ/3401 on Assistance for Capacity Development in Locust Control are under implementation. The objectives of the projects consist in reducing locust damage on crops and rangelands to preserve food security and livelihoods, in particular of the most vulnerable rural households.

The outputs are as follows:
- National capacities of the technical staff of responsible Ministries improved in particular on: a- locust survey and forecast; b- control techniques and operations using Ultra-Low Volume (ULV) technology and c- mitigation and monitoring of the impact of pesticide use on human health and the environment.

- Locust campaigns well-prepared, implemented and monitored.

Early warning systems are an important component of the IPM approach for countrywide applications. To reduce pesticide usage and have more efficient results on plant protection, pesticides should be applied in the right time. Due to the high risky character of the wheat rust diseases that can cause epidemics and result in big food loss, the project GCP/INT/193/IFA on Reducing Risks of Wheat Rusts Threatening Livelihood of Resource-poor Farmers through Monitoring and Early Warning has an important role.

The outputs are as follows:
- Establishment of an effective monitoring and early warning system.

- Upgrading of regional laboratories; establishment and assessment of international trap nurseries.

- Regional information exchange and networking enhancement.

- National and regional distribution of wheat cultivated areas surveyed and GIS maps development.

Conclusions

To use the natural resources in a sustainable manner and to ensure food supply for people in Central Asia, adoption and promotion of IPM is important, and FAO will provide assistance and has a comparative advantage in implementing IPM using the participatory FFS approach.

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THE PEST-AND PESTICIDE PERSPECTIVE OF FAO'S PESTICIDE RISK REDUCTION TEAM

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Abstract

Farmers want to avoid losing crops to pests, diseases or competition with weeds. When problems arise, farmers need the access to effective and appropriate solutions. Good agronomic practices, including Integrated Pest Management, are key to preventing and managing pest problems. Pesticides are designed to kill living organisms and are intentionally dispersed in the environment, applied to food and often used by unskilled and untrained people. They are often not needed, and even when they do serve a useful purpose, they may be applied on the wrong crop, in the wrong doses, at the wrong time, or with wrong equipment. Poor practice in the field means higher risks to farmers, unsustainable production and pesticide residues in food and in the environment. Many of these problems exist in industrialized countries, but in developing countries, the problems are even worse. Pesticides available to farmers, or most affordable to them, are often older types that tend to be more hazardous and less selective than newer ones. The prescribed protective gear or spraying equipment is often not readily available. Oversupply of pesticides and poor stock management can lead to creation of obsolete stock threatening health, the environment and act as a barrier to sustainable development in most developing countries. Pesticides need to be managed well to reduce the risks and to be of help to farmers in protecting their crops. Using the right product in the correct way and at a recommended dose significantly lessens their negative impact on health, environment and food safety. FAO's Pesticide Risk Reduction Group helps the government, farmers and the private sector to produce and protect crops sustainably, while minimising the risks involved. This paper explores examples of how the work by FAO's Pesticide Risk Reduction Team is related to pest and pesticide management and contributing to an integrated approach to sustainable production intensification.

Keywords

FAO; Pesticide Risk Reduction; Pesticide management; HHPs; IPM; GAP; Sustainable production intensification; Food safety.

Pesticide Management – More Food Less Risk

(www.fao.org/agriculture/pesticides)

Field crops, particularly those stressed through drought, temperature extremes, poor nutrition or other factors, are also susceptible to damage from pests and diseases. Applying the methodologies advocated through the Save and Grow (FAO, 2011) approach should produce healthy and less stressed crops that can resist pests and disease attack and that are grown in ecosystems that prevent pest and disease proliferation.

Crop protection can be achieved through cultural, mechanical, biological or chemical means. In an Integrated Pest Management (IPM) regime, efforts are made to manage the cropping ecosystem in a way that ensures plant health and naturally controlled or suppressed pest populations. When an agricultural ecosystem is stressed by poor management practices and pest problems emerge, a combination of control measures are used, with an emphasis on those that are least damaging to the ecosystem as a whole.

FAO's Pesticide Risk Reduction Team (AGPMC), promotes IPM, within a sustainable crop production intensification (SCPI) context, as the most suitable strategy for crop production and protection, particularly for smallholder, resource poor farmers.

Pesticides are nevertheless used extensively in crop protection throughout the world. These chemicals are almost uniquely designed to be toxic to living organisms and are intentionally dispersed in the environment, including directly on food, by largely unskilled people.

Pesticide use presents risks to health and environment through direct and indirect exposure. It is therefore crucial to manage pesticides effectively in order to reduce these risks as much as possible and thereby make crop production more sustainable.

Effective management is achieved through a combination of both education and regulation (which includes legislation and other processes, like monitoring and enforcement). Appropriate legislation and establishment of technical and administrative infrastructures will support life cycle management and monitoring of pesticide use and impacts.

Education of end users is equally necessary to help bring needed changes at the field level.

AGPMC provides the policy and technical tools to help countries to do that through (Fig. 1):

• The International Code of Conduct on Pesticide Management – a guiding framework for life cycle management of pesticides (FAO, 2013)

• Technical guidelines expanding on specific recommendations of the Code of Conduct and other technical aspects of pesticide management (FAO/AGPMC, 2013)

• Standard setting for pesticide residue in food and pesticide quality standards that are used internationally (FAO/WHO, 2010)

• Field projects to help countries establish or strengthen legislation, policies and strategies for pest management (IPM) and pesticides management

• Tools to assist countries (e.g. databases, process guides, toolkits)

• Farmer Field School (FFS) programmes to raise awareness of risks and to help provide effective, low-toxicity alternatives

Reduced reliance on chemical pesticides, use of less hazardous pesticides and appropriate use of pesticides protects the health of farmers, rural communities and food consumers; protects ecosystems, reduces input costs for farmers and improves trading opportunities for farm produce because pesticide residue limits are observed.

Producing and protecting crops sustainably

Integrated Pest Management (IPM) is the key to the sustainable intensification of crop production. Through the participatory approach of Farmer Field Schools, millions of farmers have learnt to manage pests and diseases using ecological methods. They gain better understanding of how soil systems, water management, crop seeds and varieties, growing systems, pest/disease ecology, harvest and post-harvest strategies and market access are all interlinked. This helps farmers to maximize yields, reduce the use of pesticides and other inputs and improve livelihoods.

Making the right tools available
Farmers must have access to crop protection information and tools when they need them. FAO's Pesticide Risk Reduction Group works with governments and the private sector to promote ecologically-compatible pest management. This may include the use of natural enemies and microbial control agents, traps and behavior disruptants, plant extracts, mechanical devices and low risk chemicals. Some of these can be produced locally, generating new business opportunities for farmers.

Assisting policy makers
FAO's Pesticide Risk Reduction Group provides several tools to help governments, the private sector and others manage pesticides better:

The International Code of Conduct on Pesticide Management - a voluntary framework backed by many technical guidelines to advise the governments, industry and other stakeholders on pesticide life cycle management;

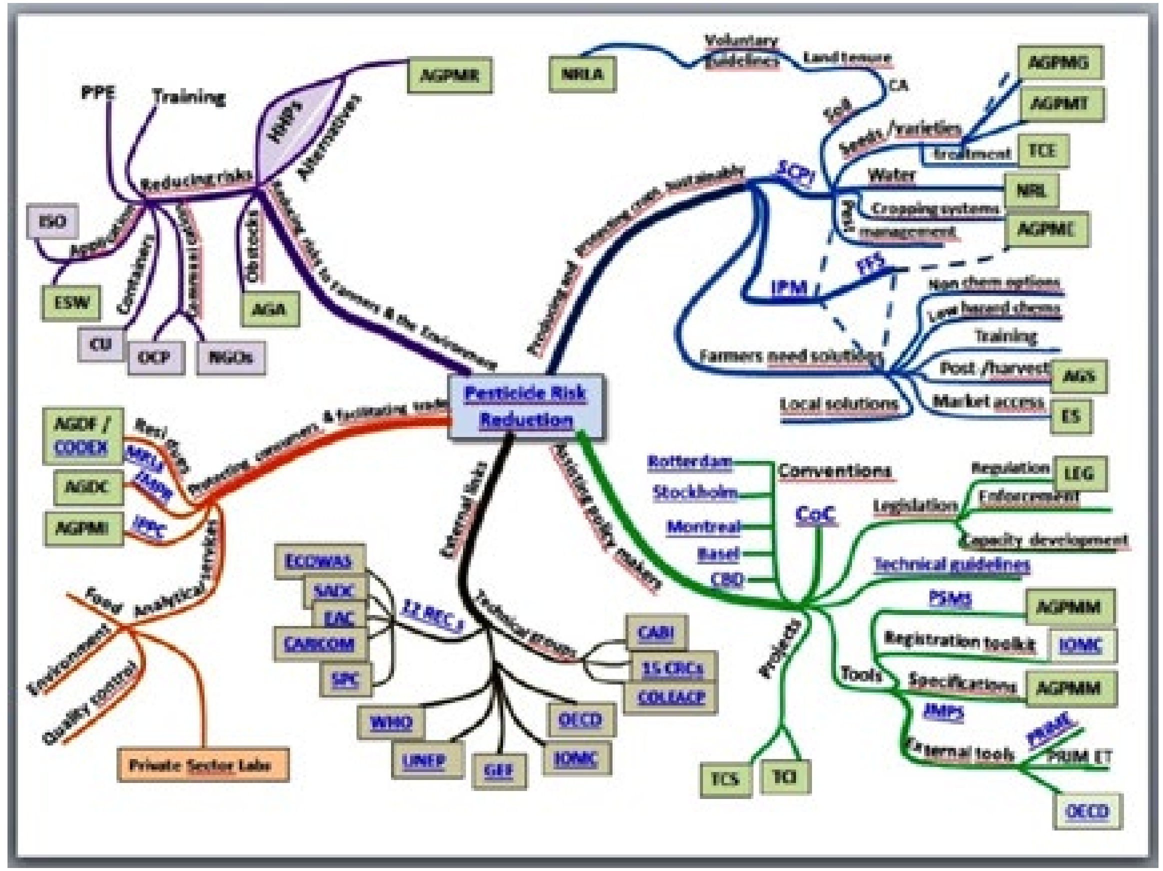

Figure 1: A mind-map showing the working and linking of the FAO Pesticide Risk Reduction Group (AGP:AGPMC)

Pesticide Specifications to check pesticide quality against internationally accepted standards;

Legislation supporting countries to bring their pesticide laws and regulations up to date;

Disposal of obsolete pesticides and Phasing out of Highly Hazardous Products (HHPs) is actively supported by FAO in order to reduce risks to farmers, consumers and the environment.

The tools include the following:

Pesticide Stock Management System (PSMS), an on-line database for countries to use in managing pesticide registries, new and old pesticide stocks and storage sites;

Registration Toolkit being developed to help countries evaluate and make decisions about which pesticides to permit;

Pesticide Risk Mitigation Engine to rank pesticides according to risks to health and the environment and help make decision on pest management strategies; and

Field Projects helping countries to solve complex problems

Protecting Consumers and Facilitating Trade

Pesticides can pass into plants or stay on their surface leaving residues. This can affect human health. FAO and WHO work to set Maximum Residue Limits (MRL) for pesticides in all foods. They also advise on how to minimize the risk that excessive residues are left on a crop.

Importing countries may reject products that have residues above the accepted MRL, causing farmers to lose income. Consumers have the right to eat safe food, so systems must ensure that farmers use pesticides properly. Adoption of Good Agricultural Practices helps avoid trouble with residues and hygiene and meet other trade requirements. High standard laboratories are needed to monitor residues in food and produce for export. FAO's Pesticide Risk Reduction Group helps countries to access or establish suitable facilities.

When agricultural products are traded, there is a risk that pests and diseases will be transferred with shipments. Effective pest management should ensure that only un-infested produce is exported. We collaborate with the International Plant Protection Convention to protect farmers and the environment and to facilitate trade.

Reducing Risks to Farmers and the Environment

FAO's Pesticide Risk Reduction Group helps governments build capacity to educate farmers. Farmers learn to identify and apply alternative options to the use of chemical pesticides. Or, when there is no alternative, to apply low risk products work with skilled people and use the right equipment. Our guidelines, projects, advice and training help countries realize these good practices.

Highly Hazardous Pesticides cause great harm to health and the environment. Millions of people are poisoned by pesticides each year, mostly in developing countries. AGPM assists governments to replace such pesticides with less hazardous alternatives.

After pesticides are used, empty containers must be disposed of safely and not be used for storage of water and food or for any other purposes. AGPM helps countries to set up container management schemes.

International bans, oversupply and mismanagement of pesticides have resulted in the accumulation of over 500,000 metric tonnes of obsolete stockpiles globally. Since 1994, FAO's field programme partnered with bilateral donors, the European Commission, national governments, the Global Environment Facility, NGOs, the private sector and other UN agencies to reduce the risks to public health and the environment from these highly toxic materials.

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List of acronyms

FAO divisions and department/groups as shown in Figure 1:

AGP: Plant Production and Protection division

AGPMC: AGP – Pest and Pesticide Management Group

AGPME: Ecosystem Approach to Crop Production Intensification group

AGPMG: Plant Genetic Resources and Seeds group

AGPMI: The International Plant Protection Convention (FAO IPPC secretariat) group

AGPMM: Locust and transboundary plant pest and diseases (EMPRES) group

AGPMR: Rotterdam Convention (FAO RC Secretariat) group

AGPMT: The International Treaty on Plant Genetic Resources (ITPGRFA) group

AGA: Animal Production and Health division

AGS:Rural Infrastructure and Agro-Industries division

AGDC: Advisory Group for Data Communications unit

AGDF (CODEX): Food Safety unit

ES:Economic and Social Development department

ESW: The Gender, Equity and Rural Employment division

LEGN: The Development Law service unit

NRL: Land and Water division

NRLA: Land Tenure Management unit

TCE: FAO's Emergency division

TCI: FAO Investment Centre division

TCS: Policy and Programme Development Support division

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CHALLENGES IN ASSESSING PESTICIDE LIFE-CYCLE MANAGEMENT AND KEY ARABLE FARMING PRACTICES IN SELECTED EASTERN EUROPEAN AND CENTRAL ASIAN COUNTRIES AND RECOMMENDATIONS FOR MITIGATION MEASURES

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Abstract

In the context of a regional FAO project (GCP/RER/040/EC) covering a wide range of possible issues regarding pesticide management (i.e. from a survey on legal aspects of pesticide registration to management of obsolete stocks), the authors, both in their capacities as international consultants (IC) of FAO, report on the first results on the sustainability of selected key arable crop scenarios based on a model (DEXiPM®) and on the implementation of the International Code of Conduct on Pesticide Management (the Code) and regulatory status of highly hazardous pesticides in three eastern European (Armenia, Georgia, Moldova) and in some central Asian (Kyrgyzstan, Tajikistan) countries. The methodology chosen included the use of templates and questionnaires which were then filled by national consultants (NC), analysing the data obtained, identifying the needs for each country and providing recommendations eventually endorsed by National Governments and stakeholders. These recommendations are to be converted into projects specifically addressing the most urgent needs of these countries. Significant differences in the profiles of the countries were identified. Numerous challenges were encountered – starting with the selection and recruiting of national experts, and the communication between the ICs with NCs in a multilingual and multicultural environment. As an example, the term "cropping system" is used to describe crop rotation. In some countries, this term and its translations into national languages is neither known nor practiced (e.g. wheat is often grown year after year). These continuous cropping systems show low sustainability as judged by unbalanced nitrogen fertilizer use and high herbicide/fungicide use and comparatively low yields. Specific recommendations to strengthen pesticide management and the sustainability of arable land use are given.

Keywords

FAO; Pesticide Risk Reduction; Pesticide Management; HHPs; IPM; GAP; Sustainable production intensification; Implementation of the Code of Conduct.

Introduction

Pesticides are products designed for the control of pests, pathogens and weeds in crop production with the aim of higher yields and better quality of crops. However, the improper use of pesticides may pose risks to users, lead to residues in crops and have adverse effects on the environment. Most countries have therefore implemented a risk-benefit evaluation in registering pesticides in combination with a pesticide life-cycle management to control and, if necessary, reduce the risks associated with the use of these products. The Code (FAO and WHO, 2013) is the global benchmark with recommendations on the life-cycle management of pesticides. In the context of a regional project, FAO has initiated a survey on pesticide life-cycle and arable crop farming practices to assess the current situation in selected Eastern European and Central Asian countries. The objective is to identify the strengths and weaknesses of the implementation of the Code and of current arable farming practices to better be able to respond to the needs of these countries.

Sustainability of selected key arable cropping systems in eastern European countries

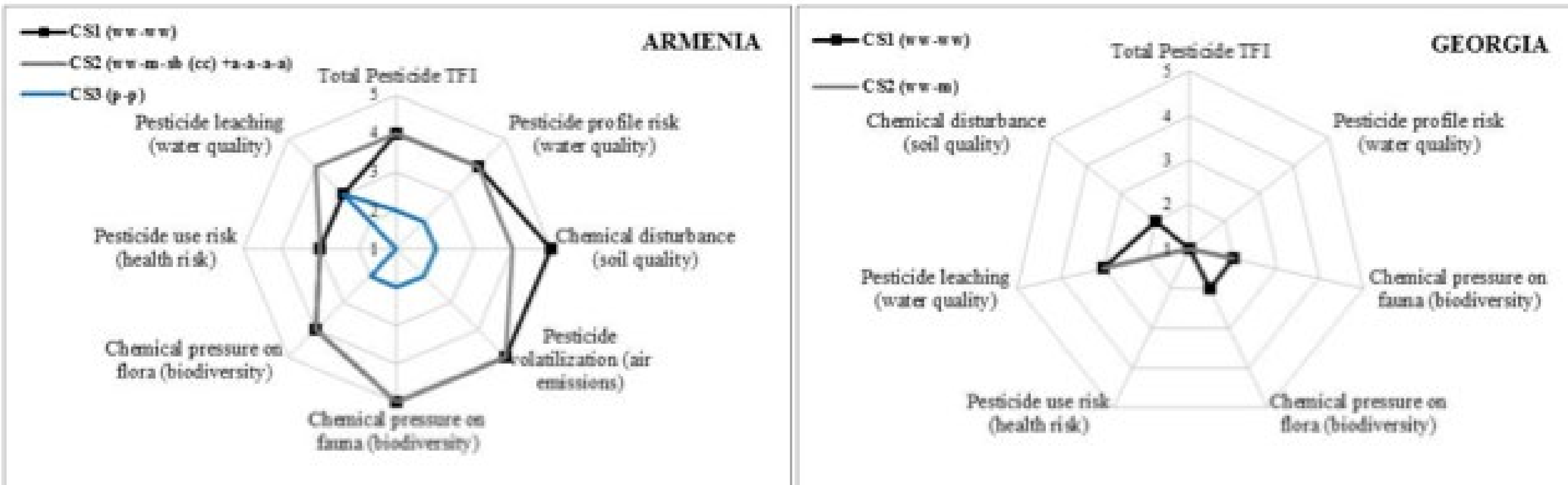
DEXiPM® (Pelzer et al. 2012) was used as the tool to assess sustainability of key arable systems of the different countries involved in this project. This is a model that assesses all the dimensions of sustainability (economic, environmental and social) through a qualitative multi-criteria assessment, based on the DEXI software (Bohanec 2009), and identifies the strengths and weaknesses of cropping systems. This tool was developed by the French National Institute for Agricultural Research (INRA) and within the EU project ENDURE (European Network for Durable Exploitation of Crop Protection Strategies;) (http://www.endure-network.eu.).

The economic assessment showed that all cropping systems in all countries are not economically sustainable. These weaknesses were mainly linked to the lack of potent cultivars (i.e. more productive and less sensitive to pathogens) due to underdeveloped seed industry or seed quality control system, unbalanced fertilization use that does not cover the crop requirements, high production costs (i.e. cost of fuel due to deep tillage and use of outdated equipment, cost of pesticides) and low financial security of the farms that restricts them to no investments.

Overall, the environmental sustainability of the cropping systems assessed received a "very low" score and was linked to the high frequency of pesticide applications, doses of application (i.e. use of maximum recommended doses for pesticides), pesticide eco-toxicity (i.e. use of products known to have adverse effects on health and on the environment) and lack of appropriate pest monitoring that leads to unnecessary interventions increasing production costs and the impact on the environment and farmers' health. These results ranged from the highest pesticide-input systems for both systems in Georgia to the low-input systems (CS1 and CS2) in Armenia that had a "high" environmental sustainability score. The differences between systems per country for various environmental indicators as impacted by the pesticide load can be seen in Figure 1.

Evaluation of the social sustainability of the systems indicated that all cropping systems are not sustainable. Overall, the weaknesses in these systems stemmed from 1) the significant health-related risk for the farmer (i.e. high pesticide use risk), 2) the low 'access to knowledge' (i.e. lack of farmers' knowledge and skills, no affiliation to a farm support network, and low availability of relevant advice for the strategy), and 3) the limited 'access to inputs' especially for seed material of good quality but mainly due to financial reasons. The only exception was the continuous potato system in Armenia that received a "medium" score due to the high interaction of this system with the society in terms of contribution to employment, an existing affiliation to a farm support network (e.g. cooperatives) and the easy 'access to output market' (market flexibility and product quality compliance with health requirements).

Recommendations to improve sustainability of cropping systems – The need for development of IPM is sound especially for both systems in Georgia and the continuous potato system in Armenia as crop protection is mostly pesticide-based. More diverse crop rotations using winter and spring-summer crops that provide varying patterns of resource competition and crop protection management is overall recommended. The introduction of monitoring systems for pests, and scouting for weeds and disease incidence together with related economic thresholds that help in the decisions ‘if’, ‘when’ and ‘what’ to



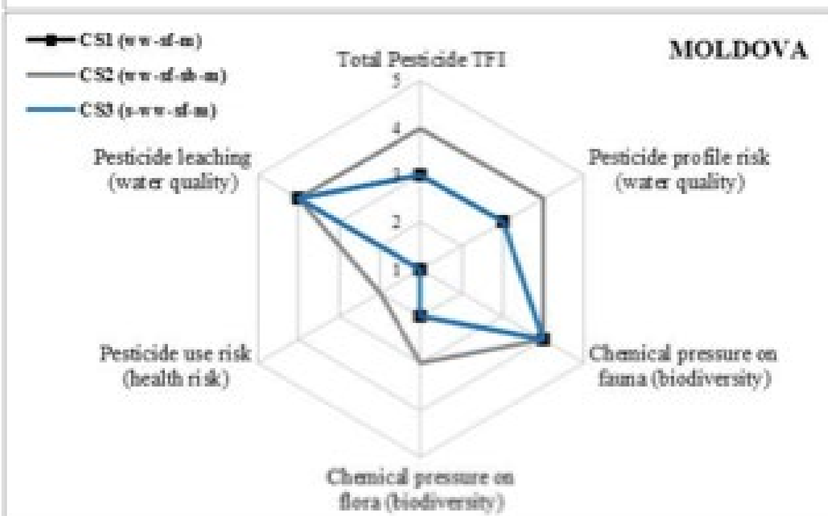


Figure 1[a]. DEXiPM evaluation of various indicators as affected by pesticide input for the different key cropping systems per country.
[a] The five qualitative states for the Treatment Frequency Index (TFI) of pesticides (including seed treatments) corresponds to: 1; very high (>7), 2; high to medium (]4.5-7]), 3; medium to low (]2-4.5]), 4; low (]0-2], 5; none. Lines indicate DEXiPM score for each system; maximum score (5) indicates the most sustainable evaluation. Where a, alfalfa; cc, cover crop; m, maize; s, soybean; sb, spring barley; sf, sunflower; p, potato; ww, winter wheat.

spray or control mechanically depending on the pest, weed and disease infestation each year is strongly recommended. All the above issues are linked with the lack of farmer knowledge and skills when it comes to crop production issues (i.e. availability of alternatives to pesticides, crop requirements) that certainly need to be tackled. Farmer training programmes are strongly recommended to provide them with knowledge on crop specific guidelines, IPM principles and the sustainable use of pesticides.

Implementation of Pesticide Management according to the Code and Status of Highly Hazardous Pesticides

The "International Code of Conduct on Pesticide Management" is structured in 12 Articles, each of which contains several sub-articles. The Code defines an entire landscape of pesticide management. Each Article gives detailed guidance for all stakeholders involved – governments, industry, farmers, public interest groups and international organizations – how their role in pesticide management can best be filled.

The Articles 3 to 11 with their sub-articles had been transformed into a questionnaire where answers to specific questions on actual situation on pesticide management could be given as "definitely yes" or "definitely no". All questions had the same direction so that in a theoretical complete implementation of the Code in a country, all questions would have been answered as "definitely yes". Answers were graded from a 4 for "definitely yes" to a 0 for "definitely no". Answers were coded in accordance with the grades, inserted in excel spreadsheets and the degree of implementation was calculated by the average for each individual article. In addition, weak points (0 and 1 for "definitely no" and "rather no" respectively) could be easily identified.

Thus, degrees of implementation of the Code were determined, where percentages ranged from 40 % to 80 %. These values allow to define a kind of country profile with strengths and weaknesses and to formulate specific recommendations for strengthening pesticide management in the country in agreement with available FAO and WHO Guidelines addressing specific issues in pesticide life cycle management.

Article 3: Management of pesticides

Essentially, all countries in the survey have the competence to regulate the use of pesticides. However, the official quality control of pesticides, labelling and packaging and also monitoring of product stewardship by industry are the serious challenges for the majority of the countries for several reasons, such as budget-capacity and expertise-wise.

For example, for packaging and labelling, the National authorities in the registration process, are expected to conduct an evaluation of the data package and have to make instructed decisions on pesticide packaging (size, leak- and children-proof, compatibility of the packaging with the pesticide formulation, labels, instructions for use etc. hazard warnings) which then have to be implemented by pesticide industry. Most of these points are risk-assessment and risk-reduction decision making where agronomists, chemists, toxicologists, legal and administrative staff have to work together to achieve an adequate implementation of the regulations. Unfortunately, the survey clearly shows that both the number of staff and its expertise in national authorities as well as in the industry is lacking to carry out these activities in these countries.

Article 4: Testing of pesticides

The access to unbiased test results on intrinsic properties of pesticides in terms of physical-chemical, environmental, residue forming and toxicological properties is a prerequisite for a sound and transparent risk assessment and, if possible, risk management. The answers to the questions addressing the status in the countries point to some shortcomings: the strongly felt need is the lack of residue studies covering the actual use and climatic conditions in these countries. As use rates, pre-harvest intervals, cultivars, epidemiology of pests and climatic conditions may not be adequately reflected in the residue studies submitted, a proper evaluation of residue formation is not possible. This may lead to excessive exposure of the general population to residues of pesticides.

Article 5: Reducing health and environmental risks

The majority of responding countries report on the lack of a systematic evaluation of worker exposure and integration of suitable personal protective equipment (PPE) into the leaflet. Equally important is the lack of maintenance of spray equipment, good practice in using field sprayers and of alternative control measures and IPM strategies. A number of other issues were identified, like weak product stewardship from the side of industry and lack of systematic re-examination of pesticides on the market and risk reduction measures like replacement of more hazardous formulations with the same active ingredient with a less toxic and hazardous formulation (e.g. replacement of an insecticide emulsifiable concentrate with a product formulated as capsule suspension).

Article 6: Regulatory and technical requirements

This article deals with regulatory requirements – often met in most countries – and technical requirements like inspection services and laboratories for quality control of pesticides and for monitoring of pesticide residues in food, significantly more challenging to establish and maintain in good working order. Here again, there is a general lack of expertise and funding. Equally important is the managerial aspect – to make best use of the information gained in the laboratory work to create a positive feedback loop to the registration committee taking the decisions. Furthermore, technical recommendations are either not available or outdated, providing inadequate guidance to pesticide industry preparing the dossiers for registration.

Article 7: Availability and use & highly hazardous pesticides (HHP)

Restricting or withdrawing the registration of HHP and risk reduction are the two sides of a medal. Whereas HHP are withdrawn from sale in most countries (HHP questionnaire) and less harmful alternatives had been found, the limitation to availability and use restrictions is an on-going task in most countries.

Article 8: Distribution and trade

The points under Article 8 bundle a range of activities where the focus is mainly on licensing of pesticide distributors and product stewardship from the side of industry. In most countries, there is little or no pesticide industry – therefore, traders and subsidiaries of multinational companies are the major stakeholders. Apparently, the cooperation and exchange of information on the import and sale of pesticides is considered as having room for improvement.

Article 9:
Information exchange

The due information exchange on regional and sub-regional level, between the government, international organizations and other stakeholders is essential for taking adequate measures to control and reduce the risks associated with pesticide storage, use and disposal.

Article 10:
Labelling, packaging, storage and disposal

The accumulation of obsolete stocks is a major concern in the countries covered by the survey. In the last years, considerable effort has been invested by the international organizations to inventorize and dispose of obsolete stocks. Equally important, however, is the routine use and disposal of small amounts of pesticides and packaging. The apparent lack of a collection and disposal system for used containers leads to dispersion of these containers to the environment and leaching of significant amounts of remaining pesticides to soil and water.

Article 11:
Advertising

Wrong or misleading advertising does not seem to be considered a major issue in most countries.

Conclusions

In conclusion, the self-evaluation revealed degrees of implementation of the Code of conduct between typically 40 % and 80 %. The questionnaire was transformed into a country profile in the form of a status and needs assessment and was provided to national authorities for endorsement during national stakeholder meetings. The needs were translated into recommendations based on available FAO- and WHO Guidelines and serve as a basis for technical notes for future activities by FAO to specifically address the most urgent needs of the countries.

In that way, the project team is convinced to best assist these countries to strengthen pesticide management in these countries with optimal targeted activities addressing short, medium and long term needs. Ideally, the present survey serves as a baseline assessment that could be followed by an impact assessment in a couple of years to monitor the progress achieved by means of these activities.

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REDUCING THE USE OF HAZARDOUS PESTICIDES IN GEORGIA

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Abstract

In Georgia, approximately 4 kg of pesticides on average are yearly applied on tilled soil, whereas various used pesticides are produced in Europe and their analogue pesticides in China, India, Turkey or Bulgaria. From August 2010 to July 2012, the project entitled Reducing the use of hazardous chemicals in developing countries: potential of implementing safer chemicals including non-chemical alternatives - tools for Georgia and the EECCA region, was implemented by WECF and its Georgian partners. One of the core aims of the project was to invest the usage of pesticides in agriculture in Georgia, its legislative regulation and to identify and demonstrate the usage of non-hazardous bio pesticides in agriculture.

As found by means of the project, in Georgia, the liberalisation of legislation in the field of hazardous chemicals has been done through a very simplistic approach, and in many cases, the only action to be taken was the elimination of this or that law. At the same time, Georgia became party to a number of international conventions and treaties and country made important commitments on proper chemicals management. One of the findings of the project was that pesticides available on the Georgian market are partly not authorised, most of them being low quality chemicals. Packaging and marking of pesticides are neither regulated nor controlled. Distribution networks, users and consumers are unaware of the risks related to pesticides application. Interventions are indispensable, such as awareness raising, establishment and implementation of strict regulations on marking, packaging and labelling of harmful chemicals. Current regulations related to harmful chemicals and chemical substances should be reviewed. The first step undertaken by the project team was the responsibility to develop a handbook with a pesticide database in Georgian language. Besides developing information materials on substitution of harmful pesticides, the project established a demonstration plot on organic farming and a safe pest management for the cultivation of crops and vegetables.

Keywords

Legislative regulation, authorisation, pesticides, agriculture.

Introduction

Georgia is situated in the South Caucasus region, bordered by Armenia, Azerbaijan, Russia and Turkey. Georgia had 4.4 million inhabitants in 2011, 49% of which lived in rural areas. According to statistical data, total area of tilled soil in Georgia is 472 thousand ha, with 100.215 ha under perennial crops. Up to 370.000 ha of this area (excluding the farms with small parcels up to 0.2 ha) is potential user of pesticides. From August 2010 to July 2012, the project Reducing the use of hazardous chemicals in developing countries: potential of implementing safer chemicals including non-chemical alternatives - tools for Georgia and the EECCA region was implemented by the Georgian NGO Greens Movement Georgia, SEMA, the Georgian Environmental and Biological Monitoring Association (GEBMA) and coordinated by WECF. The project received financial support from the SAICM Quick Start Programme Trust Fund. The aim of the project was amongst others to invest the usage of pesticides in agriculture in Georgia (Caucasus), its legislative regulation and to identify and demonstrate the usage of non-hazardous bio pesticides in agriculture. The presented project was based on 2 approaches: Firstly, investigation of the legal aspects of hazardous chemicals and its implementation; secondly, providing recommendations and information, accompanied by awareness raising, demonstration on substitution of hazardous chemicals in agriculture.

Legal aspects of hazardous chemicals

Before 2003, the legislation of Georgia was mainly based on the approaches and norms remaining from the Soviet period, which made the requirements for production, use and disposal of hazardous chemicals stricter than in following period. After 2003, in line with general liberalisation of the legislation, the laws in the field of production, use and disposal of hazardous chemicals were also liberalised, which had a negative influence on the issues of protection of human life, health and economic interests. The project observed that liberalisation of legislation in the field of hazardous chemicals in Georgia has been done through a very simplistic approach, and, in many cases, the only action was eliminating a certain law without providing a substitution. The following laws were abolished:

The Law on Licensing of Activities in the Field of Production of Agrochemicals, Trade with Agrochemicals, Laboratory Activities in the Field of Agro-chemistry and Soil Protection and Detecting the Quality of Agrochemicals and on Issuance of Import and Export Permits for Agrochemicals; the Law on Licensing Production of and Trade with Pesticides and Permits for their Export/Import, as well as for Import and Transit of Phytogenous Products Subject to Control; the Law on Hazardous Chemicals and the Georgian Sanitary Code.

At the same time, Georgia became party to number of international conventions and treaties, and country-made important commitments, including those in the field of hazardous chemicals. These international conventions, including 2001 Stockholm Convention on Persistent Organic Pollutants that obliges Georgia to ban 9 most hazardous for the environment pesticides (endrin, toxaphene, aldrin, dieldrin, heptachlor, chlordane, mirex, DDT and benzachlor) and extremely hazardous chemical group (polychlorinated biphenyls).

Despite the fact that in Georgia issues covered by the Stockholm Convention are regulated by not less then 4 ministries and many lower level state authorities, there still is not any legal act in place that corresponds to the obligations outlined in the convention. For example there is no regulating relation between these structures, and the rights and responsibilities of the Focal Point are not defined, neither the requirements for accountability and creation of unified national database. Since 2004, Georgia is a party to 1998 Rotterdam Convention on the Prior Informed

Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, which regulates international trade procedures for 37 hazardous chemicals. Amongst others the Rotterdam Convention sets out the following:

• Procedures for including new chemicals into the list of chemicals controlled by the Convention;

• Measures for raising public awareness, educating and informing the population of the countries on hazardous chemicals and cooperation between the countries in this area;

• Measures for improving efficiency of hazardous chemical monitoring and studies.

Convention also allows for exemptions:

• Upon request of the country, it can use one of the banned pesticides for a certain period of time;

• If the country registers its intention, it can produce or use DDT within the strictest framework of WHO requirements and only in cases when the purposes are local and the substance cannot be replaced by other accessible, efficient and allowable alternative means.

To summarise, at the current stage, the level of compliance of Georgia with the regulation of hazardous chemicals is far from satisfactory. Serious deficiencies in the field of informing the consumers have been identified.

Status of enforcement of the hazardous chemical import regulations

It was observed from the obtained documents that despite the legal ban, large quantities of the chemicals included in the list of the banned materials of the Ordinance No 133/n (26.03.2001) of the Minister of Labour, Health and Social Security are still being imported to Georgia. The investigation demonstrated that a number of chemicals banned are represented just by a generalised code; for instance, code 3808 50 000 00 includes the list of banned pesticides. Despite the ban, those chemicals are being imported under the general code and it is impossible to identify which substances in particular and for which purposes have been imported. In the period from January to March 2011, a total amount of 563 kg chemicals with the code 3808 50 000 00 were imported mainly from Turkey and China. Further, some of the chemicals included into the list of the Ordinance No 133/n (26.03.2001) of the Minister of Labour, health and Social Security are not coded at all.

Georgian pesticide market

According to the official state statistical data, the total area of tilled soil in Georgia is 472.000 ha, with 100.215 ha under perennial crops. Up to 370.000 ha of this area (excluding the farms with small parcels up to 0.2 ha) are potential users of pesticides (approx. 4 kg/ha)

Currently, in such a small country as Georgia, up to 190 active substances and about 400 of their various derivative complex preparations are being registered. The total annual quantity of imported pesticides is about 1300-1500 tons, whereas in 2010, approximately 8000 kg of chemicals regulated by Rotterdam and Stockholm Conventions were imported to Georgia (based on the Customs Office data).

Year	Insecticides (kg)	Fungicides (kg)	Herbicides (kg)	Germicides (kg)	Rodenticides (kg)	Other (kg)	Total kg
2011	*264 589*	773 051,6	328 076,2	32 917	*25 775*	84 920,4	1 509 329
2010	240 337	804 266	166 387	780	39 054	54 640	1 305 464

Table 1: Overview of import of pesticides in 2010 into Georgia by types. (Source: web page of the Ministry of Finance)

Various pesticides from Europe produced by the companies like BASF, Syngenta, Bayer, Newfarm or Dupont, and their analogue pesticides produced in China, India, Turkey and Bulgaria, are being sold at Georgian market. In the experts' opinion, the European products are of higher quality, technologically purified and respectively expensive. As for Chinese, Indian and Turkish products, both, in terms of their price and purity and affectivity, the quality is relatively low; hence, their reliability is doubtful and their impact on the environment and human health due to unfiltered additional substances even more adverse. For the purpose of importing cheap chemicals, some importers register several analogues of one and the same chemical produced. For example, Fungicide "Acrobat" produced in China is much cheaper and its quality is much lower compared with its European analogue. Active substance of the widely used preparation "dust" is Deltamethrin is registered in veterinary, but applied for plants protection as well, against various sucking mites and gnawing bugs. Though there are about 150 specialized pesticide shops, farmers' houses, and distribution networks, consumers are unaware of the risks related to pesticides' application, storage and disposal. Further packaging and marking (Georgian text and application instructions on the labels) of pesticides are neither regulated nor controlled.

Adequate measures are needed

To mitigate the risks of harmful environmental impacts of the pesticides, the project identified the following required measures:

• The strictest regulations of marking and labelling the harmful chemicals should be established, providing maximum information about harmful properties of such substances;

• Current regulations of storage, packaging, distribution and application of harmful chemicals and chemical substances should be reviewed;

• Mechanisms necessary for implementation of monitoring of turnover of the harmful chemicals within the country should urgently be introduced ;

• To achieve full transparency of turnover of the harmful chemicals, the codification system and mechanisms should be improved;

• Extensive campaign should be arranged to improve the awareness of population of pesticides' application safety rules;

• Personal protection means should be

available at all specialized shops, and such personal protection equipment should be offered along with the application instructions, and their use should be compulsory;

• A reliable data base on the properties of authorized pesticides should be made available in Georgian language to importers, retailers, authorities and farmers;

• A campaign on the substitution of harmful pesticides should be initiated.

Steps moving forwards: Set up of a pesticide database in Georgian language

Due to the observed illegal import, the low awareness on the risks of pesticides among authorities, users and other stakeholders, the project took the responsibility to develop a handbook with a pesticide database in Georgian language. The Handbook presents the basic principles on pesticides toxicity and safe use, and on safe alternatives of hazardous pesticides. For each in Georgia registered pesticide of the main groups, namely organo-chlorines, organo-phosphorus compounds, carbamates, organic mercury compounds, copper and arsenic contained compounds and pyrethroids, information is given on its chemical formula, CAS, IUPAC numbers, physical and chemical properties, preventive and first aid measures, etc. It is intended for practitioners, agricultural workers, toxicologists, health physicians, teachers and students of universities, scientists and others. Synonyms and trade names of pesticides are arranged in alphabetical order.

Steps moving forwards: Substitution of harmful pesticides

Unlike artificial technologies, currently ecologically clean production is being significantly promoted and demand for them grows annually all over the world. Adaption and implementation of the regulations on pesticides, dissemination of information on substitution of harmful pesticides should be the main task for a safer agriculture in Georgia. Therefore, the project started with providing the information about the alternative pesticides, their reliability and effectiveness in order to mobilise decision makers:

• A booklet with practical instructions on how to prepare plant tinctures for crop protection, as safe crop protection was developed for farmers, NGOs, training and extension services.

• The effectiveness of local-made preparations of bio-pesticides was demonstrated The impact of crop rotation, intercropping and features of permaculture were made visible.

• One Georgian company has developed successfully certified bio-pesticides against mildew, false mildew and phytophtora and were launched on the market.

• The project has inventoried the policy vacuum on chemicals management and brought together stakeholders. A document with policy recommendations in cooperation with a wide range of stakeholders was produced and presented to all relevant policy-makers.

• The project raised awareness with the European Commission on chemical safety. The European Commission is negotiating the accession contract with the Georgian Government, where Georgia has to adapt its legislation to the EU legislation. This includes a proper legislation on harmful chemicals.

Conclusions

The project has been a major advance in promoting chemical safety in Georgia. The vacuum in policy created by political and economic transitions in recent years, has created a situation in which there is little awareness of chemical safety issues, and public ability to regulate chemical use and protect workers and the public has declined.

The project has raised awareness both among policy makers and the public, built alliances among government, private sector, and non-governmental staff, demonstrated viable alternatives to the most hazardous chemicals in the agricultural sector, and raised the capacity of public officials and NGO staff to continue dealing with the daunting issues of chemical safety across the country

Though this project was an extremely important first step, it created political will in several departments of the ministries. However, there is still a limited number of people, organizations, companies, and government officials who recognize the scope of the problem and the urgency of alternatives. So work like this will need to continue to raise awareness and introduce new solutions, policies and practices.

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MAINSTREAMING SUSTAINABLE CHEMICALS MANAGEMENT IN AGRICULTURAL SECTOR IN THE REPUBLIC OF MOLDOVA

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Integration of environmental requirements in the agricultural policies

With the goal of reduction of risks for public health and environment, improvement of state of agricultural ecosystems, increasing of the quality of agricultural products and solving the problems of prior pollution are among the priorities of the sustainable development of the agro-industrial sector of the Republic of Moldova. These measures will have at their background the principles of Sound Chemicals Management. The goals of SCM in the agricultural sector of the country have to be oriented at the following major institutional strengthening, legal enforcement and practical actions:

• Transposition of the provisions of the Directive 2009/128/EC on sound use of pesticides and of the EC Regulation 1107/2009 in the Law on the phytosanitry products and fertilizers nr. 119 of 22.06.2004;

• Development of the Guide on the implementation of the International Code of Conduct on the Distribution and Use of Pesticides, FAO, 2002 (http://www.fao.org/agriculture/crops/core-themes/theme/pests/code/en/);

• Application of the provision of the FAO Guides (Guidance on Pest and Pesticide Management Policy Development (2010), Guidelines for the Registration of Pesticides (2010) etc (http://www.fao.org/agriculture/crops/core-themes/theme/pests/code/list-guide-new/en/);

• Organization and continuous conduction of repackaging, transportation, elimination of the remaining obsolete pesticides and clean up/remediate the contaminated sites, with an action plan for 2014-2020, based on the ongoing projects, financed by the development partners and the Government. Dissemination at country level of the available experience of the 6 pilot cleaned-up sites.

The article describes the current state and specific elements which could be taken in consideration during the process of mainstreaming the environmental requirements into agricultural policy and legislation in the Republic of Moldova.

Recommendations on the integration of sustainable chemicals management (scm) in agriculture

Integration of environmental requirements in agricultural policy, with the goal of reduction of risks of environmental degradation and improving the quality of agricultural ecosystems – is one of the priority directions in the framework of promotion of sustainable development of the country and strengthening of the agricultural complex. These measures have to be based on SCM provisions.

The Objective of promotion of SCM in agriculture included the following:
• promotion of the efficient production, treatment and management of ecological agricultural products in such a away, which will increase the income and life conditions of the farmers;

• stimulation of treatment and trade of primary agricultural products with the support of investments, which have the following goal: encourage agricultural products which protect the environment, which deliver useful goods for the society and promote the rational use of natural resources, development of new technologies and promote innovations, compensate the owners of lands from the state protected areas;

• carrying out training programmes and awareness campaigns for the farmers (development of the necessary infrastructure for the application of sustainable agriculture, support of small and medium scale models in the North, Centre and South of Moldova);

Development of the environmentally inoffensive agricultural technologies and infrastructure:

• establishment of the mechanisms for checking of the quality of water, used for irrigation;

• ensuring an integrated plant protection process against pests and diseases;

• applying conservative agriculture techniques;

• using agricultural vehicles with Euro standards on emission;

• sustainable management of the agricultural wastes;

• finalizing the process of elimination of POPs stockpiles and remediation of contaminated sites.

In addition, the following EU requirements will be applied:

– Integration of environmental objectives in agricultural policies;

– Reduction of the risks of degradation and ensure the sustainability of agricultural ecosystems;

– Reduction of water pollution, of soil and air pollution, chemicals and waste management;

– Conservation of agricultural biodiversity;

– Rural Development.

For 2007-2013, the EU planed the allocation of 20 milliards Euro for agroecological measures (22 % from the total allocations for the rural development).

Among the inaction costs, we could mention the following:

- Use of chemicals was justified by the higher volumes of harvest;

- At a global level, up to 97% of river and lakes pollution is a result of using chemicals in agriculture;

- According to WHO, 2 million poisoning cases from pesticides are registered annually in the world;

- The chemical substances are present not only in vegetal, but also in animal production;

- Lack of knowledge of the appropriate techniques of application of chemicals, taking into consideration the security norms;

- Lack of control from state authorities on the import of chemicals and their application according to the international standards;

- Not corresponding condition for the storage of the obsolete pesticides, with the risks of soil and surface water pollution;

- No deposit-refund and recycle schemes in place for the pesticides packaging

- Pesticides wastes, including packaging are placed on landfills and serve as an additional risk for animals and people.

The Benefits of implementation will cover the following:
- Increase in quality and less harmful agricultural products;

- Increase of exports of fresh and treated products;

- Protection of water, soil and air from contamination with chemicals;

- Improvement of the public health and reduction of health care costs as a results of exposure to agricultural chemicals;

- Increase of the incomes of the farmers and of the economic agents, which will increase the trade of agricultural products at the local and regional level;

- Creation of new jobs and increase of local budgets.

Brief Assessment of the policy documents in the sector

The National Strategy for the sustainable development of the agro-industrial secotr of Moldova for 2008-2015 was approved by the Governmental Decision nr. 282 on 11 March 2008.

The General objective of the Strategy is to ensure a sustainable growth of the sector, as well for the improvement of the life quality in the rural area, by increasing the competitiveness and productivity of the sector.

The Strategic Program of Actions of the Ministry of Agriculture for 2011-2015

The Ministry of Agriculture and Food Industry, based on the current state, internal and external factors in agriculture, developed the following mid-term priorities:

• Implementation of the reform in the food security sector;

• Restructuring in the wine making sector;

• Support the development of a modern market infrastructure;

• Implementation of the conservative agriculture;

• Reform of the meat and milk sector;

• Support of the added value agriculture;

• Support for recycling of agricultural wastes;

• Restructuring of the education and research capacities in the domain.

The Food Safety Strategy for 2011-2015, approved by GD nr. 747 on 03.10.2011 have the general objective to protect human health and ensure the interests of consumers related to the food safety. It is planned to carry out the following specific actions:

a) Improvement of the legal base;

b) Establishment of a national authority;

c) Strengthening the control procedures.

Program for the promotion of the production and trade of ecological products (HVA)

For the Republic of Moldova, the ecologic agricultural production is a real chance for the access to external markets. Thus, this is an new priority element, which, for the next 5 years, is including the following three years of conversion (with certification) and three years of support (with market access and export).

Legal and regulatory base

The adoption of the Law on the ratification of the Stockholm Convention on POPs (as of 19 February 2004) concluded and strongly supported the preparatory work, performed in Moldova for the evaluation of the existing situation and development of planning and normative documents in this domain. By this law, the MoE was nominated as the national authority responsible for the coordination of the implementation of the provisions of the convention.

The strategic directions on the reduction of the negative impact of POPs, regulated by the Stockholm Convention and other POPs related treaties on the environment and human health in Moldova, are reflected in the National strategy for the reduction and elimination of POPs approved by Government Decision No. 1155 as of 20 October 2004. In order to implement the Article 7 of the Convention a National Implementation Plan for the Stockholm Convention on POPs was developed and approved by the above Decision as well. The facilitation of the ratification of the Convention and the development of the Strategy and NIP was possible due to the support obtained from the GEF through the WB.

The Strategy is oriented at the establishment of a nation-wide chemicals safety management system and solving of the POPs priority problems. The national policy is calling for phased approach and well-developed implementation plans of significant treaties related to the POPs risks. The policy has two key management objectives: 1) remediation and elimination of POPs from the environment and 2) management of POPs throughout their entire life cycle, to avoid, prevent or minimize their release into the environment.

Existing regulatory gaps have to be filled-in and legislation has to be amended to ensure cross-sectoral and media consistency and timely transposition of international obligations. The legislation shall address specific POPs issues, which are not currently covered by existing legal and regulatory framework, both at the national and sectoral levels.

Implementation regulations, procedures, standards and guidelines shall be drafted in an integrated manner, clarifying monitoring, reporting, control, implementation and enforcement responsibilities of the respective ministries and agencies, and creating a unified and integrated computerized system of tracking regulated POPs, dangerous and toxic substances throughout their life cycle.

As a part of administrative management, a possibility of establishment of the centralized database should be explored. This should be based on the upgrade of centralized monitoring and laboratory capabilities and complemented by the focused training of selected staff. Coordination, compatibility and integration of monitoring, laboratory and control capabilities shall be enhanced, in order to improve

POPs cycle information and data management and facilitate more effective and efficient national programming, planning and decision making in this domain.

The NIP priority provisions on information and monitoring foresees the following actions:

• To prepare realistic and needs oriented research, development and monitoring programmes;

• To improve the institutional and technical capacity for monitoring of POPs and related priority sources/major releases;

• To monitor reduction of releases as an indicator of NIP implementation success.

The NIP underlines the need for establishing an adequate information dissemination mechanism, ensuring public participation, development of specific awareness programs and involvement of industry and other users.

For the first time, the definition of POPs was included in the draft Law on environmental protection in 2010 (based on the proposal from the Sustainable POPs Management Office and Pollution Prevention Division of the MoE). The law included and special Chapter on the Management of POPs, which introduced the conditions for the management of POPs with the goal of eliminating the negative impact of these substances on environment and public health at the local, national and global levels, as well as a ban, taking out of use as soon as possible, limitation of production, import or use of these substances. Among the responsibilities of the central environmental authority in this domain is the implementation of the monitoring mechanisms for PCBs, PCDDs and PCDFs.

An important institutional strengthening, proposed by the draft Law on environmental protection was the establishment of the Environmental Protection Agency (EPA). Among other functions, the EPA, which will be subordinated to the MoE, will be responsible for the organisation and coordination of the Integrated Environmental Information System and of the Integrated Environmental Monitoring System. The EPA will carry out the centralised development of databases and additional information, will develop national reports and will transmit them to the central environmental authority.

According to the National Program on the Sustainable Chemicals Management (GD No. 973 as of 18 October 2010) the establishment of the Chemicals Management Agency (hereafter "CMA") is planned for the 2010-2015 period.

The National Program on Sustainable Chemicals Management has the following provisions in the field of information management and monitoring:

1. Establishment of the Information System includes the following:

• Providing equipment to the central public authorities for the access to the international databases on chemical substances, in order to improve the efficiency of the actions to eliminate the consequences of the chemical accidents.

• Creation of a database on accidents and fires with the involvement of the chemical substances, which will serve for the development of the measures for the elimination of risk and of the impacts on environment and human health.

• Revision, adjusting or development of the statistical forms for the management of chemicals and wastes in order to report within the international conventions.

2. Development of the research and monitoring capacities includes the following:

• Improving the capacities of ESS and other institutions for the management of accidents with chemical substances, which will ensure the elimination of their impacts.

• Development of the integrated monitoring programme of chemical substances in the environmental components, which will allow for planning and ensure measures of supervision and control of the potential toxic substances, including POPs, other dangerous substances and heavy metals for the monitoring of emissions and transfer of pollutants; improving the laboratory capacities.

• Development of a database on the emissions of chemicals and provision of the online access to the database, which will eliminate the gaps in distribution and exchange of the information.

• Development of a programme of monitoring and research of the impact of the chemical substances on the public health, which will be used to plan actions for the determination of the effects of the pollutants, including POPs, on environment and public health.

The Annex II to the Programme, Action Plan for the implementation of the Stockholm Convention for 2010-2015 foresees the following actions:

• Strengthening of the national monitoring capacities in the field of POPs;

• Development of the monitoring programmes for POPs in environment, drinking water, food, air and human body;

• Strengthening of the capacities of the IES laboratory;

• Promotion of the standards for sampling;

• Update of the inventory of POPs emissions.

At the time of writing this report, all proposed drafts, laws and regulations were completed, and the MoE was working to put these documents in the procedure for coordination and approval.

The requirements of the POPs monitoring are included in the draft Regulation on the Development and Functioning of the National System of Integrated Environmental Monitoring in the Republic of Moldova and Programme on Environmental Monitoring for 2010-2015, developed by the SHS in 2010.

In the field of POPs, monitoring these draft documents are focused on:

• POPs in surface water and sediments (as a part of water monitoring);

• POPs in soil;

• POPs in the atmospheric air and precipitations (trans-boundary air pollution);

• PCBs in soil and oils (electro-energy equipment).

In the period when the Law on environmental protection will enter into force, by mandate of the MoE the EPA will be responsible for fulfilling environmental POPs reporting obligations to the Secretariat of Conventions Stockholm, Rotterdam, Basel Convention and UNECE Protocol on POPs and UNECE PRTR Protocol.

Conclusion of finding on POPs in Moldova:

Priority actions needed:

• Adoption of the new legislation on chemicals and wastes;

• Strengthen institutional capacities in the field of POPs (in the MoE, EPA (planned), SEI);

• Repackaging, transportation for elimination of the remained obsolete pesticides;

• Remediation of POPs contaminated sites (warehouses, solution preparation points and contaminated soil);

• Protection and monitoring of the pesticides landfill site in Vulcancesit;

• Improvement of POPs and PCBs monitoring capacities;

• Improve capacities for international reporting;

• Awareness and information for population.

Major issues within the need for improved legislation for chemicals management in Moldova

include the following:
- Insufficient application of the Law on the administration of hazardous substances and products (lack of a register of chemicals, lack of evidence of their use etc), incompatibility of these with the international initiatives and actual requirements essential for chemicals management vis-avis production, trade, packaging, classification and labelling of chemical substances;

- Even though the procedure for imports is authorized by the Chamber of License and approved by some relevant Ministries according to the requirements, a re-examination of procedures is needed. Establishing a database which would register the quantities of imported and used chemicals should be a significant step in estimating risk associated with their use. The establishment of registry of chemical substances/products, is mentioned in the Law on the regime of dangerous products and substances, and will be an important component in the management of chemicals;

- The existing control system, including the procedures for licensing of chemical imports (does not regulate the spectrum and quantity of imported substances) doesn't comply with the principles of Globally Harmonized System of Classification and Labelling of Chemicals which sets out the basis for a global security programme for chemical products and substances;

- Issues raised at the international level related to management of waste, specific to substances such as asbestos from construction and demolition waste, the content of heavy metals in diverse products such as batteries, paints, mercury, etc., are not in the focus of central public administrative authorities;

- Sectoral management of chemicals (by branches of the economy) does not correspond with agreements of international conventions ratified by Moldova (there are no restrictions on the use of some chemicals (POPs, heavy metals, etc) and use of chemicals is not regulated in accordance-with accepted international standards; chemicals used in industry are not subject to supervision by the central public policy bodies with the exception of hazardous chemical substances;

- Legislation specific to the issue of chemicals management, including strategies and national policies do not include provisions vis-a-vis promotion of SAICM initiatives for sustainable chemicals management, including achievements of the Millennium Development Goals, including education and public awareness activities.

Considered through the concept of sustainable development and the perspective of adhering to EU legislation the new approach for chemicals management in conformity with ratified agreements and conventions is required. European legislation is the starting point for a number of states for the elaboration of national legislation and successfully represents a cooperative model between states.

One of the most important strategies for the achievement of sustainable development is the promotion of a legislative system coherent with current requirements at the international level.

Proposals for the promotion of SCM in the agricultural sector:

For the strategic documents till 2020 there are proposed the following objectives and actions:

• Introduction of SCM in action plans in force and which will be developed;

• Implementation of the provisions of the Law on chemicals and of its regulations;

• Integration of pesticides classification provisions and implementation of the CLP Regulation;

• Information and training on classification requirements of all companies, involved in import and trade of pesticides and fertilizers in Moldova;

• Harmonisation with Directive 2009/128/EC on sustainable use of pesticides and of the Regulation 1107/2009 on the plant protection products trade in the Law on phytosanitary products and fertilizers, nr. 119 din 22.06.2004, and relevant regulations;

• Proposals for the development of an action plan for the implementation of the National Program for the sustainable management of the chemicals for 2016-2020, in the agricultural sector;

• Development of the Guidelines – on the base of FAO International Code of Conduct on the Distribution and Use of Pesticides, FAO, 2002 (http://www.fao.org/agriculture/crops/core-themes/theme/pests/code/en/);

• Clean-up of the POPs contaminated sites, with an action plan for 2014-2020, and total elimination till 2025, inventory and mapping of contaminated and cleaned sites. Replication of clean-up pilot projects.

• Inventory of the new POPs, in the Annex A to the Stockholm Convention (http://chm.pops.int/Implementation/NewPOPs/TheNewPOPs/tabid/672/Default.aspx);

• Strengthening institutional capacities of the institutions involved in the agricultural secor in SCM.

• Transposition of requirements of Guidance on Pest and Pesticide Management Policy Development [2010], Guidelines for the Registration of Pesticides [2010], Guidelines for quality control of pesticides [2011], Guidelines on good practice for ground application of pesticides [2001], Guidelines on management options for empty containers [2008], Guidelines on Prevention and Management of Pesticide Resistance [2012]);

• Transposition of the provisions of the Directive 2009/128/EC on sound use of pesticides and of the EC Regulation 1107/2009 in the Law on the phytosanitry products and fertilizers nr. 119 of 22.06.2004;

• Development of the Guide on the implementation of the International Code of Conduct on the Distribution and Use of Pesticides, FAO, 2002 (http://www.fao.org/agriculture/crops/core-themes/theme/pests/code/en/);

• Application of the provision of the FAO Guides (Guidance on Pest and Pesticide Management Policy Development (2010), Guidelines for the Registration of Pesticides (2010) etc (http://www.fao.org/agriculture/crops/core-themes/theme/pests/code/list-guide-new/en/);

• Organization and continuous conduction of repackaging, transportation, elimination of the remained obsolete pesticides and clean up/remediate the contaminated sites, with an action plan for 2014-2020, based on the ongoing projects, financed by the development partners and the Government. Disseminate at country level the available experience of the 6 pilot cleaned-up sites.

FAO SESSION: PESTICIDE MANAGEMENT: MORE FOOD LESS RISK

CONCLUSIONS AND RECOMMENDATION

J. Breithaupt
FAO

The six presentations at the FAO session explored different examples of successful pesticide risk reduction and demonstrated how the risk mitigation measures are connected to pest and pesticide management and contributing to an integrated approach to a sustainable production intensification.

Different **aspects of successful pesticide risk reduction approaches** are documented, focusing on numerous stages and aspects **throughout the pesticide life cycle** and contributing to **reducing the adverse effects of the use of pesticides to health and the environment.**

Initial results of an ongoing regional project (GCP/RER/040/EC) entitled Improving capacities to eliminate and prevent recurrence of obsolete pesticides as a model for tackling unused hazardous chemicals in the former Soviet Union identified the strengths and weaknesses of the countries within the pesticide life cycle management and made some recommendations with regard to addressing key issues and challenges the countries face. One goal is to establish a regional forum geared towards providing resources for full-scale clean-up and a region-wide system capable of dealing with challenges posed by pesticides. Activities will include the disposal of stockpiles, but the priority lies in building capacities from passing legislative reform, implementing awareness-raising programmes, improving pesticide registration and regulatory processes, to the promotion of alternatives to the most hazardous chemicals in use.

Recommendations to improve the legal and regulatory framework on pesticide management in Eastern European and Central Asian countries are presented and suggestions for future actions are provided by the experts.

The importance of integrating environmental requirements in the agricultural policies in Moldova is documented in order to reduce risks for public health and environment posed by pesticides, while, at the same time, improving the state of agricultural ecosystems, increasing the quality of agricultural products and solving the problems of pollution in the past.

In Georgia, the project entitled Reducing the use of hazardous chemicals in developing countries: potential of implementing safer chemicals including non-chemical alternatives - tools for Georgia and the EECCA region (implementing agencies WECF, Greens Movement and GEBMA) conducted a pesticide life cycle assessment, identified the weaknesses and implemented or anticipates pesticide risk mitigation measures. The project activities and results could serve as a success story for the wider region in Eastern Europe and Central Asia.

The Presentations underline that is essential that farmers should gain a better understanding of how water management, soil systems, farming/growing systems, crop seeds and varieties, pest/disease ecology, harvest and post-harvest strategies and market access are all interlinked.

It becomes evident that only a holistic approach to pest- and pesticide management will help farmers to maximize yields, reduce the use of pesticides and other inputs and improve livelihoods.

All the presented examples and recommendations, tools, guidance documents and policies contributing to a successful pesticide risk reduction can help countries develop their own action plans towards a sustainable production while preventing adverse effects on human health and on the environment.

FAO promotes Integrated Pest Management (**IPM**) within a sustainable crop production intensification (**SCPI**) context as the most suitable strategy for crop production and protection, particularly for smallholder and resource poor farmers.

It is FAO's hope that through effective **implementation of the new *International Code of Conduct on Pesticide Management***, we can achieve significant reduction of risks to health and the environment from pesticides, while improving the productivity, sustainability and livelihoods of farmers everywhere.

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STATE OF THE ART AND LATEST DEVELOPMENT IN FORMER SU STATES AND CENTRAL EUROPEAN REGIONS



DISPOSAL OF OBSOLETE PESTICIDE STOCKS - CASE STUDY IN ROMANIA

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Abstract

Over the last decades, Romania has been dealing with the legacy of the obsolete pesticide stocks due to the extensive production and use of especially organochlorine pesticides.
Determined to stop the negative effects of over-usage of pesticides, in 2001, Romania joined the Stockholm Convention, which, at that time, included nine POPs pesticides. The Convention became effective starting from the 17th of May 2004. National Implementation Plan and its strategy of implementation was one of the first policies dealing with obsolete pesticide stockpile management and elimination in Romania.

In supporting the elimination of obsolete pesticide stocks, EU provided Romania with a grant of 3.5 million EUROs through the PHARE-program to implement a project aimed to dispose the pesticides stocks. The total project cost was 4.8 million EUROs, the difference between the EU grant and the total project cost was provided by the Ministry of Agriculture and Rural Development.

The PHARE Project carried out over the period from December 2004 to November 2005 collected and transported about 1735 tonnes of obsolete pesticides for destruction to Germany spread over 114 locations in Romania. To date, it is one of the largest cleanup projects of its kind in Europe, based on a professional project team and high-quality implementation routines.

Beside the stockpiles disposal, another important outcome of the project was the setting up a National Strategy and Action Plan for preventing new build-up of pesticides waste stocks in future.

Therefore, for the period 2007 to 2012 the Romanian Government focused on the implementation of its National Strategy and Action Plan.

Activities like campaigns on awareness raising and training of farmers for sustainable and safely use of pesticides currently placed on the market, establishment of container management system, implementation of the safe use of crop protection products initiative, combating counterfeiting of plant protection products, development of the Code of Best Agricultural Practices contributed to the successful implementation of the National Strategy and Action Plan at the national level.

Moreover, the best way to ensure that no pesticide stocks are built up and human and wildlife are not exposed to pesticides is organic farming[1], the amount of organ-

1 http://www.fao.org/docrep/003/ac116e/ac116e02.htm

ic farms in Romania has increased from 50 farms in 2000 to 9691 farms in 2011 with a total area of approximately 250,000 hectars.[2] The National Sustainable Development Strategy Romania 2013-2020-2013 highlights the potential of organic farming as a comparative advantage of Romania with regard to increased agricultural production.

The establishment of organic farming is the most comprehensive approach for the reduction of pesticide exposure to human and the environment which also guarantee that no pesticide stock are generated for these farms. This approach is, at the same time, a cornerstone in the development of sustainable production and consumption in Romania.

Approach, Achievements and Results

Since 1948, OCPs have been used in Romania. Products were mainly based on aldrin, chlordane, dieldrin, endrin, heptachlor and toxafene as active ingredients. All these products were imported, except those based on DDT and heptachlor, which were produced at the integrated petrochemical plant in Borzesti. They have been used on large agricultural areas, on meadows and alpha-alpha cultures (also called lucern).[3] For seed treatments in particular, Dieldrin based pesticides were used in Romania[4] between 1965 and 1970. Among the persistent chlorinated pesticides, one of the most used products were the ones based on heptachlor. After 1988, these types of products have not been consented in Romania . Concerning lindane, significant quantities were produced and used as insecticide on a wide range of plants, for foliage treatment, for trees and wood treatment and against ecto-parasites in human and veterinary treatment8 in Romania. After 2006, the production and use of lindane was banned on the Romanian territory according to the provisions of EU Regulation (EC) No. 850/2004 on persistent organic pollutants.[5]

In supporting the elimination of obsolete pesticide stocks, EU provided Romania with a grant of 3.5 million EUROs through the PHARE-program to implement a project aimed to dispose the pesticides stocks. The total project cost was 4, 8 million EUROs, the difference between EU grant and the total project cost (1, 3 million EUROs) being provided by the Ministry of Agriculture and Rural Development.

The project *"Disposal of pesticides (re-packing, collection and elimination of pesticide residues on the Romanian territory) EUROPEAID/115815/D/SV/RO – Obsolete pesticides"* comprised of two distinct components: supervision of obsolete pesticides clean-up action and, technical assistance to the Government in policy and strategy development in order to prevent new pesticide stocks from developing. The project was also linked to the elimination of pesticides stockpiles and waste which was identified as the Key Objective 1 in the Romanian National Implementation Plan. The project implementation implied following the steps, which are described below.

Step 1 – update of the pesticide inventory

As the international experience shows, inventories often underestimating the size of stocks - or other chemicals than recorded are present at the site. This was also the case of Romania, where the reassessment provided up-dated information and were

2 EkoConnect (2012) Organic agriculture moving East. Länderbericht Rumänien

3 http://en.wikipedia.org/wiki/Alfalfa;

4 http://chm.pops.int/Implementation/NIPs/NIP-Submissions/tabid/253/Default.aspx

5 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2004R0850:20120710:EN:PDF

additionally identified amounts of obsolete pesticides which needed to be disposed.

Step 2 – remediation of the pesticide stockpiles

Initially, the contract covered the elimination of 1409 tonnes of obsolete pesticides as it was provided by the existent national inventory. After the reassessment of the inventory due to the additionally identified amounts, another 1107 tonnes were disposed.

Therefore, the PHARE Project carried out over the period December 2004 – November 2005 collected and transported for destruction to Germany about 2516 tonnes of obsolete pesticides spread over 227 locations in Romania. It was one of the largest cleanup projects of its kind in Europe to date, based on a professional project team and high-quality implementation routines.

The project team comprised of: the Ministry of Agriculture, the Forest and Rural Development, as PHARE Project Implementation Unit; the Ministry of Agriculture, the Forest and Rural Development, Phytosanitary Units and local branch offices; the Ministry of Finance, as Central Finance and Contracts Unit; European Commission Delegation to Romania; SAVA Brunsbüttel (BRD), as Contractor; Ramboll (DK) in consortium with Tauw (NL) and UBA-Austria, as Supervisor, with IHPA as Sub-consultant.

Sound project management and supervision was obtained on the basis of a good contracting framework, as well as good partnership and cooperation between the Contractor, the Supervisor, and the Implementing and Contracting Authorities. The implementation routine contributed to a large extent to the successful implementation of the project. It consisted of the following:

1. Re-assessment of the inventory: The re-assessment provided up-dated information for the Contractor's take-over of the site (logistics, contents) and gave a clear picture of the situation at take-over, making possible for the Contractor to improve the planning and the supervision's cost control. The new inventory was managed by Waste Information Management (WIM) System of Tauw (NL). The site take-over from the Authority to Contractor (Site Takeover Document) required the agreement on re-assessed amounts, the agreement on Contractor's liability, signature of parties involved (legal representative of the Ministry of Agriculture – local phyto-sanitary Director, Contractor - Site Manager, Supervision - Engineer).

2. Repackaging, weighing, temporary storage: The project ensured that the pesticide waste was repackaged in UN approved packaging materials, under strict occupational health and safety measures. An on-site laboratory for identification of waste composition was set up. The transport of the waste was done according to ADR rules, and the disposal was performed in a licensed incineration facility (SAVA in Brunsbüttel, Germany). The final proof of destruction has been issued by SAVA to the Ministry of Agriculture and Rural Development.

Pesticide store and repacking in Romanian PHARE project (Source: John Vijgen, IHPA)

3. The site hand-over from Contractor to Authority/Owner: The Hand-over document required an agreement of repackaged amounts, returning into Authority's liability, signature of parties involved (legal representative of the Ministry of Agriculture – local Phyto-sanitary Director, Contractor - Site Manager, Supervision – Engineer). The Contractor's payment is based on Site Take-over and Hand-over forms (Euro/tonnes), as well as on the export lists.

Pesticide store and repacking in Romanian PHARE project (Source: John Vijgen, IHPA)

Step 3 – prevention of build-up of new Pesticide stocks

Besides the stockpiles disposal, another important outcome of the project was the setting up a National Strategy and Action Plan for preventing new build-up of pesticides waste stocks in future. This included 5 dedicated tiers:

1. Tier 1 - Further development of the legal framework in terms of Government's Role in sustainable use of pesticides and in hazardous waste management;

2. Tier 2 - Establishing of a national stakeholders platform and ensuring maximum participation;

3. Tier 3 - Campaigns on awareness raising and training of farmers;

4. Tier 4 – Empty Container Management System;

5. Tier 5 – Follow up activities for good agriculture practices among Romanian farmers.

Accession within the EU, starting with 2007, made an outstanding contribution to the implementation of the measures and actions included in the National Strategy and Action Plan developed under the above-mentioned project. The stakeholders involved in the development and implementation of the National Strategy and Action Plan implementation were the following: the Ministry of Environment and its subsidiary bodies such as the National Environmental Protection Agency and the National Environmental Guard, the Ministry of Agriculture and its Phytosanitary Units, the National Agency for Agricultural Consultancy, the Ministry of Health, plant protection industry, farmers and Romanian Crop Protection Association.

Tier 1 – further development of a legal framework

One of the important step was the consolidation of the legal framework in terms of Government's role in sustainable use of pesticides and in hazardous waste management (e.g. approximation of the EU Directive on plant protection products, the Directive on sustainable use of pesticides, the Waste Framework Directive, the Hazardous Waste Directive, Directive on the incineration of waste, the National Strategy and National Action Plan for Waste Management, etc.).

Tier 2
– National stakeholder platform

National stakeholder's platforms/working groups to ensure maximum participation in the field of pesticides (National Committee on Plant Protection Products Permitting, national working groups on waste, etc.) were developed.

Tier 3
– Campaigns on awareness raising and training of farmers

In order to prevent the occurrence of obsolete pesticides, the Ministry of Agriculture and Rural Development together with Romanian Crop Protection Association (AIPROM) periodically runs awareness raising and farmers' training campaigns on how to use the pesticides that are currently placed on the market in a sustainable and safe way. For example, the European Crop Protection Association (ECPA) began implementing the safe use of crop protection products initiative since 2002 (so called "SUI"). In Romania, the project started in September 2010 with the support of ECPA, with the initiative of the AIPROM and the relevant authorities and in consultation with other key partners in the industry. The project aims to protect the health of farmers and the environment by improving knowledge of the principles of fair use of plant protection products, the use of protective equipment certified and

to comply with the rules of transportation, storage and application. One of the first actions was the development of a study of marketing at farm level in Romania, followed by a site visit to examine the situation in detail. Taking into account the differences between farms on technology in Romania, were determined the critical points and farming segments were the action plan of the project, which had to be focused (i.e. labeling, using only the products approved and from reliable sources, storage and transport of products, application equipment, protective equipment and not least triple rinsing and delivery of used packaging).

Romanian Crop Protection Association took the initiative to combat counterfeit products used for plant protection by a 3-year project, supported by the ECPA. The project aims to address the distributors and users of plant protection products in particular, but also the farmers and authorities. The project was entitled "SCUT" (eng. SHIELD) signifying the effect hoped against counterfeiting expansion of plant protection products, trade and usage.

Among the project objectives, we can include the followings: changing attitudes and counterfeiting based approach to plant protection products to both distributors and farmers plant protection products and the authorities, under the slogan "Toward zero tolerance for plant protection counterfeit products"; sustainable development of agriculture by reducing adverse effects on human health and the environment; improving national phytosanitary legislation by proposing specific anti-counterfeiting measures.

In order to achieve these objectives, several activities took place at the national level, such as: running sustainable campaigns in order to inform and educate the public, particularly distributors and farmers; providing customized anti-counterfeiting training to control agencies, distributors and farmers; providing expertise and training materials on anti-counterfeiting practices with attention to parallel trade and repackaging; changing the relevant legislation in this field; preventing and reducing illegal trade of counterfeit plant protection products by educational projects and developing an open market alert system.

Tier 4
– Empty Container Management System

Concerning the management of empty packages and containers, as proposed by the National Strategy, several actions have been taken. Romanian Crop Protection Association (AIPROM) took the lead and developed the empty container management programme, so called "SCAPA", which is currently running. All services, such as collection of the empty containers and packages from farmers as well as distributors, are free of charge provided by the SCAPA. Implementation of SCAPA is organized and financially supported by AIPROM member companies and companies participating in the system.

Tier 5
– Follow up activities for good agriculture practices among Romanian farmers

All three initiatives, i.e. "SCAPA","SUI" and "SCUT", support the implementation of the EU Directive 2009/128/EC on sustainable use of plant protection products. The most important measures taken were related to the certification of users, defining the professional users of plant protection products, verification and certification of protective equipment, best practice in the application of plant protection products, empty container management system settlement and combating plant protection products counterfeit.

Moreover, to support the farmers, the Ministry of Agriculture and Rural Development has developed the Code of Best Agricultural Practices, which is periodically updated.

This all together ensures that pesticide stocks are not build up again and that the overall pesticide management is developed to the extent possible including the management of empty containers. However, still pesticide use is associated with the threat to human health and the environment trying to balance external costs and benefits.

The best way to ensure that no pesticide stocks are built up and human and wildlife are not exposed to pesticides is organic farming . Within the last ten years, organic farming has gained momentum in Romania. According to the data report of the Eurostat and the Ministry of Agriculture and Rural Development, the amount of organic farms in Romania has increased from 50 farms in 2000 to 9691 farms in 2011 with a total area of approximately 250,000 hectares.[6] The National Sustainable Development Strategy Romania 2013-2020-2013 highlights the potential of organic farming[7] as a comparative advantage of Romania with regard to increased agricultural production.

Conclusions and Lessons Learnt

The conclusions and lessons learnt from the Romanian experience can be summarised as follows:

- A comprehensive strategy and action plan at the national level is the key for an efficient implementation of relevant policies and for providing the appropriate funding resources.

- A key to success is the cooperation and communication among the relevant stakeholders (ministries, agencies, producers, retailers, private owners, control bodies) involved in the pesticides and obsolete pesticides management.

- A comprehensive assessment and establishment of a detailed inventory is essential to have a control over the pesticides stocks.

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6 http://www.fao.org/docrep/003/ac116e/ac116e02.htm;

7 EkoConnect (2012) Organic agriculture moving East. Länderbericht Rumänien;

• Streamlining of the existing policies in the field of pesticides and POPs management and development of subsequent legislation is essential for ensuring the effectiveness of the implementation.

• Awareness raising activities are crucial both in the clean-up activities as well as in the prevention of re-occurrence of obsolete pesticides. It can act as a driver for these change progresses.

• During the clean-up activities, it is important to get the local authorities' commitment and participation in facilitating of works execution.

• Clean-up activities are only sustainable if they are combined with a strategy for avoidance of the re-occurrence of obsolete pesticides.

• It is necessary to establish an empty container management scheme/system as part of the "life-cycle concept" to minimize the risks to both humans and the environment.

• The establishment of organic farming is the most comprehensive approach for reduction of pesticide exposure to human and the environment which also guarantee that no pesticide stock are generated for these farms. This approach is at the same time a cornerstone in the development of sustainable production and consumption in Romania.

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PRESENTATION ON OBSOLETE PESTICIDE REMAINDERS IN AZERBAIJAN REPUBLIC

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According to the order of the Cabinet of Ministers of Azerbaijan Republic from May 7, 2012, the Ministry of Emergency Situations, the Ministry of Ecology and Natural Resource and the Ministry of Agriculture established a working group consisting of representatives involved in developing proposals for disposal of pesticide remnants.

According to the decision of Cabinet of Ministers of Azerbaijan Republic from December 3, 2012, the Ministry of Emergency Situations became involved in pesticide remnants removal.

According to Regulation 8.48.1 approved by Presidential Decree No. 394 from April 19, 2006 the Ministry of Emergency Situations and other relevant state authorities are involved in the implementation of state control over the protection and maintenance of pesticide and biological agent production plants:

According to the Law on Technical Safety of Azerbaijan, approved by Decree No. 357 from November 2, 1999, the potential threat to the safety of objects is under state control, and according to Law Fire Safety approved by decree No. 313-IQ from June 10, 1997, fire safety control of these objects is carried out by the relevant bodies of the Ministry of Emergency Situations of Azerbaijan.

Technical and fire safety inspections of pesticides and agro-chemical storage tanks in the Republic are carried out by the State Agency for the safe conduct of work in industry and mining control, and State Fire Control Service of Ministry of Emergency Situations.

By the Law No. 554-II from December 09, 2003, on accession of Azerbaijan Republic to the Stockholm Convention on “Persistent Organic Pollutants” from May 22, 2010, among the 12 basic substances are only DDT, PCB and Dioxin/Furan present in Azerbaijan. From these substances only the DDT was produced in our Republic and since 1982 the use of it was suspended and was prohibited.

In 1989-1990, considering that a lot of obsolete pesticide remnants were still in the areas, there was a need to build the Jangi Pesticide Disposal Polygon in the framework of the former “Azerkandkimya”. For construction of such polygon, a special area was allocated in the foothills 53 km away from Baku, 4 km away from Jangi village in the Absheron district.

Till the closure of the former “Azərkəndkimya” Scientific Production Association, 8,000 tonnes of obsolete and prohibited pesticide waste (DDT, calcium arsenate, calcium Cyanamid, hexachloran, granazone, xomesin, sineb, etc.) were collected from different regions of Azerbaijan and buried.

After closure of “Azerkendkimya”, due to the lack of control until 2005, the concrete covers of the concrete containers were illegally opened and more than 4,000 tonnes pesticide waste was carried out to the markets and sold to the people as fertilizers, and the rest was kept without using.

In 2006, when the initial inventory was implemented, it was found that pesticides were scattered in the land fill and approximately 3,500-3,700 tonnes of pesticide waste were still present in the bunkers.

According to the Decree No170 of Cabinet of Ministers from July 25,2007 Jangi Pesticide Landfill was given to the State Phytosanitary Control Service under the Ministry of Agriculture, and measures were taken into consideration to improve storage conditions, some of pesticide waste was gathered from the regions and buried in Jangi landfill. However, the problem is not yet solved so far: considerable amounts of pesticide waste are still present under dangerous conditions which can harm people and environment.

According to the order of the Cabinet of Ministers, a working group was established consisting of the representatives of the Ministries of Emergency Situations, Ecology and Natural Resources and Agriculture, in order to discuss current situation. Following materials were discovered in the country:

1,520 tonnes dust illustrated, 1,064 m^3 buried unknown pesticide, 1,000 drums with liquid pesticide, 73,116 m^2 soil contaminated with toxic substances, 28,428 m^2 contaminated warehouse floor surface were determined.

The absence of information on small unknown landfills does not mean that in the future during excavations these substances still have to be found.

• Salyan district center: In the storage of supply base of chemical products in the former "Azərkəndkimya" Unity – 200 tonnes mixed pulverized pesticide. 500 rotten polidofen (20%DDT) drums scattered around the area of 13,975 m^2 contaminated with liquid pesticide. 300m^3 - unknown pesticide remnants buried in the soil;

• Salyan district Dayikend settlement area - Some of unknown pesticide remnants and the polidofen (20% DDT) drums from the former "Azərkəndkimya" pesticide storage were buried in the well. 9,800 m^2 area was contaminated with unknown pesticide remnants;

• Neftchala district area–Lower Garamanli area- Half ruined fertilizer storage of the former "Azərkəndkimya" 5 tonnes natrium propinat herbicide was found;

• Jalilabad district Uzuntapasettlement area -The former "Azərkəndkimya" Pesticide warehouse approximately 40 tonnes and 10 tonnes unspecified powder pecticide remainders were found. Besides that approximately 450-500 pieces 20 litre -200 litre of liquid dalapone (herbicide) drums corroded in different parts of the territory. 2,350 m^2 plots of land, at the same time around 4 storage building areas, approximately 5840 m^2 contaminated area by a variety of chemical products;

• In Aghjabadi district Hindarkh settlement area- Approximately 2500 m^2 area of the storage of the former district village chemistry union contaminated with pesticide, in other part approximately 40 tonnes unspecified pesticide mixture was found;

• Beylagan district Khalaj village area-During collapse of the pesticide storage of the Former "Azərkəndkimya" Union, some remainders of the pesticide left under the destroyed storage, other part left under the soil layer and dispersed nearby areas. Some part of the area was dug and approximately 900 m^2 area was contaminated with mixture of pesticide. There are approximately 60 tonnes of a mixture pesticide in the area;

• Füzul idistrict Horadiz city area - After the collapse of the storage of the chemistry products of the former “Azərkəndkimya” Union pesticide remainders contaminated 16,100 m² area. There are more than 500 tonnes pesticide remainders (DDT, hexachloran, izofen etc.);

• Goranboy district Dalimammadli settlement area-3,600 m² area of the half destroyed fertilizer storage of the former “Azərkəndkimya” Union was contaminated with pesticide remainders to a depth pf 15-20 cm. Outside of the storage an area of 4,800 m² and 2,100 m² soil was contaminated with pesticide remainders;

• Ujar district central area-3450 m²2 area of the storage of the former “Azərkəndkimya”was contaminated with the mixture of pesticide soil. 50 t sharp smell pesticide mixture (the main part –izofen) was found. Ujar district Mususlu settlement area-Fully destroyed pesticide storage of the former “Azərkəndkimya” Union pesticide remainders were spread around and contaminated 2400m²2area.

• Yevlakh district area-In the area of the fully destroyed storage of the former “Azərkəndkimya” Union 5 places approximately with 100 t unknown pesticide mixture and 1000 m²2 area was contaminated with the spread of pesticide remainders.

• Aghdash district Laki settlement area-In the destroyed storage 100 tonnes pesticide mixture (mainly butifos and fentiuram) were spread in and outside of the storage. 100 tonnes pesticide mixture were carried to another nearby area, where an area of 5600 m² was fully contaminated with pesticides;

• Khachmaz district Lajat village area (10 km far from Khudat) - In the storage of the former “Azərkəndkimya” Union pesticide remainders were buried in an area of 168 m³ and covered with soil. Entering this area a strong smell of pesticides can be observed. Black spots on the soil can be clearly seen;

• Siyazan district area - 876 m² area including storage of the former “Azərkəndkimya” Union, the entrance of the city on the side of the railway was contaminated with the pesticide remainders. Outside of the storage 5 tonnes of unknown pulverized pesticide mixture was found

• Sumgayıt city “Azərikimya”Union area of SOCAR – In the factory of Sumgayt, DDT, lindane and hexachloran were produced from 1958-1980. Besides the use in the Republic these products were also was sent to other cities in the Soviet Union;

• Samukh district area - 300 m² area of three pesticide storages of the former wine-growing factory were highly contaminated by pesticide remainders;

• Kolayır village –in the storage of the former “Azərkendkimya” Union of Samukh district chemistry union an area of 98 m³ was excavated: izofen, chlorofos, hexochloran were buried - Near the houses 100 tonnes of the hexochloran pesticide mixed with fertilizer are in the open air.

• Shamkir district Dallar settlement area - In the half destroyed storage of the former “Azərkəndkimya” Union 90 tonnes in the form of a ball. There is a 20-30 cm thick layer of pesticide on the bottom. Outside of the storage, in the open air approximately 30 tonnes pesticide remains were found.

• Aghstafa district–half destroyed fertilizer and pesticide storage of the former “Azərkəndkimya” union. Approximately 35 tonnes of pesticide remains and 25 tonnes of fertilizer mixed with pesticides were found. The contaminated area around the storage is approximately 600 m².

Activities that have been implemented to improve the situation of the pesticides during 2008-2011:

As the result of the monitoring:

• 3,084 tonnes obsolete, highly toxic and prohibited pesticide powder was found and repackaged between 2008 and 2010 (In 2008 from the districts: Aghjabadi, Yevlax, Ujar, Zardab-2,048 tonnes, in 2010 – from Aghjabadi district 1,036 tonnes) they were carried to Jangi pesticide range;

• Liquid polidofen (1,180 drums and 200 pieces contaminated poddon) in Ganja city was re-packed and carried to the storage built on the same site;

• In Zardab 1,143 m^3 area was contaminated with different types of chemical substances around the building for the disabled people. The contaminated area was excavated and the material was carried to the range;

• In November, 2011 the EECCA GEF-pilot project “Re-pack of obsolete, highly toxic and prohibited pesticide remains” was implemented in Azerbaijan Republic. From 3 regions of the Republic 70 tonnes pesticide waste was repacked and carried to the range according to FAO standards.

The project included training and supervision by an international expert.

POPs FREE MOLDOVA: 10 YEARS OF EFFORTS

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Abstract

The article presents the actions undertaken by Moldova and the results obtained in the last 10 years in POPs stockpiles management and elimination of the risks caused by them in relation to the environment and human health.

Practical measures in this regard began in 2003, following a special decision of the Government, and concur with signing and ratification of the Stockholm Convention on Persistent Organic Pollutants by the Republic of Moldova. These actions have been funded by the Government, but they have been substantially supported by international organizations and Governments of development partner countries.

During that period, all known stockpiles of obsolete pesticides including POP pesticides were collected and approximately 3,350 tons of waste was stored. Of these, 1,500 tons were evacuated abroad and destroyed. These activities are still continuing and in the next two years almost all remaining stocks from warehouses will have been eliminated. More than 930 tons of PCB containing capacitors were removed. The national inventory and mapping of POPs contaminated areas (cca.1,600 sites) and inventory of PCB in transformer oils of approximately 30,000 units of electric power equipment were conducted.

Progress is being made in the modernization of the legal framework on chemicals and waste management. As a result of extensive information and awareness campaigns on POPs, the level of education and awareness at all levels increased substantially.

In achieving these objectives, the Ministry of Environment, Ministry of Agriculture and Food Industry, Ministry of Defense, Ministry of Economy, local authorities, research institutes, international and local consulting companies and experts, NGOs are involved. Over 20 projects have been implemented in this area.

All these actions have a continuous and sustainable character and aim at achieving European and international standards on safe management of POPs, hazardous chemicals and wastes in general.

Keywords

Persistent organic pollutants (POPs), POPs management, obsolete pesticides (OP), polychlorinated biphenyls (PCB), contaminated sites, POPs database, Stockholm Convention on POPs

Introduction

Moldova has never produced pesticides, including POP pesticides, but has a long tradition in agricultural production and hence used large amounts of pesticides in the past. It is estimated that between the 1950s and 1990s about 560,000 tons of pesticides were used in the Moldovan agricultural sector, including 22,000 tons of organochlorine pesticides. In the absence of an adequate pesticides management strategy, like the prevention of new stockpiles accumulation, more than 3,000 tons of now banned and useless pesticides have been accumulated over the years in storage facilities all over the country. The number of those facilities stood at about 1,000 in 1990. Subsequently, the warehouses have been dilapidated in many cases. The passage of time and exposure has resulted in the deterioration of the packaging material. Studies have shown conclusively that these materials have contaminated the sites and surrounding soils and nearby surface waters. When obsolete pesticides were placed in storage, they were generally indiscriminately mixed with each other in bags and drums. This resulted in a mixture of POPs pesticides and non-POPs pesticides and there is no economically viable way of determining the compositions of all the resultant mixtures in the repackaged plastic and steel drums. Representative sampling/analysis indicated that the average amount of POP pesticides in the obsolete pesticide stock in Moldova is about 20-30%.

Main stages and results of POPs management and elimination

The Moldovan Government initiated a strategy to address POPs issues in 2002 based on its own financial and human resources by approving a special decision on additional measures for centralized storage and neutralization of obsolete pesticides /1/. Having signed the Stockholm Convention on Persistent Organic Pollutants on May 23, 2001, the Republic of Moldova became eligible for international support in solving these problems. In the following period, all the actions in this area were based on cooperation with international institutions and experts, financed from the national budget, but with strong support from the international organizations. Over the last 12 years more than 20 projects in the area of management and elimination of POPs and other dangerous chemicals and wastes have been or are currently implemented.

The main objectives of the implemented projects were to protect human health and the environment by safely managing and disposing of POPs contaminated pesticides and PCB stockpiles, establishing sustainable POPs stockpiles management and strengthening the regulatory and in-s¬titutional arrange¬ments for long term control of POPs and other toxic substances in line with the requirements of the Stockholm Convention and related other conventions and protocols ratified by Moldova. The amount of funds used for these purposes up to now is approximately US$18 million.

The Ministry of Ecology and Natural Resources (now: the Ministry of Environment) was the central national environmental authority designated as the Stockholm Convention competent authority and as such is responsible for coordinating the POPs-related activities of all government bodies involved in chemicals management issues. Such responsibilities are borne also the Ministry of Agriculture and Food Industry (MAFI), the Ministry of Economy, the Ministry of Defense (MoD), the Ministry of Health, the Department of Emergency Situations (DES), the Customs Service, other central public authorities, as well as the local authorities. A National Coordination Committee (NCC) for the implementation of the Stockholm Convention, bringing together senior officials from the key ministries and led by the Ministry of Environment (MoE), was established in July 2002 to provide overall guidance and coordination for NIP development and implementation. An inter-ministerial group for the repackaging, collection and centralized storage of obsolete pesticides, led by the MAFI, has been in action since November 2002 (See also /1/).

All actions taken in the area of management and destruction of obsolete pesticide stockpiles can be divided into the following stages:

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All actions taken in the area of management and destruction of obsolete pesticide stockpiles can be divided into the following stages:

Stage 1 – Inventory of Obsolete Pesticide stockpiles and development of NIP for the Stockholm Convention

The first inventory of OP stocks in Moldova had been made between 2002 and 2004 with the support of a GEF/WB grant for enabling activities regarding the implementation of the Stockholm Convention and was based on the documents available at that time to the Ministry of Agriculture and Food Industry. The inventory results revealed 1,700 tons in 350 poorly equipped warehouses, and approx. 4,000 tons that were buried in a landfill in the South of the country, most of them mixed or of unknown composition. After the completion of the repackaging and storage measures of OP, it was found that the amount collected from the various warehouses was twice as large as expected because of their inadvertent mixing with fertilizers due to inadequate storage conditions and damaged packaging materials.

Also, under this grant the National Strategy on the reduction and elimination of POPs and the National Implementation Plan for the Stockholm Convention on POPs have been developed and approved by the Government on October 20th, 2004 and later on, on February 19th, 2005, the Moldovan Parliament ratified the Convention.

Stage 2 – Repackaging and temporary storage of OP stockpiles
In November 2003, the Ministry of Defense (MoD) and the Department of Emergency Situations started the repackaging and transportation of the obsolete pesticide stockpiles from about 350 warehouses scattered across the country to the newly selected centralized district storage facilities, one in each administrative districts. These warehouses were chosen based on a number of criteria to ensure safe storage. Each of the warehouses was examined during the environmental assessment of the project to evaluate their integrity. While this system of centralizing the storage of obsolete stockpiles is an improvement, it is not a long term solution. Centralizing the hazardous matter allows for improved security and monitoring and will facilitate ultimate disposal, which has to remain the goal.

The expenditures for these measures were covered initially by the National Environmental Fund (NEF) and the national budget. Starting from 2005, they have been funded within the NATO/OSCE “Project for the destruction of pesticides and dangerous chemicals” implemented by MoD. In one district, these activities have been carried out within the Regional Project „Elimination of Acute Risks of Obsolete Pesticides in Moldova, Georgia and Kyrgyzstan”, implemented by Milieukontakt International.

As a result, by the end of 2008, approximately 3,350 tons of obsolete pesticides had been relocated to 37 guarded central district warehouses.

Stage 3 – Strengthening the regulatory framework and capacity building for POPs management
Between 2006 and 2010, a GEF/WB “Persistent Organic Pollutants Stockpiles Mana¬ge-ment and Destruction Project” was implemented by the Ministry of Environment in Moldova, based on a GEF grant of $6.35 million and a counterpart contribution of $3.72 million from the Moldovan state’s budget and National Ecological Fund, including $1.6 million allocated for disposal of obsolete pesticides. To facilitate project implementation, a special team, POPs Sustainable Management Office, was established under the MoE, based on the team which was working in the field of POPs since 2002, ensuring that use is being made of capacity once it’s built.

This project was the cornerstone in strengthening the policy and regulatory framework for POPs management and control in the Republic of Moldova. Through his project the main objectives of the NIP have been achieved. The project assisted the Government of Moldova in confining stockpiles of pesticides in such a way that harm to the environment or human health is largely prevented. Furthermore, the regulatory framework and institutional capacity to address POPs related issues has been strengthened.

The major results achieved in these activities are as follows:

• New or revised national policies and regulations, like the National Programme on Sound Chemicals Management, Law on environmental protection, Law regarding the regime of harmful substances and products, Law on plant protection, Law on production and domestic waste, Law on payment for environmental pollution as well as guidelines have been developed. Among the materials published are the Handbook on inventory and mapping of

POPs contaminated sites and the Handbook on remediation of POPs contaminated sites. Over 12 packages of draft legal and regulatory documents, including a Law on Environment Protection, a Law on Chemicals and a Law on Waste, have been completed and are in the process of coordination and approval;

• A National Concept of the Information Manage¬ment and Reporting System on POPs has been developed;

• Two modern laboratories have been equipped with high resolution equipment used for monitoring and identification of POPs in environment components;

• Environmental, plant protection and energetic inspectors have been trained in enforcement and compliance with the POPs convention requirements based on the new legal documents on POPs management;

• Organic farming has increased after the introduction of a regulation on organic farming in 2005. While in 2003 there were only 11 certified farms practicing organic farming, this number has increased to 253 farms and 35,000 hectares in 2010, thus avoiding the pesticide use on this land. The National Strategy for Sustainable Development highlighted organic farming as one of the priorities for R&D of the Moldova.

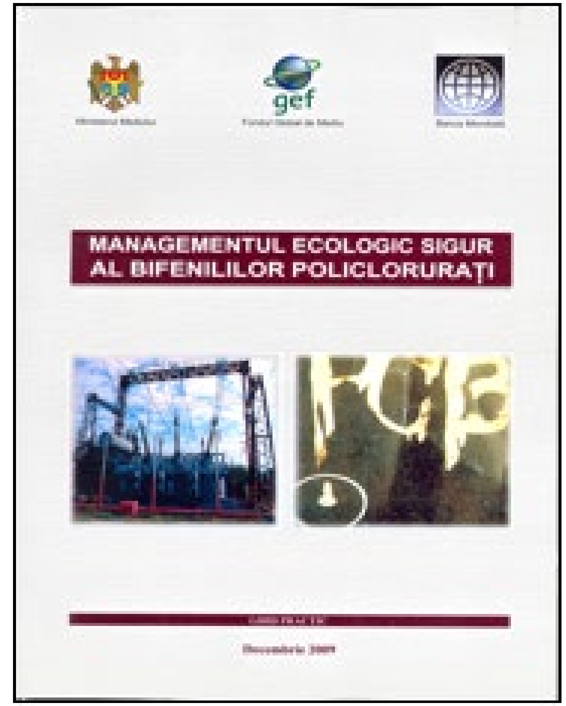
• A public awareness and information campaign has been conducted trough local, regional and national seminars and conferences, radio and TV programs, documentary movies and TV ads, articles in local and national newspapers, project website www.moldovapops.md, etc. The special surveys showed a significant increase of public awareness in the field of POPs;

• Results obtained have been presented within more than 70 local, national and international workshops and conferences, including the last six International HCH and Pesticides Forums.

Stage 4 – Elimination of POPs stockpiles

Elimination of POPs stockpiles in Moldova began in 2006 under the POPs Stockpiles Management and Destruction Project. At that time, the priorities were established on the evacuation and destruction of over 3000 tons of OP from 37 central district warehouses and of approx. 1000 tons of PCB-containing electrical capacitors from 13 transformer stations.

In the following two years, all 18,660 electrical capacitors containing PCB found in the country (934 tons, including highly polluted soil) have been dismantled/excavated, shipped and destroyed abroad. Remediation works at the biggest transformer station have been carried out, too.



Source: POPs Sustainable Management Office, Moldova

In parallel with elimination of PCB, 1292 tons of pesticides and contaminated packaging from 11 districts were exported and incinerated. These activities were taken up again in 2011 within the projects implemented or coordinated by the MoE, MoD and MAFI, with financial support from the national budget and from international organizations such as Czech Development Agency (CzDA), NATO, OSCE, the European Commission (EC) and FAO. At the moment, the amount of pesticides destroyed stands at about 1500 tons. The details can be found in Table 1.

Thus, presuming a successful completion of all projects that are now under imple-ment-tation, all stocks of pesticides stored in warehouses will be eliminated by the end of 2015.

Stage 5 – Inventory and mapping of POP pesticide polluted areas and PCBs in transformer oils

One of the tasks of the POPs Stockpiles Management and Destruction Project refered on a national inventory and mapping of POPs polluted sites. The objective of this study was to identify the POPs polluted areas posing the highest environmental and health risks, as well as mapping of those areas using a GIS tool. These activities were carried out in 2008-2010.

An original methodology of POPs pollution study and hazards assessment was developed aiming at: (i) identification and assessment of potentially POPs contaminated sites all over the country; (ii) creation and completing of the POPs database as well as mapping and visualization of acquired data; and (iii) establishing common reporting formats and assuring database support.

Project	Financing Agency	Implementing/ coordinating Agency	Period of elimination works	Amount of OP eliminated, tons	Present status (Oct. 2013)
• *POPs stockpiles management and destruction*	• GEF/WB • MD Gov • NEF	• MoE (POPs PMT)	• 2007-2008	1293	• Finished
• *Remediation of environmental burdens caused by pesticides in Moldova:* - *Stage 1* - *Stage 2*	• CzDA	• CzDA • MoE (POPs PMT)	 • 2011-2013 • 2013-2015	 202 250	 • Finished • Ongoing
• *Elimination of obsolete pesticides stocks with major risks (liquid OP)*	• NEF	• MoE (POPs PMT)	• 2013-2014	200	• Ongoing
• *Disposal of dangerous pesticides from the Transdniestrian Region of Moldova*	• OSCE	• OSCE Mission to Moldova • MoE (POPs PMT)	• 2013-2014	150	• Ongoing
• *Destruction of pesticides and hazardous chemicals in the Republic of Moldova*	• NATO/ OSCE • NEF	• NATO • MoD	• 2013-2014	1269	• Ongoing
• *Improving capacities to eliminate and prevent recurrence of OP as a model*	• EC/FAO	• FAO • MAFI	• 2013-2015	250	• Ongoing


Table 1: Elimination of OP stocks in Moldova, source: POP's Sustanaible Management Office, Moldova

All potentially contaminated sites identified were described based on a unified questionnaire; the coordinates of the POPs sites were determined using GPS; photo images and composite soil samples were taken at each site before being further analyzed for POPs in a certified laboratory. About 1600 contaminated sites were identified and described.

An integrated GIS system for POPs data mapping and analysis has been developed allowing effective storing, managing and presenting of POPs-related information, such as the geographic locations of the sites, concentrations and other related parameters, as well as distribution of health and environmental hazards. The database is available on the Ministry of Environment website: http://pops.mediu.gov.md. The information on POPs-polluted sites gets periodically updated by environmental authorities.

With the POPs database, the central and local authorities got a new tool which significantly improved the management of contaminated sites. It effectively supports the policy and decision making process in the field of contaminated sites management /3/.

A national inventory of PCBs in dielectric oils from power equipment had been conducted in 2008-2011 with the financial and technical support of the Global Environmental Facility and Canadian International Development Agency through the World Bank and the Moldovan National Environmental Fund.

Oil samples were taken and analysis made on the PCB content from about 30,000 units of power equipment, owned by eight companies of generation, transmission and distribution of electricity, as well as by consumers /4/.

An inventory registration system and national database for electrical equipment containing or contaminated with PCBs above a concentration of 50 ppm have been developed and will serve for its further management and gradual elimination, as required by the international agreements and national legislation.

Stage 6 – Remediation of POPs polluted site

In parallel with the inventory of contaminated sites, in 2008-2009, within the CIDA/WB Project "Remediation of POP pesticide polluted areas and inventory of PCB contaminated oil in power equipment", several pilot remediation activities had been carried out.

This study on the remediation of POP-pesticide-polluted areas was carried out as a complementary measure to the actions undertaken in the field of sustainable POPs management and has the following specific objectives: (i) to identify Best Available Technologies (BAT) for of POP pesticide polluted areas, taking into account technical, financial and ecological aspects; (ii) to assess their potential environmental/health benefits and impacts; (iii) to implement appropriate remediation techniques at a few selected sites.

Based on the assessment, which included aspects of practical and economic feasibility of implementation, taking into account costs, expected performance, efficiency and potential impacts on the environment and human health, two techniques – isolation in controlled soil stockpiles and biological treatment with the Daramend technique – were selected and tested/validated at three pilot demonstration sites in order to identify the most appropriate methods for Moldova with a view to recommendation of remediation strategies for other OP sites throughout the country pending the availability of financial resources /5/.

Based on practical experiences, the Guidelines for local environmental authorities were compiled on how and when to carry out remediation measures on areas polluted with POP pesticides.

Conclusions and lessons learnt

The conclusions and lessons learnt over more than one decade of experience in the management and disposal of POPs in Moldova can be summarized as follows:

• A comprehensive strategy and action plan at the national level is the key for an efficient implementation of relevant policies and for providing the appropriate funding resources;

• A key to success is the cooperation and communication among the relevant stakeholders (ministries, agencies, control bodies, local authorities, retailers, private owners) involved in the POPs management;

• The establishment of a reliable cooperation with the donors at an early stage was important. Due to this fact, transparency and better planning of project activities in terms of finance and procurement have to be established;

• The approaches and decisions that led to successful achievement of the objectives were based on the fact that all initiated projects and measures carried out had continuity in time and trained personal. All parties have to respect their commitments and activities and complement each other and complete their tasks within the set time frame;

• A comprehensive assessment and establishment of a detailed inventory is essential to have a control over the POPs stockpiles;

• Streamlining of the existing policies in the field of POPs management and development of subsequent legislation is essential for ensuring the effectiveness of the implementation;

• From a practical implementation point of view, one of the important decisions was the establishment and maintenance of the project management team (e.g. POPs Sustainable Management Office under the Ministry of Environment) that, once established, continued to work in order to ensure the sustainability and effectiveness of Stockholm Convention implementation. This unit is responsible for fiduciary activities of POPs projects and additionally has been involved in the implementation of other environment projects;

• The selection and contracting of qualified consultants, both local and international, facilitated the successful implementation of planned activities and transferring knowledge to personnel;

• Compliance of and contribution from the government and the partners who have agreed to support projects are non-negotiable for the successful implementation of activities.

• Awareness raising activities at all levels of society are crucial throughout the entire process of approaching and solving of POPs issues;

• Based on the results obtained, the international institutions and experts involved in POPs management consider Moldovan projects a success in that most objectives were achieved as planned. As a result, the experience and the knowledge gained has been analyzed and taken as a blueprint by other governments in the region, as they follow the approaches developed and partly hire the trained experts as consultants.

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OVERVIEW OF POST-DISPOSAL PROBLEMS WITH OBSOLETE PESTICIDES IN POLAND

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Abstract

Completion of the pesticide tomb disposal program in Poland is definitely a milestone in the process of eliminating environmental risks caused by pesticide waste. But can we consider the case closed?

This presentation discusses current issues related to pesticide waste and how far we have come in solving them. It specifically describes the effectiveness of the tomb disposal program in Poland, which is now complete with the exception of a few sites. This presentation also reviews efforts being taken to eliminate risks caused by the "Rudna Gora" pesticide landfill in Jaworzno, Poland and the stage of work on developing regulations dealing with the historic contamination of the ground. Currently, the lack of clear legislation regarding the issue and disputes over the responsible authority hamper taking any restorative measures around the landfill even more than the lack of funds.

A separate issue discussed in the presentation involves a stunning case of importing from Ukraine to Poland over a dozen thousand tons of HCB in the form of soil mixed with HCB waste for thermal disposal. Due to violations of official procedures and standards for safe transportation, storage and utilization of this type of waste, the case ended up being prosecuted by the authorities and was widely reported in the media.

Key words

Pesticide waste disposal, unwanted pesticide, pesticide landfill, tombs, Rudna Góra landfill, HCH and HCB waste, expired pesticides, testing of pesticides, biobed.

Introduction

From 2009-2011 Poland made a huge progress in disposing of its pesticide waste stockpiled over many years when it used thermal incineration as a major method of disposing of pesticides contained in underground storage tanks, the so-called tombs. The process of removing the tombs took many years and during the last HCH Forum we presented the problems encountered along the way and what was accomplished as of June 2011 [1]. But can we consider that enough was done to end the problem with obsolete pesticides in Poland? We might think so, judging from the "National Waste Management Plan for 2014", where we find no mention that any further actions in this respect are necessary. The plan does not indicate the need to complete the tomb removal process, neither does it recognize the Rudna Gora site in Jaworzno, which is the EU's largest landfill of pesticide post-production waste. The issue of tombs was formally considered closed and the problem of "historic waste", including reducing the environmental impact of the Rudna Góra landfill, was ignored. But how does it look in reality?

Tombs – historical pesticide dump sites

In the beginning of March 2012, the Office of Inspector General in Poland issued a report on the outcomes of the National Waste Management Plan for 2010. The Plan envisioned that the tomb removal process would have been completed in 2010. The report gives specific data on the stage of completion as of 30.06.2011, which indicate that as of the date,18 516 tons of pesticide waste were disposed of, 890 tons were undergoing disposal and for 11 out of 242 registered tombs the removal process have not yet started. The amount of waste still to be disposed of was estimated at 305 tons. The report underscores that the disposal process conformed to all substantive and legal requirements, but it alerts to some serious shortcomings in monitoring of the sites from which tombs were removed and a failure to include a plan for the disposal of the remaining tombs in the National Waste Management Plan for 2014. The latter shortcoming was partially taken care of by putting the tombs located on areas owned by the National Treasury on a list of so-called "ecological bombs", which are disposed of with the support of the National Fund for Environmental Protection and Water Management under the program named "Remediation of environmentally degraded areas and removal of contamination sources that have particularly adverse effect on the environment" that was carried out in 2011 - 2016. According to the information received from the Ministry of Environmental Protection, in the end of October 2013 there were still five tombs to be disposed of with around 50 tons of waste (plus contaminated rubble and soil), out of which three are located on privately owned land. There are some tombs which were not found, and the search is still running. Some tombs, whose location could not be confirmed, were crossed out from official lists - it is possible that in the future they will be found and will need their disposal. Removal of those tombs might pose a problem, because it is difficult for private individuals to get public funding and support for remediation projects. Nevertheless, we can say that despite the many shortcomings and difficulties, the tomb disposal program has progressed successfully and is coming to an end. It is worth mentioning that close to 100% of funds used for tomb removal and site remediation projects came from Poland's resources and the National Fund for Environmental Protection and Water Management. Poland spent close to 50 million euros (including VAT) on the cleanup projects, which on one hand speaks well of Poland, but also questions the reasons for not making a good use of EU grants.

Rudna Góra Landfill

The situation is very different for the Rudna Gora industrial landfill in Jaworzno, which for years has remained Poland's most serious problem when it comes to pesticide waste. The site, which was mentioned on numerous occasions during the past HCH Forums [2, 3] contains over 160 000 tons of mixed hazardous waste and takes up an area of around 20 ha. The landfill site belongs to the Organika-Azot Chemical Plant, SA, and in part to the City of Jaworzno. Cleanup of the landfill is extremely difficult not only because of the high costs expected with a project of this magnitude, but also because of a complicated ownership status and insufficient legislation. For the past two years, there has not been any breakthroughs that would allow for an optimistic look into the future, nevertheless we can report on a few facts that might be of interest to those following the history of the site. The important, but not the best news, is about the results of FOKS (Focus on Key Sources) international research project which was carried out in different locations including Jaworzno and ended in the first quarter of 2012. The project failed to meet its expectations with respect to developing a comprehensive technical solution for closing the landfill. The results were limited to a general conclusion that an optimal solution would involve erecting a vertical, impervious, bentonite barrier to prevent the contaminated underground water from flowing towards the Przemsza valley, covering the landfill with an impervious mineral liner (geomembrane) to protect the waste stockpiles against precipitation, and regular collection and treatment of waste water coming from the landfill. This very perfunctory idea makes it difficult to set the required conditions of tender to develop a technical design for the project and makes it impossible to estimate costs of the project, even in very rough figures. On a positive note, we also have information that in mid-2013 the National Fund for Environmental Protection and Water Management provided funds to the President of the City of Jaworzno that would allow to continue testing around the Rudna Gora landfill and other places of pesticide storage, as well as develop project designs and perform legal analysis. Currently the City is working on the tender specifications for contracts involving further field studies and case reports. Since it was impossible for the Organika Azot Chemical Plant to independently reduce the environmental impact of the landfill, the Plant filed a request with the Silesian Province Marshall's Office to change its so called "Restorative Decision", which made the Plant solely responsible for the problem. The Office is currently in the process of deciding whether to dismiss or modify its "Restorative Decision" in a way that would allocate responsibilities with respects to further actions. The process receives support from the Plant's Hazardous Waste Task Force, established by the Silesian Province Marshall's Office. The situation is made more difficult by the lack of progress in passing amendments to the legislation on the so called historic contamination caused by state-owned enterprises before Poland transitioned to the free market economy. The interpretation applied to current regulations makes it impossible for the country to provide financial assistance to successors of state-owned enterprises because of the limitations imposed on public funding. According to this interpretation, involving the state in solving the problem would necessitate the Plant to file for bankruptcy. The bankruptcy, not without its undesirable social impact, would only worsen the situation with respect to the environment since the Plant monitors contamination around the site, maintains the technical infrastructure of the landfill and through its treatment facility treats waste water from the landfill site. Presently the Ministry of Environmental Protection is working on a bill replacing the current Environmental Protection Law. Amendments being proposed right now do not include language that would be satisfactory for the problem at hand. Recently, as a result of the work done by the Plant's Hazardous Waste Task Force, a decision was taken that the Marshall's Office would petition the Ministry of Environmental Protection to introduce the desired language into the bill. Right now, it is hard to say when, and if at all, the proposed amendments will become law.

Newly-generated pesticide waste

Beside the problems with the historical contamination, there are some other issues with the disposal of pesticide waste. The use of chemicals for the protection of crops in agricultural practice always results in small amounts of pesticide waste. This fact cannot be ignored in the national action plans for sustainable use of pesticides. The waste can be divided into four groups:

– expired crop protection products,

– products that do not conform to formal requirements and technical specifications,

– pesticide-contaminated materials (water, soil, plants, items of clothing),

– leachates from filling and rinsing of the sprayers.

Expired pesticides are the result of errors in their distribution and planning of treatments. Until 2013, Poland was using a system for expanding the expiration date, based on testing the active substance content and the most important physical and chemical properties that ensure the proper use and action of the product. The system was a long tradition, with over one thousand samples analyzed every year, some of them representing commodity of substantial amount and value. Products which lost their usability due to prolonged storage were about 1-2% of all tested samples. The new Act on plant protection products of March 8 [4], 2013 introduced a provision that an expired plant protection product must be withdrawn from the market with a decision by the Plant Health and Seed Inspection Service. The product must also be treated as waste. This created a situation, where waste is being generated since not every batch of expired products is picked up by the manufacturer to be further reprocessed or disposed of at the production plant.

The second group of products, which results from all sorts of irregularities or fraudulent activity needs to be addressed, since every year in Poland there are a few dozen cases related to complaints filed by pesticide users, inspections by the Plant Health and Seed Inspection Services or investigations by the authorities (police, customs offices, prosecutor's office and border patrol). Products included in this group have insufficient usability (e.g. a lower level of active substance or presence of non-standard impurities) or cannot be approved for use on the market (e.g. products with labels in a foreign language, products with missing labels, counterfeit products).

Waste in the form of contaminated materials is generated incidentally, mainly due to failing to take precautions recommended by the plant protection good practice guidelines [5]. Waste generated this way can be quite dangerous due to potential risks for humans, animals and the environment.

Management of the above mentioned groups of pesticide waste must be very orderly. Its key element is ensuring their proper security, pickup by a special licensed company and disposal at a proper incineration plant. Poland has a good system that provides a solution to the problem. There are a number of companies authorized to pick up pesticide waste and some hazardous waste incineration plants adapted to dispose of this type of waste.

Filling of a sprayer and washing it down are processes posing potential risk for the environment from the use of pesticides, both being a source of the so called point-source pollution. The aim is to introduce an environmentally safe procedure for filling and washing sprayers and to evaluate the efficiency of pesticide decomposition in the biobed mix. The project realized at Plant Protection Institute intended to introduce an organized and orderly procedure to be followed during filling and washing of sprayers and it was necessitated by both Polish regulations and the European Parliament's Directive on the sustainable use of pesticides. The project resulted in construction and start-up of a sprayer filling and washing station. The station serves a practical as well as experimental purpose: it meets the IPP needs for sprayer washing and allows to conduct a study on the rates of decomposition of active substances. It also has an eco-friendly effect in terms of protecting the environment against the point-source pollution of soil and underground water.

HCB waste import to Poland

Beside the problems with the historical contamination and newly-generated pesticide waste there are some other incidental events, as exemplified by the stunning case of importing over a dozen thousand tons of HCB waste from Ukraine to Poland. In 2011, around 15 thousand tons of waste containing HCB was imported to Poland. Import declaration documents stated that the waste was supposed to be HCB-contaminated soil with HCB concentration of around 1.5%. The waste ended up at a hazardous waste incineration plant. The waste was stored in damaged and leaking big-bags all over the plant's area instead of the designated locations and it produced foul smell around the incinerator, located close to the Baltic Sea, which alarmed local residents and the media. An investigative report by a newspaper lead to the prosecutor looking into irregularities in administrative decisions issued in connection with the import and storage of waste. There were also questions about the way waste was stored and incinerated. Prosecutor's investigation revealed that the plant violated operating requirements by burning amounts of waste that exceeded the permit limit, which resulted in HCB residues found in incinerator ashes. Independent reports indicated multiple violations of the daily capacity and emission limits for the incinerator. Moreover, it turned out that post-incineration cinders and ashes were not stored at a hazardous waste landfill, instead they were illegally stored in a gravel pit, contaminating the ground and surface water. Right now, according to the information from the Environmental Inspection Service there is still around 4500 tons of waste to be disposed of and the disposal will continue until the end of 2014. Within a period of two years, the Environmental Inspection Service fined the incineration plant several times and performed a number of inspections and the plant is still under investigation with multiple leads.

Summary

Polish tombs with pesticide waste were first named “ecological bombs” in 1992. Back then experts from the Institute of Plant Protection defined the risk for humans, animals and the environment caused by the emission of toxic substances from those sites. Since then, Poland, using its own funds, closed most of the tombs, disposed of their content in hazardous waste incinerators and placed contaminated soil on sufficiently secured landfills. We took an important step towards eliminating the risks, but the accomplishments were not error-free.

The problem of pesticide waste generated as a result of crop protection is also solved from its technical and organizational side. The waste can be disposed of through contracting with companies picking up waste at Polish hazardous waste incineration plants. A solution was also found for the so-called point-source pollution caused during rinsing and filling of sprayers - all we need to do is to implement it into the common practice.

The outstanding problem is the Rudna Gora landfill, which the largest site of this kind in Europe. According to many experts it is Poland's major task in the area of eliminating the risks posed by hazardous waste landfills. Much is being done in this case, but we need to break an impasse, which is in the way of the real remediation activities. The impasse is connected to Rudna Gora's legal status and the complicated nature of future restorative measures.

The case of importing to Poland large quantities of HCB to be disposed of shows how important it is to be aware of the risks associated with improper handling of pesticide waste. A valid purpose of hazardous waste disposal should be achieved in a way that ensures safety on each and every step of the process.

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HIGHLY HAZARDOUS PESTICIDES: PUBLIC OUTREACH AS AN IMPORTANT TOOL TO REDUCE EXPOSURE

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I.

1. The international community well recognizes environmental and health-related risks caused by exposure to highly hazardous pesticides (HHPs). HHPs emerged as a topic of great concern by many countries at the Third International Conference on Chemicals Management (ICCM3) in September 2001 when a large number of countries from all UN regions supported actions on HHPs, including developing a priority list of substances for a progressive ban and substitution with safer alternatives. Countries of Eastern Europe, Caucasus and Central Asia face serious problems caused by exposure to HHPs because of the large volume of agricultural chemicals including pesticides used in the region and large number of workers employed in agriculture. These countries are also faced with problems related to huge amounts of obsolete pesticide stockpiles accumulated in the region as a toxic legacy from the Soviet times.

2. Pesticides in developing and transition countries have significant impacts on human health and economics. WHO experts estimate, that there are possibly one million cases of serious unintentional pesticide poisonings each year[i] . However, this is just a fraction of the real problem. Experts state that in reality there could be as many as 25 million agricultural workers in the developing world suffering from some form of occupational pesticide poisoning each year. Many of these cases are not registered. These health outcomes have economic impacts.

A recent UNEP report noted that the cost of inaction related to pesticide use in Africa is greater than the total Official Development Assistance to general health care in Africa, excluding HIV/AIDs[1]

i Acute Pesticide Poisoning: A Major Global Health Problem, J. Jeyaratnam, World Health Statistics Quarterly, Vol. 43, No. 3, 1990, pages 139-44, http://www.communityipm.org/toxictrail/Documents/Jeryaratnam-WHO1990.pdf

3. There are several key activities that could advance chemical safety and the SAICM goal. These activities could be implemented in the intersessional period between ICCM4 and ICCM5.

These activities include the following:
1. FAO paper on alternatives to HHPs

Safer alternatives, particularly ecosystem-based approaches to pest management, are a key part of phasing-out HHPs. Countries would benefit a great deal from an information paper on replacing HHPs, prepared by FAO. At the very least, the paper should include HHPs used in the highest volume, or that are otherwise a priority for replacement. One source of information for ecosystem-based alternatives has already been approved by the Stockholm Convention COP6 for work on alternatives to endosulfan.[2]

1 UNEP. 2013. Costs of Inaction on the Sound Management of Chemicals.
2 UNEP/POPS/POPRC.8/INF/14/Rev.1;

2. Surveys of HHP registrations, uses, restrictions, and prohibitions
Tackling HHPs requires knowledge of which HHPs are used in the country. A simple survey would help to identify HHPs among current registration lists and/or patterns of pesticide use in the country, and those which have been estimated as particularly hazardous for use under their conditions. The regional coordination group could develop a simple questionnaire, which would be sent to all national SAICM focal points in the region. National SAICM focal points could work with personnel from the Ministry of Agriculture to examine pesticide registration lists to determine which potential HHPs are present and which pesticides have been banned in the country. If no registration information exists, then the information on pesticide use could substitute.

3. Collection of success stories on HHP phase-outs
Countries can benefit a great deal from the experience of other countries. A successful HHP phase-out could provide some useful information on substitutes and processes for phase-out in the region. For example, Stockholm Convention Parties will be obligated to phase-out endosulfan, an HHP. Experiences with this process could be collected by the regional focal point and then re-distributed to national focal points and personnel from the Ministries of Agriculture to permit more efficient actions in the substitution process. These success stories could also be added to the clearinghouse described above.

4. Clearinghouse of HHP registration, bans, and restrictions from surveys
It would very helpful to countries if the results of the surveys could be organized and made available on-line. Regulators would benefit from knowing which substances have been banned in other countries, particularly neighbouring countries or countries growing the same crops. More importantly, the clearinghouse would help define future activities on HHPs by outlining country experiences. For example, the need to define alternatives for certain crops might be informed by clearinghouse information that indicates widespread registration or use of a substance. Overall, the clearinghouse would provide a sensible one-stop location for the survey results and pave the way for further solutions.

II. Russian NGO Outreach Campaigns on HHPs

Starting from 1997 NGOs from Eastern Europe, Caucasus and Central Asia (EECCA) have been successfully working on addressing chemical safety problem in the region. Being a Hub of the International POPs Elimination Network (IPEN) Russian based NGO Eco-Accord coordinated and supported more than 90 EECCA NGO projects in the region focused on POPs and other toxic chemicals including mercury, lead, and endocrine disrupting chemicals directly linked to. Eco-Accord also conducted a first of its kind review on persistent organic pollutants (POPs), including obsolete pesticide stockpiles in Russia.

EECCA NGOs organize press-events, outreach campaigns, awareness and capacity building workshops and trainings obsolete pesticides and other POPs and toxic chemicals.

1. In 2004, Eco-Accord together with Women Network in the Urals conducted a project on public participation in primary inventory of obsolete pesticide stockpiles. A workshop in Cheliabinsk with participation of local authorities, NGOs, experts

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http://synergies.pops.int/2013COPsExCOPs/Documents/tabid/2915/language/en-US/Default.aspx and local community groups helped to initiate a dialogue between decision makers and civil society groups on pesticide management, including the following:

- official obsolete pesticide inventory in Cheliabinsk region;

- public involvement into identification of illegal obsolete pesticide storage and use;

- discussion of the Methodological recommendation on public participation in primary inventory of obsolete and banned pesticide stockpiles (Eco-Accord, Moscow 2003 http://www.ecoaccord.org/pop/mr/index.htm) ;

- identification of pilot regions for the implementation of the methodological recommendations ;

- elaboration of recommendations for further public involvement into primary inventory of obsolete and banned pesticides.

Later Cheliabinsk NGOs conducted activities that resulted in the identification of the additional amount of obsolete and banned pesticides and pesticide contaminated sites in the region.

Methodological recommendations on public participation in the primary inventory of obsolete and banned pesticide stockpiles were further approved and used by many regional state environmental control bodies in different parts of Russia and other EECCA countries.

2. Information and educational projects on pesticides health and environmental hazards were conducted in 11 out of 12 EECCA countries. Since 2004, numerous materials, which are a valuable source of information for civil society groups and governmental agencies working on pesticide management in EECCA, have been prepared.

3. EECCA NGOs cooperate a lot with the scientific community in the region. This cooperation helps to produce education materials for institutes and universities on issues of pesticide health and environmental risks, including inter alia "Global agro-ecological problems: security of agricultural products", "How to produce environmentally safe food products on contaminated sites", etc.

NGOs participate in the discussions and round tables on pesticides, including inter alia "Agro-2012" round table and international exhibition "International chemical assembly – ICA 2012. Green chemistry", workshop on «Green Chemistry – Global challenges – request for innovations », Moscow 2012, round table on "Future of sustainable development of agriculture: WTO requirements", August 2013.

4. A draft resolution on Highly Hazardous Pesticides was prepared by NGOs and presented at the fifth regional meeting of the Strategic Approach to International Chemicals Management (SAICM) held in Macedonia in September, 2013.

5. At a meeting of the leading environmental organizations in Russia (more than 100 organizations from all regions of Russia) - Conference "Ecology, Politics and Civil Society in Contemporary Russia" ("Yablokovskie Debates 2013") held on October 5th in Moscow, also discussed the problem of reducing the risks of for man and the environment from pesticide pollution and the problem of management of stocks UP in light of the performance of the Russian and international legislation.

HISTORY AND PROBLEMS OF KANIBADAM OBSOLETE PESTICIDES BURIAL SITE IN NORTHERN TAJIKISTAN

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The development of agriculture in Tajikistan is closely related to a history of widespread use of pesticides for the control of plant diseases and unwanted field weeds. Tajik agro-climatic conditions are favourable for rapid development of different pests. It was even found that the potential crop losses in case of low effectiveness of protective measures can account for about 30% of Tajik harvests.
Pesticides were never produced in Tajikistan. Plant protection products were always imported from abroad and by the end of the 1980s import and distribution of pesticides was carried out in a centralized manner through a network of state organizations under the name of "Tadjikselhozkhimiya"(literally translated:"Tajikagrichemistry"). This organization had the full responsibility for ensuring proper storage, efficient use and stock administration of pesticides waste. In the period 1965 – 1990 imports of pesticides into Tajikistan ranged between 7 and 14 thousand tons annually (calculations based on 100% active substance).

Problems

- A serious problem is the fact that people in Tajikistan still use the prohibited and obsolete pesticides and also its containers. Pesticide residues are a source of environmental pollution and can cause negative health effects.
- Particularly dangerous are the stocks of POPs pesticides in warehouses, former agricultural airfields and burial sites. There is, however, little reliable information available on the state of the different obsolete and POPs pesticide sites in Tajikistan.
- In order to prevent the negative impact of obsolete and POPs pesticides on human health and the environment, and the fact that DDT was officially banned in 1969/1970 by the Soviet government, the Government of the Soviet Republic of Tajikistan adopted resolution №104 on 13 March1970 for the construction of the Vakhsh and Kanibadam burial sites for the disposal of the republic's stocks of obsolete pesticides.

Kanibadam burial site

- Kanibadam burial site is located at 275 meters above Kanibadam city and at a distance of almost 6 kilometres from the first houses. From the burial site the fields slope towards the city in north-west direction carved by two main canals the Isfarinka canal and Great Fergana irrigation canal (GFC). There are numerous wells in between the burial site and the city that have been constructed for different purposes. The total area of the burial site is 1.4 hectares. The area relief consists of branching dry ravines. This area can be considered as a territory with possible rains, mudslides and other natural phenomena that cover the part of the city territory to the GFC and Isfarinka canals. The Kanibadam burial site lies within the territory of a natural protected area, the Kayrakkum Reservoir which is internationally protected by the Ramsar Convention.

The burial area for toxic wastes is a trench of 3-4 meters depth, and is not waterproof and without any cover. According to data provided by JSC "Kanibadam-Kimiyo" this burial site was in use from 1973 to 1990 and had a national importance. The main pesticides buried are calcium arsenate, HCH, DDT, butiphos, CCC (Chlorocholine chloride), copper trichlorophenolate, nitrophen, ground sulphur, microbiological preparations and many other substances used in the Sughd Region and the Gorno-Badakhshan Autonomous Region.

- From its construction on in 1973 until 1989, the Kanibadam burial was operated without any compliance with sanitary norms of health and environmental safety. A project design for the burial site has never been found.
- According to data provided by the JSC "Kanibadam-Kimiyo" the total amount of pesticides received before the burial site was closed in 1990 was around 4,000 tonnes of pesticides and more than 3,000 empty pesticide containers. The burial site is reported to contain also a large number of biological preparations.
- Disposal of toxic chemicals at Tajik burial sites was mainly carried out by dumping. Sometimes stocks were burned on the location. At the Vakhsh burial site about 7,500 tonnes of pesticides (including about 3,000 tonnes of DDT) were buried between 1973 and 1991. At the Kanibadam burial site 4,000 tonnes, including 1,000 tonnes of biological preparations were buried. A significant amount of the toxic chemicals that were buried contain POPs, especially DDT.
- A serious concern is the extremely poor state of maintenance of the sites. In recent years they were virtually not guarded and there was no control whatsoever at the sites. Lack of proper fencing around sites makes them still today accessible to local people and animals. Water runoff drainage systems built previously on the burial sites territories to counteract rains and mudslides, were not maintained and have been completely destroyed. As a result, there is a considerable risk for human health and the environment on and around the sites.
- High temperature in summer and intense solar radiation contribute to evaporation and decomposition of pesticides. Repetitive winds of local origin and often storms lead to the transfer of harmful substances from burial sites for considerable distances.

GEF/UNEP Project"Implementation of theActivitiesfor the Preparation ofa National Implementation Planon PersistentOrganic Pollutantsinthe Republic of Tajikistan" (2006-2007)

- Within the frame of this project the soil at Kanibadam burial site was analysed. A presence of pesticides in the soil mixtures was reported at 2,195 mg/kg to 31,831 mg/kg, including POPs from 327 mg/kg to 8,024 mg/kg. The percentage of DDT and its metabolites was reported to be between 17 to 35%, and isomers of HCH – between 3 to 13% of the total amount of toxic chemicals. In the majority of samples (85%) dieldrin was found at 0.05 to 1.14 mg/kg. Presence of HCB and eptam (thiocarbamate), ovex, acrex, dinoseb and dursban was reported.

University of Applied Sciences of North-western Switzerland Tox-Care-Project: "Management of Hazardous Substances and Goods in Central Asia, Tajik working programme" (2012 – 2015)

In the frame this project a risk assessment training was carried out In cooperation with the Dutch engineering companies Tauw and Witteveen+Bos and the International HCH and Pesticides Association (IHPA) in 2012.

- The Kanibadam burial risk assessment shows that the level of soil contamination decreases with the distance from the site. At 100 m distance, concentrations of DDT and BHC exceeded the maximum permissible concentration (MPC) by 8 times, at a distance of 1,200 m DDT exceeded the MPC by 3.5 times, and the BHC content – by 1.3 times. At a 2 km distance only the presence of DDT has been detected in amounts that are not exceeding the MPC.
- In cooperation with the Committee for Environmental Protection under the Government of the Republic of Tajikistan, IHPA and Milieukontakt International in 2015 recommendations for short term risk reduction and long-term disposal were made based on the 2012 risk assessment.

Field Activities during risk assessment in 2012 at the Kanibadam site.

GEF Small Grants Programme project implemented by the Tajik NGO Bono to construct a temporary cover at Kanibadam burial site (2013)

In 2013 as part of a GEF small grant project, the Tajik NGO Bono organised a first action to cover the landfill with a layer of 0.5 m soil from nearby slopes in order to stop the major odours and dust emissions.

This created a temporary but no permanent solution. The work of Bono can be used as a good starting point to find international donors that would be interested in financing a long-term solution for Kanibadam burial site.

Recommendations to mitigate the impact of the burial site on the environment and possible next steps:

1. to organize local permanent monitoring at the burial site for the toxic chemicals;

2. to put warning signs on all sides with brief information about the burial site and its risks for public health and the environment.

3. to raise public awareness about health and environmental risks (seminars, trainings, meetings, articles, speeches on radio and television, publishing brochures, booklets, leaflets, etc.);

When these steps are fulfilled and the basic structure for actions has been created the following steps are proposed

4. to develop and implement effective measures to reduce negative impacts on public health and the environment;

5. to fence the burial site off with barbed wire and make sure that the territory is guarded;

6. to cover the burial site temporarily to prevent spreading of pesticides to air, water, surface water and groundwater;

7. alternatively it could be possible to cover the surface temporarily by bentonite clay, as deposits are located in the village of "Kim", in the nearby Isfara district;

8. to construct a drainage basin for rainwater and surface meltwater collection to prevent the water from entering into natural water bodies and groundwater;

9. to determine the contamination level of surface soil (there is no vegetation at the surface of the burial site, which could be an indicator of the soil contamination);

10. to clarify the exact dimensions of burial site.

STATE OF THE ART AND THE LATEST DEVELOPMENT IN FORMER SU STATES AND CENTRAL EUROPEAN REGION

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This session took place during the last day of the 12-th HCH and Pesticides Forum. The Session was chaired by Tomasz Stobiecki and Stanislaw Stobiecki (Institute of Plant Protection – National Research Institute Sosnicowice Branch – POLAND). We had six presentations from five different countries:

1. The Republic of Moldova: "POPs free Moldova – 10 years of efforts: results, continuations and plans" presented by Liudmila Marduhaeva from the Ministry of Environment. The presentation summarizes the achievements and presents current activities related to the liquidation of inventories of POPs in Moldova.

2. Romania: "Disposal of obsolete pesticide stocks - case study Romania" presented by Mihaela Claudia Paun - Policy Adviser for Impact Assessment and Pollution Control Directorate Ministry of Environment and Climate Change. Big clean-up activity for obsolete pesticides stockpile disposal, starting from inventory through remediation, re-inventory, repackaging, final destruction and final steps of prevention of build-up of new pesticide stocks are described and discussed in this presentation.

3. The Republic of Poland: "An overview on obsolete pesticides problems in Poland after completion of main disposal actions" presented by Tomasz Stobiecki from the Institute of Plant Protection – National Research Institute Sosnicowice Branch. This presentation discusses current issues related to pesticide waste: newly generated pesticides waste, Rudna Gora landfill, import of HCB from the Ukraine to Poland and the problem with leachates from rinsing of the agricultural sprayers. It also specifically describes the effectiveness of the tomb disposal program in Poland, which is now complete, with the exception of a few sites.

4. The Republic of Tajikistan: "Kanibadam burial site of obsolete pesticides: History and problems" presented by Murodjon Ergashev from the Foundation to support civil initiatives (FSCI, Tajikistan). The presentation describes the storage of obsolete PPP in the biggest such a place in Tajikistan. It also provides the information on the origin of the landfill, the quantity of waste disposed of and the measures taken to inventory waste and diagnose the problem.

5. The Russian Federation: "The current situation of environmental pollution by pesticides in the Russian Federation and measures to resolve it" and "Extremely dangerous and obsolete pesticides: what the public need to know?" both presented by Oxana Tsittser from the Ministry of Natural Resources and Environment of the Russian Federation. The first presentation describes the results of environmental monitoring for contamination of PPP in the territory of the Russian Federation.

The another one describes the risks posed by the storage of hazardous waste, the possible solutions and the steps taken by various organizations in the Russian Federation.

The presentations provide a picture of the activities undertaken in the region in order to eliminate the old inventories of POPs. In some presentations, the methods for treatment of waste currently generated as well as the activities aimed at preventing the formation of new waste, are described. The information presented give the opportunity for an optimistic view on the possibility to solve the problem in the former SU states and Central European Region.



GLOBAL EXPERIENCE ON POPS AND OBSOLETE PESTICIDES WASTE MANAGEMENT


SUSTAINABLE MANAGEMENT OF OBSOLETE PESTICIDES IN ETHIOPIA BY THE JOINT VENTURE "POLYECO-TREDI"

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Abstract

In May 2012, the JV Polyeco-Tredi was awarded through international tendering the World Bank funded project for the management of 360 tn of Obsolete Pesticides in Ethiopia. The scope of services included the provision of UN packaging and protective equipment for the safeguarding of a total of 450 tn of OPs identified in the country, and the export and final disposal of 360 tn. During the Project execution, the Project was extended to also include the disposal of the additional quantity of 90 tn safeguarded by the Ministry of Agriculture (MoA). The objective of this article is to share the experience gathered during the execution of the project, the obstacles and contingencies that occurred, and the flexibility that JV showed in order to provide prompt solutions. The disposal of OPs was undertaken in two accredited incineration facilities in Sweden and France, facilitating the potential to provide high quality services to the client at competitive prices. Moreover, it has to be highlighted, that all types and categories of hazardous pesticides were included in the waste streams and significant problems occurred from the degraded Malathion waste, due to its storage in poor conditions at the Ministry of Health (MoH) storehouses. Malathion waste stream, constituted the main quantity of OPs, exceeding 200 tn, and the JV efficiently tackled the significant problems that occurred during its transportation, in cooperation with competent Port Authorities, Basel Convention focal points and other stakeholders. Lessons learnt from the challenging task, combined with the specific weather conditions and other significant obstacles during the export works in Ethiopia and Djibouti, will be presented for consideration in the implementation of future OPs management projects.

Keywords

Obsolete Pesticides, Ethiopia, POPs, Malathion, Basel Convention, safeguarding.

Introduction

The Ethiopia ASP project was launched in September 2007 following the GEF Funding of 2.62 million, while the Tender for Safeguarding and Disposal Services was issued in February 2012. The goods and services provided within the scope of the JV Project were divided into three parts:

- Supply of goods and materials for the safeguarding by the JV/Project Management Unit of 450 tn of Obsolete Pesticides at different storehouses and locations within the country

- Safeguarding of 186 tonnes of obsolete pesticides at the Ministry of Health Store (Mekenisa main garage) in Addis Ababa and Tigray Regional Health Bureau Stores (TRBH Garage A and B) in Mekele.

• Transport and disposal of 450 tonnes of OPs by high temperature incineration, at licensed facilities in France and Sweden.

Mobilisation

Following finalisation of administrative and contractual procedures, the project equipment and consumables were manufactured in Europe and shipped to Ethiopia in twelve 40' Containers in mid July 2012. POLYECO field experienced personnel comprising two chemical engineers and one foreman arrived in Addis Ababa at the end of July 2012 to start site preparation works. Although equipment arrived at the end of August at Djibouti and despite the fact that the JV and MoA, promptly prepared and submitted relevant customs documentation, the delivery of containers in Gotera Main Garage started at the beginning of September and was finalised at the end of the same month. Containers remained at customs authorities for several days due to customs clearance bureaucratic procedures. Before commencement of safeguarding works, the following procedures were implemented:

• All equipment was set up at suitable places at the site.

• Signs and traffic management were erected as necessary.

• Security requirements were set up, as required for the safe performance of the works.

• Temporary power, wiring and lighting requirements were set up.

• On-site sanitary facilities and water supply was ensured for the contractor.

Work areas were marked and zoned as clean zone, buffer zone or dirty zone, according to EMP.

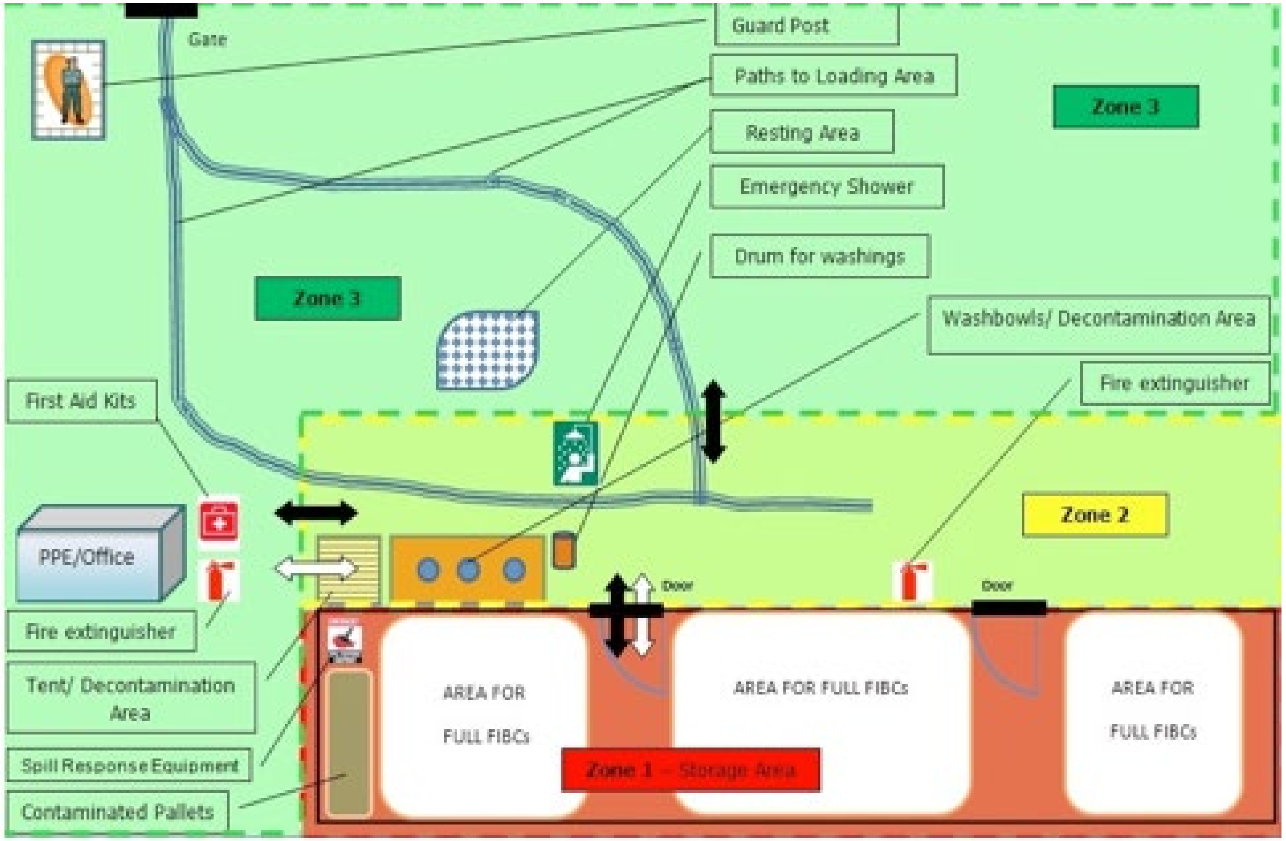
Specific rules were set up for the different areas and measures applied to avoid cross-contamination between the two areas.

Licensing

Notification Application was prepared and submitted to the Competent Authorities at the beginning of July 2012. Eleven transit and disposal countries were included in the predefined routes specified in the Licensing application for Sweden and seven countries for France. Following notification from the shipping line, that due to huge congestion in the Jeddah terminal, the port of Salalah was lately used as an alternative route, two more licensing applications for Sweden and France were prepared and submitted to Ethiopian EPA including Oman as transit country, in order to cover all potential changing routes. The Swedish Authorities promptly issued export licenses in early September, and JV actions focused on the issuing of remaining transit countries consent, such as Djibouti and Saudi Arabia. In November, the shipping line suddenly added port of Aden (Yemen) in its scheduled route to Europe, and the JV informed the client that in accordance to the Environment Protection Law No. (26) of 1995, the Republic of Yemen, Article (54), it was prohibited for vessels or aircraft or any other means to enter the territorial waters as a transit passage if they carry radioactive, toxic or hazardous waste, except if prior permission from the cabinet and approval from the parliament was granted. Unfortunately, it was identified that this procedure would last from three to six months and JV, following communication with Basel Convention Secretariat, evaluated all alternative solutions, such as potential utilisation of other shipping lines with already licensed routes and also proceeded to negotiations with the shipping line in order to grant an exception from Yemen port, particularly for the vessels carrying malathion waste. Through numerous meetings with the shipping line, The JV arranged to achieve an exception from Yemen port for the 1st cargo of OPs from Ethiopia destined to Sweden. Furthermore, it has to be stated that although Swedish Permit was promptly issued, significant delay occurred in the issue of the licensing permit from France. The Notification application was by mistake of the Ethiopian EPA delivered to the French authority responsible for the transit of waste and not for disposal. The JV took immediate action to remedy the situation, prepared and submitted the notification application to the correct authority and only 2 days after a meeting with French competent Authority, the export license to France was also issued, by the end of December. At this point, it has to be emphasised, that the issue of modification of the shipping route was an obstacle that also previous OPs contractor in Ethiopia had faced and did not manage to convince the shipping line to change the route. As a result, in that past case the contractor prepared new TFS, while the JV successfully managed to agree with the shipping line on a route that would not include Aden Port also for the forthcoming vessels, carrying the remaining 150 tn of Ethiopian OPs to France and to Sweden. The final export licenses for the 1st and the 2nd shipment were issued by the Ethiopian EPA in December 2012 and early April 2013, respectively.

Safeguarding

Safeguarding works commenced in mid-August 2012 following facilitation of road clearance to the Site and kind provision of UN approved packaging equipment by MoA. Heavy rain restricted the works at the end of August, since water was entering the storehouse through the roof. Supporting plywood was positioned on the ground to facilitate the forklift's movement and at a second stage, an auxiliary path was constructed. Due to the difficult working conditions and the necessity to work with high level protective equipment (type 3 Overalls, full face masks), the JV took decision to double manpower in order to accelerate safeguarding works. Repackaging works in Makenisa



Pictures 1-2: Zoning of the Site area and repackaging works commencement

were finalised within 30 days following the commencement of works, and 400 FIBCs and 13 Drums in total were fully packed. Due to space restrictions and poor storage conditions, 271 repacked FIBCs were transported to Gotera Main site for temporary storage. At Mekele store, safeguarding works for 30 tn were completed within three days, and within four days all OPs were transported to Gotera Main Site. POLYECO personnel remained in Addis Ababa, in order to evaluate the safeguarding works conducted by MoA and to provide any additional support requested. Safeguarding works were finalised by MoA by the end of December 2012.

Export of OPs

Following communication with Ethiopian stakeholders, it was decided that the export of OPs would take place in two steps, and corresponding cargo separation will be facilitated. The containers stuffed with repacked pesticides should be escorted by a pick up truck of the Ministry of Agriculture carrying PPE and spill response equipment from Addis Ababa up to the border of Djibouti, and from the border of Djibouti up to the Dibouti harbour the containers should be escorted by national police of Djibouti. The JV promptly proceed with early container booking; however, due to bureaucracy procedures imposed by stakeholders from Djibouti (Chamber of commerce, Custom Authorities etc) the first empty containers arrived in Addis Ababa early in December. Stowage/loading works were initiated, and fourteen containers were loaded with 300 tn of OPs and transported to Djibouti, having Norrkoping Port in Sweden as a final destination. The containers were loaded on MSC vessel and departed Djibouti on the 29th of December 2012. Following the issuance of export licence by Ethiopian EPA, the JV booked the first available shipping containers to export the remaining 150 tn of OPs and the cargo was loaded on MSC Vessel on the 2nd of May 2013.

Temporary Storage at Antwerp Port

The 300 tn of OPs arrived in Antwerp Port in February 2013, and odour issues that were identified alarmed the hazmat authorities. It has to be stated that within the 300 tn of OPs, 220 of Malathion waste, produced in 1998 was included. This malathion waste had undergone poor storage condition during all these years and had provoked significant odor issues to the neighborhood of Mekenisa and especially to the students from the nearby school. Malathion has probably undergone chemical degradation due to the long term storage, and although it was packed in accordance with IMDG requirements in UN approved packagings, it was still emitting significant odour. The JV took immediate action by conducting chemical analysis, air sampling, air measurements inspections and negotiations with Belgian Hazmat and Environmental Authorities. Even though numerous meetings were conducted, and Belgian Stakeholders confirmed that the cargo is not posing a threat and granted approval for its loading on board, the shipping company still declined to accept the cargo. Alternative options such as disposal within Belgium at high temperature incinerator were evaluated in cooperation with stakeholders. Following continuous and substantial efforts by the

JV, the shipping line altered its initial decision and, at the end of March 2013, granted its approval for the continuation of the trip to the final destination of Sweden.

Disposal of Waste

Following the approval by the shipping line, all blocked containers in Antwerp Port were delivered to SAKAB at the beginning of April 2013, and the destruction process was initiated. Furthermore, the remaining 150 tn of OPs arrived in France and Sweden at the beginning and in the middle of June, respectively. The destruction process of the 450 tn was finalised successfully by the end of June 2013, before the official project closure, contrary to the obstacles, occurred in such a challenging project.

Conclusions

Based on the obstacles that occurred during the project implementation, the following conclusions derived. These shall be taken into account in future OPs management projects:

• With reference to the licensing issue, it is important that through communication with Shipping Lines, contractor identifies all potential transit countries that might be added in the itinerary of the route in the future. There is a high possibility that predefined route is altered and, in that case, contractor shall respond immediately in order to achieve potential exclusion as the JV successfully managed.

• Even experienced Competent Authorities may fall into mistakes during the licensing procedure. Therefore, it is essential that the contractor follows the progress of the notification application closely in order to take remedial actions.

• It is preferable that packaging equipment is defined and supplied by the experienced contractor in accordance with project needs. In Ethiopian case study, the type of the packaging equipment for the 450 tn of OPs was predefined by the competent authority as a supply component during tendering procedure.

• Project preparation consultants and stakeholders should take into account the fact that the safeguarding and disposal component in hazardous waste management projects is crucial, and adequate time shall be allocated, especially taking into account various unforeseen parameters may arise during project execution. The Ethiopian ASP project was launched in 2007, and the safeguarding and disposal component was procured after 5 years with a total assigned duration of only 7 months.

• Even unfavourable and unpredicted situations such as the raised odour issue in Antwerp Port can be managed efficiently following consultation and coordination with all relevant competent authorities.

• Development and application of sophisticated logistic plans in developing countries will not ensure the minimisation of delays and demurrage costs, due to the bureaucratic conditions that prevail.

• There are always significant differentiations among the registered OPs inventories and the actual pesticides that the contractor will encounter on site. The worst case scenario in terms of potential hazards shall always be taken into account.

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REGIONAL WORKSHOP ON CONTAMINATED SITES

IN MOZAMBIQUE 2011-2012: EXPERIENCES OF THE DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ)

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Abstract

To address the consequences of stockpiles and contaminated sites in Southern Africa as an extension of the African Legacy Project under the Global Environment Facility (GEF), GIZ, in co-operation with United Nations Industrial Development Organization (UNIDO) and the International Council of Chemical Associations (ICCA), organized two consecutive workshops in Mozambique in 2012 to build local capacity in the identification, risk assessment, and remediation of contaminated sites in the region. Lessons learnt and a practical guide for authorities to deal with the challenges have been compiled in a short YouTube film, while further projects in co-operation with the private sector are being planned. The article gives an overview and draws conclusion from the experiences in Southern Africa while making a case for future involvement in land recycling.

"There has been hardly any progress over the past decade in Africa, where 50,000 tonnes of stockpiles has an estimated management cost of US$250 million" (Weber, Vijgen, Aliyeva 2012: The need for an integrated approach to the global challenge of POPs management). The effects of such stockpiles, as well as former industrial sites, for which the same statement holds true, will be felt in the future, with marked impacts on arable land in Africa due to simultaneously growing populations as a challenge to food security and industrialization causing future competition for land use.

As a contribution to the issue described above, and in the context of its mission for the German government and a member of the Global Alliance on Health and Pollution (GAHP) to rid the world of the negative health impacts of hazardous chemicals, specifically affecting the vulnerable population in Least Developed Countries (LDCs), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) with the Sector Project on Chemical Safety (ChS) initiated a series of workshops to date in Southern Africa, based in Mozambique with 17 participants, mainly from Mozambique, but with several from South Africa, Lesotho, Swaziland, and Uganda, between March and December 2012.

The Workshops

GIZ, UNIDO and ICCA decided to stage a training workshop, UNIDO covering travel expenses and ICCA and GIZ covering expenses related to the workshop itself, as an extension of the GEF-sponsored capacity strengthening and technical assistance endeavours for the implementation of Stockholm Convention's National Implementation Plans in African LDCs[1], pro-

1 Section 1(e) of Article 6 of the Stockholm Convention states that Parties would "endeavour to develop appropriate strategies for identifying sites contaminated by chemicals listed in Annex A, B and C; if remediation of those sites is required it should be performed in an environmentally sound

viding technical assistance and expertise in the management of contaminated sites in the form of a pilot demonstration for the local experts in the region on dealing with (potentially orphaned / legacy) contaminated industrial sites.

In the first workshop, the basics were laid by introducing the theoretical principles of assessment and management of contaminated sites, having already compiled a cadaster (land registry) of legacy sites in a country. The second workshop on the topic "Identification, preliminary evaluation and inventory of contaminated sites" (10-12 December, 2012) took the theoretical considerations to the field with a practical, hands-on experience session at Dondo Impregnation Plant in Beira, Northern Mozambique on the 14th of December. The overall intention was to clearly prioritize activities nationally and break the infinite assessment cycle, based on environmental and economic grounds and in accordance with the national situation and legal framework.

In the earlier workshop, there had been site visits to three potential legacy contaminated sites in Matola, 20km outside Maputo, including a leather factory near a river, relevant for the health impact, and a dumping area from a fertilizer factory then used to recycle scrap metal. Day two consisted of various presentations, including local examples of dumpsites and one by German expert Dr. Friebertshäuser on the principles of investigation, risk assessment, remediation and monitoring of contaminated sites in Germany, serving as the basis for discussing the principles of contaminated sites management, specifically the identification process, also featuring prominently in the film[2].

On day three, discussions of the case studies presented continued. ICCA experts then used the leather factory that the participants had visited on the first day as a model site to simulate the application of the principles of contaminated sites management. The afternoon programme was reserved for a case study designed ad-hoc by the experts in order to create a case from scratch and walk the participants through every phase of remediation. With the site still fresh in memory, the exercise helped the experts to better understand comprehension gaps of the participants. The selected site was a tannery visited by the group on day one.

It is essential to start off by analyzing a legacy contamination[3] by carrying out a socio-economic impact[4] and risk assessment of contaminated sites, assessing the capacities of the existing laboratories, pos-

manner". This implies that countries which ratified the Convention will need to rehabilitate sites contaminated with POPs chemicals. The LDCs in Eastern and Southern Africa which are parties to this Convention are therefore required to develop appropriate legislative framework and then importantly a strategy to identify sites contaminated by POPs chemicals. Many countries in the region have recognized the problem of sustainability that POPs projects would face when they deal only with the disposal of stockpiles ignoring the related problem of subsequent clean-up and remediation of contaminated sites. Thus, Component 3 of the project aims at introducing appropriate strategies for identifying sites contaminated with POPs and ensuring effective planning for the implementation of remediation measures to clean up contaminated sites.

2 The film can be found under http://www.youtube.com/watch?v=XPGi-1OlwA8

3 A "legacy contaminated site" is a historical legacy from former industrial activity conducted when there were few, if any, environmental regulations in force. The nature of the contamination varies greatly, from heavy metals to hydrocarbons and organic chemicals. Water contamination occurs largely as a result of rainfall flushing chemicals, contaminated sediment, and dissolved compounds into nearby streams or the groundwater beneath a site, e.g. where there is poor storage and spillage due to poor handling of chemicals such as solvents or oils. Contaminants upon entering the water environment can affect even distant receptors.

4 Former polluters, often small- and medium-sized enterprises where the original polluter can no longer be identified to pay for the remediation, negating the effectiveness of the "polluter pays" principle.

sibly organizing training and awareness building workshops for national experts, decision makers and other stakeholders.

After that initial phase, a site-identification has to take place. The aim of this phase is to identify and assess the potential level of contamination potentially presenting a risk at the site. The Environmental Site Assessment encompasses preliminary investigations including review of historical sources (like photographs, maps, etc.), review of regulatory records and physical setting information (topography, geology, etc.), interviews with (former) owners, occupants, neighbours etc., a visual survey of the site, conclusions, and recommendations with associated cost estimates.

During the Site Assessment phase, questions about the (potential) defined source of contamination (e.g. size, location), pathways (including the reach of the contaminant) and the receptor (human, environmental, special cases like nature reserves) of concern have to be addressed. A Qualitative Risk Assessment, i.e. developing a conceptual model identifying potential pollutant linkages, consists of a desktop study to assess the level of contamination that could present a risk at the site[5]. Conceptual site models are an essential element of the assessment and present possible connections between identified potential contaminant sources, pathways and receptors. A risk assessment includes (risk-based) decision-making and its consequent actions, e.g. which problems need to be dealt with most urgently or the decision for a certain remediation measure over another.

These theoretical and more superficial first steps are followed by a deeper Soil and Groundwater Investigation based on soil borings and sampling (chemical / physico-chemical analysis), groundwater sampling, followed by another, now more detailed risk assessment[6] or a Site-Specific Risk Assessment with the linkage of pathways, receptors and (planned) use[7] of the (potentially) contaminated land, still using the generic quantitative models.

Following this, countermeasures have to be evaluated, including source reduction (e.g. excavation of hotspots and removal of a leaking tank and the surrounding contaminated soil), pathway management (e.g. using a barrier to restrict the flow of contaminated water), and modifying exposure of the receptor (e.g. by choosing a future land use where opportunities for exposure are reduced). Often the easier and cheaper solution may be preferable to a technologically complex, though more thorough solution, depending on the risk involved and the (prospective) land use.

Remediation based on a feasibility study and a cost-benefit-analysis[8] must be carried out where there are unacceptable risks

5 Understanding the history of a site is crucial to understanding the potential for source contaminants to be present. A site containing contaminants may not cause significant harm to a receptor in its existing use, but where a development (a new use of the site) is proposed there is the possibility that significant pollutant linkages will be created. Therefore, it is important that low risks identified in this phase are not discarded entirely from the assessment process. The usual approach to risk assessment examines the source of contamination in relation to the receptor.

6 By carrying out a detailed risk assessment, it may be possible to reduce the scope of site remediation works required. Quantitative Risk Assessment is a stepwise approach, sequencing ever increasing data quality with site investigation, samples, laboratory results, comparison of results with science-based guideline values etc.

7 For example, a human health risk assessment for a residential development requires near-surface soil sampling. Where contamination of groundwater is suspected – thus again affecting humans and the ecosystem – the risk assessment is likely to require an assessment of contaminant mobility in the soil.

8 While investigating a potential contaminated site, special attention must be paid to the overall cost which includes: site assessment costs (initial investigation) to risk assessment costs to clean-up costs. The conventional approach is that lower investigation costs give rise to higher clean-up costs, while spending more time and money during the investigation stage and hence more precision leads to lower clean-up costs.

to health or the environment in relation to the current or intended use of the land and its wider environmental setting, e.g. in order to protect human health and the environment or enable redevelopment. Generally, remediation activities are measures taken to eliminate or reduce pollutants/ contamination (decontamination measures) or to inhibit or reduce the expansion of contamination without removing it (containment measures).[9] The preferable method depends on the substances present [10] and their concentration, as well as external factors. In all remediation measures, appropriate personal protection equipment and other safety measures must be applied as per usual.

9 They include excavation, secured relocation of material, containment (lining, in-situ sealing systems, cover systems, Permeable Reactive Barriers (PRB), or solidification with reagents to immobilize the substance, e.g. hexavalent chromium transformed to trivalent chromium), treatment-based remediation including pump-and-treat and / or long-term groundwater monitoring

10 E.g. carbon adsorption for pesticides, air stripping for CHC incl. vinyl chloride, BTEX etc., biological purification processes (aerobic, anaerobic, co-metabolism by addition of methane) mainly for CHC, chemical oxidation (by hydrogen peroxide or ozone) for CHC, phenols, pesticides, cyanide, or ion exchange for heavy metals or cyanide. Water filter units with activated carbon can also be applied.

The practical part of the second workshop with site walk-through and interviews of persons familiar with the site, a historical search on the site's use, including historical and current aerial photographs and archives of relevant authorities, and gathering of soil, hydrologic and geologic data on-site gave valuable practical experience to the local experts in combination with experiences from the international experts.

Another relevant point is the continued enforcement of adherence to threshold values (sustainability element) on sites currently being used to prevent the creation of further contaminations.

Concerning the actual health and environmental risks encountered on-site, it was established that the impact risk for groundwater was particularly high, as the depth of the groundwater was only 2m below the ground level according to site personnel, resulting in the infiltration of impregnating oil through unsealed soil into the groundwater, with a drinking water well only 100 m away. Additionally, gaseous emissions into the atmospheric air occurred due to all process steps taking place outdoors, resulting in the percutaneous and inhalative exposure of workers.

Lessons to be learnt

Even simple steps like interviews with neighbours or employees can lead to useful results without any chemical analysis. By performing a thorough preliminary investigation, laboratory analyses – which are very costly contexts like Mozambique's – can be partially avoided. Several on-site test procedures are available for an initial evaluation of an area of potential concern or contaminated site, some of which are low-cost and straightforward. Numerous contaminations are for instance immediately recognizable by their colour, oily luster, or by a characteristic odour of the soil / water. E.g. originally colorless oil generates a green respectively black coloration of the soil as a result of the partial microbial degradation.

The workshops showed that even larger enterprises sometimes fail to apply sound chemicals management, even where population's drinking water supply is affected.

Even well-trained and competent representatives of the governmental environmental authorities, who are also sensitized to the dangers of hazardous chemicals, do not always have the analytical methods needed to analyze unknown chemicals. Even with minor investments in equipment and pertinent instructions, improvements in the management of hazardous chemicals can be achieved.

Conclusions

According to World Bank data[11], it would take 100 years at the current rate to complete the necessary clean-up activities in Africa regarding stockpiles, which means that plainly more has to be done. More urgently, contaminations from these and orphaned industrial sites must be stopped in order to negate increasing negative health and environmental impact. In order to achieve this, several elements must be taken into account:

Firstly, a comprehensive legislation (nota bene: incl. at precautionary level) must be the aim, as positive European experiences show. Moreover, high-end measures and simple solutions can equally contribute to the process. Regional co-operation and co-ordination to that effect is invaluable specifically for countries catching up on the necessary steps.[12] To this end, capacity building programmes tailored to the specific needs of the target groups (e.g. SMEs and governmental authorities) have to be developed and implemented in the selected countries. By doing so, the main targets are to help develop technical capacities of local actors for future clean-ups, but include training materials on sustainable chemicals management, as opposed to one-off measures, and identification of viable financing possibilities for the partner countries to clean up contaminated sites.

With financing generally constituting the bottleneck, hinging itself on (political) will of stakeholders and governments, the central question is about the possible entry point for the intended projects. Also, competition for the resources and duplication of the efforts where money is actually available has to be avoided through constant open communication.[13]

Reflection on the correct entry point

Individual trainings for authorities or companies may have some immediate impact, but unless there are regulations in a legal framework as well as enforcement or incentives, it will not be sustained. Backing from policy makers and the society at large is thus paramount to create sustainability, for which good public relations work is relevant. Hence, a concerted effort on all of these levels between all relevant stakeholders is needed. What needs to follow projects like the one in Mozambique is a continued process of coordination based on communication and shared or complementary activities. A concerted effort thus consists of communication and co-ordination of efforts of stakeholders (as opposed to a competition scenario), as well as prioritized, meaningful (i.e. sustainable) and impact-oriented actions.

On the financial side, it should be noted that clean-ups / site-remediations are not an attractive topic for investors. However, especially in growing and industrialising Developing Countries, land recycling for various types of land-use and to relieve pressure from (future) competition for land, constitutes an increasingly appealing topic due to its economic benefits for companies and city planners, especially due to the frequently convenient location

11 Following Weber, Vijgen, Aliyeva 2012, using data from: World Bank (2002) Africa: Africa Stockpiles Program (ASP): funding the prevention and disposal of obsolete pesticides from African countries. Work Program Inclusion-Resubmission (FAO-World Bank Co-Submission), New York.

12 The same goes for the connection with sound general chemicals management, improving knowledge and expertise on preventive and remediating actions in equal measure. The result is a holistic approach to chemicals management in all its aspects.

13 This kind of spirit of co-operation, as envisaged in South Africa, can even lead to shared use of practical yet costly equipment which any one stakeholder alone could not afford. It is important to consciously take note of these possibilities in the analysis from the very beginning.

of legacy sites on the outskirts of growing cities and on the margins of the potentially arable land of the dwindling rural areas. All of these elements make land recycling a useful starting point for future activities in the sector.

OBSOLETE PESTICIDE MANAGEMENT IN AFRICA; THE AFRICAN STOCKPILE PROGRAMME (ASP)

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The legacy of Obsolete Pesticides is not only related to near Eastern and Central Asia countries. In Africa the widespread presence of Obsolete Pesticides has created problems for more than 20 years. According to information from FAO the quantities in Africa amount to 27,395 tons compared to the EU recorded quantity of 241,000 tons for Eastern Europe (2006).

The environmental and health risks posed by the existence of Obsolete Pesticides in Africa are serious. In response to concern over these risks the ASP was established. The ASP is a Partnership initiative with the overall objective of mobilising international funding and technical support to eliminate the existing stockpiles of obsolete pesticides from the African continent, and to put in place preventive measures that will ensure that reformation of stockpiles does not occur. The first phase of ASP covered seven countries: Tanzania, Ethiopia, Mali, Morocco, Nigeria, Tunisia, and South Africa which in total was supported by USD 20,900,000. A second phase is planned covering 15 additional countries.

The objective of this document is to share the experience gathered during the execution of the first phase of the ASP programme providing inspiration on how to implement such projects and hopefully resulting in exchange of information among the near Eastern and Central Asia project teams and their African counterparts. The document provides country information on the lessons learnt relating to organizational structures established to implement the project; execution approaches; financial aspects as well as observations on the cooperation between the countries and the donors.

SARDAS LANDFILL, HCH MONITORING AND REMEDIATION

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Abstract

From the seventies to the early nineties, the Sardas landfill (Sabiñánigo, Spain) was used to dispose of municipal, construction and industrial wastes. Which were deposited directly onto on Eocene marls without any leachate collection system or bottom liner. The industrial wastes consist of residues derived from the production of chlorine and lindane, including various hexachlorocyclohexane (HCH) isomers. Both in powder and free phase form as Dense Non Aqueous Phase Liquid (DNAPL). This DNAPL is currently seeping as leachate from the landfill to the surrounding area.

Since 2009, the site was investigated and partially remediated by the National and Regional environmental authorities. The jobs completed, consisted in the drilling and construction of more than sixty monitoring and pumping wells: the environmental characterisation of soil, groundwater, and DNAPL, including the installation of two groundwater pump and treat systems.

The DNAPL flow path is complex and takes place at various levels. After flowing through the waste and seeping through the weathered bedrock base of the landfill, the DNAPL descends to depths of up to 40 metres through fractures in the marls. The main receptor is the River Gállego reservoir. It is located down gradient and is adjacent to the site.

The DNAPL is currently being extracted from pump wells. At the same time, a detailed hydrological survey is being undertaken in nearly all of the existing monitoring points in order to optimize the control of the contamination and environmental risks.

In addition, analyses of dioxins and furans have been completed in samples of soil and groundwater. The results indicate their presence in both of these media. Tests are being conducted to determine the reaction of HCH with the marl substrate and also to verify if an alkaline hydrolysis of the organo-chlorides occurs when interacting with basic leachate.

All these tests and analyses are aimed at to stopping the flow of the DNAPL plume, and, at the same time, to verify the environmental situation of the soil and groundwater, and to increase the knowledge of this site's particular problem. With all of these data, an attempt is made to develop the appropriate corrective actions in the future.

Keywords

Lindane, HCH, marls, landfill, leachate, groundwater, reservoir, DNAPL, Sabiñánigo, Spain.

Introduction

The Sardas landfill is situated near the town of Sabiñánigo, in the Autonomous Community of Aragón, close to the northern border of Spain with France (Figure 1). This landfill has been used for over two decades, for the uncontrolled disposal of heterogeneous wastes, from both local industries and municipal urban waste. The total waste volume, is estimated at around 350.000 m3, which includes organ chlorine waste, chlor-alkali wastes, wastes containing heavy metals, oils and hydrocarbons, and urban wastes.

The Sardas landfill is located along a geological ridge structure of folded rock layers. The northern flank of this anticline dips at approximately 30º to the north, while the southern flank is orientated south and is almost vertical. The base of the landfill consists of Eocene marls (Larrés marls formation), which is weathered at the surface and fractured in depth.

The industrial and municipal wastes were deposited directly onto the weathered marls. Without any prior basal impermeabilisation system or a leachate collection system in place. During the period of operation, it is estimated that between 30,000 and 80,000 tonnes of HCH in powder form were deposited into the landfill. Including approximately 2,000 tonnes of liquid waste (DNAPL).

The industrial waste, consists of residues derived from the production (1975-88), of chlorine and lindane including various HCH isomers. Powder form and in free phase form as DNAPL. The latter is currently seeping as leachate.

In the beginning of the nineties, the landfill was abandoned and superficially sealed. Some years later, a road was built through the toe of the landfill. Resulting in the removal of impacted material and deposited, at an unprepared site down gradient and adjacent to the River Gállego Reservoir. One of the consequences of cutting a road, through the landfill, was the necessity for the installation of a slurry retaining wall, both to provide slope stability and to provide a hydraulic barrier to retain the leachate.

The aforementioned reservoir is down gradient to the site, and the water rests upon quaternary alluvial materials. Consisting in silts, sands and gravels which are linked with reservoir's level. Both the reservoir and alluvial aquifer are the principal receptors of the leachate plume.

Figure 1: Location of Sabiñánigo, Spain

Project description

The project included a comprehensive site characterization, necessary to develop a conceptual model of the site. Simultaneously, a provisional remediation system was installed. In order to commence the elimination of the hotspots and to stop the leachate plume reaching the reservoir.

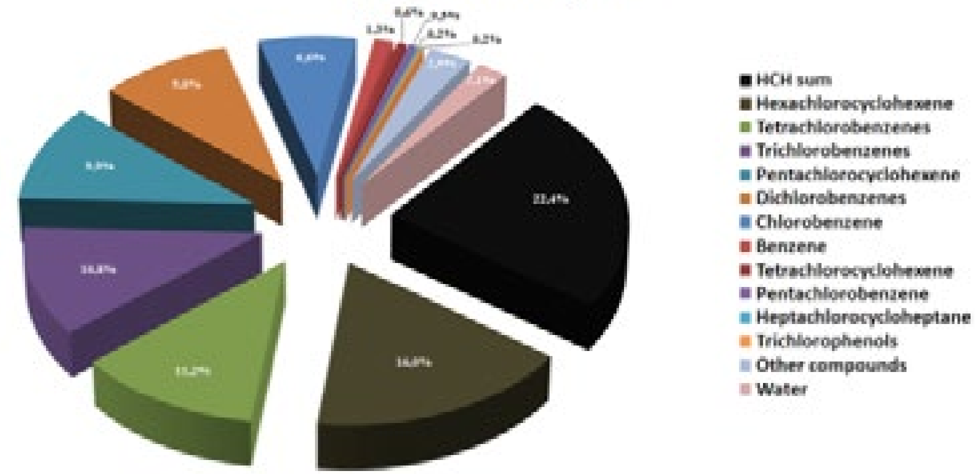
Site characterization

The investigation of the site was funded by the National and Regional environmental authorities. Several companies were contracted to complete the site characterisation, with the objective to develop the site conceptual model, evaluate the environmental situation and apply the best remediation techniques to the site.

An approximate total length of 1,000 metres of ground was drilled in order to install 57 monitoring wells and 12 pumping wells. Two pneumatic pumping plants were installed along with a wastewater treatment system consisting of decantation, physicochemical treatment and activated carbon filtration.

In order to increase the knowledge of the problematic of the site, and also attain the most efficient treatment strategies, diverse investigation techniques have been applied. This included electrical tomography campaigns in the field, laboratory analyses for dioxins and furans, and laboratory tests examining the reaction of organic and basic leachate with the marl substrate. Additionally, laboratory remediation tests have been conducted on waste containing HCH, using per-sulphate, zero-valent iron nano-particles, hydrogen peroxide, etc.

Figure 2. DNAPL composition



Hydrogeological investigations of the different geological formations have been completed, including pump tests, packer tests in boreholes, periodical field measurements of physical and chemical parameters in piezometres (pH, conductivity and temperature), continuous groundwater level measurements and chemical analyses of groundwater quality, with an extensive range of organic and inorganic parameters. In addition, a hydraulic balance of the landfill has been completed.

Soil, groundwater and DNAPL analytical survey. Since 2009, hundreds of soil and groundwater samples have been collected.

Figure 2: presents the compounds analysed for, including HCH (five isomers).

Table 1 (next page) demonstrated above presents the results of the analyses for dioxins and furans completed on soil samples and fill material. It was obtained from the slope of the road cutting and from the boreholes. Water samples were also collected from the installed piezometers, and from the drainage trench at the foot of the slope where leachate seeping from the landfill accumulates.

Due to the presented results, it is planned to undertake a further study of the dioxins

Table 1. Dioxins and Furans Analytical Results (date April 4th 2013)

	Uds.	Talud PS28	S39DT1	S39DT2	S39DT3	Uds.	LIX-O	LIX-A
Compound			Solid				Liquid	
2,3,7,8-TCDD	ng/kg	>90	<20	<10	>11,000	ng/l	-	-
1,2,3,7,8-PeCDD	ng/kg	>70	17	11	>11,000	ng/l	-	-
1,2,3,4,7,8-HxCDD	ng/kg	>900	430	45	>36,000	ng/l	-	-
1,2,3,6,7,8-HxCDD	ng/kg	>110	700	63	>27,000	ng/l	-	>20
1,2,3,7,8,9-HxCDD	ng/kg	5	210	25	>18,000	ng/l	>600	>20
1,2,3,4,6,7,8-HpCDD	ng/kg	40	680	2,600	>250	ng/l	>900	>10
OCDD	ng/kg	230	2,700	15,000	>300	ng/l	>1,100	>10
2,3,7,8-TCDF	ng/kg	150	150	170	>9,900	ng/l	>1,800	>10
1,2,3,7,8-PeCDF	ng/kg	240	100	210	>900	ng/l	>300	>10
2,3,4,7,8-PeCDF	ng/kg	63	65	220	>2,000	ng/l	>290	>10
1,2,3,4,7,8-HxCDF	ng/kg	31	230	590	>700	ng/l	>190	>10
1,2,3,6,7,8-HxCDF	ng/kg	18	57	200	>170	ng/l	>80	>10
1,2,3,7,8,9-HxCDF	ng/kg	14	5,4	29	>6,000	ng/l	>20	>10
2,3,4,6,7,8-HxCDF	ng/kg	13	20	160	>500	ng/l	>100	>10
1,2,3,4,6,7,8-HpCDF	ng/kg	49	90	410	>250	ng/l	>200	>10
1,2,3,4,7,8,9-HpCDF	ng/kg	8	6,6	180	>230	ng/l	>80	>10
OCDF	ng/kg		1,3	240	>290	ng/l	>690	>10
I-PCDD/FTEQ low	ng/kg	290	219	299	60,840	ng/l	24,000	4,700
I-PCDD/FTEQ top	ng/kg	290	239	319	60,840	ng/l	24,000	4,700
WHO-PCDD/FTEQ low		-	-	-	-	ng/l	25,000	5,800
WHO-PCDD/FTEQ top		-	-	-	-	ng/l	25,000	5,800
Dry matter	%	66.7	79.1	79.4	75.5	%	-	-

and furans. To check if the origins were from the production of HCH, or formed due to consequence of the presence of urban waste in the landfill.

Table 2, represented below, exhibits the elevated concentrations of the organochlorine compounds, especially HCH, both inside the landfill and outside in the area adjacent to the reservoir of Sabiñánigo.

Site remediation

At present, twelve wells are connected to a pumping system for DNAPL extraction. Five points are located on the ridge overlooking the slope within the landfill and seven are located at the foot of the landfill, down gradient of the slurry retaining wall and road. Periodically, the groundwater from the wells are pumped to 1 m3 storage containers, in which the HCH liquid mixed with water is allowed to decant before it is removed for external waste management (incineration).

The remaining water is then pumped to a specifically designed wastewater treatment plant, including physicochemical and activated carbon treatment before being discharged clean into the reservoir. At the

Figure 3: Settling tank (left) and pumping trench

base of the landfill, a drainage trench with a collection sump, has been installed and a pump periodically extracts the leachate emanating from this zone.

From 2012 to 2013, 0,4 m3 of DNAPL phase and 18 m3 of wastewater has been extracted by the two pumping stations. At the same time, more than 5 x103 m3 of organic leachate from the surface pump trench has been treated using physicochemical methods.

The objective of the tests and analyses, were to verify the environmental situation of the soil and groundwater of the site. The results were used to develop, the site conceptual model, and to provide the best solutions to prevent the flow of the plume and if possible, stop its advance.

Table 2. Organic compounds in groundwater (date March 15th 2013)

Date: March 15th 2013	Unit	S38-A1	S38B-A1	S38C-A2	PS24-A2	PS24-A3	PS26-A1	PS26-A2	PS26B-A1	PS26B-A2	ST1
		Piezometer									
Sampling Depth	m	13	27	6	24	30	4	9	26	38	8
Dist. Gállego Reservoir	m	180	180	180	110	110	0	0	0	0	0
Distance to the landfill	m	0	0	0	70	70	180	180	180	180	170
Benzene	µg/l	28,258	25,098	1,935	508	1,583	<0.1	<0.1	<0.1	24.74	596
Chlorobenzene	µg/l	25,861	21,061	4,01	1,378	2,796	<0.1	<0.1	<0.1	2.51	2,705
Dichlorobenzenes	µg/l	8,009	3,550	901	280	406	5.87	9.77	0.36	0.18	2,248
Trichlorobenzenes	µg/l	1,231	685	85	45	39	2.14	2.76	0.18	0.11	541
Tetrachlorobenzene	µg/l	21	18	1.64	1.28	0.65	<0.2	<0.2	<0.2	<0.2	15
Pentachlorobenzene	µg/l	0.37	0.28	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenol	µg/l	<0.2	<0.2	35.37	<0.2	33.45	0.76	0.91	0.29	20.51	<0.2
Chlorophenols	µg/l	509	368	25	2.8	3.4	<0.2	<0.2	<0.2	<0.2	0.32
Dichlorophenols	µg/l	98	12	1.51	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
HCH Sum	µg/l	3,763	4,141	414	26	413	12	12	9.53	5.81	481

Site Conceptual Model

The site is complex; however, a brief description of the site conceptual site model is presented as follows (next page):

The knowledge, of the geology and geomorphology of the site, is fundamental in understanding the mechanisms of the flow of the leachate. The landfill, is located on a gully and bounded in by two ridges, and is now covered by the waste. The flow direction of the leachate, will be similar to the flow of water in the gully before it was filled in and covered.

It must be highlighted that the inferior part of the landfill is saturated with a semi steady groundwater level, and it is from here where the leachate seeps into the surrounding area near the slurry wall.

Two principal DNAPL hotspots have been identified, one situated within the landfill and the other-outside, in the proximity of the slurry wall. Both hotspots are on ground possessing low permeability; marls in the base of the landfill, and silt adjacent to the slurry wall.

Figure 4: DNAPL Pumping station 1

The migration of the plume occurs both in the dissolved phase through the groundwater and as DNAPL. The main transport route of the plume is through the shallow soil levels, and through fill material towards the principal receptor of the Río Gállego Reservoir. At the same time, there is another transport route via the stratification and fractures within the rock substrate where DNAPL has been detected at depths of over 40 metres.

Figure 6: Cross section. Conceptual model.

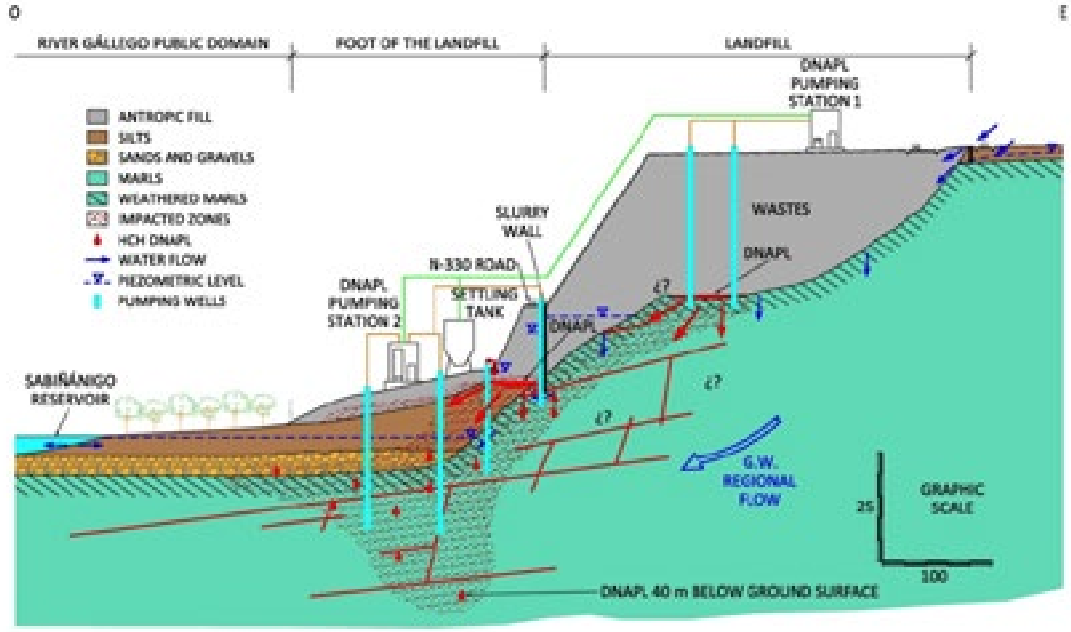


Figure 5: Site layout

The principal receptor is the reservoir of the Río Gállego located adjacent to the site and a connecting quaternary alluvial aquifer existing in the zone.

Conclusions

After four years of the investigation of the Sardas landfill and surrounding area, a conceptual model of the site has been developed. The model indicates that the site poses a major environmental risk to the Río Gállego Reservoir and associated aquifers.

It has been determined that there are two DNAPL hotspots and that the flow route of the plume from landfill, is through fill material, weathered bedrock and through rock fractures within the marls.

57 monitoring wells and 12 pumping wells were installed, the former to control the environmental situation of the site and the latter, to remove HCH waste from the hotspots. Also, a trench has been installed down gradient of the landfill slurry wall and road in order to collect HCH seeping from the toe of the landfill.

The risks to both human health and the ecosystem are still an issue. Currently, the work is progressing, in order to define safe levels and thereby implement appropriate measures to safeguard the environment and potential impacts on the local population.

Further additional treatment tests are required to assess other alternative potential remediation measures, such as the use of surfactants to help in the extraction of DNAPL, oxidation-reduction processes, etc. Other treatment alternatives will also be reviewed such as in-situ remediation techniques and immobilization or isolation.

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Sardas Landfill, HCH monitoring and remediation

GOBIERNO DE ARAGON

EMGRISA

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12th HCH & Pesticides Forum Kiev, Ukraine 2013

Introduction

From the seventies to the early nineties, the Sardas landfill (Sabiñánigo, Spain) was used to dispose of municipal, construction and industrial wastes. Which were deposited directly onto on Eocene marls without any leachate collection system or bottom liner. The industrial wastes ,consists of residues derived from the production of chlorine and lindane ,including various **hexachlorocyclohexane** (HCH) isomers, Both in powder and in free phase form as Dense Non Aqueous Phase Liquid (**DNAPL**). This DNAPL is currently seeping as leachate from the landfill to the surrounding area.

Since 2009, the site was investigated and partially remediated by the National and Regional environmental authorities. The jobs completed, consisted in the drilling and construction of more than sixty monitoring and pumping wells: The environmental characterisation of soil, groundwater, and DNAPL. Including the installation of two groundwater pump and treat systems.

The DNAPL flow path is complex, and takes place at various levels. After flowing through the waste, and seeping through the weathered bedrock base of the landfill. The DNAPL descends to depths of up to 40 metres through fractures in the marls. The main receptor is the River Gállego reservoir. It is located down gradient and adjacent to the site.

The DNAPL is currently being extracted from pump wells. At the same time, a detailed hydrological survey is being undertaken, in nearly all of the existing monitoring points. In order to optimize the control of the contamination and environmental risks.

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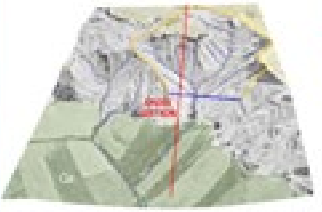
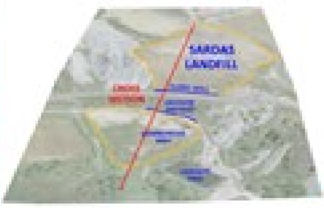
All of these tests and analysis have the objective to stop the flow of the DNAPL plume. At the same time to verify the environmental situation of the soil and groundwater, and to increase the knowledge of this site's particular problem. With all of this data, try to develop the appropriate corrective actions in the future.

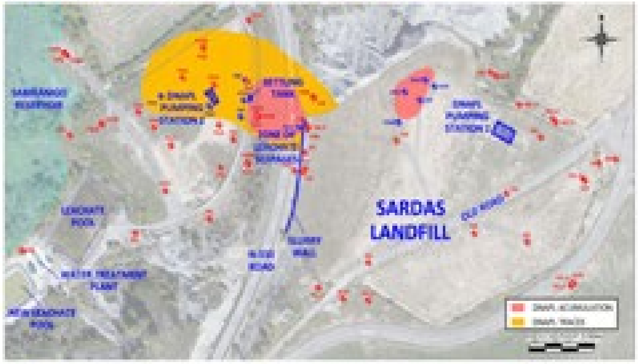
Site layout and cross section

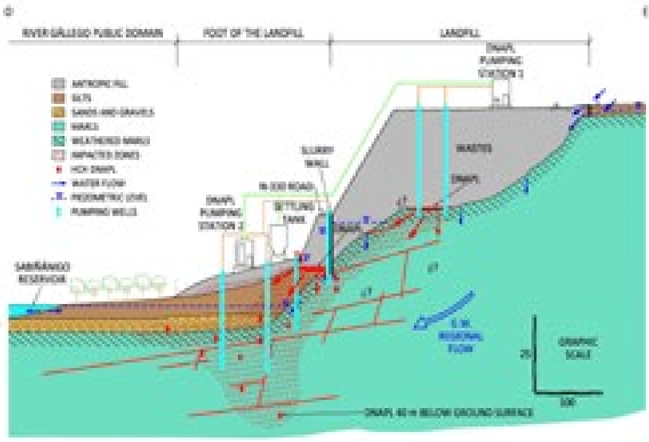


1956 3D View

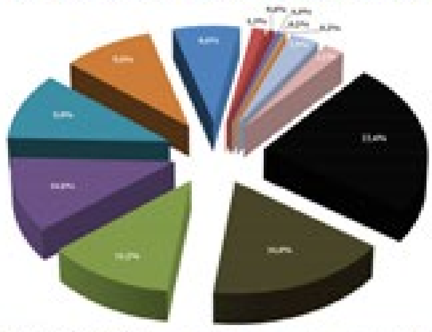


2010 3D View





DNAPL Characteristics and risks

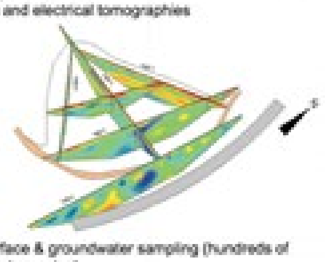


- Hexachlorocyclohexene
- Tetrachlorobenzenes
- Trichlorobenzenes
- Pentachlorocyclohexene
- Dichlorobenzenes
- Chlorobenzene
- Benzene
- Tetrachlorocyclohexene
- Pentachlorobenzene
- Heptachlorocycloheptane
- Trichlorophenols
- Other compounds
- Water

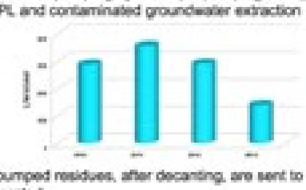
- Complex organochlorine mixture
- Many components are persistent in the environment with a very slow degradiation rate
- POPs Persistent Organic Pollutants according to the Stockholm convention
- High density, close to 1.5 gr/cm³. The contaminant penetrates to great depth by gravity (detected down to 40 m aprox.
- Bioaccumulative
- Inhalation, ingestion and contact toxicity
- Carcinogenic
- High toxicity to aquatic fauna.
- River Gállego (the main receptor) is adjacent to the site

Site characterization & remedial activities

- 69 Boreholes. More than 1300 meters of total drilling
- 30 Trial pits excavated
- Seismic and electrical tomographies



- Soil, surface & groundwater sampling (hundreds of individual samples)
- Hydrogeological study, including pump tests, packer tests, continuous level measurements and extensive hydrochemical analyses
- Water balance of the landfill
- Laboratory treatment tests with hydrogen peroxide, persulfate and zerovalent iron nano-particles.
- Thermal desorption pilot test
- Laboratory chemical attack tests to check the reaction between DNAPL and the bedrock (marls)
- 2 Pneumatic pumping systems (12 pumping wells)
- DNAPL and contaminated groundwater extraction



- The pumped residues, after decanting, are sent to be incinerated
- Contaminated water treatment (physicochemical and activated carbon treatment)

Site conceptual model

- The landfill does not possess underlining, was placed directly upon the ground surface
- 350,000 m³ of mainly hazardous wastes
- The base of the landfill is water saturated, containing leachate
- The bedrock (marls) is fractured
- The flow of leachate from the landfill is over 3000-5000 m³/yr
- There is a superficial level of weathered marls
- A significant source of DNAPL is located inside the landfill
- There are multiple source of DNAPL downstream of the landfill
- DNAPL was detected at variable depths, from the surface to more than 40 m in depth
- There are two types of leachate: organochlorine and alkaline (pH 12-13)
- River Gállego (main receptor) is close to the site

Further actions

Improvement of the conceptual model of the site

- Further treatment pilot trials and hydrogeological tests
- Additional boreholes and maintaining hydrogeologic controls
- Determination of the vertical component of the deep groundwater flow system
- Investigating the possibility of alkaline hydrolysis or other reactions in the chemical degradation of organochlorines

Maintaining remedial actions

- Increasing the number of DNAPL pumping wells
- Perimeter isolation measures to reduce water ingress into the landfill
- Improvement of the leachate drainage system

Comprehensive risk assessment for human health & ecosystems in order to design a reliable and secure permanent solution for the site

FIELD EXPERIENCE OF POP'S MANAGEMENT IN UKRAINE

I. Marchevsky
CEO, S.I.Group Consort Ltd

The company SI Group Consort Ltd. (Israel) is probably one of the biggest and unique operators of hazardous waste in Eastern Europe.

SI Group Consort Ltd. was established in 2007. The main purpose of establishing exercise was providing activities in several sectors :
• environmental projects : operators are licensed Ukrainian company " Si Bud Systems LLC " and "Sigmas Ecology Ltd", which are having all licenses, resources and experience for hazardous waste operating;

• transportation and logistics services: LLC "ABC Trans" - a licensed transporter having a modern fleet, its own production facilities and transport permits, including international (ADR) for a Dangerous Goods transportation;

The main activity of the company is to implement the integrated environmental programs, including and at the whole state level. And we have succeeded in this.

An integrated approach is to find and develop the best solutions for a specific customer's waste, its placement and complexity of retrieval, and ultimate disposal / destruction of the world by using modern technologies.

Now is practiced by S.I.Group Consort Ltd. the full service hazardous waste management :

- development of technological regulations and instructions in cooperation with the specialized research institutes;

- processing of permits on the international movement of hazardous wastes in close cooperation with states authorities of EU members acc. to Basel convention;

- extraction and repackaging of hazardous waste in certified packaging;

- transportation of the hazardous waste by licensed transport (trucks, vessels, railway)

- destruction / disposal of waste at the facilities of the leading European operators (Veolia, Tredi, Tradebe etc.)

- operations to eliminate the effects of environmental accidents.

All stages, without failure, be approved by the relevant documents that provide the proper level of quality control and transparency in the provision of services. Sure our company is certified according to international standards ISO 14001:2004 and ISO 9001:2008, as well as all subsidiaries

As a National operator for dealing with hazardous waste company S.I. Consort Group Consort, Ltd. with the assistance of its subsidiaries in Ukraine was able to successfully execute the national tasks for the release of Ukraine from residues of hazardous waste left over from the Soviet era.

Some data on the export of hazardous waste from the territory of Ukraine :

2011:
- 10 412 t – obsolete pesticides from all over Ukraine;

- 9 486 t – hazardous waste of HCB (Kalush, Ivano-Frankovsk region);

- 2 351 t – hazardous waste of MNCB-mononitrochlorbenzol (Gorlovka chemical plant, Donetsk region)

- 300 t – hazardous waste of PCB (sovtol oil)

2012:
- 13 061 t - obsolete pesticides from all over Ukraine

- 3 429 t - hazardous waste of HCB (Kalush, Ivano-Frankovsk region)

- 392 t – hazardous waste of MNCB-mononitrochlorbenzol (Gorlovka chemical plant, Donetsk region)

- 272 t – hazardous waste of beryllium (Former military plant “Zapad”, Kiev)

2013:
- 572 t - obsolete pesticides from all over Ukraine

- 441 t – hazardous waste of MNCB-mononitrochlorbenzol (Gorlovka chemical plant, Donetsk region)

- 11 992 t - hazardous waste of HCB (Kalush, Ivano-Frankovsk region)

Total for the period 2011-2013 exported and disposed more than 52 400 t of hazardous waste.

S.I. Consort Group Co, Ltd. offers its services in the implementation of complex programs and large-scale projects at the following way:

- analysis and study of the situation on the spot with the assistance of scientific organizations

- the feasibility study of the project , the technological regulations of work , the development schedule

- execution of works according to customer requirements and legal demands: the collection of hazardous waste , packaging, transportation, disposal / destruction on the respective powers of the European Union

- cleaning and decontamination of the work area , restoration works

- elimination of the consequences of environmental accidents

- monitoring of ecological and sanitary-epidemiological situation in the jobsite

- full documentation of each stage of the works from the moment of loading until the final disposal.

The company specializes in works with large amounts of the special hazardous wastes 1-2 classes, namely organic-chlorine residues (POP’s), Mercury contaminated waste, polluted packaging waste, PCB etc.

We have gained unique experiences that allow us to develop solutions with optimal “budget / time” without compromising quality execution.

We are pleased to offer all of our unique experiences and capabilities to achieve the ideal result of our cooperation as well as to find new partners in working with hazardous waste!

OBSOLETE PESTICIDE MANAGEMENT IN ETHIOPIA

H. Shimelis
National Project Coordinator ASP;
Ministry of Agriculture, Addis Ababa, Ethiopia

Ethiopia has a long track record on implementing obsolete pesticides (OPs) disposal projects. In the past, Ethiopia accumulated huge quantities of OPs mainly due to the following factors: inadequate storage and poor stock management; import of unsuitable products; donation or purchase of excess quantities; product bans.

The Ministry of Agriculture (MoA) have since 1996 been engaged in cleaning the country from the OPs stocks and in total 3 projects have been implemented from 2000 up to 2013. 1) Phase-I Obsolete Pesticides Project 1,575 tons of OPs were safeguarded and 1507 tons of OPs disposed of in EU; 2) Phase-II Obsolete Pesticide Project about 1100 tons under two contracts were disposed of in EU and 3) Africa Stockpiles Program (ASP) where Joint Venture "Polyeco-Tredi" has safeguarded over 230 tons and disposed of 450 tons of OPs.

The total project funds for the three projects including repacking, shipment and disposal of about 3,050 tons, capacity building, and project management amounted to a total of 15,000,000 USD. The donors were: The governments of Belgium, Finland, Japan, Netherlands, Sweden, the United States of America; Crop Life International, and Global Environment Facility through the World Bank.

As a result of increased capacity in the country, specifically in the MoA, implementation and execution of projects has changed over the years. The acquired experience has allowed the MoA to undertake more responsibilities in planning and executing the safeguarding operations. In Phase-II obsolete Pesticides Project and the latest ASP Project the MoA staff, with only little assistance from waste management contractors and appointed Technical Advisor, have repacked/safeguarded and collected over 1,300 tons of OP from 800 stores, distributed throughout the country. This considerably reduced project costs by substituting international hazardous waste management contractors and ensured the swift completion of the projects.

TOX-CARE PROJECT IN CENTRAL ASIA
MANAGEMENT OF HAZARDOUS SUBSTANCES AND GOODS

A SUB-REGIONAL PROJECT FOR CENTRAL ASIAN COUNTRIES: CONSULTING, TRAINING AND DEMONSTRATION-PROJECTS

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Project Background

The University of applied Sciences North-western Switzerland together with the Regional Environmental Centre of Central Asia (CAREC) launched in 2004 the implementation of the regional project "ToxCare" related to the management of hazardous substances and goods. The project is financed by the Swiss Government, Federal Office for Environment, as part of its efforts to foster cooperation and environmental protection within the GEF Constituency that unites Azerbaijan, Kazakhstan, the Kyrgyz Republic, Switzerland, Tajikistan, Turkmenistan, and Uzbekistan.

The project is aimed at supporting Central Asian countries in their effort to build national as well as local capacities in the area of management of hazardous substances, materials and wastes and is expected to lead to an increase of investments in the waste management sector in Central Asian countries.

Landfill site in Bishkek, Kyrgyz Republic

PCB – containing condenser storage in Tajikistan

Objectives and Methodology

The primary objective of the project is to increase the knowledge and expertise of country representatives from the Central Asian region in the area of management of hazardous substances, materials and wastes. The project includes two major components: (1) the training program in the area of management of hazardous waste and chemical substances, and (2) implementation of pilot projects in cooperation with organizations (industries, municipalities and institutions) interested in the development of hazardous waste management systems and/or in implementation of a technical project on the handling of hazardous substances and goods.

Obsolete pesticides management in Tajikistan: mission 2012

In 2009 the ToxCare project organised a workshop in Dushanbe on Persistent Organic Pollutants (POP's) and obsolete and

POP's pesticides and PCB management. In parallel TAUW (NL) and its consortium partners IHPA (DK), Witteveen+Bos (NL) and Milieukontakt (NL) analysed with the support of the World Bank the situation of the contamination through POP and obsolete pesticides in the southern part of Tajikistan. As there was one major remaining obsolete and POP's pesticides contaminated site in the northern part of Tajikistan, close to Kanibadam, to be analysed, it was decided to organise a common mission to this place in 2012.

The major objectives of the mission were:

1. A five day training for eight local experts in contaminated site assessment, risk assessment and burial site management at the obsolete and POP's pesticides landfill Kanibadam

2. Presenting in a national workshop in Dushanbe the outcomes of the risk assessment in Kanibadam and developing a national implementation strategy in accordance with the National Implementation Plan (NIP) for the Stockholm Convention on POP's in Tajikistan.

The mission was planned and executed in a joint project with the following partners:

• University of Applied Sciences Northwestern Switzerland, Prof. Maurice Jutz, (lead)

• IHPA (DK), Mr John Vijgen, TAUW (NL), Mr. Boudewijn Fokke, Witteveen+-Bos (NL), Mr Maarten van der Wijk and Ms Ingrid van der Rijk

• Committee for Environment Protection under the Government of the Republic of Tajikistan, Mr Salimov, Talbak, Chairman

• FSCI, Chair of Public Association "Foundation to support civil initiatives" (TJ), Ms Muazama Burkhanova, PhD (lead local organisation and project support)

Kanibadam POP and obsolete pesticides Polygon: history

During the Soviet Era huge quantities of pesticides were imported to Tajikistan and bordering countries to be used by the community farmers. The main crop was raw cotton. The problem dates back to the 1950s and 1960s, when the import and use of pesticides, in what were then Communist countries, was increased in order to raise agricultural production. Pesticides were distributed to farmers nearly free of charge, leading not only to overuse, but also to unsound management of residuals and packaging materials. The assortment of used pesticides included chemicals which later were included in the POPs-list of the Stockholm Convention such as: Aldrin, Dieldrin, Heptachlor, Endrin, Hexachlorobenzene, Toxaphene and DDT. These plant protection chemicals accumulated in the environmental components of the densely populated, irrigated territories of the Republic of Tajikistan and became serious sources of concern. Therefore also the Soviet banned the use of obsolete and POP's pesticides and constructed all over their territories polygons with sarcophagi to permanently store the banned pesticides. After the collapse of the Soviet Union these well-guarded and maintained polygons were left orphaned. These polygons were and are opened (waste mined) by mostly young men to sell these pesticides to poor famers. Poor farmers use these as alternative for the officially approved expensive pesticides. These waste miners are exposed to toxic waste and have ruined these sites resulting in an enhanced dispersion of these toxic chemicals in the surrounding environment. Nowadays the environmental challenges caused by these past actions, may contribute to serious health and environmental pollution risks in Central Asia. Pesticide diffusion to the environment knows no borders and given the transnational nature of this issue, the governments of Kyrgyzstan, Uzbekistan and Tajikistan need to cooperate and coordinate on their environmental security together to find best solutions.

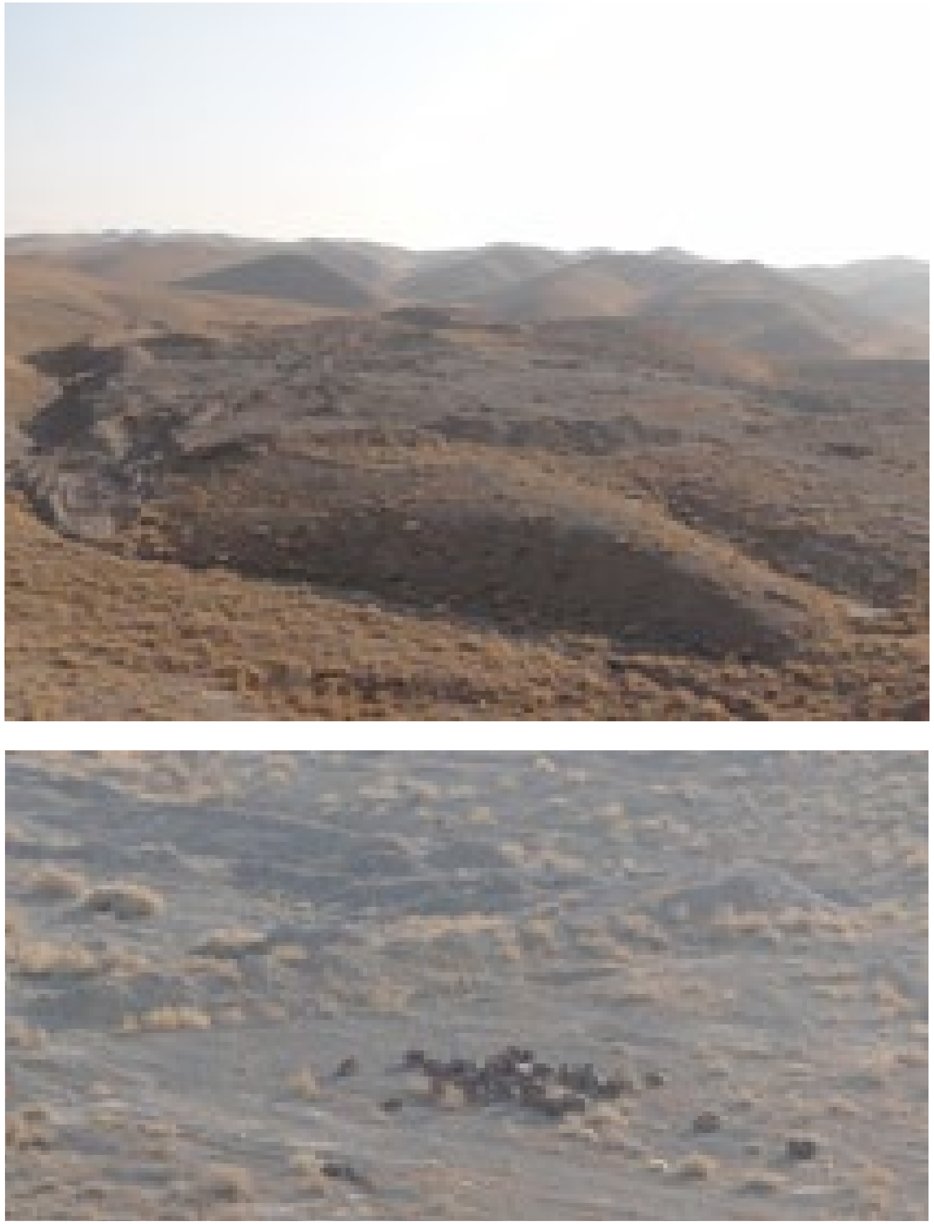
Kanibadam polygon is located in Sugd region in 7 km from Kanibadam city in southeast direction. Territory of this polygon is about two hectares. About 9,000 tons of POP and obsolete pesticides have been buried on the site in the past. The relief of this territory is hilly with a dendritic drainage pattern. The drainage gullies are most of the year dry. The surface of the hillocks and slopes are stony (dessert pavement) due to wind erosion of the finer soil particles. The soil texture is silty / clayish till at least up to 30 meter. The soil has a low permeability. Therefore most of the rainwater is drained by runoff causing the all kind of soil erosion. The groundwater at the polygon is deeper than 30 meters minus surface.

The territory of this polygon is located hypsometrically, 275 meter higher then Kanibadam city with the inclination of relief to the city, where there are two main canals and seven groundwater wells of various purposes. Availability of dry ditches, two of which have their roots in the burial places, stipulates in great extent the flowing of sediments. From geological point of view the site contains mudstone stream sediments with pebbles, boulders and gravel. Such layer is characterized by high penetrability for precipitations with components of various substances, including obsolete and POP's pesticides.

Activities under the mission 2012

The mission of 2012 was carried out to:

- Assess the Kanibadam polygon togerther with the stakeholders in Kanibadam to:



Overview of the Kanibadam polygon

- Build awareness of the environmental site conditions and its impact
- Build capacity on the site assessment and environmental sound site management

  - Share the site assessment results with the decision makers in Dushanbe to:

- Build awareness of the environmental site conditions and its impact
- Create a sense of urgency to act now to improve the environmental conditions
- To discuss to short term simple measures eliminating the direct risks

  The expected results are to:

- Gain a better understanding understanding of the understanding of the

Group session on making a Conceptual site model

Instruction using Personal Protective Equipment

Kanibadam site conditions

- Identify knowledge gaps to design short term mitigation measures addressing the direct risks
- Raise the awareness that fencing, run-off control etc. are simple and effective environmental risk reducing measures
- Create a steppingstone for the local and national agencies to turn these sinks in sites that are maintained and controlled as long as there is no means available for final disposal of the obsolete and POP's pesticides.

Site assessment training

The training was a theoretical and practical training in site assessment. The four following phases of environmental sound site management were discussed:

- Phase 1 Preliminary site assessment
- Phase 2 Site assessment
- Phase 3 Site management
- Phase 4 Site monitoring and aftercare

Site assessment results

Nowadays, the environmental condition of the Kanibadam polygon is extremely bad. Due to lack of fencing and guarding (site management) sarcophagi are waste mined and chemicals migrate off site. Trespassers (mostly children) with cattle, flora and fauna are exposed to toxic waste.

At the Kanibadam site buried pesticides are manually mined and using backhoe. All over the territory empty metallic and plastic containers can be found. The scattering of obsolete and POP's pesticides, leading to the soil contamination of polygon territory, is observed. High temperature during summer periods and in-tensive solar radiation contribute to decomposition of pesticides. Frequently recurring local winds and windstorms contribute to transmission of harmful substances and objectionable odour from the burial place to great distances. This Kanibadam polygon is seen as an environmental hotspot. It is a leaking sinks.

Erosion control measures such as terraces, a sluice, built in former time in this polygon for reducing run off; collecting rain and controlling gully erosion are destroyed. The soil erosion processes contribute to the contamination of low territories with obsolete and POP's pesticides.

Various soil samples are taken for chemical analyses and the fieldwork results and chemical analytical results are used to update the Conceptual Site Model (CSM). With the CSM the knowledge gaps for designing short term mitigations measures reducing the direct risk are identified. These results are reported in a Kanibadam site assessment report of Witteveen+Bos and Tauw.

Workshop in Dushanbe

The two day workshop was held in Dushanbe to give the representatives of the relevant ministries and the staff of the Vashkh polygon the opportunity to participate. The workshop started on October 29 and was closed the day after.

The results of the Kanibadam training were presented by trainees. The status of the implementation of NIP on the POP pesticides Stockholm Convention was shared by Ms. Bobritskaya Ludmila Sergeevna. Gaps and hurdles for site reha-

On-site training with PPE

Soil sampling

bilitation were inventoried in group sessions and plenary discussed. The overall conclusion was that implementation of the necessary measures elaborated in the NIP and mentioned in the World Bank report came to a standstill because the whole package of mitigation measures reported

Hotspot sampling

Certification ceremony

in the World Bank report is as a whole finically not feasible for Tajikistan to implement under the current financial re-gime of the World Bank.

The outcome of the discussion was used to write a road map with the focus on simple and effective short term measures from the above mentioned package addressing the direct risks.

The final result of the workshop is a resolution conveying the message that immediate appropriated short term measures reducing the direct environmental risks due to the obsolete and POP's pesticides should be taken for the:

• Polygon in Vashkh and Kanibadam

• Former community farms with buried stocks obsolete and POP's pesticides

• Sites with remnants of stocks of obsolete and POP's pesticides

Immediate actions to be taken

The outcomes of the risk-assessment during the ToxCare mission in 2012 are

summarised in an action list attached to the above mentioned resolution. These actions should be implemented as soon as possible in order to protect the local population and environment from further negative impacts of emissions of the polygons and other obsolete and POP's pesticides contaminated sites. The proposed short term actions are simple and can be implemented with local available material and are not costly. Examples of these measures are:

- Reinstall site management
- Install proper fencing and warning signs
- Inform local population about the danger of
    - Using obsolete and POP's pesticides
    - Entering the POP and obsolete pesticides contaminated sites
- Create local commitment and engagement in order to create sustainability by establishing local owner-ship by:
- Implementing construction measures with local craftsmen and workers
- Establishing a local defence organisation that will take care of construction works implemented and take access control and guards
- Prohibit cattle breeding in the surroundings

Because of the low precipitation and the deep groundwater level the workshop participants are confident, that these simple actions can be effective. But express that the other necessary mitigation measures are still to be prepared and planned while the short term measures are containing the site.

The remaining mid-term mitigation measures are:

1. Monitor migration of the pollution to be aware of the effects of the short term measures

2. Capping the polygon preventing infiltration of rainwater and migration of contaminants to deeper soil layers and finally to the groundwater

3. Implement soil erosion control measures preventing off site migration of contaminants

The remaining long term mitigation measures are:

1. Repack and dispose all the POP and obsolete pesticides

2. Remediate the contaminated soil


HEALTH PROBLEMS AT OBSOLETE PESTICIDES SITES
(EXPOSURE AND TOXICITY OF PESTICIDES)



PREVALENCE AND RISK FACTORS FOR LIVER DISEASE IN THE SANTOS AND SÃO VICENTE ESTUARY

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Abstract

The Santos and São Vicente Estuary suffers from contamination by toxic industrial waste that has affected the local population health. This study aims to evaluate the prevalence of liver disease in the Santos and São Vicente Estuary, alongside possible risk factors. A cross-sectional study was conducted in four contaminated estuary areas (Pilões and Água Fria, Cubatão Center, São Vicente, Guarujá) and in an outside Estuary area (Bertioga). A questionnaire that addressed socioeconomic conditions, occupational exposure, alcoholism, and morbidity was applied in 820 households in each area. The prevalence of liver disease, hepatitis, cirrhosis and liver, biliary tract or pancreas cancer was calculated. The associations between the outcome prevalence and the areas were calculated using the Chi-square test, Fisher's exact test or the Difference between two proportions test. Univariate and multiple logistic regression models for the analysis of the risk factors were applied. The significance level for all analyses was 5%. Hepatitis prevalence among all participants was higher at Pilões and Água Fria (1,2%). Among the individuals who reported having liver disease, hepatitis was the most frequently mentioned disorder, and there was a statistically significant association between residence in Pilões and Água Fria and hepatitis presentation (Pearson χ^2: z=18.1;$p<0.05$). 13% to 49% of people who reported having liver disease did not report exposure of any kind. Occupational exposure to chemicals, alcohol consumption, consumption of locally produced milk (OR=2.88; CI95%:1.24 – 6.70) and fruit (OR=2.43; CI95%:1.13 – 5.23) and water from natural sources (OR=4.44; CI95%:1.73 – 11.40) appeared as risk factors for liver disease. Thus, the contamination of the environment at Santos and São Vicente estuary is still a public health concern.

Keywords

Cross sectional study, environmental contamination, liver disease, hepatitis, cirrhosis.

Introduction

The Santos and São Vicente Estuary, located in the southern coast of the state of São Paulo, suffers from contamination by toxic industrial waste, which has polluted natural resources and affected the health of the local population (Santos Filho et al,1993; Silva, 1998; CETESB, 2001; Luiz-Silva et al, 2002; Santos Filho et al, 2003; Zago et al, 2005; Oliveira et al, 2007). However, there is still much to be researched regarding the magnitude of the problem and the potential health effects that may result from exposure to these toxic substances. Therefore, this study aims to evaluate the prevalence of liver disease in the region of the Santos and São Vicente Estuary, alongside possible risk factors.

Methodology

A cross-sectional study was conducted in four areas of the estuary, located near or on industrial waste areas: Pilões and Água Fria (area 1), Cubatão Center (area 2), São Vicente Continental (area 3) and Guarujá (area 4), and in one area outside the estuary: Bertioga (area 5), a control area, with no history of contamination. Figure 1 shows the five selected areas.

The data collection instrument was a questionnaire that addressed socioeconomic conditions, infrastructure, demographics, occupational exposure, alcoholism, smoking and morbidity. The questionnaire was based on the questionnaire developed by the National Cancer Institute (INCA in Portuguese) entitled "The Household Survey on Risk Behaviors and Morbidity Referred of Non-communicable Disease" (INCA 2003) and adapted for this study's aims. Eight hundred and twenty households in each area were randomly selected. In order to be considered a liver disease case, an individual being interviewed had to present any of the following documents: a letter from a physician attesting the presence of the disease; a recent prescription of medicine for liver disease; or any other document from the Labor Court confirming the presence of any liver disease. The questionnaire was pre-tested in one of the

Figure 1: Studied areas: located in and outside the Santos and São Vicente Estuary

estuarine areas, and relevant adjustments were implemented before its use in the main study. A term of free and informed consent for each interviewed household was filled out. The study was approved by the Ethics Committee of the Hospital das Clínicas, Faculty of Medicine, University of São Paulo (Research Protocol No. 350/07).

The prevalence of liver disease, hepatitis, cirrhosis and liver, biliary tract or pancreas cancer was calculated. The associations between the prevalence of the outcomes of interest and the areas were calculated using the Chi-square test (incorporating the Yates correction for continuity), Fisher's exact test or the Difference between two proportions test and univariate and multiple logistic regression models for the analysis of the risk factors. The significance level for all analyses was 5%, and the analyses were performed using the Statistical Package for Social Sciences (SPSS) 15.0 for Windows.

Results

There was no statistically significant association between the presentation of liver disease and residency in the studied areas ($p = 0.13$). However, the prevalence of this disease in Cubatão Center was higher and statistically different from the prevalence observed in Guarujá (comparison between two proportions test $z = 2.16$, $p = 0.03$).

In the no-exposure sample, the prevalence of liver disease at São Vicente Continental was higher and statistically different from the prevalence observed in Guarujá (comparison between two proportions test $p = 0.02$). The prevalence of hepatitis among all participants was higher in Pilões and Água Fria (1,2%). Among the participants who reported having liver disease, hepatitis was the most frequently mentioned disorder, and there was a statistically significant association between residence in Pilões and Água Fria and hepatitis presentation (Pearson χ^2: $z = 18.1$, $p < 0.05$). People presenting other liver disease (48.7%), cirrhosis (13.3%) and hepatitis (27.7%) did not report exposure of any kind.

Figure 2 shows the prevalence of participants that mentioned having some kind of the studied liver disease and exposure to

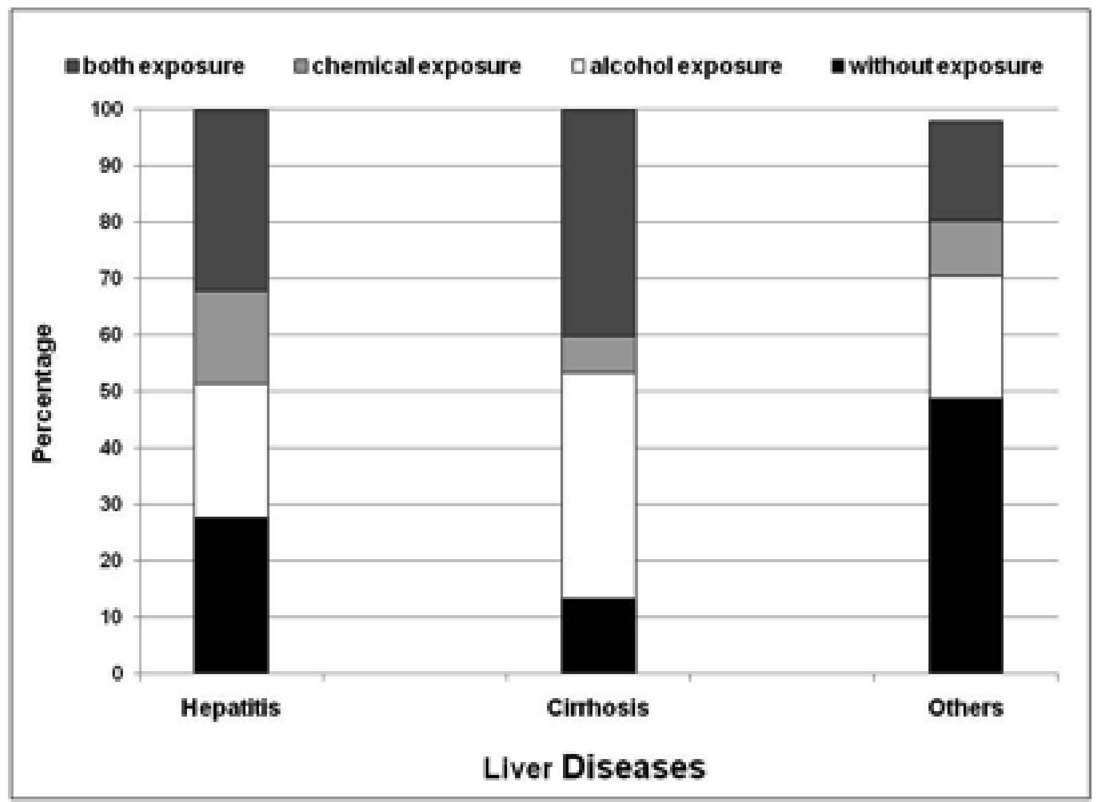

Figure 2: Prevalence of participants that mentioned having some kind of the studied liver disease and exposure to alcohol and chemical substances

Table 1 shows the risk factors that, in this study, were shown to be occupational exposure to chemicals, alcohol consumption, the consumption of locally produced milk and fruit and water consumption from natural sources.

Table 1. Results of single logistic regression and multiple logistic regression models.

		Single model OR (CI 95%)	Multiple model OR (CI 95%)
Liver disease			
	Occupational exposure to chemicals	2.50 (1.78 – 3.49)*	1.90 (1.29 – 2.80)*
	Alcohol consumption	2.08 (1.56 – 2.79)*	1.62 (1.10 – 2.37)*
	Local fruit consumption	2.43 (1.13 – 5.23)*	3.13 (1.12 – 8.19)*
	Local milk consumption	1.87 (1.10 – 3.17)*	1.51 (0.64 – 3.59)
Hepatitis			
	Occupational exposure to chemicals	3.22 (2.07 – 5.02)*	2.69 (1.62 – 4.47)*
	Alcohol consumption	1.94 (1.31 – 2.90)*	1,55 (0,93 – 2,57)
	Local fruit consumption	3.91 (1.70 – 8.99)*	4.58 (1.60 – 13.13)*
Cirrhosis			
	Occupational exposure to chemicals	3.40 (1.23 – 9.40)*	1.52 (0.53 – 4.35)
	Alcohol consumption	5.87 (2.13 – 16.17)*	6.22 (1.68 – 22.98)*
Others liver disease			
	Local milk consumption	3.44 (1.71 – 6.94)*	___________

Liver disease (without occupational exposure)	Alcohol consumption	1.84 (1.16 – 2.92)*	1.82 (1.14 – 2.90)*
	Local milk consumption	2.88 (1.24 – 6.70)*	2.52 (0.99 – 6.40)
Hepatitis (without occupational exposure)	Alcohol consumption	2.17 (1.13 – 4.16)*	2.07 (1.08 – 3.97)*
	Natural local water consumption	4.44 (1.73 – 11.40)*	5.88 (2.24 – 15.45)*
Cirrhosis (without occupational exposure)	Alcohol consumption	7.72 (1.56 – 38.30)*	____________
Other liver disease (without occupational exposure)	Local milk consumption	4.86 (1.70 – 13.90)*	____________

*statistically significant

Discussion

The prevalence of total liver disease among all participants was low, but hepatitis was the most frequently mentioned disorder. The prevalence of hepatitis, among all participants, of Pilões and Água Fria, Cubatão Center and Continental São Vicente were higher than the prevalences at Guarujá and Bertioga. However, about one third of the people who mentioned having hepatitis and almost half the people who mentioned having other liver disease reported not being exposed to chemical and alcohol consumption. The consumption of locally-produced food may serve as route for exposure to environmental contaminants. However, almost all interviewed households (97.0%) in the present study reported that they did not consume food produced in their communities, and the consumption of local milk. Fruit and local sources water appeared as risk factors for liver disease and hepatitis, as did occupational exposure to chemicals and alcohol consumption.

The adoption of a cross-sectional design seemed to be the best choice to explore the effect indicators of the environmental exposure to chemicals in the Santos and São Vicente Estuary. Despite the well-known histories of area contamination and inhabitant exposure throughout the last four decades, complete contamination routes are not well-defined and there is also concern regarding the ability of public health services to identify and treat cases of disease related to exposure to environmental contaminants.

Conclusions

The contamination of the environment at the Santos and São Vicente estuary is still a public health problem, and it is still necessary to consider the limitations of the health system in identifying and diagnosing all cases of environmental exposure to different contaminants as risk factors for the presence of disease.

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EFFECT-BASED ASSESSMENT OF PERSISTENT ENVIRONMENTAL POLLUTANTS USING MAMMALIAN REPORTER ASSAYS

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Abstract

Environmental risk assessments based on chemical analysis combined with hazard based equivalency factors are limited by the relatively small set of contaminants that are routinely included in environmental screening programs, as well as by the limited toxicological knowledge that is available for the vast majority of compounds. This drawback may be obviated by including a complementary assessment approach that focuses on biological effects of compounds cocktails rather than on chemical analysis of the presence of individual compounds. This can be achieved by the use of reporter assays that respond to specific biological effects, such as CALUX assays. These assays are based on human cell lines that were modified to respond specifically and quantitatively to compounds that impose a certain effect on the cells. There are over 25 CALUX assays available, including assays for endocrine disruption, dioxin receptor-mediated signaling, endpoints that relate to genotoxicity and carcinogenicity, and multiple stress pathways. Due to its standardized set up, it allows for reproducible high throughput measurements. The assays are used for a wide variety of applications, among which effect-profiling of pure compounds, hazard assessment of complex (environmental) mixtures, and screening of human tissue in epidemiological studies.

Keywords

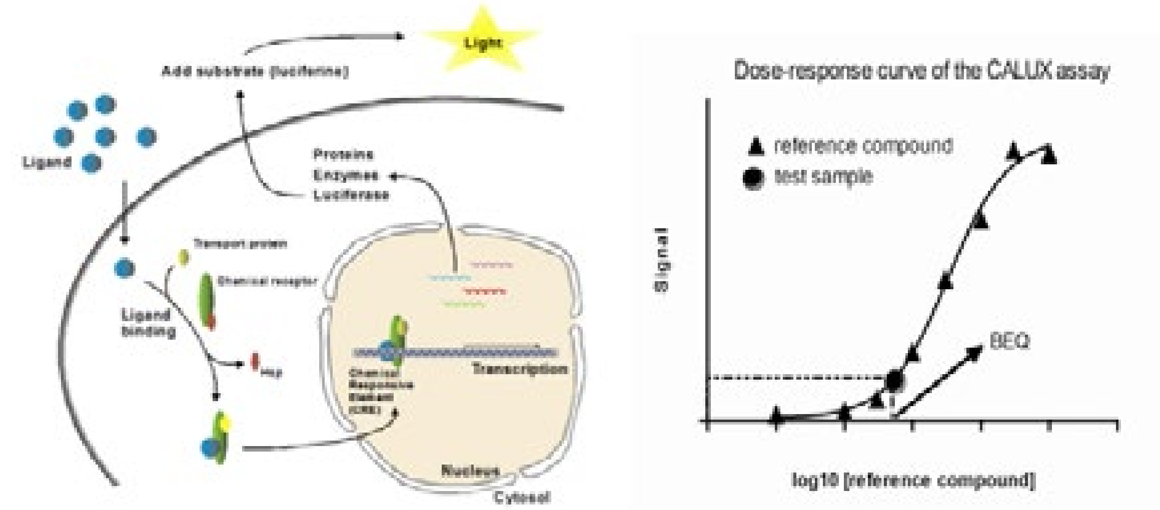
POPs, Pesticides, CALUX, reporter assays, effect-based assessment.

Introduction

From the millions of chemical compounds produced by man, a substantial part ends up in the environment. In general, environmental hazard assessments focus on chemical analysis by measuring only a limited set of prioritized compounds for the reason that they frequently occur and /or are known to provoke adverse health effects. Although, in many cases, this chemistry-based approach may give a representative impression of the toxicological hazards of a sample, this approach will not identify hazard by compounds that are not included in the screening program. However, simply including more compounds does not solve this problem, as most compounds have not been thoroughly tested for their in vivo effects. In addition, chemical analysis cannot assess the possible interactive behavior of compounds in mixtures.

These flaws may be overcome by including effect-based testing, i.e. direct assessment of adverse effects without the requirement of prior knowledge of the sample composition. Toxicological hazard assessment of pure compounds is generally done by animal testing. Obviously, ethical issues related to animal testing, high cost, variability in the constituents of the sample and amount of time required for analysis, disqualify this approach for standard applications in environmental screening programs.

An alternative approach is effect-based hazard assessment, i.e. by the use of in vitro assays, which rely on cells derived from relevant vertebrate species. These tests focus on distinct effects on the tissue or cellular level that play an important role in the onset of major toxic effects at the organism level (such as carcinogenicity, genotoxicity, reproduction toxicity and developmental toxicity).



The CALUX consist of mammalian cells that were modified to respond specifically to a certain effect by the production of an enzyme, luciferase (left). Cells are exposed to a test sample along with a concentration series of a reference compound. After an exposure period, the substrate is added for the luciferase, after which light production is quantified on a luminometer. The final result is expressed as biological reference compound equivalences (BEQ), by interpolation in the dose-response curve of the reference compound (right).

CALUX reporter assay principle

The CALUX panel is a set of human cell line-based reporter assays that were modified to generate a very specific and dose dependent response to compounds or mixtures that impose a certain effect. These cells produce light upon exposure to samples that impose the effect of interest, and the amount of light produced is proportional to the amount of specific biological activity in the sample. The effect is expressed relative to the effect of a well-defined reference compound (see box).

Relation of CALUX assays with in vivo toxicity

Currently, over 25 CALUX assays are available that are predictive for various toxic effects at the cellular level. These cellular effects were targeted for their relation with major toxic events in vertebrate species. Some examples of how the in vitro assay data relate to in vivo effects are listed below:

• The AhR receptor, which binds dioxins, dioxin-like PCBs and various PAHs, has a pivotal role in the initiation of dioxin related toxicity (Marlowe and Puga, 2005) and in detoxification processes. The central role for AhR was confirmed in studies with mice, in which AhR-knockout resulted in reduction of toxic effects by dioxin and PAHs (Gonzalez and Fernandez-Salguero, 1998; Nakatsuru et al., 2004; Shimizu et al., 2000). The AhR-based DR CALUX is optimized for the detection of dioxins and dioxin-like PCBs. The related PAH CALUX cell line is sensitive for especially those PAHs that have been indicated as mammalian carcinogens (Pieterse et al., 2013);

• Disruption of the endocrine system can result in multiple adverse effects, including reproduction and developmental disorders and various cancers. CALUX assays are available for the detection of interference of cellular processes via a range of endocrine receptors, including the Estrogen Receptor alpha (ERα), the Estrogen Receptor beta (ERβ), the Androgen Receptor (AR), the Progestin Receptor (PR), the Glucocorticoid Receptor (GR), the Retinoic Acid Receptor (RAR) and the Thyroid Receptor beta (TRβ). These assays were validated by screening of model compounds. Moreover, the predictive value of the ERα CALUX, the AR CALUX and the PR CALUX for in vivo effects was confirmed in studies that showed good correlations of the assays with analogous in vivo models (Sonneveld et al. 2006; Sonneveld et al., 2011);

• Peroxisome proliferator-activated receptors (PPARs) are major regulators involved in lipid and glucose metabolism, which also relates them to chronic disorders such as obesity, and obesity-induced inflammation and diabetes. Currently CALUX assays for PPARα, PPARγ, and PPARδ are available;

• P53 is the major regulator for cell cycle arrest, activation of DNA repair mechanisms, and initiation of apoptosis in response to DNA damage, processes that directly relate to genotoxicity. Mutations that disrupt the functionality of the p53 gene lead to uncontrolled cell growth and, thus, cancer. Validity of the p53 CALUX as predictor of genotoxic action has been confirmed in a validation study using a reference set of test compounds proposed by the European Union Reference Laboratory for alternatives to animal testing (EURL ECVAM) (Van der Linden et al., 2013).

Effect-profiling of pure compounds

The CALUX panel has been used for the generation of in vitro effect profiles for an extensive set of persistent environmental pollutants. These effect profiles provide information on the potency of the compound with respect to a large number of toxicity endpoints. Moreover, they could provide an indication for the type and level of pollution that is present in field samples, for which profiles of the total mixture have been generated. Despite the heterogeneity of the responses towards the various compounds, dominant effects could be observed: Major part of the tested pesticides interacted with major hormone receptors, particularly anti-androgenic, anti-progestagenic and /or estrogenic were observed. It was previously stated that endocrine disruption is a dominant effect of many pesticides, which may be linked to known adverse health effects, such as carcinogenicity and developmental disorders (Mostafalou and Abdollahi, 2013). Most of the pesticides that have been associated with carcinogenicity do not have an effect on the p53 CALUX, which indicates a non-genotoxic carcinogenic mode of action. Dioxins, dioxin-like PCBs and carcinogenic PAHs are characterized by their inducing effect of AhR-mediated activity. The effects evoked by the heavy metals and the organometals confirm that they are very diverse with respect to their toxic effect. From the screened compounds, 14 compounds showed a response in the p53 CALUX assay indicative of genotoxic effects. Genotoxicity is confirmed in scientific literature for 11 of these compounds.

Applications

The CALUX assays are effect-based biological measurement techniques, for which the use is not restricted to specific matrices or research areas. Analyses are done for food and feed compliance testing, environmental quality testing, effect profiling of pure compounds, and screening of human tissue, for instance, in epidemiological studies. The assays have been used in research projects worldwide. We provide some illustrative examples of projects that relate to environmental safety.

Soil and sediment

The DR CALUX is frequently used as sensitive and cost-effective alternative for the assessment of dioxins and dioxin-like PCBs in soils and sediments. This approach is approved by regulatory agencies in multiple countries.

While PAHs form one of the most widespread and heterogenic group of environmental pollutants, screenings are generally restricted to one or a few prioritized congeners. The PAH CALUX offers an alternative approach by quantification of the AhR-mediated activity of the total PAH mixture. This appears to be a strong indicator for the abundance of carcinogenic PAHs (Pieterse et al., 2013). The comparison of PAH CALUX measurements with chemical analytical data of river sediment, sewage sludge and industrial soil showed that application of this bioassay reduces the risk of underestimating the actual toxicity as compared to the exclusive use of chemical analytical data.

In a project on the hazard assessment of a pesticide dump site in Tajikistan, a combined approach using chemical analysis and a set of CALUX reporter assays was used (Rijk et al., 2013). CALUX-based bioactivity profiles specifically indicated the high endocrine disrupting activities at the hotspots. Comparison of the bioassay data with chemical analytical data showed that the analysed compounds could only account for a part of the total biological activity.

Water

CALUX assays are frequently used in water quality assessments for the detection of endocrine activity. The main emphasis is put on the presence of estrogenic activity, which is frequently detected in many water systems worldwide and has been shown to have devastating environmental effects at even ng/l concentrations (Kidd et al., 2007). Based on the biological activity detected, many responsible compounds have been identified chemically, including synthetic hormones and industrial chemicals (Campbell et al., 2006) Recently, other types of endocrine activity in water samples have gained more attention, including activity on the glucocorticoid receptor by pharmaceuticals (Van der Linden et al., 2008).

Indoor environment

Indoor dust is a sink for a highly heterogeneous set of pollutants, such as flame retardants and plasticizers originating from household items. A study in which effect-profiles of household dust and various flame retardants were compared showed interactions with hormone receptor for multiple compounds and revealed several candidate high-priority endpoints and compounds for the monitoring of indoor environment (Suzuki et al., 2013).

Wildlife

Several studies have been aimed at the detection of biological activity in wildlife, to assess the effects of exposure to anthropogenic compounds. Recently, in a study on bioaccumulative pollutants in liver and / or blubber extracts from high-trophic animals from Baikal Lake dioxin-like and anti-androgenic activities were identified, while no activities were measured in the estrogen-, progesterone- and glucocorticoid receptor CALUX'. In a combined bioassay – chemical analysis approach, p,p'-DDE was identified as major contributor to the anti-androgenic activity (Suzuki et al., 2011).

Screening of human samples

CALUX-based analyses have been performed on serum, breast milk, and urine samples, as well as on tumour material. Within the European NewGeneris project, maternal and cord blood samples from over 1000 mother – newborn cohorts have been analysed for estrogenic-, androgenic- and dioxin-like activities. One of the major advantages of the bioassays was their high sensitivity, due to which only small sample volumes were required. The results gave strong indication of a relation between dioxin levels and aberrant anogenital distances among male newborns (Papadopoulou et al., 2013; Pedersen et al., 2010).

Future perspectives

The strong potential of effect-based testing using in vitro assays is gaining increased attention, not only by the scientific community but also by regulatory authorities. To illustrate, in a recent EU report, it was stated that the current knowledge gap with respect to mixture toxicity should be bridged in respect of the principle of reducing tests with vertebrate animals (European Union, 2012). Moreover, various initiatives that will promote further use of in vitro methods in the near future are ongoing, such as the ToxCast and Tox21 programs by the US-Environmental Protection Agency, the establishment of the European Union Reference Laboratory for alternatives to animal testing (EURL ECVAM) in 2011, and the establishment of multiple research consortia that focus on the development of alternative toxicity testing strategies for several adverse health effects (such as the EU FP7 program ChemScreen).

Whereas regulatory guidelines for environmental health quality typically rely on threshold concentrations for prioritized compounds, environmental quality standards can also be set for effect-based data. For the detection of dioxins and dioxin-like PCBs, biological equivalence values are available and acknowledged for various matrices, such as food, soil and sediment. Recently, the Dutch KWR Watercycle Research Institute proposed trigger values for endocrine activities in drinking water based on the ERα-, AR, PR-, and GR-CALUX' (Brand et al., 2013).

Recent developments in assay automation and volume downscaling have resulted in a substantial increase in throughput in combination with a decrease in assay volume and thus sample requirement. This further promotes the use of larger effect-based panels for various applications.

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TO REACH OR NOT TO REACH
OR: INADEQUACIES OF OUR CHEMICAL LEGISLATION

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The over-all defining criteria for inclusion of POP-chemicals (i.e. Persistent Organic Pollutants) in the Stockholm Convention lists will - beyond the general properties of toxicity and eco-toxicity, including persistence and bio-accumulative properties - be the potential for long-range environmental transport.

Unintended presence and generally global, individual distribution of these chemicals in living organisms, including habitats and physical surroundings is exemplified by data from equatorial plains, temperate regions and urban areas to arctic regions (re DDT, PCB, HCB & mercury etc.), often far away from places or geographical zones where the original release into the environment took place and resulting from intentional uses or handling or unintentionally as part of chemicals life cycle, processing or waste handling. While indications are given on a possibly stabilised/ only slightly changing situation as for example for atmospheric Dioxins and chlorinated POPs in the Baltic Sea region, new investigations point to still emerging problems concerned e.g. with fluorinated compounds on the Faeroe Islands and mercury in arctic regions.

As for the legislative process concerned with SVHC-chemicals (Substances of Very High Concern), it is a disturbing fact that the inclusion of individual chemicals into the Convention lists not only is a lengthy process per se. Generally it is also unduly delayed due to legislative inadequacy (cfr. unclearly defined burdens of proof) and/or lack of political will to utilise existing tools. The application of Precautionary Principle as defined thru the EU chemical legislation REACH, is lacking behind, as exemplified by present concerns over EDCs, i.e. Endocrine disrupting Chemicals, such as brominated flame retardants and fluorine household chemicals.

ENDOCRINE ACTIONS OF PESTICIDES IN THE FLEMISH ENVIRONMENT AND HEALTH STUDIES

(FLEHS I & II): dose-effect relationships between biomarker concentrations in urine and serum of Flemish adolescents and hormones and sexual maturation

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Abstract

In 2002, the Centre for Environment and Health in Flanders (Belgium) started a human biomonitoring program (FLEHS I). For 1679 adolescents residing in nine study areas with differing pollution pressure, exposure to the pesticides p,p'-DDE and HCB, hormone levels and the degree of sexual maturation were measured. Possible confounding effects of lifestyle and personal characteristics were taken into account. In 2007, a second cycle of the Flemish human biomonitoring program (FLEHS II) started. The main purpose was generating reference values for several biomarkers, both of exposure and effect, and establishing dose-effect relationships. In this survey, not only the pesticides p,p'-DDE and HCB, but also metabolites from organophosphate pesticides and para-dichlorophenol (2,5-DCP), a metabolite of para-dichlorobenzene, were estimated.

Data on internal exposure of the pesticides p,p'-DDE and HCB showed a positive correlation with sexual maturation and the aromatase index for boys and with free T4 (both boys and girls), while a negative association with sexual development in girls was found. For HCB, a positive correlation was also found with testosterone and pubic hair development (boys) and TSH levels in the blood (boys and girls).

The organophosphate pesticide metabolites were negatively associated with sex hormone levels in the blood of the boys and with sexual maturation (both boys and girls). The pesticide metabolite 2,5-DCP was negatively correlated with free T4, while a positive association with TSH was reported (boys and girls).

These results show that even a relatively low concentration of pesticides can have significant influences on hormone levels and the degree of sexual maturation in 14-15 year-old adolescents

Keywords

Endocrine disruption, pesticides, FLEHS, hormones, human biomonitoring, sexual development.

Introduction

The Flemish Environment and Health Study (FLEHS) of 1999, a preliminary small scale biomonitoring study, provided some evidence to suggest that levels of internal exposure to pollutants were associated with observable differences in effect markers (Den Hond et al. 2002; Koppen et al. 2002; Staessen et al. 2001; Van Den Heuvel et al. 2002; Van Larebeke et al. 2006). Therefore, in 2002, the Centre for Environment and Health in Flanders (Belgium) started a human biomonitoring program (FLEHS I, 2002-2006). For 1679 adolescents exposure to the pesticide metabolite p,p′-dichlorophenyldichloroethylene (p,p'-DDE) and hexachlororbenzene (HCB), hormone levels and the degree of sexual maturation were measured. In 2007, the second cycle of the Flemish human biomonitoring program (FLEHS II, 2007-2011) started. The main purpose was generating reference values for several biomarkers, both of exposure and effect, and establishing dose-effect relationships. In this survey, not only the pesticides p,p'-DDE and HCB, but also metabolites from organophosphate pesticides and para-dichlorophenol (2,5-DCP), a metabolite of para-dichlorobenzene, were measured.

The goal of this presentation is to determine the possible associated health effects between the pesticides, measured in the serum and urine of the Flemish adolescents between 2003 and 2011, and hormone levels and data on sexual maturation.

Methods and Materials

Selection and recruitment of the participants

In both the FLEHS I and II studies, 14-15 year-old adolescents were recruited in Flanders (Belgium). During FLEHS I, 1679 adolescents were recruited in 9 areas in Flanders with a different pollution pressure (two industrial sites, two harbours, two cities, a rural area, a zone around waste incinerators and a fruit cultivating area), while in the FLEHS II study 200 participants were recruited around the whole Flanders (reference group) and 400 in two industrial hotspot regions. Sampling was performed between October 2003 and July 2004 (FLEHS I) between May 2008 and February 2011 (FLEHS II). The study design was approved by the medical-ethical committee of the University of Antwerp.

Statistical data treatment

Geometric means with 95% confidence intervals were calculated for the reference populations of respectively 1679 (FLEHS I) and 200 (FLEHS II) adolescents using SAS 9.2. To define dose-effect relationships, stepwise multiple regression analysis with correction for pre-defined confounders and selected covariates was done. Confounders for the pesticides HCB and p,p'-DDE were sex, age, BMI, smoking behaviour and amount of blood fat when expressed per amount of serum. Confounders for the organophosphate metabolites and 2,5-DCP were sex, age and the amount of creatinine when expressed per volume of urine. Confounders of data on testosterone, reaching the adult stage of testosterone, estradiol, and the aromatase index (ratio testosterone/ estradiol) were age, smoking, hour of blood sampling and BMI. The parameters "illness during the last 14 days" and season were added as covariates to the multiple regression models. Confounders of data on LH and FSH were age, BMI and smoking. Confounders of data on SHBG were age, BMI, smoking and having not eaten before sampling of the blood, while alcohol consumption was added as a covariate. Confounders of data on sexual development were age, BMI and smoking. Confounders of data on thyroid hormones were age, BMI, sex and illness during the last 14 days. The LOQs in urine samples were 3 µg/L for DMP and DMTP; 1 µg/L for DMTP, DMDTP and DETP; 2 µg/L for DEP, DEDTP and 0.4 µg/L for 2,5-DCP. The LOQs for HCB and p,p'-DDE yielded 20 ng/L serum. For samples below the limit of quantification (LOQ), half of the LOQ was used for calculations.

Results

Dose-effect relationships: Sex hormones and degree of sexual maturation

The sex hormones (total and free testosterone, reaching the adult stage of total and free testosterone, total and free estradiol, the aromatase index, sex hormone binding globulin SHBG, luteinizing hormone LH and follicle stimulating hormone FSH) were only measured in the blood of the boys participating in the studies. The data on sexual development were obtained for both boys and girls.

In the FLEHS II survey, HCB was positively correlated with total testosterone (p=0.004), reaching the adults stage of testosterone (p=0.04, OR=1.29), the aromatase index (p=0.007) and pubic hair development (p=0.052, OR=1.77). For girls, a negative association with reaching menarche at the age of 14-15 years old (p=0.03, OR=0.39) was reported. The pesticide metabolite p,p'-DDE was negatively correlated with breast development in girls (p=0.03, OR=0.74), while a positive correlation with the aromatase index (p=0.02) in boys was observed. A positive association between HCB and free (p=0.002) and total (p=0.0001) testosterone, the aromatase index (p=0.0007) and pubic hair development (p<0.0001) was also found for the boys in the FLEHS I study (Dhooge et al. 2011). In this previous study, also positive relationships between p,p'-DDE and pubic hair development (p=0.002) and genital development (p=0.001) in boys and between HCB and total estradiol (p=0.0001) in boys were observed, but this could not be confirmed in the FLEHS II survey.

The sum of organophosphorus pesticide metabolites (both methyl and ethyl metabolites) were significantly negatively correlated with free estradiol concentrations in the blood of the boys (p= 0.03 for methyl group and p= 0.01 for the ethyl group, both after Ln transformation). The sum of the ethyl metabolites was also negatively associated with free testosterone (p=0.04, after Ln transformation) and reaching the adult stage of free testosterone (p=0.04, OR=0.53, after Ln transformation). For the girls, negative associations were found between the sum of ethyl metabolites and breast development (p=0.048, OR=0.78), while for the boys a negative relation between sum of methyl metabolites and genital development was observed (p=0.04, OR=0.46).

Dose-effect relationships: thyroid hormones

Dose-effect relationships on thyroid hormones (thyroid stimulating hormone TSH, free triiodothyronine fT3 and free thyroxine fT4) were established for all adolescents.

In the FLEHS II survey, the pesticides p,p'-DDE and HCB were positively correlated with fT4 (p=0.02 and 0.08, respectively), while for 2,5-DCP a negative association was found (p=0.001). TSH was positively associated with HCB (p=0.02) and 2,5-DCP (p=0.02). No significant relationships with fT3 were found in the latest study, but a positive association between fT3 and HCB (p=0,006 for girls and p=0,046 for boys; unpublished results) was reported in FLEHS I.

Conclusion

The data on internal exposure of the pesticides p,p'-DDE and HCB indicated a faster sexual maturation in boys, while for girls signs of a delayed development were found. Thyroid hormones, especially fT4, showed positive associations with these persistent, chlorinated pesticides. Similar observations were found for the marker PCBs and several hydroxylated PCBs (unpublished results), indicating similar mechanisms of action. Dose-effect relationships for organophosphate pesticide metabolites showed the association with delayed sexual development for both boys and girls, while the pesticide metabolite 2,5-DCP seemed to have an influence on the concentrations of thyroid hormones in the blood of boys and girls (negative effect on fT4 and a positive association with TSH). These results might imply that even a relatively low concentration of pesticides can have significant influences on hormone levels and the degree of sexual maturation in 14-15 year-old adolescents.

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ORGANOCHLORINE PESTICIDES AND HEALTH IN CHAPAEVSK, RUSSIA,

TWO DECADES OF EPIDEMIOLOGICAL STUDIES

Chapaevsk (population 72,000) is a small city located in Central Russia (950 km south-east of Moscow), half of its area was occupied by chemical industries. The Chemical Plant produced chlorine-containing industrial and agricultural chemicals, such as the organochlorine pesticides (OP), including hexachlorobenzene (HCB), and beta-hexachlorocyclohexane (HCH) from 1967 to 1987, which generated polychlorinated dibenzodioxins/dibenzofurans (PCDD/PCDFs) as industrial contaminants (Revich et al. 2001). By 2003, the production of all chemicals at that plant ceased. Environmental contamination by OP may have resulted from improper disposal, storage of hazardous waste from factories, or environmental release of organochlorine by-products of the manufacturing process (Shelepchikov et al. 2008).

Since 1994, ecological studies conducted in Chapaevsk to estimate OPs/dioxin levels in blood, milk, and to assess cancer risks and reproductive health status. High levels of these compounds have been detected in serum and milk samples from Chapaevsk residents, as well as in environmental samples and food (Akhmedkhanov et al. 2002; Revich et al. 2001). The male cancer mortality observed rate in Chapaevsk was higher than expected, especially for lung cancer and urinary organs. Further studies have demonstrated the effects on semen quality among worker of plant (Goncharov et al. 1999), an increased rate of breast cancer in women working at the plant and local residents who eat contaminated pork or fish (Revich et al. 2002).

Since 1998, international team from Russia and Harvard School of Public Health conducted a pilot cross-sectional study of growth and pubertal outcomes among 2516 Chapaevsk boys at the age of 10-16 years (Lee et al. 2003). We presented elevated frequency of cryptorchidism, varicocele and delayed puberty among these adolescents (Sergeyev et al. 2000). In 2003, this was followed by establishing a longitudinal cohort of 516 families, called the Russian Children's Study, with primary objectives of examining the predictors of prepubertal serum organochlorine compounds among the Chapaevsk boys and evaluating their associations with the measures of physical growth, sexual maturation, reproductive health and biological markers.

We have discovered higher median serum levels of HCB and β-HCH among 355 boys of 8-9 years in comparison with other populations (158 and 167 ng/g lipid, respectively). Lower body mass index, longer breastfeeding duration, local dairy consumption, close residence to chemical plant and long residence in Chapaevsk were associated with higher prepubertal concentrations of OPs (Lam et al. 2013). In adjusted models, serum OP concentrations measured at 8–9 years of age were associated with reduced growth, particularly reduced BMI, during the peripubertal period of 4 years of follow-up (Burns et al. 2012). Higher serum HCB was associated with higher serum insulin, and the odds of insulin resistance over 4 years of follow-up (Burns et al. 2011). Higher prepubertal serum OP concentrations were associated with a later age of attainment of sexual maturity measures over 7 years of follow-up (Lam et al. 2013).

Since 1997, simultaneously with studies, there were environmental remediation and social rehabilitation programs, financed by the Russian, regional and local governments in Chapaevsk. Soil in Chapaevsk was remediated and mean dioxins TEQ in breast milk of Chapaevsk citizens declined 3.8 times over the ten year time period, from 41.1 pg/g lipids in 1998 to 10.9 pg/g lipids in 2007 (Sergeyev et al. 2008). Based on our recent study, (Sergeyev et al. 2013) we could observe a secular trend towards increased linear growth, BMI and earlier attainment of sexual maturity during the 10 to 14 year period (from 1999 to 2012/13) among the adolescents of Chapaevsk.

HUMAN CONTAMINATION BY PERSISTENT TOXIC SUBSTANCES

PROPOSALS TO IMPROVE EXPOSURE ASSESMENT

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Worldwide, most health information systems on chemical body burden and, specifically, on the population distribution of human contamination by persistent toxic substances (PTS) are weak and incomplete, if they exist at all. Unfortunately, in many countries, public health, preventive medicine, and medicine at large, are currently not properly assessing such exposures and their health effects (Gasull et al., 2013; Kolossa-Gehring, 2012; Porta et al., 2008, 2012a; Porta, 2012; Viso et al., 2009). It is important that this situation changes as soon as possible. With some exceptions (see references in Kolossa-Gehring, 2012; Patel et al., 2012; Porta et al., 2008), there are few population-based, sys¬tematic and comprehensive analyses of the exposure to and the effects of common environmental contaminants on clinical outcomes and clinically-relevant physiological endpoints (CDCP, 2009; Lee et al., 2009; Porta et al., 2008, 2010; Weinhold, 2003). Many such pollutants are known to alter a range of physiological functions significantly, and known or reasonably suspected to contribute to cause severe clinical effects, as well as a substantial burden of disease (Alonso-Magdalena et al., 2011; Barouki et al., 2012; Casals-Casas and Desvergne, 2011; Engel and Wolff, 2013; Henkler and Luch, 2011; Hernández et al., 2009; Hou et al., 2012; Manikkam et al., 2012; NRC, 2006, 2008; NTP, 2011; Peters et al., 2012; Porta, 2004, 2006; Prüss-Ustün et al., 2011; Soto and Sonnenschein, 2011; Swedenborg et al., 2009; Vandenberg et al., 2012).

Some highly prevalent chemical agents and chemical mixtures have immune-disrupting, oxidative, proinflammatory, neurotoxic, neuroendocrine, nephrotoxic, metabolic, carcinogenic, non-genotoxic or epigenetic properties and effects (Alonso-Magdalena et al., 2011; Barouki et al., 2012; Casals-Casas and Desvergne, 2011; CDCP, 2009; Henkler and Luch, 2011; Hernández et al., 2009; Hou et al., 2012; Lee et al., 2009; Manikkam et al., 2012; Morrens et al., 2012; NRC, 2006, 2008; NTP, 2011; Peters et al., 2012; Porta, 2004, 2006; Soto and Sonnenschein, 2011; Swedenborg et al., 2009). Scientific evidence on such effects is often neglected, disregarded or downplayed in the biomedical literature and by institutions and organizations. Such toxic exposures may also partly explain important disease–dis¬ease associations; e.g., between some cancers and obesity, diabetes, au¬toimmune or inflammatory disorders (Gasull et al., 2012; Porta et al., 2009, 2012). Furthermore, at present, the functional properties of many envi¬ronmental agents are better known than those of many genetic loci. Throughout the life course, key causal processes in the etiopathogenesis of some highly prevalent human diseases involve chronic contamina¬tion by persistent toxic pollutants and the ensuing accumulation of ge¬netic and epigenetic alterations. In this respect, we should reflect on these words from the editor of The Lancet: “And why has the gene revolution failed so spectacularly to deliver anything tangible for patients? Because we have underestimated, even wilfully disregarded, the complexity of disease. Our indifference to physiology—to an understanding of systems in disease—has been a catastrophic loss to medicine" (Horton, 2011).

In my view, the available evidence indicates that we are not assessing comprehensively to what mixtures is the general population significantly exposed in critical periods of life, how many persistent toxic pollutants we accumulate during the life course, or even the number of chemicals whose continued presence in the human body it is most relevant to analyze (Porta et al., 2008, 2012a, 2012b, 2013). However, some studies suggest that citizens of the postindustrial economies often accumulate mixtures of 50, 70, 100 or even more toxic agents (ContamiNation, 2003; Watson, 2005; Weinhold, 2003; Woodruff et al., 2011).

In Catalonia, for instance,
– 73% of the population accumulates 10 or more persistent organic pollutants (POPs) (of only 19 analyzed);

– 34% of citizens have concentrations in the top quartile of ≥3 of the 8 most fre¬quent POPs;

– over 30% of the population has concentrations in the top decile of 1 to 5 of the 8 most prevalent POPs;

– half of the population has levels of 1 to 5 POPs >500 ng/g;

– among women 60–74 years old (a subgroup with an obviously high incidence and prevalence of morbidity),

a) 83% have concentrations of ≥3 POPs in the top quartile, and

b) 48% have concentrations of ≥6 POPs in the top quartile;

– less than 4% of the Catalan population has concentrations of all the 8 most common POPs in the lowest quartile (Porta et al., 2010, 2012b, 2013).

Hence, it is not accurate to state that most of the population has low concentrations of POPs: contamination from selected toxic chemicals is common at high and low concentrations (Porta et al., 2012b).

In summary, I invite you to integrate in your own framing these issues:

a) we know quite a lot about the generalized human contamination by environmental chemical agents (a statement that is fully compatible with the assessment that most countries lack the necessary monitoring systems) (Porta et al., 2008);

b) we also know quite a lot about the toxic effects of environmental pollutants (a statement that is fully compatible with the proposal that we need both more research, and more energetic policies to decrease human contamination by such pollutants); and

c) we know too little about the causes and the etiopathogenesis of the most prevalent diseases, and we will continue to miss relevant causes and mechanisms if we neglect toxic chemicals.

Or we may put it this way: when we do not integrate biomarkers of internal dose of environmental pollutants in our research on the etiopathogenesis of human diseases of complex etiology,

1. we are trying to study 'something' that hardly exists (fully uncontaminated human beings);

2. our causal inferences are less likely to be relevant for human health; and

3. we are likely to miss causes and mechanisms of the processes that we aim to study (e.g., causes of changes in gene expression, of accumulation of genetic defects, of alterations in metabolic functions). Knowledge on the joint effects of 'chemical cocktails' during the life course ought to be used more often when building

causal scenarios that aim at being relevant for human health.

It is hard to explain why human contamination by environmental chemical agents is not integrated deeply into medicine and, more gener¬ally, into basic, clinical and epidemiological research (Alonso-Magdalena et al., 2011; Barouki et al., 2012; Casals-Casas and Desvergne, 2011; ContamiNation, 2003; Gasull et al., 2012; Henkler and Luch, 2011; Hernández et al., 2009; Horton, 2011; Hou et al., 2012; Howard and Lee, 2012; Hoyo et al., 2009; Kauffmann and Nadif, 2010; Lee et al., 2009; Lee and Jacobs, 2010; Manikkam et al., 2012; NRC, 2006, 2008; NTP, 2011; Peters et al., 2012; Porta, 2004, 2006, 2008, 2009; Porta and Álvarez-Dardet, 1998; Porta et al., 2009; Soto and Sonnenschein, 2011; Stein, 2012; Swedenborg et al., 2009; Tickner, 2011; Vandenberg et al., 2012; Watson, 2005; Woodruff et al., 2010, 2011). There is strong evidence showing that scientific neglect of toxic chemicals is partly due to investigators', institutional, political and social biases, including academic, cultural and economic influences (Greenland, 2012; Michaels, 2008; Porta, 2008).

May I thus also suggest that we should more often seriously consider integrating biomarkers of internal dose of environmental chemical pollutants in our efforts to prevent human diseases. When we neglect less the generalized human contamination by environmental chemical agents and their toxic effects, we will expand mechanistic biologic knowledge, and we shall as well increase the effectiveness of interventions and policies that enable the primary prevention of diseases that cause a huge economic burden and human suffering.

Conflict of interest statement

The author declares no competing interests.

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NEUROTOXICITY OF PERSISTENT ORGANIC POLLUTANTS WITH SPECIAL REFERENCE TO PCBS AND AUDITIVE FUNCTIONS

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POPs include many different organic chemicals with common properties such as long-persistence, widespread diffusion in the environment, and accumulation in fatty tissues of living organisms. A growing body of scientific evidence associates human exposure to POPs with various health outcomes, including neurodevelopmental impairment. These effects may be elicited by mechanisms such as endocrine system disruption, oxidative stress, or epigenetic mechanisms, though the exact mechanisms are not clear. Many laboratory studies have been carried out using unrealistically high doses which makes extrapolation with regard to environmental human exposures very difficult. However, as a whole, a recently published literature search shows that the epidemiologic studies did not strongly implicate any particular organochlorine pesticide as being causally related to adverse neurodevelopmental outcomes in infants and children. Future work in this area may be improved by the addition of more sensitive outcome measures for the evaluation of neurodevelopmental damages induced by chemicals. For instance, we have successfully introduced into epidemiological research of neurotoxic effects of PCBs the measurements of otoacoustic emissions (OAEs). These methods have been applied in experimental studies in animals, however they have not been used extensively in epidemiologic investigations. Data from studies in the Slovak Republic among children and adolescents, show adverse associations between PCB exposures and OAEs, and therefore PCBs may have the potential to damage the outer hair cells of the cochlea. Moreover we have shown that child, rather than maternal or infant PCB concentrations are associated with poorer performance on otoacoustic tests of cochlear status at age 45 months, suggesting a possible short-term effect. We have undertaken preliminary steps to apply the OAE methodology to other POP exposures, such as HCB and HCH.

HEALTH PROBLEMS AT OBSOLETE PESTICIDES SITES (EXPOSURES AND TOXICITY OF PESTICIDES)

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The symposium on exposure and effects of HCH and POP pesticides should assist to answer the following questions:

1. Can low levels of persistent pesticides be detected in biological fluids (serum, urine, milk) or tissues (fat, organs) of exposed humans?

2. Does exposure to dump and waste sites or landfills containing persistent pesticides lead to changes in internal levels (= biomarkers of exposure) of these pollutants in people living in neighbourhood areas?

3. Will such elevated levels of pollutants be relevant enough to induce biological effects? And: What kind of effects could be expected in the exposed human and animal populations?

Exposure and Effects of Pesticides

Reproduction

The FLEMISH Environment and Health studies in Flandern, Belgium illustrate the clear dependence of human pollutant levels from pollutant pressure in designated areas: Adolescents residing in study areas with slightly differing densities of contamination also differed with regard to serum levels of pollutants. Biomonitoring samples of study participants living in areas of waste incinerators had significantly elevated blood and urine levels. Also sex hormone concentrations were increased. However, differences in hormonal levels and sexual maturation could only in part be explained by differences in internal levels of contaminants and may also be due to differing individual pollutant patterns and yet unknown factors (Croes et al., 2009).

Another study reported on a cohort of 8–9 year old boys in Chapaevsk, a small city in Central Russia, where half of the city was occupied by chemical industries producing chlorine containing agricultural chemicals including HCB and HCHs. OCP (organochlor pesticide) concentrations were found to be associated with total time living in Chapaevsk, distance from OCP source, but also with local dairy consumption, longer duration of breast feeding and lower BMI in these children (Burns et al., 2009).

In the city of Ufa, a hot spot of dioxin pollution, higher dioxin concentrations were found in ejaculate of men diagnosed as infertile. High dioxin levels were also associated with pathospermia (Gromenko et al., 2008).

Cancer

Excess cancer risk is increasingly found to be associated with abundant use of pesticides in agricultural, commercial and home and garden applications. Positive associations are also found between childhood leukemia and pesticide exposures. Other studies suggest that occupational agents like chlorinated solvents or organochlor compounds (PCBs) may play a role in the causation of exocrine pancreatic cancer, while DDT's association with breast cancer has been described repeatedly (Alavanja et al., 2003; Meinert et al., 2000). Exposures remain high: New studies report that more than half of the study population in Spain had concentrations in the top quartile of ≥1 POPs (Bosch de Basea et al., 2011).

Neurotoxicity

In more recent systematic reviews on neurodevelopmental outcomes of children exposed to pesticides (organophoshates, organochlorines), PCBs, mercury, cadmium and/or lead during early life, the majority of studies indicate a negative impact.

There is increasing evidence that chemicals present in the environment can interrupt neurodevelopmental processes during critical periods of development, with adverse effects on structure and function, leading to functional disturbances in children, adolescents and adults. Exposed neonates can exhibit, i.a., hearing loss, higher proportion of abnormal reflexes, while young children show more attention deficits and other behavioral problems.

Important to know: Neurodevelopmental disorders like autism, ADHD (attention deficit and hyperactivity disease), mental retardation and cerebral palsy are common, costly and are all lasting for lifetime (Trnovec et al., 2010; Jurevicz et al., 2013).

Liver diseases

Brazils Santos and São Vicente Estuary suffers from contamination by toxic industrial waste. Prevalence of liver disease, hepatitis, cirrhosis and liver, biliary tract or pancreas cancer was evaluated in a study at St. Paulo University, Brazil. Occupational exposure to chemicals, alcohol consumption, consumption of locally produced milk and fruit, and water from natural sources, appeared as risk factors for liver diseases (Carvalho et al., 2013).

In conclusion, there is evidence from more recent international studies presented at the symposium in Kiev that elevated exposures to persistent organochlorines and other pesticides can occur in proximity to dump and waste sites or landfills and affect biomarkers of exposure (concentrations of chemicals in the environment) and have detrimental effects on exposed human and animal populations. Especially at risk are early life stages with respect to reproductive and neurodevelopmental effects (fetal origin of adult diseases). Additional areas of concern are cancer in young and adult life, liver diseases and derailed energy metabolism, which is increasingly attracting attention.

All of the aforementioned aspects deserve more attention and need more scientific input, i.a., advances in analytical procedures (Pieterse et al., 2013). Finn Bro-Rasmussen pointed out that environmental pollution is still ongoing more or less unimpededly regardless of new chemical legislations (REACH), and that it remains difficult to cope with the situation (Bro-Rasmussen et al., 2013). It would be important to demonstrate reduced levels of internal exposures associated with occurrence of changes in biological parameters following clean-up of chemical waste sites in order to strengthen correlations between exposures and biological consequences.

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INVENTORY, MONITORING AND RISK ASSESMENT



PESTICIDES SPREAD FROM NUBARASHEN OBSOLETE PESTICIDES BURIAL SITE (ARMENIA) (SUBMITTED PAPER)

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Abstract

In 1980s the special place was allotted for pesticides burial near Nubarashen village in the vicinity of Yerevan – capital city of Armenia. At the territory of the organized burial site about 500 tons of obsolete pesticides were buried; the volume of organochlorine pesticides made 250 tons.

In 2012, in order to assess the pollution and the real threat, sampling and laboratory analyses of soil taken from neighboring sites were done. Sampling was done from the plots beginning the entrance to the burial site, directly above the burial site and was continued up to inhabited settlements of Mushavan and Jrashen. Eighteen average samples were taken, among which 5 were from plots of Jrashen and Mushavan. The samples were analyzed for organochlorine POPs pesticides.

Visualization of analytic results for DDT and its metabolites, as well as HCH isomers was of special attention. Soils from the outward nearest plots on the average contained 1.4 mg/kg DDT, while soils from the same plots, if sampled from the depth of 20 cm, contained on the average 2.3 mg/kg DDT. Soil taken directly from the burial site contained about 59 mg/kg DDT, while soil near the drainage tube contained 13.5 mg/kg. Below the burial, soil taken from the depth of 1 m contained on the average 1.6 mg/kg p,p'-DDE and 6-8 mg/kg p,p'-DDT. In the same direction at a distance of 20 to 100 m the amount of DDT in samples of soil made appropriately 1.1 and 0.2 mg/kg. At the plots of summer houses below the burial (>500 m) residues of p,p'-DDE made 0.008 mg/kg, whereas p,p'-DDT = 0.04 mg/kg. In samples of soils from Mushavan and Jrashen DDT averaged from 0.005 to 0.01 mg/kg.

Nubarashen burial site of obsolete pesticides in the vicinity of Yerevan is an object of visual pollution.

Keywords

Obsolete pesticides; burial site; persistent organic pollutants; DDT; HCH.

Article

The burial site of obsolete pesticides near to Yerevan City is an object of visual pollution. The problem of obsolete and banned pesticides became mostly urgent since late 1970s, when there arose the necessity of final disposal (burying) of obsolete and banned pesticides (mainly organochlorine ones) accumulated at the territory of Armenia.

In early 1980s, the special place was allotted for pesticides burial near Nubarashen village. At the territory of the organized burial place about 500 tons of obsolete pesticides were buried (finally disposed), of which the volume of organochlorine pesticides made 250 tons [Aleksandryan A. et al., 2003].

The complexity of the problem dealing with the obsolete pesticides burial is worsened by the fact that the site allotted for this burial is located in the zone of active landslide processes, which can cause damage, crippling and a possible breakthrough of the "innage" and subsequent penetration of residues of buried obsolete pesticides, including organochlorine ones, into the environment resulting in environmental pollution [Aleksandryan A., 2005].

The problem of Nubarashen pesticides burial site, in particular, its environmentally sound liquidation (elimination) is stated in the National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants [Aleksandryan A. et al., 2004].

After the infringement of the burial site integrity, due to unclear reasons, there actually occurred a secondary pollution of the environment by mentioned pesticides. In 2010 the Ministry of Nature Protection performed activity on conservation of the burial site, covering the Nubarashen pesticides burial site, repairing the drainage system and fencing.

In 2012, in order to assess the degree of impurity and pollution scales and for assessment of the real threat, sampling and laboratory analyses of soil taken from neighboring sites were done to determine soil pollution by the buried pesticides. Average samples were taken using "envelope" method and then provided to the Laboratory.

Sampling was done from the plots beginning at the entrance to the burial site, directly above the burial site and was continued up to inhabited settlements of Mushavan and Jrashen. Upon sampling, we took into consideration the localization of the burial site on the slope of the hill, as well as the summer houses located at the lower level. Taking into consideration the fact that pollution might have originated only in the direction of downwards placed plots, sampling was done precisely in that direction. The samples were analyzed for organochlorine POPs pesticides.

Visualization of analytic results for DDT and its metabolites, as well as HCH isomers was of special attention. Comparing the results of analyses with the topographic location of the plots, we found that soils from the outward nearest plots on the average contained 1.4 mg/kg DDT, while soils from the same plots, if taken from the depth of 20 cm, contained on the average 2.3 mg/kg DDT. Soil taken directly from the burial site contained about 59 mg/kg DDT, while soil near the drainage tube outgoing from the burial contained 13.5 mg/kg. Below the burial, at the fence from the outward part, soil taken from the depth of 1 m contained on the average 1.6 mg/kg p,p'-DDE and 6-8 mg p,p'-DDT. In the same direction at a distance of 20 to 100 m the amount of DDT in samples of soil made appropriately 1.1 and 0.2 mg/kg.

At the plots of summer houses below the burial (>500 m) the residual amount of p,p'-DDE made 0.008 mg/kg, whereas p,p'-DDT = 0.04 mg/kg. In samples of soils taken at the settlements Mushavan and Jrashen the amount of DDT, on the average, made from 0.005 to 0.01 mg/kg.

Table: Results of analyses for POPs pesticides in samples of soil taken from the Obsolete Pesticides Burial Site, mcg/kg, 2012

NN	Sampling points	Organochlorine pesticides										
		α-HCH	HCB	β-HCH	γ-HCH	Heptachlor	o.p`-DDE	p.p`-DDE	o.p`-DDD	p.p`-DDD	o.p`-DDT	p.p`-DDT
1	Sampling point 1: directly at the entrance of the burial site	7.0	7.1	53.8	12.2	8.0	34.2	128.1	27.1	110.2	453.3	1425.5
2	Sampling point 2: the same point from a depth of 20cm	28.5	11.3	95.7	15.2	7.2	102.7	171.6	44.2	201.3	687.8	2390.2
3	Sampling point 3: near drainage tube (lower boundary of the burial)	33.7	108.2	213.0	23.5	6.3	780.0	1149.6	323.5	1230.8	3842.4	13504.5
4	Sampling point 4: directly from the surface of the burial	281.2	230.9	461.7	233.6	44.6	3888.0	3675.2	1136.0	3765.3	12964.6	59816.4

5	**Sampling point 5: the lower boundary of the burial**	63.7	59.1	648.6	33.7	19.8	769.3	1554.1	237.5	758.2	2320.1	8320.5
6	**Sampling point 6: the lower boundary of the burial (1 m from burial surface down the hill)**	22.2	11.4	103.2	20.0	10.9	728.2	1613.3	163.8	439.0	1596.2	6300.7
7	**Sampling point 7: at a distance of 20 m from the lower fence of the burial site**	4.6	3.6	34.3	12.1	11.3	209.1	1250.8	56.1	65.8	485.7	1144.9
8	**Sampling point 8: directly downwards from the burial site, leftwards from Aviators' summer houses (to the left)**	4.2	2.5	25.3	7.7	12.2	149.4	949.7	39.3	41.7	329.4	725.2

9	**Sampling point 9: at a distance of 100 m downwards from the fence of burial site**	5.5	3.1	14.2	10.5	13.8	50.5	32.0	8.3	9.1	91.8	210.3
10	**Sampling point 10: forefront of summer-house plot downwards from the burial site**	4.7	3.2	2.0	4.6	13.1	6.5	8.3	2.4	3.4	11.5	41.9
11	**Sampling point 11: the remote part of the summer-house plot (downwards), at the country road**	4.4	3.1	19.7	4.6	13.9	9.1	10.1	1.9	3.0	10.7	31.5
12	**Sampling point 12: downwards from the burial site at the high-way**	4.2	2.5	23.6	5.5	14.4	3.6	5.5	2.7	2.6	7.1	24.5
13	**Sampling point 13: 100 m below summer houses**	7.3	6.1	21.7	10.6	14.6	12.1	29.2	4.9	8.2	31.6	86.7

The analysis of data obtained allows to draw conclusion that the actual migration does not deal with the temporal migration of pesticides, while pollution is caused by disintegration of the burial site and the follow-up recovery works. As a result, there occurred a certain spread of pesticides into the soil of nearby plots; to this latter indicate the analyses of soils from the plots in the direct vicinity to the burial site.

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RESIDUES OF ORGANOCHLORINE PESTICIDES IN SURFACE WATERS OF ARMENIA (SUBMITTED PAPER)

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Abstract

Within the frames of monitoring studies performed in 2012 for residual amounts of Persistent Organic Pollutants (POPs) in different environmental media samples of water from the Lake Sevan and rivers of Armenia were analyzed.

Residues of POPs pesticides were revealed in studied samples of surface water with the help of "Gas-Chromatograph/ Mass-Spectrometer GCMS-QP2010 SE EI 230V CELV incl. GC-2010 Plus" (Shimadzu Corporation, Japan).

According to research findings, in all tested samples of surface water the residual amounts of pesticides were revealed at microgram (μg) levels:

- Hexachlorocyclohexane isomers varied from 0.006 to 1.1 μg/L;

- DDT and its metabolites made 0.004-0.5 μg/L;

- Heptachlor amounted 0.1- 0.86 μg/L;

- Hexachlorobenzene made 0.09-0.3 μg/L;

- Aldrin: 0.01-0.3 μg/L;

- Dieldrin: 0.01-0.2 μg/L;

- Endrin: 0.02-0.2 μg/L;

- Mirex: 0.01-0.1 μg/L.

The summary quantity of HCH isomers in analyzed samples of water varied in the range of 0.00013-0.0014 mg/L, while DDT and its metabolites made 0.00002-0.0015 mg/L.

DDT was determined only in Masrik and Gavaraget rivers; in other water basins only products of DDT degradation were found: DDE and DDD.

The comparison of research results obtained in 2012 with earlier data of 2002-2003 demonstrated that the tendency was observed to a significant decrease of organochlorine substances residual amounts in surface water of Armenia.

Keywords

Monitoring studies; persistent organic pollutants (POPs); surface water; residual amounts.

Within the frames of monitoring studies performed in the Republic of Armenia in 2012 for residual amounts of Persistent Organic Pollutants (POPs) in different environmental media 12 samples of water from the Lake Sevan and rivers of Armenia were analyzed.

For measurements in water of open reservoirs of the Republic of Armenia DDT, HCH, Lindane (γ-HCH), Heptachlor and Hexachlorobenzene were chosen from the list of pesticides regulated by the Stockholm convention. The first three pesticides had production value and for many years were applied as means of pest control and against diseases of plants almost in all agricultural regions of the country. Heptachlor was used, both as pesticide and as the substance with potential to be formed in various technological processes [Aleksandryan A., 2010].

Twelve samples of surface water were taken and analyzed in order to investigate the content of OCPs.

The study involved rivers Masrik, Martuni, Gavaraget, Hrazdan, as well as Sevan Lake and water reservoirs (storage ponds) “Yerevanyan” and “Akhpara”.

Sampling was done according to the unified method for samples taking followed by determination of pesticides residual amounts.

The average water samples analyzed using Gas-Chromatography method for 15 pesticides, including those of interest: DDT and metabolites, HCH isomers, Heptachlor, Hexachlorobenzene, Aldrin, Dieldrin, Endrin, and Mirex. Residues of POPs pesticides were revealed in studied samples of surface water with the help of “Gas-Chromatograph/ Mass-Spectrometer GCMS-QP2010 SE EI 230V CELV incl. GC-2010 Plus” (Shimadzu Corporation, Japan).

The amounts of pesticides in studied samples were as follows:

- Hexachlorocyclohexane isomers varied from 0.006 to 1.1 mcg/L;

- DDT and its metabolites made 0.004-0.5 mcg/L;

- Heptachlor amounted 0.1- 0.86 mcg/L;

- Hexachlorobenzene made 0.09-0.3 mcg/L;

- Aldrin: 0.01-0.3 mcg/L;

- Dieldrin: 0.01-0.2 mcg/L;

- Endrin: 0.02-0.2 mcg/L;

- Mirex: 0.01-0.1 mcg/L.

According to study results in all tested samples the residual amounts of pesticides were revealed at mcg levels, whereas in 2002-2003 the content of pesticides (DDT and its metabolites, heptachlor, HCH and its isomer, as well as hexachlorobenzene) in samples of water from open reservoirs of Armenia exceeded standards of these substances in water of reservoirs [Khachatryan A. et al., 2004; Aleksandryan A., 2006].

There are different Maximum allowable concentrations (MACs) for water of open water reservoirs for household use.

In water of open water basins intended for fishery no residual amounts of HCH and its isomers, DDT and its metabolites are allowed.

MACs of HCH and its isomers, DDT and its metabolites in samples of water taken from open water basins intended for agricultural use make 0.02 mg/L and 0.1 mg/L, appropriately.

MACs of HCH and DDT in drinking water make 0.002 mg/L.

DDT was determined only in Masrik and Gavaraget rivers; in other water basins only products of DDT degradation were found: DDE and DDD.

In analyzed samples of water the summary quantity of HCH isomers varied in the range of 0.00013-0.0014 mg/L, while DDT and its metabolites made 0.00002-0.0015 mg/L.

Table 1: POPs Pesticides: Residues in samples of water from Sevan Lake and rivers of Armenia, 2012 (meg/L)

NN		Organochlorine pesticides														
		α-HCH	HCB	β-HCH	γ-HCH	Heptachlor	Aldrin	o,p'-DDE	p,p'-DDE	Dildrin	o,p'-DDD	Endrin	p,p'-DDD	o,p'-DDT	p,p'-DDT	Mirex
1	Water, Masrik River	0.254	0.072	0.404	0.130	0.860	0.200	0.202	0.052	0.012	0.054	0.052	N/R	0.028	0.086	0.318
2	Water, Martuni River	0.026	0.034	0.092	0.006	0.168	0.010	0.046	N/R	N/R	0.018	N/R	N/R	N/R	N/R	0.184
3	Water, Sevan Lake near Airivank Village	0.020	0.036	0.058	0.018	0.380	0.032	0.084	N/R	N/R	0.032	N/R	N/R	N/R	N/R	0.082
4	Water, Gavaraget River	0.884	0.188	1.216	0.412	3.310	0.356	0.538	0.180	0.034	0.244	0.346	0.050	0.244	0.392	0.074
5	Water, Sevan Lake, North-East of Small Sevan	0.008	0.010	N/R	N/R	0.082	N/R	N/R	N/R	N/R	0.008	N/R	N/R	N/R	N/R	0.064
6	Water, Sevan lake, Lchashen Bay	0.134	0.076	0.302	0.086	0.214	0.014	N/R	N/R	N/R	0.022	N/R	N/R	N/R	N/R	0.096
7	Water, Hrazdan River head	0.026	0.056	0.064	0. 006	0.158	0.010	N/R	N/R	N/R	0.012	N/R	N/R	N/R	N/R	0.118
8	Water, Akhpara	0.018	0.048	0.088	0.064	0.216	0.012	0.004	0.012	N/R	0.018	N/R	N/R	N/R	N/R	0.018

NN		Organochlorine pesticides														
		α-HCH	HCB	β-HCH	γ-HCH	Heptachlor	Aldrin	o.p'-DDE	p.p'-DDE	Dildrin	o.p'-DDD	Endrin	p.p'-DDD	o.p'-DDT	p.p'-DDT	Mirex
	Reservoir (storage pond)															
9	Water, Hrazdan River near Arzni Village	0.024	0.042	0.050		0.200	0.014	N/R	N/R	N/R	0.014	N/R	N/R	N/R	N/R	0.066
10	Water, Yerevan Reservoir (storage pond)	0.018	0.036	0.070	0.042	0.204	0.034	N/R	N/R	N/R	0.016	N/R	N/R	N/R	N/R	0.024
11	Water, Hrazdan River "Aeration" treatment station	0.040	0.024	0.068	0.012	0.632	0.026	0.082	N/R	N/R	0.030	N/R	N/R	N/R	N/R	0.038
12	Water, Hrazdan River. Masis town	0.028	0.024	0.028	N/R	0.112	N/R	N/R	N/R	N/R	0.008	N/R	N/R	N/R	N/R	0.128

The comparison of research results obtained in 2012 with earlier data of 2002-2003 demonstrated that the tendency was observed to a significant decrease of organochlorine substances residual amounts in surface water of Armenia.

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THE USE OF EFFECT-BASED ANALYSIS FOR ENVIRONMENTAL HEALTH RISK CHARACTERISATION OF POPS PESTICIDES DUMPSITES

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Abstract

One of the problems concerning dumpsites with (obsolete) POPs pesticides and other hazardous chemicals is to provide a comprehensive analysis of the environmental health risks. Typically, risks are classified by chemical screening of the source site and direct surroundings, using a predefined set of compounds, which can be unsuitable for complex mixtures and samples with unknown compounds ('black boxes'). In this paper, we present the application of effect-based testing as an alternative and complementary approach to conventional chemical analysis, using Kanibadam POPs burial site (Tajikistan) as a case-study. CALUX bio-based reporter assays are used to profile soil samples containing a complex mixture of known and unknown compounds. The results are compared with the risk assessment based on conventional chemical screening for organochlorine compounds.

It is shown that conclusions from both chemical and effect-based analysis are quite similar. Contamination levels within the burial site are, in our case, over 100 times the risk-based soil quality standards. However, the results from the effect-based analysis shows for a specific spot that additional toxicological activity is present to what can be explained by the compounds that were identified and quantified by the chemical analysis.

It is concluded that effect-based bioassays are suitable as an alternative and complementary approach to conventional chemical analysis. Effect-based analysis is especially preferred as a screening methodology for hazards, and in cases where complex mixtures are expected. To make risk assessments more comprehensive, as well as more toxicologically relevant, it is highly recommended to perform an effect-based analysis.

A remaining challenge is how to assess off-site migration of POPs and to embed this into risk assessment. Therefore, for further investigation, it is suggested to profile potential sinks that act as exposure matrices, such as meat, dairy products and fish. The effect-based analysis of such samples could provide a more realistic risk assessment for human health, taking into account ongoing accumulation and degradation in the surroundings of a POPs

Keywords

Dumpsites, POPs and hazardous chemicals, risk assessment, CALUX, bioassay, Tajikistan.

Introduction

Despite international attention to POPs, many old stockpiles and dumpsites of (obsolete) POPs pesticides and other hazardous chemicals still exist around the world. One of the problems for characterisation of the environmental quality of the soil and groundwater at these sites is that assessment is typically performed by means of the chemical analysis of a predefined set of compounds. Although this will provide an indication of the presence of the compounds and associated environmental risks, the major drawbacks are as follows: i) sites can be a 'black box' with unknown compounds dumped which are not analysed; ii) degradation results in many degradation products, which are not always analysed, or otherwise difficult to interpret; iii) interaction of various compounds are not taken into account; and (iv) analysis of a complete set of compounds, even if they are known, is often not technically and/or financially possible.

In this paper, we present the application of effect-based testing as an alternative and complementary approach to chemical analysis. CALUX (Chemically Activated LUciferase eXpression) bio-based reporter assays are used to profile complex mixtures of soil samples from a dumpsite of obsolete and POPs pesticides (see box). Site risks characterised with CALUX are compared to risks characterised using conventional chemical screening of soil samples for organochlorine pesticides. In this paper, the suitability of effect-based bioassays for risk characterisation of POPs polluted hazardous waste dumpsites is evaluated and recommendations are made towards its application.

Case: Kanibadam dumpsite

Kanibadam is a POPs and obsolete pesticide dumpsite, located close to the densely populated and fertile Ferghana valley in Northern Tajikistan. It is estimated that about 4000 tonnes of phased out and banned pesticides were buried and burnt at Kanibadam between 1973 and 1990. The pesticides included DDT, lindane, other organochlorinated pesticides, organophospates, arsenates and other toxic compounds. At the time of research, the site, located just 3 km upstream of the city of Kanibadam, was neither fenced nor protected.

Methodology

A topsoil sampling campaign was carried out to provide a screening on the contamination level present within the burial site and its direct surroundings. From the direct surroundings, dust deposition samples, runoff samples in drains, baseline samples and samples from suspected sources outside the burial site were taken. In total, 21 composite samples have been obtained each consisting of 10 individual samples using only the upper 20 cm of soil. The samples were sieved (0.2x0.2 cm) and homogenized in the field. The samples have been analysed for the most commonly present organochlorine pesticides and their degradation products (HCH-isomers, DDT, and the "drins"). The results were normalised for organic matter content and clay fraction and screened against soil target values from the Netherlands as a Tier 1 risk assessment.

Five of these soil samples were selected for CALUX analysis, two of which from inside the burial site ('Source' and 'Gully east') and three from the surroundings ('Drain 4' 100m down from the polygon, 'Drain 5' 2 km down from the polygon, and 'Baseline wind' 200m upwind from the site).

The CALUX panel comprises mammalian cell line-based reporter assays for the detection of over 25 distinct effects at the cellular level (e.g. endocrine disruption, dioxin receptor-mediated signalling, genotoxicity and acute toxicity). It measures the biological activity of a sample without the requirement of prior knowledge of the exact chemical composition of the sample. The CALUX assays are performed using an automated platform in 384-well plates, where biological activity is measured using a luminometer as described (Piersma et al., 2013). For this case, 8 assays were selected (Table 1).

The activities measured on the CALUX assays are expressed as biological equivalences (BEQ) relative to a reference compound. For pure compounds, the biological potencies relative to the reference compounds can be established (REP values). Comparison between chemical analytical data and bioassay data for the soil samples was done by comparison of the expected sum BEQ (based on the chemical analytical data and the REP values for the individual compounds) and the actual measurements of the total BEQ using the CALUX assays.

Results and Discussion

The results of the chemical analysis show that:

- HCH-isomers are detected in small amounts. Only within the source area high levels are found, with a maximum level of 900 mg/kg dry matter (dm) (sum). The most common HCH-isomer at this location is α-HCH. However, at other locations β-HCH or γ-HCH was most present. Dutch Intervention Values of β-HCH (1.6 mg/kg dm) were exceeded in two cases inside the polygon;

CALUX assay	Biological effect
ERα (estrogen receptor α) CALUX	endocrine disrupting effects by (pseudo)estrogens
AR CALUX (antagonist testing; androgen receptor)	endocrine disrupting effects by anti-androgens
PR CALUX (antagonist testing; progestin receptor)	endocrine disrupting effects by anti-progestins
AP1 CALUX (AP1-signaling pathway)	effects on cell differentiation, proliferation and apoptosis which relate to carcinogenesis
DR CALUX (AhR receptor)	dioxin(-like) compounds related effects
PAH CALUX (AhR receptor)	(carcinogenic) PAHs-related effects
nrf2 CALUX (nrf2-signaling pathway)	measure for oxidative stress
p53 CALUX (p53-signaling pathway)	measure for genotoxicity

Table 1: CALUX assays included in the research

- Drins (aldrin, endrin, dieldrin) are rarely detected and only in negligible amounts;
- DDT and its degradation products DDD and DDE are nearly detected in all samples (19 samples out of 21). The highest reported value is 360 mg/kg dm (sum). In seven cases inside the polygon and in drain samples, Dutch Intervention Values for (sum) DDT were exceeded (1.7 mg/kg dm).

It is shown that drain and dust samples indicate (still) ongoing off-site migration via surface runoff and wind erosion. A source-path receptor analysis (Witteveen+Bos and Tauw, 2013) shows that exposure of local people can occur via direct contact, inhalation of contaminated dust, spreading of surface runoff via water bodies, and consumption of contaminated food. The site possesses potential direct risk for trespassers and indirect risk for consumers of meat and dairy products of grazing cattle.

CALUX -results (table 2) show that the samples elicit various responses from the exposed cells in the bioassays.
In general, the two samples taken from inside the polygon areas ('source' and 'gully east') show the highest responses. A decreasing trend in the biological activities going from the source towards the drains can be observed. Especially the results of the ERα-CALUX are clearly elevated within the source area. The 'gully east' sample shows an activity comparable to 1,75 µg 17β-estradiol/kg soil. To our knowledge there are no environmental quality standards (EQS) for compounds based on their estrogenic potency. However, as an indication: For estradiol an EQS of 0.4 ng/l has been proposed for water by the Scientific Committee on Health and Environmental Risks of the European Union (EU, 2011).
Furthermore, activity is measured on the anti-AR, anti-PR and AP1 receptors. In combination with the high stability of

CALUX assay	ERα	anti-AR	anti-PR	AP1	P53	PAH	DR
Reference compound (eq.)	17β-estradiol	flutamide	Ru486 (mifepristone)	TPA	actinomycinD	benzo[a]pyrene	2,3,7,8-TCDD
Sample name	g/kg ds soil	g/kg ds soil	g/kg ds soil	g/kg ds soil	g/kg ds soil	g/kg ds soil	g/kg ds soil
BW	2,85E-08	8,34E-03	4,30E-06	0,00E+00	0,00E+00	6,84E-05	7,5E-09
Source	1,03E-06	2,50E-01	8,59E-04	1,55E-06	5,49E-05	3,74E-05	9,6E-07
Gully East	1,75E-06	2,50E-01	4,30E-05	0,00E+00	0,00E+00	1,04E-03	5,2E-06
Drain 4	4,12E-08	2,50E-03	1,29E-05	0,00E+00	0,00E+00	1,01E-04	5,6E-07
Drain 5	1,12E-08	2,50E-02	1,29E-04	0,00E+00	0,00E+00	6,83E-05	1,0E-08

Table 2: Absolute results for bioactivity values (BEQ) measured of CALUX assays

the compounds, and depending on the exposure scenario, this indicates a health threat for hormone disruption, developmental disorders, and carcinogenicity. The DR-CALUX and PAH-CALUX assays show low activity, indicating that dioxins, dioxin-like PCBs and PAHs are not a matter of concern. Within the 'gully east' the concentration of PAHs is highest, but only 1 mg BaP/kg soil. For instance, the Intervention Value in the Netherlands is 40 mg BaP/kg. For the p53, activity was only measured from the sample 'source', indicating that except for this location, no genotoxic effects from samples are observed.

In figure 2 (next page), results of the comparison between calculated and measured values (in g/kg BEQ) are presented for ERα-, AR-anti, PR-anti and AP1-CALUX. For the other assays, no comparison could be made due to a lack of chemical data. If the expected BEQs are compared with the measured BEQs it is striking that especially for the sample "source" biological activity could not be predicted from values generated by chemical analysis, except for ERα. Additional toxicity (endocrine disruption and AP1 related activity/carcinogenity) seems to be present at this spot. For the sample "Gully east", also located inside the burial site, activity on AP1 was predicted but not measured. This relates to the fact that the expected levels are close to the detection level of this particular assay.

The comparison shows that the mixtures either have unknown compounds that aggravate responses or that individual compounds within the mixture have an enhancing (or in one case, counteracting) effect with regard to toxicity.

Conclusions and Recommendations

The results of both the chemical analysis and the biological, effect-based assay show that, for our case-study, risks are present for both the ecosystem and human health. Even 20 years after the last dumping has taken place, contamination levels are far above the risk-based soil quality standards. Furthermore, substantial toxic effects are measured. Although conclusions on site risks are in essence similar, by effect-based analysis, it is shown that at one particular spot toxicological effects are higher than expected based on chemical analysis of known compounds. Thus, it is indicated that additional toxicity from compounds that were not analysed is present, or that compounds in the mixture pose a synergistic action.

It is concluded that effect-based bioassays are suitable as an alternative and complementary approach to chemical analysis of the environmental samples for risk characterisation of POPs polluted and hazardous waste dumpsites. To make risk assessment more realistic, as well as more biologically relevant by showing responses on biological effects, it is highly recommended to perform an effect-based analysis. It is especially preferred to use biological effect-based bioassays for risk assessment when:

- chemical analysis do not show clear results, where high levels are expected (an indication that unknown compounds could be present);
- the pollution is a complex mixture of (known and unknown) compounds that may interact;
- analysis of individual compounds is either impossible or too expensive.

The method can be used as a screening without the analysis of individual compounds. Obviously, the predictive value of the effect-based analysis depends on the set of assays that were selected for the assessment. Based on the effect-based analysis, the follow-up analyses may be performed, for example, for chemical analytical identification of the compounds that elicit the adverse effects.

In this investigation, effect-based analysis is successfully used to characterise site risks of samples taken from a dumpsite and its direct surroundings. However, off-site migration and subsequent accumulation of POPs chemicals is more difficult to embed in a risk assessment, especially when chemicals were dumped decades ago.

Since that time, substantial transport to nearby and large distance sinks (environmental compartments, living organisms and food) has occurred. With current investigation and analysis techniques, the contribution of such a dumpsite to the deterioration of nearby sinks can still not sufficiently be mapped. One way to start

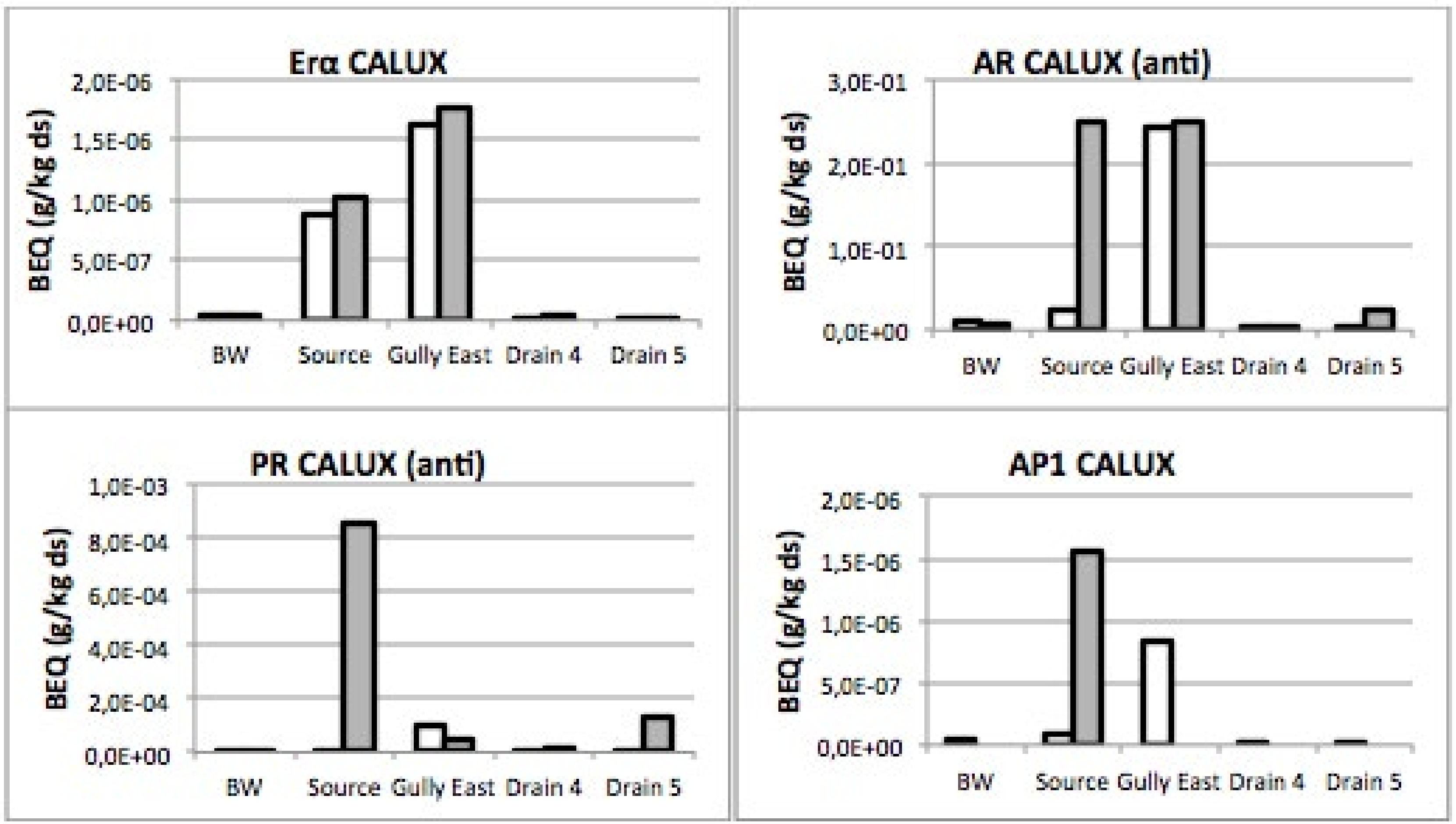

Figure 2: Expected (white bars) versus measured (grey bars) BEQ values of CALUX assays

understanding the impact is to investigate potential sinks that act as human exposure matrices, such as house dust, meat, dairy products and fish. Additionally, biological samples such as blood and mother milk could be analysed. The effect-based analysis of such samples could provide a more realistic risk assessment for human health, taking into account ongoing accumulation and degradation of a POPs dumpsite in the surrounding areas.

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CHARACTERIZATION AND MANAGEMENT OF LINDANE-CONTAINING WASTE AT AN ABANDONED LINDANE PRODUCTION FACILITY IN HUESCA PROVINCE (SPAIN).

PRIMARY EMERGENCY ACTIONS FOR ORGANOPHOSPHATE WASTE CONDITIONING AND EX SITU MANAGEMENT

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Abstract

The remaining raw chemicals and uncontrolled waste after closure of Inquinosa, a lindane-production facility located in the municipality of Sabiñánigo (Huesca, Spain) in 1991 has caused a major concern regarding health and safety conditions and potential environmental risk. Prior to dismantling the plant, the Regional Government of Aragon awarded Adiego Hnos. S.A. the contract to carry out the design of waste characterization and management plans to provide a detailed waste inventory. This included determining the presence of lindane (gamma-hexachlorocyclohexane), setting up appropriate waste management practices and the potential waste disposal alternatives for waste obtained from the site.

During the characterization, samples were taken from bulk materials, out of date chemicals and the inspection of storage tanks and pools throughout the site. Liquid, sludge and solid substances were sampled and a broad range of lindane-containing waste was identified. Additional potential risk arose from the identification of hazardous chemicals, such as organophosphate compounds with lindane, as well as unstable conditions of waste storage drums and the waste being exposed to atmospheric agents.

As a result, a comprehensive waste inventory was carried out, including waste coding according to current European regulation and a study of alternatives for ex-situ waste management. Site-specific management protocols were developed for individual waste types in order to guarantee maximum compliance with safety standards during handling, conditioning and transportation. Consecution of the waste management plan included advice to prioritize actions in order to prevent further impact on the environment or to human health due to the potential hazardousness of the waste in the current conditions of the site. As a consequence, a primary emergency plan was designed and executed for special conditioning and incineration of waste drums containing O,O-dimethyl hydrogen dithiophosphate with lindane. This waste is corrosive, flammable and toxic for inhalation. Therefore, ATEX equipment, supplied air respirators and special containment drums were necessary.

Keywords
Lindane, Bailín, Inquinosa, Organophosphates, Sardás

Introduction
The Industrial plant of INQUINOSA is located in the Fosforera Industrial State, next to Sabiñánigo Village. The plant occupies 17,000 m2 organized in six units, where buildings occupy 1,200 m2 of the total area. The plant was operative between 1974 and 1991. During this period the plant manufactured pesticides and other agrochemical products, mainly lindane (gamma-hexachlorocyclohexane). This activity is currently included in the list of potentially contaminative activities in Spain, as per current legislation (RD9/2005). Production figures from 1989 indicated an annual production of 850 tons of lindane, generating 6,900 tons of hazardous wastes per year (mainly deposited in Sardás and Bailín landfills near Sabiñanigo). The plant is currently closed to the public and controlled by the Regional Government of Aragón (Spain).

In 2012 Adiego was awarded a contract by the Regional Government of Aragon (Spain) to carry out the characterization of the waste products left within the Inquinosa plant facilities and to present a

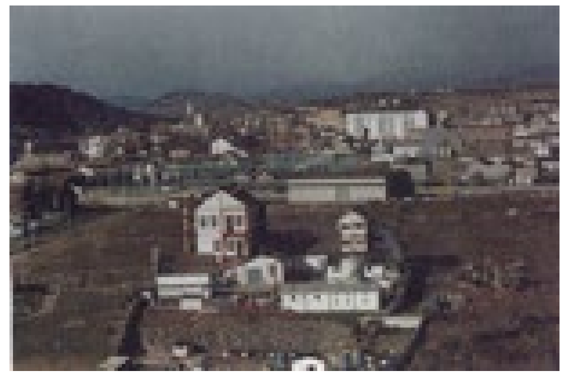


Figure 1 and 2: General view and aerial photo view of INQUINOSA plant.

Waste Management Plan. The Waste Management Plan takes the list of different waste products from the waste characterization phase and proposes management procedures according to current European and Spanish legislation and techniques for treatment of this hazardous waste.

Methodology
The characterization plan was structured into three main steps: 1) identification and visual inspection of potential wastes; 2) sampling campaign for lab analysis of liquid, solid and slurry substances for lindane confirmation, and 3) preparation of a descriptive sheet for any individual waste encountered in the Plant. Basic information included waste ID, location within the facility, waste description and estimated amount, waste characterization, safety issues, protective measures and feasible management options.

Execution of the characterization plan included 91 samples for laboratory analysis and 59 descriptive sheets. Evaluation and characterization of the waste encountered in the plant showed that 80 % of the waste contained lindane.

Descriptive sheets allowed prioritizing actions regarding wastes of singular concern, considering potential hazardousness of the waste in the current conditions of the site. As a consequence, a work procedure was designed for special conditioning and handling prior to incineration of waste drums containing O,O-dimethyl hydrogen dithiophosphate with lindane .

Large quantities of O,O-dimethyl hydrogen dithiophosphate were discovered within two of the warehouses (25-26). This organic acid is used as an intermediary product in the formation of pesticides. It is classed as corrosive to metals and flammable, it could cause injury to eyes, respiratory tract and skin. It may also have adverse effects on fertility and the substance is harmful to aquatic organisms. The presence of water hydrolyzes the organophosphate producing highly toxic hydrogen sulfide (H2S) and heat; therefore extreme caution must be exercised in the case of fire. Furthermore, laboratory analysis confirmed lindane presence. Lindane is a Persistent Organic Pollutant covered under the Stockholm Convention and a possible human carcinogen according US-EPA.

The acid was stored in large 200 L-capacity metallic drums with plastic inner coating. Due to the amount of time that this waste had been stored in the drums, the condition of the recipients had deteriorated significantly (rusted) and in some cases the drums were extremely difficult to handle. The acid found in the interior of the drums had partially solidified and deposited at the bottom of the recipient and showed a liquid layer on top, including an intermediate layer of very viscous substance between them. Nature and hazardousness of the waste and the state of the recipients justified the need for primary emergency actions.

Figure 3 and 4: View of storage drum encountered in warehouses 25 and 26 containing O,O-dimethyl hydrogen dithiophosphate and contaminated with lindane.

Figure 5 and 6: Adiego employees with personal protective equipment (PPE). Employees are wearing Tyvek suits with acid protection and respiratory equipment with eye and face protection. Figure 6 shows employee wearing self contained breathing apparatus.

Given the nature of the works a Health and Safety plan was necessary, describing additional personal protective equipment (PPE) and other safety measures to be undertaken during the works. In order to reduce employee exposure to hazards when engineering and administrative controls were not feasible or effective to reduce these risks to acceptable levels Tyvek suits with acid protection, chemical-resistant gloves and personal respiratory equipment and eye protection were required.

Adiego´s work team was integrated by two field technicians specialized in transfer and conditioning of the drums inside the warehouses and a Project Manager who was responsible for Health and Safety during the works. The working team was complemented by the Facultative Director and an external Health and Safety Manager both from the Regional Government of Aragon.

Transfer and disposal work was carried out during June 2012 as per specifications laid out in the technical guidelines described in the previous Waste Management Plan. The principle objective of the work that was carried out was the preparation and conditioning of the site and the materials necessary for the acid transfer and repackaging as part of the reconditioning protocol. The plan of work included the following specific actions:

- Access routes to the warehouse were cleared and containers (Intermediate Bulk Containers (IBC) and overpack salvage drums) were placed in relevant locations guaranteeing the absence of obstacles that could potentially obstruct or slow down a rapid evacuation of the warehouses in the case of an accident or emergency.

- A security zone was designed in an area between the two warehouses where a washing point was set up. A retention dike was installed as a necessary provision in the case that waste was spilled over workers or machinery. In addition tubular absorbents for corrosive liquids were also installed at the warehouses entry to allow containment of any spillages.

Adiego´s work team was integrated by two field technicians specialized in transfer and conditioning of the drums inside the warehouses and a Project Manager who was responsible for Health and Safety during the works. The working team was complemented by the Facultative Director and an external Health and Safety Manager both from the Regional Government of Aragon.

The procedure of work described in the Waste Management Plan indicated the transfer of the liquid waste to be carried out in-situ when possible, given the indoor location of the waste on concrete surfaces in good condition within the warehouses. The works started in warehouse 25 and were followed in warehouse 26.

Once all Health and Safety measures including personal equipment described in the technical instruction were in order, the specialized field technicians started the transfer and conditioning of the liquid waste, following the next steps:

- Operational check of protective and safety equipment, as well as of proper functioning of machinery. ATEX equipment was compulsory for the pumping device, employing an ATEX compressor for energy supply and an acid resistant double diaphragm pneumatic pump was used to transfer the liquid waste

- Selection of the drum and insert of the extraction pipe. Transfer of the liquid waste contained in the drum into the IBC. One of the technicians kept one end of the pipe inside the drum and the other checked that the liquid was being transfer into the 1000 L container. In this container, the pipe was held onto the lid of the container to prevent the pipe from accidentally slipping out and causing risk of spillages and splashing. Once the transfer of the liquid was finished in that selected drum, the extracting pipe was extracted from the drum, and the drum was closed with the screw top and marked.

- After all the liquid acid from one container drum was placed in the 1000 L containers and the pumping process was finished, the containers were labeled as "organophosphate acid", placing the pipe inside the next container to continue the transfer works.

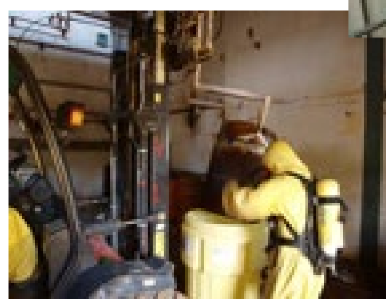
- The drums were accumulated in several rows within the warehouse, when the liquid waste from the drums in the first row had been transferred to the container; the drums were repackaged in the individual overpack salvage drums, to be able to assure all safety measures were in place to allow access to the next row.

Figure 7 and 8: View of pumping works.

Conditioning and repackaging of the individual drums, including the most viscous and partly solidified acid, into the overpack salvage drums was done individually by the two technicians. The methodology used for the packaging of the drums inside the overpack was done depending on the state of the drum. If the drum was in an acceptable state the drum was held by two intertwined straps in the upper middle part and lifted by the forklift, then the overpack salvage drum was slid underneath it, then the drum was lowered carefully and the screw top closed. In the case of severely damaged drums a different methodology was used including manual handling of the drums.

- When the procedure of reconditioning the organophosphate waste was finished in both warehouses the facilities installed for the works were dismantled.

Figure 9 and 10: Repackaging of the drums and liquid waste.



Conclusions

Execution of waste conditioning works resulted in four 1000 L IBC´s and 41 overpack salvage drums, all of them adequately labeled following current legislation. A total of 2,050 L of liquid organophosphate waste containing lindane were transported to Trédi (Séche Global Solutions) incineration plant near Lyon (France) for destruction.

Specific work procedure for waste conditioning assured a proper and safe execution. Neither personal protection equipment nor any machinery used for the loading of the containers suffered any splashes or spillages, and no emergency actions were necessary.

References

1. Safety Data Sheet Lindane

2. Safety Data Sheet 0,0 Dimethyl Hydrogen Dithiophosphate

3. Spanish Royal Decree 9/2005 14th January

4. Waste and Contaminated Soils Law 22/2011, 28th July (Spanish Boletín Oficial del Estado)

EVALUATION OF SLOVENIAN LAKES FROM 2007 – 2012 – CONTAMINATION WITH SPECIFIC PESTICIDES

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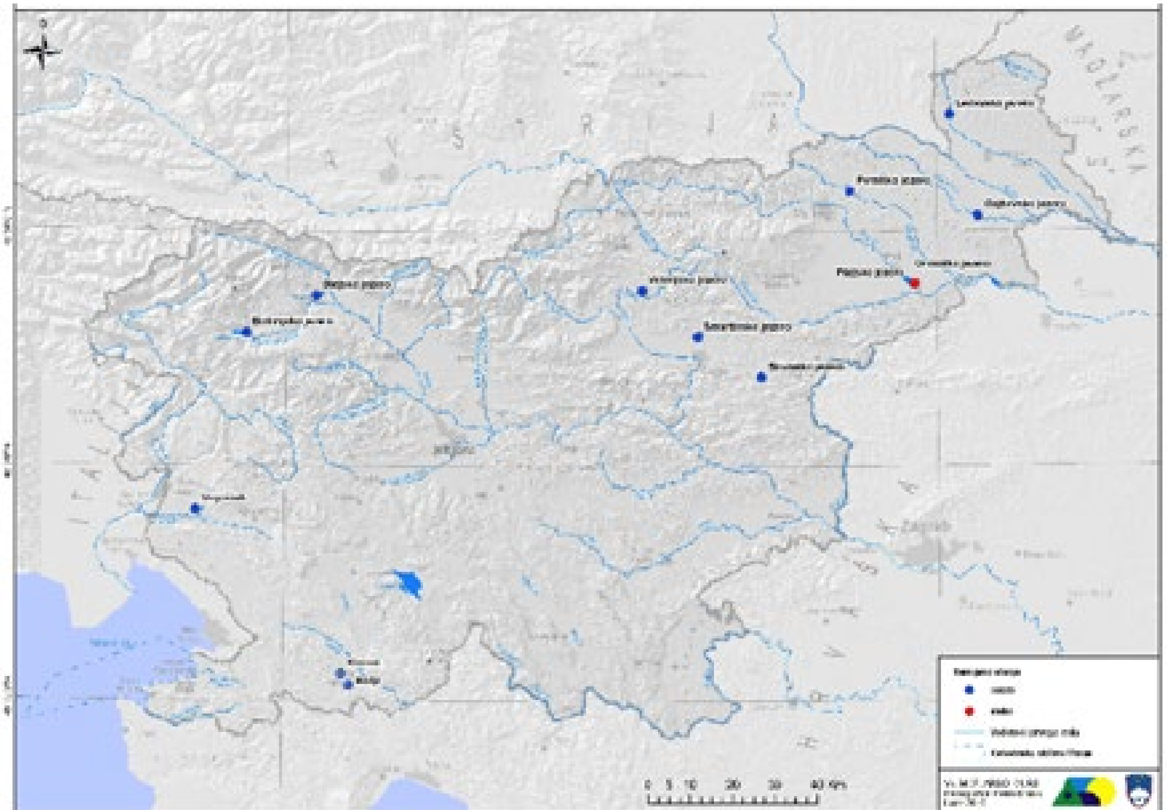
Introduction

In Slovenia there are 321 bodies of water classified as lakes. Two major ones in the pre-alpine part, Lake Bled and Lake Bohinj, and a number of smaller alpine lakes are tectonically glacial, many are intermittent due to Karst surface, and the rest were formed following dam building on rivers or subsidence due to mining. We evaluated 12 lakes for which the monitoring data were available. Two of them, namely Lakes Bled and Bohinj, are very clean probably due to the fact that there is no agricultural or industrial activity in their immediate surroundings.

Name	Superficies of lakes	Volume	Depth
	km^2	$m^3.10^6$	m
Bled Lake	1.43	25.7	31 max.
Bohinj Lake	3.28	92.5	45 max.
Velenje Lake	1.35	25	55 max.
Smartinsko Lake	1.07	6.5	6 average
Slivnisko Lake	0.84	4	5 average
Pernisko Lake	1.23	3.4	3 average
Ledava Lake	2.18	5.7	3 average
Gajsevsko Lake	0.77	2.6	3 average
Ptuj Lake	3.5	19.8	6 average
Klivnik	0.36	4.3	12 average
Mola	0.68	4.3	6 average
Vogrscek	0.82	8.5	20 max.

Table 1: Basic characteristic of 12 Slovenian lakes



Picture 1: A map of major Slovenian lakes

Monitoring

The national monitoring programme from 2009 onwards was carried out in the bodies of water with surface area above 0.5 km2. The following parameters were included: the status of phytoplankton and macrophytes, and general physicochemical parameters and concentrations of plant protection products (PPP). The samples were taken at the deepest points of included lakes. The frequency of measurements was higher in the north-eastern part of the country in view of the intensive farming and substantial use of PPP. The methods used in the monitoring of Slovenian lakes were selected in 2009 (some parameters for specific lakes from 2007) when most measurements were carried out. The Lakes Bled and Bohinj were assessed for their integral ecological status.

The following parameters were included:

- plant protection products: alachlor, atrazine, chlorfenvinphos, chlorpyriphos, cyclodiene pesticides (total), DDT (total), diuron, endosulfan, hexachlorobenzene, isoproturon, simazine in trifluralin.

- chemical: cadmium and compounds, lead, mercury, nickel, TOC – total organic carbon, nitrogen (total), ammonia, nitrates, phosphorus (total), SiO2, nitrites, sulfates, silicon, manganese, iron, aluminium, arsenic, antimony, barium, beryllium, boron, copper, zinc, cobalt, tin, chromium, molybdenum, selenium, vanadium, titanium and around 25 organic compounds.

- biological: phytoplankton, non-vertebrae-benton, macrophytes and phyto-benton.

- other: pH, electric conductance and amount of oxygen.

The sampling for biological analyses was done according to the prescribed methodology [3, 4, 5] and in accordance with the standard procedures and the requirements of the Water Directive (Directive 2000/60/EC).

S: supervisory suveillance

O: operational suveillance

F: phytoplankton

FB+M: phyto-benton and macrophytes

M: macrophytes

BN: non-vertebrae-benton

Ch: chemical parameters for lakes

R: chemical parameters for rivers

HM: heavy metals

TRP: triazine pesticides

TBT: tributyltin compounds

VCH: volatile chlorinated hydrocarbons

Name	Monitoring	Biological elements	Chemical parameters	Special pollution parameters
Bled Lake	S	F, M	Ch	no registered emissions
Bohinj Lake	S	F, M	Ch	no registered emissions
Velenje Lake	O	F, FB, BN	Ch	HM, Hg
Smartinsko Lake	O	F	Ch	HM-Hg, TRP
Slivnisko Lake	O	F	Ch	HM, TRP
Pernisko Lake	O	F	Ch	HM, TRP
Ledava Lake	O	F	Ch	TRP
Gajsevsko Lake	O	F	Ch	HM, TRP, DFH, AOX
Ptuj Lake	O	F	Ch, R	HM-Hg, TBT, VCH
Klivnik	O	F	Ch	no registered emissions
Mola	O	F	Ch	no registered emissions
Vogrscek	O	F	Ch	no registered emissions
Druzmirsko lake	O	F	Ch	HM, TRP

Table 2: shows the results of the Slovenian lakes monitoring in 2009

In the northeast region triazine pesticides were determined five times during the periods of most intensive use, whereas heavy metals were determined four times. The chemical parameters including heavy metals, volatile chlorinated hydrocarbons and tributyltin compounds were most frequently analysed in the Ptuj Lake (12 times) due to more polluted influxes. In the rest of the lakes the analyses were less frequent in view of less polluted influxes.

In 2011-2012 of some selected PPP were analysed in all lakes (Tables 3 and 4).

1) Smartinsko Lake 2) Slivnisko Lake 3) Pernisko Lake

4) Ledava Lake 5) Gajsevsko Lake 6)Vogrscek

YA – yearly average_EQS – ecological quality standards

Active substances and PPP	Unit	YA_EQS	1	2	3	4	5	6
Alachlor	µg/L	0.3	0.008	0.008	0.008	0.008	0.008	0.008
Atrazine	µg/L	0.3	0.002	0.004	0.009	0.009	0.004	0.002
Chlorofenvinphos	µg/L	0.1	0.009	0.009	0.009	0.009	0.009	0.009
Chlorpyriphos	µg/L	0.03	0.003	0.003	0.003	0.003	0.003	0.003
Cyclodiene pesticides-total	µg/L	0.01	0.002	0.002	0.002	0.002	0.002	0.002
DDT-total	µg/L	0.25	0.003	0.003	0.003	0.003	0.003	0.003
Diuron	µg/L	0.2	0.007	0.007	0.007	0.007	0.007	0.007
Endosulfan	µg/L	0.005	0.001	0.001	0.001	0.001	0.001	0.001
Hexachlorobenzene	µg/L	0.01	0.001	0.001	0.001	0.001	0.001	0.001
Isoproturon	µg/L	0.3	0.004	0.004	0.005	0.005	0.004	0.004
Simazine	µg/L	1	0.011	0.011	0.011	0.011	0.012	0.011
Trifluralin	µg/L	0.03	0.001	0.001	0.001	0.001	0.001	0.001

Table 3: Average concentration of PPP in 2011

Active substances and PPP	Unit	YA_EQS	1	2	3	4	5	6
Alachlor	µg/L	0.3	0.008	0.008	0.008	0.008	0.008	0.008
Atrazine	µg/L	0.3	0.002	0.004	0.009	0.009	0.004	0.002
Chlorofenvinphos	µg/L	0.1	0.009	0.009	0.009	0.009	0.009	0.009
Chlorpyriphos	µg/L	0.03	0.003	0.003	0.003	0.003	0.003	0.003
Cyclodiene pesticides-total	µg/L	0.01	0.002	0.002	0.002	0.002	0.002	0.002
DDT-total	µg/L	0.25	0.003	0.003	0.003	0.003	0.003	0.003
Diuron	µg/L	0.2	0.007	0.007	0.007	0.007	0.007	0.007
Endosulfan	µg/L	0.005	0.001	0.001	0.001	0.001	0.001	0.001
Hexachlorobenzene	µg/L	0.01	0.001	0.001	0.001	0.001	0.001	0.001
Isoproturon	µg/L	0.3	0.004	0.004	0.005	0.005	0.004	0.004
Simazine	µg/L	1	0.011	0.011	0.011	0.011	0.012	0.011
Trifluralin	µg/L	0.03	0.001	0.001	0.001	0.001	0.001	0.001

Table 4: Average concentration of PPP in 2012

1) Smartinsko Lake 2) Slivnisko Lake
3) Pernisko Lake 4) Ledava Lake
5) Gajsevsko Lake 6)Vogrscek

YA-yearly average_EQS – ecological quality standards

Evaluation of the chemical and biological status of the Slovenian lakes

The procedures and requirements for the quality surveillance of the surface waters are covered by the Water Directive (Directive 2000/60/EC). The criteria for the assessment of the chemical and ecological status are determined in the Decree on surface waters status (Official Gazette of the Republic of Slovenia 14/2009).

Table 5 lists the parameters for determining the chemical status. Table 6 lists the biological methods for evaluation of the ecological status, such as phytoplankton, phyto-benton, non-vertebrae-benton and fish.

Table 5: Parameters of chemical status with ecological quality standards

Number	Parameter	YA_EQS (µg/L)
1	alachlor	0.3
2	anthracene	0.1
3	atrazine	0.6
4	benzene	10
5	bromated diphenylether	0.0005
6	Cadmium and compounds (glede na trdoto vode). Carbon tetrachloride	od 0.08 do 0.15 12
7	Chlorinated alcanes, C_{10-13}	0.4
8	chlorofenvinphos	0.1
9	chlorpyriphos (ethyl) cyclodiene pesticides, aldrin, dieldrin, endrin, isodrin. DDT - total	0.03 Σ 0.01 0.025
10	1,2-dichlororethan	10
11	dichloromethan	20
12	di(2-etylhexyl)phtalate-DEHP	1.3
13	diuron	0.2
14	endosulfan	0.005
15	fluoranthene	0,1
16	hexachlorobenzene	0.01
17	hexachlorobutadiene	0.1
18	hexachlorocyclohexane	0.02
19	isoproturon	0,3
20	lead and compounds	7.2

21	mercury and compounds	**0.05**
22	naphthalene	**2.4**
23	nickel and compounds	**20**
24	4-nonylphenol	**0.3**
25	octylphenol (4-(1,1',3,3'-tetramethylbutyl) phenol)	**0.1**
26	pentachlorobenzene	**0.007**
27	pentachlorophenol	**0.4**
28	PAH – polyaromatic hydrocarbons benzo(a)pyrene benzo(b)fluoranthene benzo(k)fluoranthene benzo(g,h,i)perylene indeno(1,2,3-cd)pyrene	**/** **0.05** **Σ 0.03** **Σ 0.002**
29	simazine tetrachloroethylene trichloroethylene	**1** **10** **10**
30	tributyltin compounds	**0.0002**
31	trichlorobenzens	**0.4**
32	trichloromethan	**2.5**
33	trifluralin	**0.03**

Biological elements	**Phytoplankton**	**Phyto-benton**	**Non-vertebrae-benton**
Module*	Trophicity of nutrient burden	Trophicity of nutrient burden	Hydro morphologic changes
No. of sampling sites	1	3	6
No. of samplings/year	4	1	1
Sampling season	Vegetation season	Summer	Summer
Frequency of sampling for WMP	3 consequent years	2/6 years	2/6 years
Parameters for calculations ES	**Multimetric index (MMI_PhP)**	**Trophic index (TI)**	**Multimetric index (MMI_NVB)**
Parameters for calculations	Bio-volume, Brettum index, Chlorophyll (an auxiliary parameter)		Littoral fauna index (LFI), no of taxa, Margefel's diversity index
Evaluation ES for each year	Arithmetic mean of both parameters (4 samplings)	Arithmetic mean of TI of two sampling sites	Weight average MMI_NVB of 6 sampling sites
Evaluation ES for WMP/6 years	Arithmetic mean of MMI_PhP f 3 consecutive years	Arithmetic mean of TI in two years	Arithmetic mean of MMI_NVB in two years

Table 6: Summary of biological methods for evaluation of the ecological status of lakes

WMP - waters management plan
* describing the catogory of burden the impact of which on the groups of water organisms (biological elements of quality) is evaluated with the selected matrices

Number	Parameter	Unit	Limit values for well status
Synthetic pollutants			
1	1,2,4-trimethybenzene	µg/L	2
2	1,3,5-trimethylbenzene	µg/L	2
3	bisphenol-A	µg/L	1.6
4	chlorotoluron	µg/L	0.8
5	cyanide (free)	µg/L	1.2
6	dibutyl phthalate	µg/L	10
7	dibutyltin cation	µg/L	0.02
8	epichlorohydrin	µg/L	12
9	fluoride	µg/L	680
10	formaldehyde	µg/L	130
11	glyfosate	µg/L	20
12	hexachloroethan	µg/L	24
13	xylenes	µg/L	185
14	linear alkylbenzene sulfonates (C_{10-13})	µg/L	250

15	n-hexane	µg/L	0.2
16	pendimethalin	µg/L	0.3
17	phenol	µg/L	7.7
18	S-metolachlor	µg/L	0.3
19	terbuthylazine	µg/L	0.5
20	toluene	µg/L	74

Non-synthetic pollutants

21	arsenic and compounds	µg/L	7
22	copper and compounds	µg/L	8.2
23	boron and compounds	µg/L	100
24	zinc and compounds	µg/L	100
25	cobalt and compounds	µg/L	0.3
26	chromium and compounds	µg/L	12
27	molybdenum and compounds	µg/L	24

28	antimony and compounds	µg/L	3.2
29	selenium	µg/L	6
	Other specific pollutants		
30	nitrites	mg NO_2/L	/
31	chemical oxygen demand	mg/L O_2	/
32	sulfates	mg/L SO_4	150
33	mineral oils	mg/L	0.05
34	adsorbable organic halides (AOX)	µg/L	20
35	polychlorinated biphenyls (PCBs)	µg/L	0.01

Table 7: Limit values of specific pollutants in surface waters according to the Decree on surface waters status

In 2012, the chemical status based on the pollutants listed in Table 7 was determined 12 times in the Ptuj Lake and the Smartinsko Lake. The annual average as well as the highest concentration of tributyltin compounds was exceeded in the Ptuj Lake. In the Velenje Lake mercury was also determined four times besides other heavy metals; these did not exceed the ecological quality standards.

Lake	Confidence limits	Cases of sampling frequency in 2012	Status 2010	Stabdard of confidence
Lake Bled	High	no emission	good	high
Lake Bohinj	High	no emission	good	high
Lake Ptuj	High	12	**bad**	high
Velenje lake	Medium	4	good	medium
Smartinsko lake	Medium	12	good	high
Slivnisko lake	Medium	4	good	high
Pernisko lake	Medium	12	good	high
Gajsevsko lake	Medium	4	good	high
Ledava lake	Medium	4	good	high
Ormoz lake	Medium	no emission	**bad**	high

Table 8: Chemical Status of Slovenian lakes in 2010

Confidence limits of chemical status were high in cases of sampling frequency 12 per year; medium in cases of sampling frequency lower than 12 per year; low when there were no monitoring data , but only evidence of emissions.

The Bled Lake

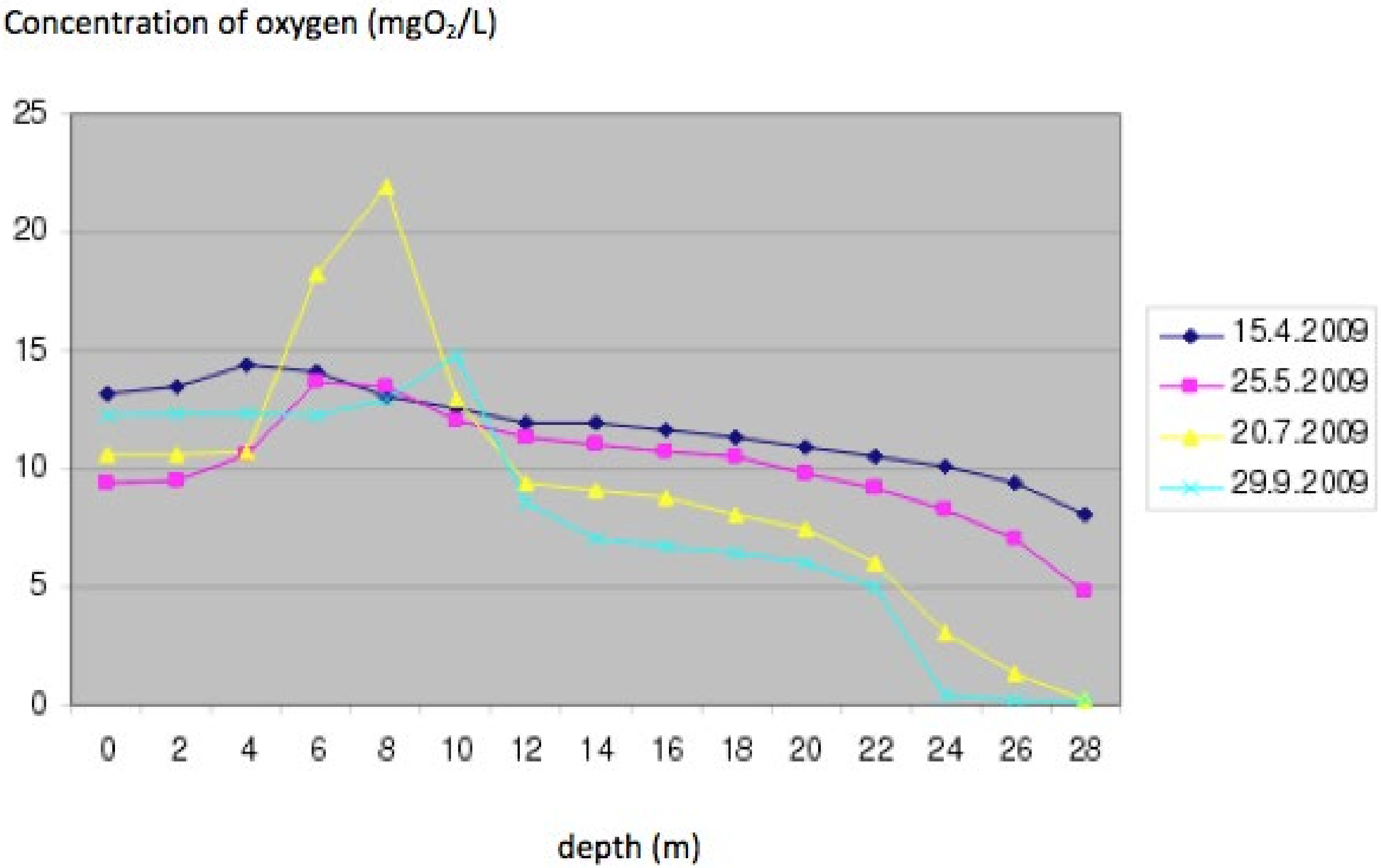
In the Bled Lake 4 samplings to determine physicochemical parameters and phytoplankton were done in the depth vertical in 2010, whereas in 2009 the status of the macrophytes was also assessed.

Picture 2: A phptograph of the Bled Lake

Parameter	Measured average value	Including in calculation	Brettum - index
		%	Absolutely
Biovolume (mm^3L^{-1})	2.20	61 %	1.35
Abundanca (number of cells L^{-1})	6346	76 %	4830
Total number of identified species	42	50 %	21

Table 9: Some parameter standards in the Bled Lake

Diagram 1: Concentration of oxygen in the Bled Lake in 2009



The moderate status of phytoplankton suggests, that the Bled Lake is overburdened with the nutrients.

Yearly average concentration	2007	2008	2009
Phosphorus (total) (µg/L)	12.7	11.0	13.2
Inorganic nitrogen sources (µg/L)	350	350	422
Chlorophyll (µg/L)	2.7	3.9	3.7
Transparency (m)	8.3	6.6	5.0

Table 10: General parameters for eutrophication and chlorophyll in the Bled Lake from 2007 - 200

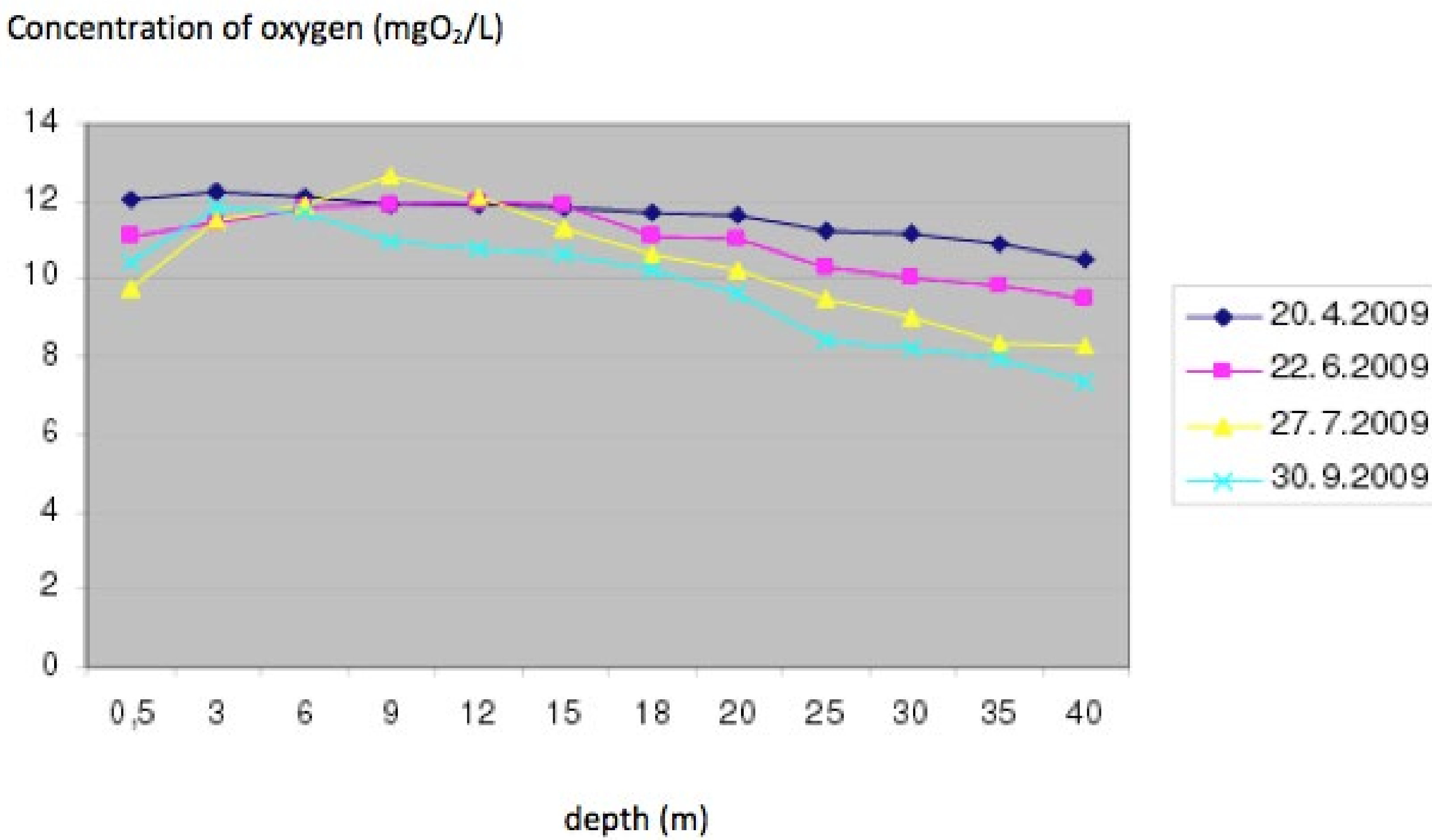
In 2009 the average concentration of phosphorus and nitrogen compounds was increased in the Bled Lake. Of particular concern was the average annual concentration of phosphorus which should be below 8 µg/L in the deep alpine and pre-alpine lakes.

The Bohinj Lake

As in the Bled lake 4 samplings were done in the Bohinj lake in 2010.

Picture 3: A photograph of the Bohinj Lake

Diagram 2: Concentration of oxygen in the Bohinj Lake in 2009



Yearly average concentration	2007	2008	2009
Phosphorus (total) (µg/L)	5.2	3.6	3.5
Inorganic nitrogen sources (µg/L)	512	454	394
Chlorophyll (µg/L)	1.0	1.0	1.2
Transparency (m)	9.2	9.0	8.3

Table 11: General parameters for eutrophication and chlorophyll in the Bohinj Lake from 2007 - 2009

The comparison of the data in Tables 10 and 11 based on the criteria and static analyses suggests, that the Bohinj Lake can be classified as ultra-oligotrophic lake, and that much cleaner than the Bled Lake.

The Velenje Lake

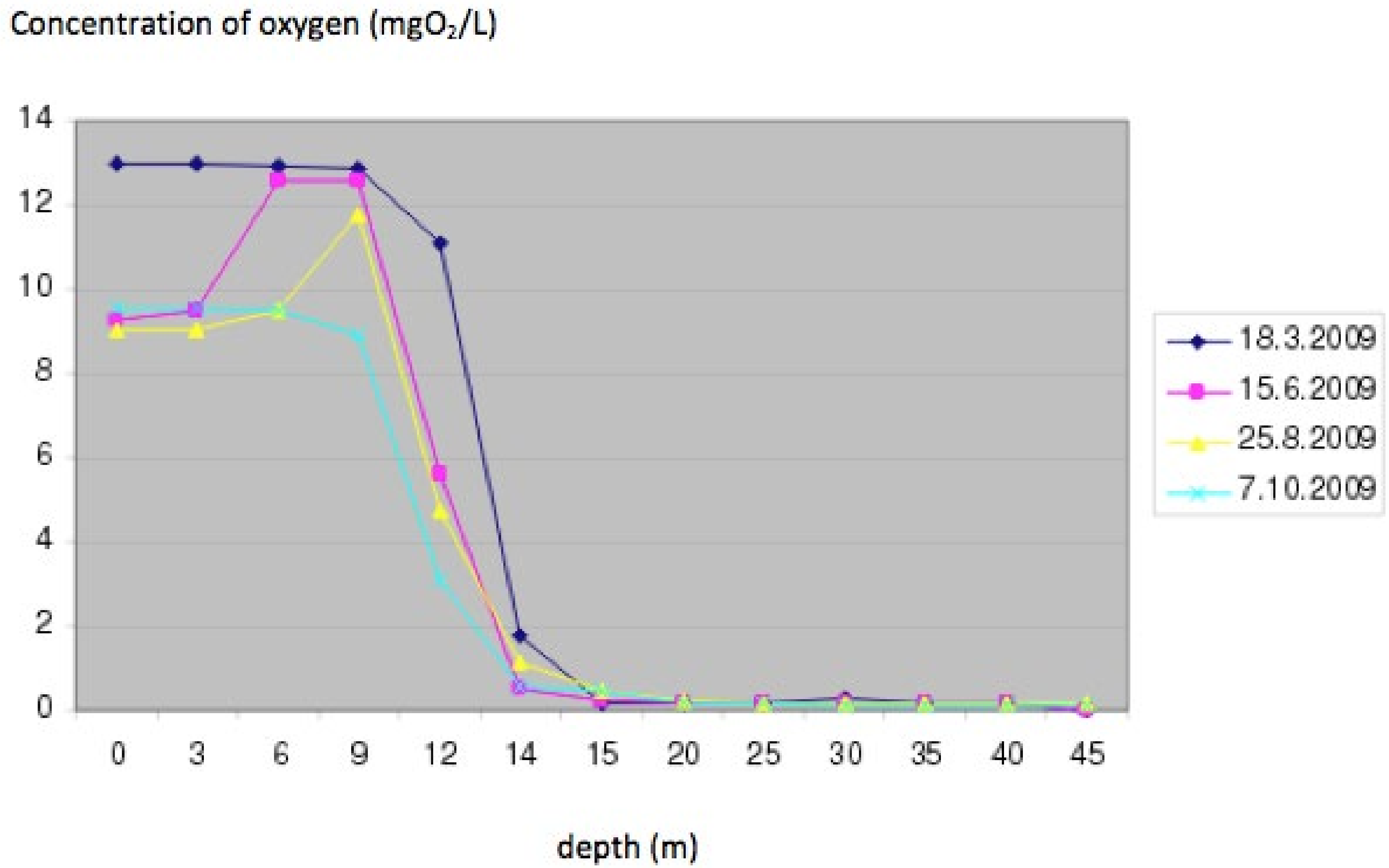
The Velenje Lake is an artificial lake in which 4 sampling were performed in 2009; the analyses were the same is in the Bled and Bohinj Lakes.

The concentrations of oxygen from the depth of 15 m were less than 1 µg/L thus indicating that the majority of the water mass was without oxygen throughout the year.

Picture 4: A photograph of the Velenje Lake

There are anaerobic degradation processes in the lake resulting in high concentration of hydrogen sulphide (H2S).

Diagram 3: Concentrations of oxygen in the Velenje Lake in 2009



There are a steam power station and a lignite mine in the immediate vicinity of the Velenje Lake which are the sources of the increased amounts sulphates, molybdenum and cobalt in the lake. The legally set limits were exceeded up to ten times (see Table 12).

Specific pollutants	Sulfates			Cobalt (filtrate)			Molybdenum (filtrate)		
	mg/L			µg/L			µg/L		
YA_EQS	150			0,3			24		
Year	2007	2008	2009	2007	2008	2009	2007	2008	2009
Velenje Lake	718	613	563	/	0.3	0.3	243	213	165
Sampling frequency	26	10	10	4	12	4	4	12	4

Table 12: Specific pollutants in the Velenje lake from 2007-2009

Yearly average concentration	2008	2009
Phosphorus (total) µgP/L	30.4	24.5
Inorganic nitrogen sources (µg/L)	766	1433
Chlorophyll µg/L	3.3	2.6
Transparency m	4.6	6.8

Table 13: General parameters for eutrophication and chlorophyll in the Velenje Lake from 2008 - 2009

In comparison with Lakes Bled and Bohinj, the Velenje Lake is highly degraded. We believe that much effort and substantial financial resources would be required to remediate the situation.

Other Lakes

The triazine pesticides, metolachlor and terbutilazin, total phosphorus and anorganic nitrogen were analysed five times per year in the other Slovenian lakes in the north-eastern region. The Gajsevsko and the Pernisko lakes were overburdened with pesticides. The concentration of metolachlor in June 2008 and 2009 were 3.2 and 3.7 µg/L, respectively in the Gajsevsko Lake (one of the smaller Slovenian lakes) whereas the yearly average were 9 and 1.5µg/L, respectively. Terbutylazine was also exceeded in this lake.

In the Pernisko Lake the average concentration of the chlorophyll, phytoplankton bio-volume and phosphorus was high. These data suggests that the Pernisko Lake was most burdened with nutrients and eutrophication followed by the Lendavsko, Gajsevsko and Smartinsko Lakes (see Table 15) resulting in the decline of wildlife in these lakes.

Extra pollutants	Metolachlor		Terbutylazin	
	µg/L		µg/L	
YA_EQS	0,3		0,5	
Lake/Year	2008	2009	2008	2009
Smartinsko Lake	0.4	004	0.1	0.03
Slivnisko Lake	0.2	0.1	0.1	0.04
Pernisko Lake	0.3	0.3	0.1	0.2
Ledava Lake	0.6	0.2	0.2	0.2
Gajsevsko Lake	0.9	1.5	0.5	0.8

Table 14: Concentrations of specific pollutants in other lakes from 2008-2009

Parameter	Phosphorus (total) µgP/L	Inorganic nitrogen sources (µg/L)	Phosphorus (total) µgP/L	Inorganic nitrogen sources (µg/L)
	Average 2008	Average 2008	Average 2009	Average 2009
Unit	µg P/L	µg N/L	µg P/L	µg N/L
Smartinsko Lake	49	708	160	494
Slivnisko Lake	29	859	37	533
Pernisko Lake	126	893	252	470
Ledava Lake	104	913	137	1018
Gajsevsko Lake	89	890	122	804
Ptujsko Lake	59	1187	35	898
Klivnik	10	827	15	661
Molja	14	525	15	529
Vogrscek	9	756	10	626

Table 15: Average annual concentrations of total phosphorus and inorganic nitrogen in other Slovenian Lakes from 2008-2009

Conclusion

In 2011 sulphates, phosphorus and inorganic nitrogen were exceeded in six lakes. These lakes did not reach a satisfactory ecological status; in some of them certain pesticides were also exceeded.

The monitoring results in 2012 showed deterioration in seven lakes including the Bled Lake which used to be judged as clean. In the Bled lake pesticides were not detected, however there was a lack of oxygen. The biological surveillance revealed best results for the Bohinj and Bled Lakes. These two Lakes are in the pre-alpine region and are the cleanest among the Slovenian major lakes.

Overburdening with the specific pollutants was noted in the Velenje Lake, the Perniški and the Druzmirski Lake. Metolachlor was exceeded in the Pernisko, Lendava, Slivnisko and Gajsevsko Lake. In the Gajsevsko Lake the concentration of terbutylazine was also exceeded. These data indicate the continuous use of PPP, particularly in the agriculturally developed northeastern region of Slovenia. However the obsolete organochlorine pesticides were found at very low levels which indicate that further monitoring of these pesticides may not be justified on the annual basis.

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INVENTORY OF POP PESTICIDES POLLUTED AREAS IN MOLDOVA

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Abstract
The objective of this study was to identify the POPs polluted areas posing the highest environmental and health risks as well as mapping of those areas using the GIS tool.

An original methodology of POPs pollution study and hazards assessment was developed aiming at: (i) identification and assessment of potentially POPs contaminated sites all over the country; (ii) creation and filling of the POPs database as well as mapping and visualization of acquired data; and (iii) setting the reporting formats and assuring the database support.

All identified potentially contaminated sites were described based on a unified question-naire; the coordinates of the POPs sites were determined using GPS; photo images and composite soil samples were taken at each site. The soil samples were further analyzed for POPs in a certified laboratory. About 1600 contaminated sites were identified and described.

An integrated GIS system for POPs data mapping and analysis was developed allowing storing effectively, managing and presenting POPs information such as geographic locations of the sites, concentrations and other related parameters as well as distribution of health and environmental hazards. The database is available on the Ministry of Environment website: http://pops.mediu.gov.md. The information on POPs polluted sites is to be periodically updated by the environmental authorities.

With the POPs database, the central and local authorities got a new tool which could significantly improve the management of contaminated sites. It can effectively support the policy and decision making process in the field of contaminated sites management.

Keywords
Persistent organic pollutants (POPs), contaminated sites, database, risk assessment.

Introduction
The decades of intensive use of pesticides in Moldovan agriculture left behind many hundreds of sites polluted with POP pesticides (emptied storage facilities, former blending stations, pesticides filling sites, equipment washing platforms, obsolete pesticides dumps, etc.). At the beginning of this study, the available information on their exact location, status and – most importantly – associated risks was scarce. This did not allow for setting priorities, selecting proper management options and policy planning.

The overall objective of this study was to identify the POPs polluted areas posing the highest environmental and health risks as well as mapping those areas using the

GIS tool. Within this overall objective, the more specific objectives were as follows:

– development of the methodology of the POPs pollution study and risk assessment;
– design of the POPs contaminated areas database;
–development of the sampling program and field trial;
– analyses of POPs contents in the collected samples;
– creating the database and mapping POPs polluted areas using the GIS technology;
– identification of environmental and health risks zones.

The assignment was conducted within the GEF/WB POPs Stockpiles Management and Destruction Project, during the period of 2008-2010 years by the Center for Strategic Environmental Studies ECOS in cooperation with Trimetrica SRL, and managed by POPs Sustainable Management Office (www.moldovapops.md).

Approaches

The problem of POPs contaminated sites in Moldova represents the legacy of at least half a century of intensive agriculture and industrial development complicated by the radical change of social and economic model undergone by the country in the 1990s. While starting the study, the information on potentially contaminated sites was either unknown or incomplete. Many of such sites have been abandoned and forgotten, and only the minority has previously been described and assessed in terms of health and environmental risks. Moreover, most existing data were inaccessible or unusable because of being scattered between different institutions (or different levels of the same institution) and existing only on paper. Besides, there was a problem of data ownership since the responsibilities in this field were not always clear.

Bearing all this in mind, the study was structured around three main elements: (i) identification and assessment of sites potentially contaminated with POPs over the country; (ii) creation and filling of the POPs database as well as mapping and visualization of acquired data; and (iii) setting the Reporting Formats and assuring the database support and training, required for further renewal and operation of the POPs database.

Identification and assessment of sites potentially contaminated with POP

To ensure the most effective and complete way to identify the potentially contaminated sites, it was decided to gather the information at the local level rather than use the data available at the central level. The information was basically collected from two sources: the mayoralties and local operators. Official letters were sent to all rural and urban mayoralties (898 in total) asking, on map, to indicate the location of former facilities related to pesticides use. In parallel, local operators with relevant knowledge and professional experience were hired to complete the task.

The information collected from the mayoralties was used as a starting point for further field investigation. The field teams visited and described all identified potentially contaminated sites, based on a unified questionnaire; determined the coordinates of the POPs sites using GPS devices; took photo images and composite soil samples at each site. The soil samples were further analyzed for POPs in a certified laboratory.

The field operators were thoroughly trained and worked in accordance with the developed standard procedures in order to assure the quality and completeness of the work done. The information obtained was processed and incorporated into the database.

The general approach to assessing the hazards associated with the sites potentially contaminated with obsolete pesticides

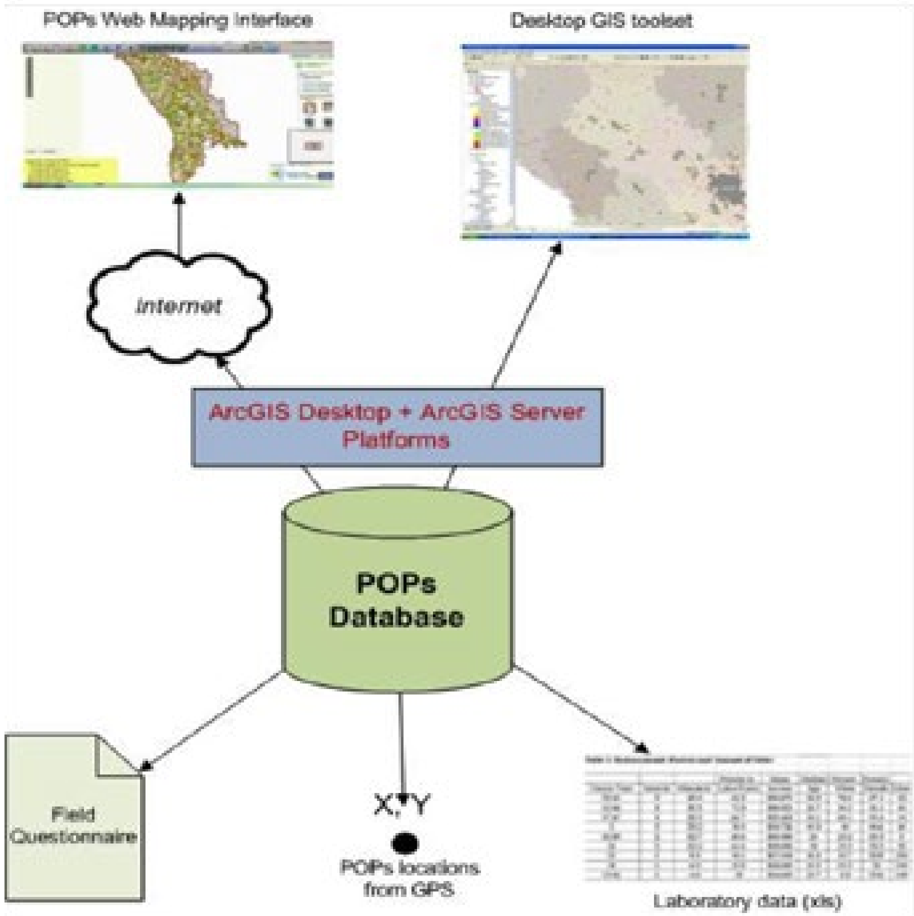

Figure 1: Scheme of the integrated GIS system for POPs data mapping and analysis

(POPs residuals, in particular) included the following: (i) gaining the information on-site concerning the status of pollution sources, the nearest risk receptors and the potential for contamination spreading; (ii) establishing the degree of environmental pollution with POPs; (iii) integration of the data gathered on-site with relevant digital map layers, information from topographical maps, aero-photo images; and (iv) calculation of "hazard indexes". /1/

POPs environmental pollution database
A POPs environmental pollution database has been developed in order to ensure a structured management of POPs information to support the effective decision making process at the Ministry of Environment.

The proposed integrated GIS system for POPs data mapping and analysis (Figure 1) allows to effectively store, manage and present POPs information such as geographic locations of the POPs sites, concentrations and other related parameters as well as distribution of health and environmental hazards (http://pops.mediu.gov.md).

The POPs Database and its fields were designed in a way to allow database structure scalability, i.e. the ability to make changes in existing configuration and add more data sets later on. Moreover, the database allows smooth compatibility with any standardized databases defined for integration into the Information Management and Reporting System (IM&RS).

All data acquired during contaminated sites investigation were entered into the POPs Database. The data incorporated into the database were fully based on the Reporting Format requirements (the field questionnaire completed by the operators on-site). At the same time, the data on POPs sites included in the database are linked with other types of information obtained in the field. The site's unique code was used for linking all available information per POPs site.

Reporting Format
The information on POPs polluted sites needs to be periodically updated, most probably, by the district ecological inspectors. This information should be transferred, processed and stored at the Ministry of Environment in order to be used in the decision-making process. A precondition for efficient use of data at the central level is to have a homogenous and standardized dataset coming from the local sources. To secure such uniformity of data a special Reporting Format is to be used by the district inspectors.

The Reporting Format was regarded as a uniform platform for sites assessment. In this sense, it consists of the following elements: (i) coordinates of the site; (ii) the field questionnaire, to be filled during site investigation; (iii) technical instructions treating in detail the field operations; (iv) photo and sampling protocols; (v) laboratory standard form; and (vi) procedures for collecting, transferring, checking data and filling the database. /1/

Inventory Findings

Distribution of sites potentially contaminated with POPs. Altogether, 1588 sites potenti¬ally contaminated with POP pesticides and 16 sites contaminated with PCB were identified and described. The territorial distribution of POPs sites averaged by districts is presented in Figure 2. The national average figure is 0.05 sites/km2 or one site per 20 km2.

Pesticide related infrastructure. During the inventory, a variety of potentially contaminated sites were identified: different types, small and large, simple and complex. In many cases, the old pesticide sites were designed and used for more than one purpose: for example, storage facilities together with blending stations and evaporation grounds; or blending stations with helicopter platform nearby. Altogether, the 1588 investigated sites hosted 2326 major pesticide related infrastructure elements: storehouses, blending stations, helicopter platforms, evaporation reservoirs, as well as illegal pesticide dumps.

Technical condition of major installations found at the POPs sites.
The technical condition of the major pesticide related infrastructure found at the investigated sites was generally poor what contributes significantly to increased environmental risk generated by the contaminated sites. While considering infrastructure engineered and built in the past, less than 9% from the total number of constructions (200 objects) were found undamaged, and those were only storehouses. /1/

Degree of POPs Contamination of sites

In total, 1651 samples from investigated sites were analyzed by the laboratory, including 1590 soil samples. Besides composite soil samples (as defined above), waste samples were taken from the debris found at some old storage facilities. Those usually represented a mixture of obsolete chemicals with construction rubble and soil. The information about their pollution level and spectrum was used for the evaluation of additional risks for the environmental and public health.

Level of soil contamination with POPs pesticides. The range of POPs pesticides analyzed in composite soil samples included the substances specified in the text of the Stockholm Convention on POPs (2001), namely aldrin, dieldrin, endrin, chlordane, DDT (six metabolites), hexachlorobenzene, heptachlor, mirex, and toxaphene, as well as hexachlorocyclohexane (three isomers).

Five POPs (groups of) compounds namely ∑ DDT, ∑ HCH, chlordane, heptachlor and toxaphene have been found in soil samples taken at investigated sites, in concentrations exceeding the national standard for organochlorinated substances in soil (0.1 mg/kg).

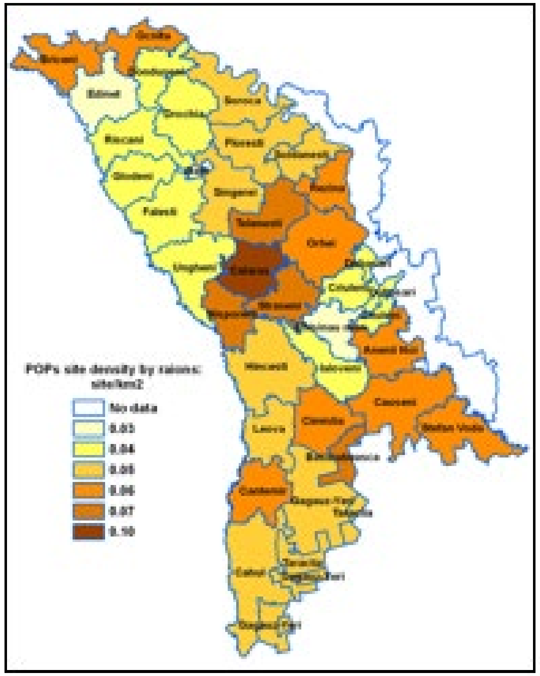

Figure 2: Territorial distribution of POPs sites by districts

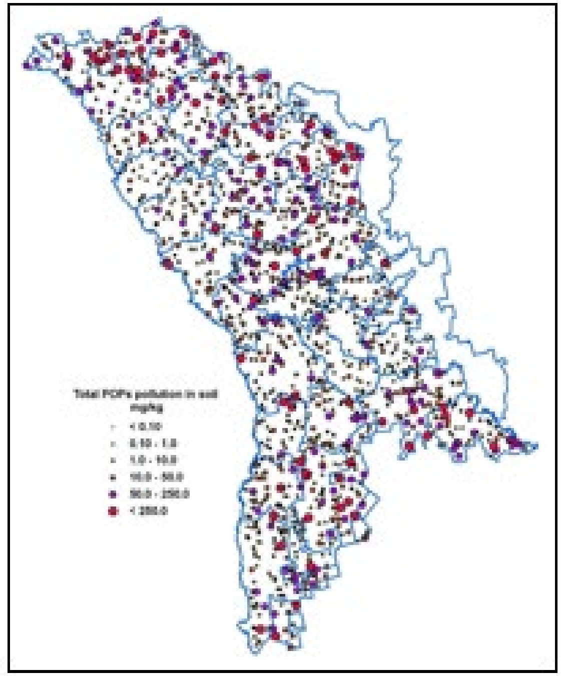

Figure 3: Spatial distribution of contaminated sites

The pollution of POPs sites with DDT and – to lesser a extent – with HCH can be defined as widespread. The share of sites contaminated with chlordane (31%) and heptachlor (22%) is also significant. Fewer sites are polluted with toxaphene (about 10%), but, very often, this is a severe level of pollution. Aldrine, dieldrine, endrine, HCB and mirex were not detected in the investigated samples.

The acquired data showed a severe level of soil contamination with POPs pesticides at some investigated sites, in the order of hundreds and even thousands of mg/kg. Many of the sites have been polluted by several POPs compounds, which pose the problem of potential synergistic effects on the humans and the natural environment. The pesticide construction waste samples were studied separately from soil samples on 42 sites. They showed a high level of contamination and have an irregular statistical distribution.

Spatial distribution of POPs polluted sites. The spatial distribution of investigated sites polluted by POPs is presented in Figure 3. The data are expressed as the sum of all POPs detected on-site in composite soil samples. 252 sites (about 16% of the total number) showed concentrations exceeding 50 mg/kg. At this level of pollution, the soil can be classified as hazardous waste. For these sites, the measures preventing the access of and contact with the population as well as remediation measures to minimize the pollution spreading are to be envisaged.

It must be mentioned that 18 administrative units have a higher prevalence of severely polluted sites (> 50 mg/kg) as compared to the average national value of 16% from the total number of sites. Most often, the pollution mix at those sites consisted of DDT metabolites, HCH isomers and toxaphene.

Prioritizing of POPs contaminations sites

To protect human and ecosystems health, it is becoming common to remediate contaminated sites. However, the great costs associated with it make it crucial to pinpoint those sites that are in greatest need of remediation.

The POPs sites hazard assessment
Besides the data on sites location, assessment of pesticide infrastructure condition, level of soil pollution on site, etc., the database users get the so-called Site Hazard Total Score (SHTS) associated with every contaminated site. The SHTS provides the numeric expression of the danger which the site is posing to human health and environment. The sites are classified/ranked by SHTS from extremely dangerous to low dangerous ones.

The assessment of contaminated sites is an important precondition for ranking them in view of developing site specific remediation strategies. At the study moment, Moldova did not have formal requirements for contaminated sites assessment. Under this assignment a hazard assessment methodology for POPs contaminated sites was developed and tested. The methodology forms the basis for a developed POPs database computerized module calculating the respective risk indexes and SHTS and for respective ranking of sites by their hazards. /1/

The Site Hazard Total Score is used for ranking the site hazard according to the five generic groups. According to this ranking scheme, the full set of investigated POPs sites were prioritized as follows:

The Beneficiary may decide to apply a different way for sites prioritization, e.g. making a priority list basing on Risk Receptors sub-index only, or using the sum of POPs concentrations as a criterion for priority setting. The developed Integrated POPs Information System is flexible enough and capable of using both pre-settled and modified algorithms. Such modifications can be done by the database administrator, by intervening in the calculation programme.

The approach to address site contamination
The ranking system based on Site Hazard Total Score itself does not and cannot serve as an ultimate management tool so that necessary measures are taken to ensure that environmental site management initiatives are implemented in timely and cost-effective manner. The Site Hazard Total Score is the only one – probably the

Site Hazard Total Score (as percentile value, based on the statistical data set)	Site hazard rank	Site priority for remediation strategy	Action needs	Number of contaminated sites	
> 95 %	I	Very high	Urgent	76	4.8 %
65 – 95 %	II	High	In short-term perspective	467	29.7 %
35 – 65 %	III	Medium	In medium-term perspective	513	32.7 %
5 – 35 %	IV	Low	In long-term perspective	440	28,0 %
< 5 %	V	Negligible	General protective / low cost measures required	76	4.8 %

most important – but still one among some other parameters which should be considered before the decision to act (clean-up measures, reducing risks measures) is taken. The ranking system proposed is extremely important when assessing a large number of POPs polluted sites in order to set priorities for further decision making process regarding sites remediation.

A step by step approach to address the site pollution is provided as recommendation for further actions. It is inspired by the way of how the issue is addressed in Canada /2/ and envisages the sites where urgent and short-term perspective measures are required.

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CLASSIFICATION OF POPS PESTICIDE DUMPSITES

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This session was used to present and demonstrate the use of a simple classification tool. This tool is developed to present a holistic view on the status of a POP pesticides dumpsite, to explain the current status of a site and facilitate the identification of the gap(s) to break the infinite site assessment circle (Joop Harmsen et al., 2009) and to sustainably manage the dumpsite.

The introduction of this session was given by Boudewijn Fokke (Tauw, the Netherlands). The fact that the status of a dumpsite can vary from uncontrolled to controlled and the dumpsite characteristics describing the status were discussed. The chosen dumpsite characteristics are environmental risks, awareness of stakeholders, the availability of funds for sustainable site management, and availability of site remediation techniques.

The next part of the session was used to demonstrate the application of the tool. The first case was presented by Ingrid Rijk (Witteveen+Bos, the Netherlands). She used the tool to demonstrate the development of the 100 hectare hazardous waste dumpsite of Volgermeer the Netherlands from an uncontrolled to a completely controlled site over the last 60 years.

Tomasz Stobiecki (Institute of Plant Protection, National Research Institute Sosnicowice Branch, Poland) gave a presentation on the status of the Rudna Góra, a POPs pesticide dumpsite near Jarworzno in Poland, over the last 100 years. Matthijs Bouwknegt and Boudewijn Fokke (Tauw), the Netherlands) characterized respectively the POPs pesticide dumpsite Suzak A in Kyrgyzstan and the Nubarashen dumpsite in Armenia. The last presentation of the session was by Joop Harmsen (Alterra Wageningen, the Netherlands) on his experiences in the 'Risk Reduction of Soil Contaminated by Obsolete Pesticides in Africa' project.

After the presentations of the cases, the usefulness of the tool was discussed with the audience. It was concluded that POPs pesticide dumpsite classification demonstrates which initiatives should be taken to arrive at a sustainable dumpsite management. It was also concluded that the tool should be improved by including the legal status of the site and the willingness to allocate funds for sustainable site management.


NEWLY LISTED POPS AND OTHER STOCKHOLM CONVENTION ISSUES

THE STOCKHOLM CONVENTION NATIONAL IMPLEMENTATION PLAN UPDATE – THE APPROACH OF ROMANIA

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Abstract

Facing the same problems as other countries in relation to POPs, Romania decided to join the global agreement and ratified the Stockholm Convention in 2004 by Law no 261. After ratification the next step was the development of its first National Implementation Plan (NIP), with financial support from GEF and technical assistance from UNIDO. The NIP was adopted by the Minister in April 2006 and sent to the Stockholm Convention Secretariat. Romania as a member state of the European Union (EU) and a party to the Stockholm Convention and has the obligation to fulfill its commitments related to the implementation of the convention.

The obligations on implementation of the convention are introduced into European law through Regulation (EC) No. 850/2004 on POPs. Pursuant to Article 7, paragraph 1, i. (c) of the Stockholm Convention and Article 8 (4) of Regulation (EC) No. 850/2004 on POPs Romania is obliged to review and update its NIP after inclusion of new POPs in the Annexes to the Convention.

In national legislation the measures on implementation of Regulation (EC) No. 850/2004 on POPs are regulated by Governmental Decision no 561/2008. Legal ground for the implementation of the NIP is the Governmental Decision no 1497/2008.

It is important to mention that the Member States have to comply with the EU requirements on POPs which are currently more stringent than those included in the Stockholm Convention. For example a limit value for PFOS was set, therefore the amount of PFOS used in textiles or other coated materials should be lower than 1 μg/m 2 of the coated material or that the phase out the PFOS containing fire fighting foams had to be done by 27th of June 2011.

Therefore Romania, through Ministry of Environment and Climate Change, conducted during 2011 to 2012 a NIP updating process at national level. In October 2012 the updated version of the NIP was submitted to the Stockholm Convention Secretariat.

The updated National Implementation Plan provides a description of POPs issues in Romania including the description of implementation activities in the past six years with regard to the 12 legacy POPs. Further it describes the inclusion of the 10 new listed substances in the NIP. The implementation plan also describes Romania's new initiatives with a view to further implementation of the Convention in respect to all listed POPs.

The overall purpose of the updated NIP on Persistent Organic Pollutants (POPs) is to fulfill legal obligations, increase awareness of POPs and their control measures, and also to take of the necessary action

and lay down a strategy and action plans for further measures related to all listed POPs.

For an effective implementation of the measures laid down on updated NIP and achievement of its eight specific objectives, a Governmental Decision for the amendment of Governmental Decision no 1497/2008 is under approval. This Governmental Decision defines the overall objective, the specific objectives, the actions to be taken, as well as the responsible authorities and the timeframe for NIP implementation.

Approach, Achievements and Results

The Ministry of Environment and Climate Change contracted the National Institute for Research and Development in Environmental Protection (INCDPM) to carry out the NIP update.

First step in the updating process was organizing the national coordination meeting to initiate the preparation for the review and updating of the NIP. The objective of the meeting was to raise awareness among stakeholders about the addition of the 9 new POPs to the Stockholm Convention, to gain the political commitment to the process and to establish the structure and procedures for executing the process.

Among the stakeholder we can mention representatives from the ministries of environment, health, labor, agriculture, industry, transport, regional development, science and technology, academia, research institutes. It is important to mention that many of the governmental and non-governmental bodies that had participated in the development of the initial NIP were also involved in the review and update process.

During the national coordination meeting the stakeholders were consulted with the following areas: import and export (required to control POPs flows into and out of the country and as a possible source of information on articles containing new POPs on the national market); industry (affected by regulations on production/disposal of waste and articles containing new POPs); waste disposal and recycling (affected by regulations on the disposal of new POPs and the recycling and disposal of articles containing new POPs).

The next step in NIP update was to determine the baseline situation with regards to the new POPs listed in the Convention. A preliminary inventory of the presence of the new POPs within the country was conducted in order to collect data on production, distribution, use, import and export of new POPs, institutional setting and infrastructure for management of new POPs, environmental contamination and exposure and enforcement mechanisms. For carrying out the preliminary inventory the team used the Guidance for Developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (updated in 2012 to include the POPs listed in 2009 and 2011) provided by the Stockholm Convention Secretariat.

Therefore, a national survey was conducted to fill in data gaps on the presence of new POPs in the country. In this sense, was developed an interactive website page on which were uploaded questionnaires for POPs data collection, as well as for public awareness on issues related to POPs. The logical structure of the questionnaires was translated into an online platform, platform served by open source solution “Limesurvey”. The platform runs on an external server connected to the internet with its own domain and a public IP address.

The preliminary inventory concluded the followings:

- Alpha and Beta – HCH is likely to be found in the Lindane contaminated sites on the and around the former chemical platforms that produced Lindane in the past.

- No waste stockpiles contaminated with or containing Clordecone have been reported.

- Although in the 70s this substance was used as a flame retarder, no information is currently found on the production and use of hexabromobiphenyl, as well as on the existence of waste stockpiles contaminated with or containing this substance.

- No information was found regarding the production of Hexabromobiphenyl ether (hexa-BDE) and Heptabromobiphenyl ether (hepta-BDE), but there are several articles in use, which contain it.

- There is no production of Tetrabromobiphenyl ether (tetra BDE) and Pentabromobiphenyl ether (penta BDE), but there are in use several articles containing it. At the level of 2009, a total quantity of 3000 kg of Pentabromobiphenyl ether containing waste (plastic materials for electronic equipments, textile materials, protective clothing, curtains, lavettes) was generated, out of which 1250 kg were eliminated and 1750 kg are still in stock.

- Regarding the existence of the stock of waste containing lindane, in the year 2009, there was a stock of 563 kg Lindatox identified in Teleorman County, from former agricultural cooperative. According to the data from Teleorman EPA, the total amount was eliminated in 2010.

- At the national level, it is likely that PeCB emissions from many primary sources have also been reduced in recent decades, due to the closing down of most of the industry sectors, but there are still uncertainties concerning the total quantities released.

- There was no production of Endosulfan, but following the request and notification to the Commission by Ministry of Agriculture and Rural Development, in accordance with the provisions of Article 8 of Directive 91/414/EEC, this product was imported and used as raticide. The quantities of pesticides containing Endosulfan used at the level of 2011 were of 41750 liters. There are no Endosulfan stocks left.

- Currently, there is small scale usage of substances containing PFOS, PFOS salts or precursors of PFOS in metal coating processes.

- Concerning the textile materials, there is no use of chemicals containing PFOS, PFOS salts or PFOS precursors in the production process, as well as there is no production and use of products manufactured by recycling textiles produced before 2003* (*the year of 2003 has been recognized as the threshold year when the use of PFOS has been discontinued in commercial repellent chemicals).

- In the field of production/import of synthetic carpets, there are no chemical substances used for the treatment of carpet surfaces, and there is no use of products made of by recycling synthetic carpets, produced before 2003, having PFOS content, as well as no production or placing on the market of synthetic carpets with PFOS, PFOS salts or PFOS precursors content.

- Neither for the pulp and paper sector, no use of chemicals containing PFOS, PFOS salts or PFOS precursors.

- In case of waste treatment, production of semiconductor, electronic and photographic sector there is no information on the use of chemicals containing PFOS, PFOS salts or PFOS precursors, or on the existence of stocks of waste containing these substances.

- Regarding the use of PFOS in fire fighting foams, this was allowed until 27 June

2011 according to the EU legislation. At the level of Inspectorates for Emergency Situations foams containing PFOS, PFOS salts or PFOS precursors are not used. Concerning the type of foams existent in stock, there is no information available.

- The quantities of PFOS containing waste in Romania at the level of 2009 were of 1000 kg, which were eliminated.

In addition to baseline data on the presence of new POPs, the information was collected on the status of “old POPs”, as well as the legal framework and institutional infrastructure in place to meet the requirements of the Stockholm Convention with regard to the new POPs. The starting point was the information already present in the initial NIP, which was reviewed in order to identify achievements of the first NIP implementation, as well as the information gaps and deficiencies that should be addressed in light of the listing of the new POPs under the Convention.

The following steps of the NIP review update process resulted in the identification of the priority issues to address in the management of new POPs. A set of 8 key objectives (see Table 1) guiding the development of preliminary country activities relevant to new POPs was established, taking into account the following criteria:

1) to what extent a particular key objective should be addressed in the national environmental protection strategy;

2) to what extent it is considered the responsibility of the involved authorities involved in the initiation, planning and implementing the actions needed to achieve a particular key objective; and

3) to what extent does a particular key objective address directly the most severe environmental problems caused by POPs substances.

Priority	Key Objective	
I	**Key Objective 1:**	Elimination of brominated diphenyl ethers from the waste stream
II	**Key Objective 2:**	Risk reduction for perfluorooctanic sulfonic acid (PFOS) with its salts and perfluorooctanic sulphonyl fluoride (PFOS-F)
III	**Key Objective 3:**	Elimination of PCBs containing equipments
IV	**Key Objective 4:**	Reduction of unintentional emissions of POPs
V	**Key Objective 5:**	Improvement of environmental protection performance in agriculture
VI	**Key Objective 6:**	Remediation of POPs contaminated soils
VII	**Key Objective 7:**	Information and public awareness
VIII	**Key Objective 8:**	Research and development

Table 1: Key-Objectives

Based on the 8 key objectives, the NIP review team identified the possible management options and drafted the corresponding action plan. The action plan included measures for:

- identification of articles containing hexabromodiphenyl ether, heptabromodiphenyl ether, tetrabromodiphenyl ether and pentabromodiphenyl and their presence in the recycling and waste streams;

- coordinating the actions on BDEs with the programmes on the management of electronic waste, with the ultimate aim of elimination of BDEs from the waste stream;

- risk reduction and elimination of PFOS, its salts and PFOS-F, and promoting the use of alternatives to these chemicals;

- reduction or elimination of releases from unintentional production, including the measurement or estimation of releases of pentachlorobenzene from source categories;

- elimination of PBCs containing equipments;

- sustainable use of pesticides in agriculture;

- identification and remediation of POPs contaminated soils;

- increasing public awareness concerning threats imposed by POPs.

The proper national framework for the implementation of the National Implementation Plan will be set by a Governmental Decision, currently under approval, that establishes the following:

- coordinating national authority for the NIP implementation;

- coordinating national authority for preparing the annual report on status of implementation of NAP;

- authorities responsible for the implementation of actions needed to achieve the 8 key-objectives identified in the NIP;

- timeframes for NAP implementation and for reporting on the status of implementation of NAP.

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ACTUAL ECOLOGICAL AND RESOURCE PROBLEMS FOR THE TREATMENT OF PERSISTENT ORGANIC POLLUTANTS

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After the collapse of the Soviet Union, the Ukraine received strong industrial infrastructure with very high potential and anomal technogenic pressure on the main ecological systems: soils (60% of ploughed lands), hydrosphere(70% technogenic deformated),geological environment (more than 2800 mine objects),biosphere (about 1000 of Red Book species).

Besides, the territory of the Ukraine has the accelerated geomigration of POPs in the surface and underground hydrosphere due to active development of the water irrigation systems, regional depressions of groundwater intake systems, mines and pits, high vulnerability of groundwater within the most hydrogeological structures (northern, central and southern regions).

However, many manufacturing processes are not flawless in terms of environmental protection. This applies, in particular, to the use of modern agricultural production of the country with a large number of pesticides. In particular, their unused balances are a source of income in the agriculture geochemical landscape, biosphere and foodchain of various chemical substances that cause irreparable damage to the environment. Therefore, the daily problem of allocation and utilization of pesticides has become more urgent.

An increase in funding for environmental programs of the Government of disposal of pesticides (the Ukraine has accumulated more than 20 thousand tonnes of pesticides) is associated with two important issues. First is the development of new innovative technologies for the processing of hazardous chemical waste in special bioreactors. This technology involves mixing products chemicals (pesticides) and special microorganisms that break down hazardous substances.

The second and the most important one has to do with increasing environmental security in the Ukraine and demonstration of European thinking on the eve of the signing of the Association Agreement with the European Union. The European Community approach based on the fact that global environmental threats are the main risks of social and economic system of the state. As a consequence, these become an obstacle to economic prosperity and sustainable development of any country.

In general, considering the nature of European integration of the Ukraine on the eve of the summit in Vilnius, the arrangement of the common EU space not only in economic, social and political spheres, but also in eco-environmental protection. Thus, special attention is paid to the Agreement with the EU mechanisms for solving environmental problems in the context of a secure European space based on innovative clean technology manufacturing and recycling.

Today the EU has the highest rate of achievement in the field of environmental and powerful management mechanisms to strengthen national environmental policies. European states have long had the status of environmental policy leaders in the world today confirming recent ranking by the World Economic Forum.

Now one of the most pressing environmental problems are savings disposal of hazardous waste. Only the amount of accumulation of obsolete crop protection chemicals (hereinafter - OCPC) at the beginning of 2009 was more than 22 thousand tonnes. The volume of hazardous waste generation in Ukraine in 2009 (the last year in which the forms of state statistical reporting number 1 - hazardous waste) exceeded 1.2 million tonnes, and total savings - 20.8 million tonnes.

Modern fitted storage for storing hazardous waste management and disposal of their established only in individual enterprises that virtually have no effect on the overall situation. The number of specialized companies in this field is extremely insufficient. Lack of appropriate conditions for the utilization and disposal of hazardous waste leads to their accumulation in industrial areas.

The problem also lies in the lack of science-based concepts of processing and disposal of hazardous waste, poor implementation of proven best modern technology, imperfections in manufacturing processes and technology cycles incompleteness processing raw materials, low-effective system of collection, lack of safe methods of disposal or location, etc. by the World Economic Forum.

In recent years, due to the reform of the agricultural sector has repeatedly changed owners unsuitable OCPC. This resulted in a large number of abandoned OCPC loss documentation destruction warehouses, containers and packaging materials, and, consequently, to the formation of a large number of unknown and mixed.

Determining of the actual amount of useless OCPC not allow a significant number of abandoned (natural) sites of accumulation, inadequate visual assessment of their weight without direct weighing due to the presence of high risk during inventory.

According to some available reports of MAP, only in 1967 and 1968, drugs from the group of POPs in the Ukraine were applied to the total number of 8470.6 tonnes. The 1971-1990 period was characterized by consistent implementation in practice declared in the sixties prohibitions and restrictions on persistent organochlorine pesticides. The prohibition of the use of these pesticides has led to the accumulation of residues in warehouses and in households so-called “raysilhosphimiyi” Ukraine- state regional for centralized and planned distribution of the POPs without taking into consideration of the assimilative potential of agriculture landscapes and biosphere including the local population.

By 1995, the Ukraine has been a manufacturer and exporter of only one pesticide, referred to the group of POPs, such as DDT. Since 1986 its production was discontinued in the Ukraine.

As the technology to recycle the majority of hazardous wastes that meet environmental regulations and standards in Ukraine is not implemented, there is no appropriate infrastructure, removal of hazardous waste from the Ukraine performed as a necessary measure for their safe disposal at specialized enterprises of other countries. Experience removal of obsolete pesticides in recent years shows that the true figure may at times exceed predefined volumes.

In 2010, the Ukraine started the implementation of practical measures aimed at eliminating the most significant accumulations of hazardous waste, including mixtures “Premix” smuggled in the region; removal of obsolete pesticides; hexachlorobenzene waste landfill of toxic industrial waste in Kalush district, Ivano-Frankivsk region; mononitrohlorbenzolu waste from the territory of State “Gorlivka chemical plant"; wastes containing beryllium from the territory of SSPE "West" (m. Kyiv).

Financing activities aimed at solving the problems accumulated over previous years hazardous waste carried from the Reserve Fund of the State Budget of the Ukraine, State and local funds for environmental protection. During 2010-2012, these goals were directed more than 1.5 billion. However, the existing distribution of environmental tax, in which 90% of the money goes to local budgets, obviously, the ratio of funding measures need revision upward expenditure of local funds for environmental protection and broader fundraising owners waste.

The Cabinet of Ministries has increased funding for the implementation of the National Action Plan for Environmental Protection of Ukraine for 2011-2015. Thus, an additional 280 million UAH will be allocated and directed to the disposal of waste pesticides and agrochemicals. In addition, funds will be allocated to utilize more than 8 thousand tons of waste hexachlorobenzene, located in zone of the unsaturated filtration above of groundwater aquifer in the area of conservation Dombrowski career in Ivano-Frankivsk region.

Increasing environmental challenges significantly affect the economic system of the state. It manifests itself not only through environmental damage, but also because of the financial losses of the national economy of the Ukraine. Thus, an effective system of disposal of chemical waste needs to be developed today. Processing of chemical waste industrial and agricultural sectors of the Ukraine in line with European environmental standards are important and paramount tasks of the national environmental policy.

Action Plan № 589 to implement the Stockholm Convention on POPs approved by the Cabinet of Ministers on 25th July 2012 provides the following:

• Strengthening the institutional system.

• Removal of accumulated unusable and prohibited use of chemical plant protection products, industrial waste of persistent organic pollutants.

• Removal / disposal of waste and equipment containing polychlorinated biphenyls.

• Elimination or reduction of emissions of persistent organic pollutants (in accordance with Annex C of the Stockholm Convention) due to unintentional production.

• Identification of the areas contaminated with persistent organic pollutants.

• Exchange of information on POPs with stakeholders and raising awareness.

• Creation of a system for monitoring persistent organic pollutants.

• Conducting research.

The principles of national policy on the treatment of POPs:

• Identification of contaminated sites, to determine the level of danger and urgency of response;

• protection of people and the environment from the harmful effects of POPs due to reduced leakage and emissions of POPs, stop using POPs and equipment containing POPs;

• promoting cooperation between interested parties who are directly or indirectly involved in issues related to POPs, or are able to solve them;

• adequate solution to the problem of emergency and banned for pesticide use, emissions and industrial waste from the group of POPs;

• effective management of toxic chemicals throughout the life cycle in order to avoid, prevent or minimize emissions and their negative impact on human health and the ecological parameters of environment;

• Attracting investment to implement measures to reduce or eliminate the threat of negative impact of POPs on human health and the environment.

The directions of state policy in the sphere of POPs are as follows:

• improvement of relevant legislation;

• organization of monitoring places of accumulation of POPs, including by means of bioassay;

• Selecting the best technology solutions for environmentally safe disposal or destruction of POPs in their places of storage;

• inventory of measures to identify and evaluate new number 9 POPs added to the list of the UN Fourth Conference of the Parties of the Stockholm Convention in May 2009;

• identification and implementation of organizational environmentally friendly technological solutions to reduce the risk of contamination, disposal or destruction of POPs;

• ensure the safe storage of chemicals classified as POPs group, revealed in their custody;

• rehabilitation of contaminated territories POPs;

• implementation of measures to prevent further accumulation of POPs in warehouses farms.

The priorities in the management of POPs include the following:

• development of national legislation that should govern the treatment of POPs in accordance with the requirements of the Stockholm Convention;

• improved monitoring of POPs in the Ukraine in the according with protective ability of soils (agriculture landscapes),-surface and underground hydrosphere and biosphere within different regions. ;

• legislative support for keeping and maintaining the State Register of storage and the number of agents assigned to the group of POPs; inventory of emergency stocks by international standards and implementing accounting system for pesticides PSMS;

• selecting the most appropriate environmentally sound technologies of economic destruction (neutralization) POPs according to security requirements based on international standards;

• disposal of banned and obsolete pesticides for use referred to a group of POPs and waste disposal equipment containing PCBs, using suitable modern environmentally friendly technologies;

• elimination or reduction of emissions of POPs;

• development of an analytical framework for improved monitoring of POPs;

• identification and rehabilitation of land and areas contaminated with POPs, using modern, including agro-biotechnology;

• an active information policy to the public and interested parties on POPs;

• mobilizing resources and providing financing, including attracting foreign investment to implement the National Plan implementation of the Stockholm Convention on POPs in the Ukraine;

The basic directions and tools for solving the problem of hazardous waste disposal savings, including the establishment of appropriate national infrastructure, should be implemented within the framework of the National Programme of waste in the period of 2013-2020, which project through the approval procedure in the relevant central executive bodies.

In modern terms, the problem of accumulation of waste production and consumption is one of the leading threats to environmental security. There is a growth of waste, including hazardous chemical, significantly extend the area of illegal dumps. In addition, the process of pollution of river network waste coal, chemical and metallurgical industry, municipal infrastructure and agriculture. This extremely inadequate introduced modern technology to attract commercial waste treatment, hardly used positive international experience in waste management and regulation of hazardous substances.

In connection with the completion of the period of implementation of the National Program of toxic waste (adopted 14.09.2000) and Applications of waste production and consumption by 2005 (adopted 06/28/1998) today the state does not have a policy document in the field of waste management.

In the absence of appropriate conditions, the removal and disposal of hazardous wastes is their accumulation in industrial areas. Today the Ukraine has not implemented any technologies to recycle the majority of hazardous waste in accordance with international standards in the absence of necessary infrastructure. The National Programme of waste for 2013-2020 has not been approved yet.

Some actions on solving the problem of household waste disposal are being taken at 6000 polygons covering about 9000 hectares and partially recycled at waste incineration plants. The service of household waste provided only 75 percent of the population each year, leading to the formation of new illegal dumps. Most landfills are overloaded or do not meet the requirements of environmental safety. Additional dangerous are connected with the disposal of waste sites in the ravine' valleys, abandoned local pits, etc.,where groundwater surface is situated too close to surface.

Despite the orders of the President of the Ukraine from 30.05.2011, to date, there is no effective management system with worn tires, and waste products from industrial rubber production, waste oil, elements of electrical and electronic equipment.

Due to the lack of separate collection of solid waste and poor economic incentives, promoting the use of waste as secondary raw materials in the state lost significant financial resources with increasing negative impact of waste on the environment. In addition, the lack of proper coordination of executive power is not fully meeting the requirements of legislation on waste as secondary raw materials.

The situation raises serious concerns with the handling of medical waste and waste medicinal products does not protect people and the environment from its harmful spatially developed and complex effects. The state of legal regulation in this area is ensuring the creation of an effective system of collection, removal and disposal of waste healthcare system and substandard medicines.

The situation that has developed in the field of waste management poses a real threat to public health and the environment in the? Ukraine. Given a large-scale nature of the problem of efficient waste management in the country, it seems appropriate to take a number of measures at the legislative and executive level to address these issues.

At the level of the Cabinet of Ministers of the Ukraine:

1. Submit a draft law on national program of waste management in the Ukraine to the Parliament of Ukraine.

2. Ensure the development and operation of information and analytical support system of state administration in the field of radioactive waste in order to provide adequate information on the state waste management system.

3. Organize the preparation and approval of complex legal, and technical measures aimed at creating infrastructure with gathering, storage and disposal of used tires, and waste products of industrial rubber production; collection, removal, disposal and recycling of waste oils; collection and recycling of waste electrical and electronic elements equipment; treatment of medical waste.

4. Ensure that the established procedure addressing the issues of determining the issuance of permits for operations in the waste management procedures and improve the development, approval and revision of limits on waste generation and disposal.

5. Develop a draft law on waste management as a secondary resource issues including recycling of waste, waste packing material and man-made mineral deposits.

6. Establish a mechanism for financial and economic preferences in the field of waste management, which involves waste into circulation as additional sources of energy and raw materials.

7. Harmonize existing national legislation in the field of waste management with European directives in this area including the new version of the classifier of waste.

HBCD PHASE-OUT IN THE STOCKHOLM CONVENTION

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The Stockholm Convention Conference of the Parties decided to add a new brominated flame retardant, hexabromocyclododecane (HBCD), in the Annex A of the Convention in May, 2013. HBCD is mainly used as a flame retardant additive in polystyrene insulation products (EPS and XPS), but also, to some extent, in textiles and high impact polystyrene (HIPS) plastic. HBCD is the third brominated flame retardant considered a persistent organic pollutant (POP) by 179 countries and, subsequently, included in the prohibition Annex A of the Stockholm Convention.

HBCD was introduced to the market in the 1960's and has been used to produce self-extinguishing polystyrene insulation materials since the 1980's. It is understood that the wider use of the flame retarded polystyrene insulation started in the 1980's. The concentrations in polystyrene insulation vary between 0,5 % in expanded polystyrene (EPS) to 4% in extruded polystyrene (XPS), depending on the fire safety requirements. The use in high-impact polystyrene (HIPS) for electric and electronic products has been minor, and, according to the present understanding, HBCD has been replaced by cheaper alternatives. In textiles, HBCD is used in backcoatings for upholstery and other interior textiles, including automotive applications. The use of HBCD for that has decreased due to its price and cheaper alternatives. There are, however, still certain uses where HBCD has been considered preferred.

HBCD is produced in the USA, the Netherlands, Israel, and China. The use volumes prior to the Stockholm Convention listing were approximately 30 000 tonnes per year, globally. Compared to the previously prohibited commercial brominated flame retardands c-pentaBDE (listed through its tetra- and pentabromodiphenylether congeners) and c-octaBDE (listed through its hexa- and heptabromodiphenylether congeners), the cumulative amount of HBCD used is manifold and has been increasing for the last decade. The main share of the market volume is used in Europe and China (approximately 40% each), and the rest in Japan, Americas, and Korea. The products and articles containing HBCD are exported to other countries too.

HBCD was considered to likely cause significant adverse effects on humans and/or environment, because of it being persistent, bioaccumulative, very toxic and undergoing long-range transport. HBCD is found in blood, plasma and adipose tissue in humans. The main sources of exposure presently known are contaminated food and dust.

The Stockholm Convention decision clearly flags the substance for phase-out. However, the decision allows the parties to continue using HBCD for producing certain EPS and XPS for 5-10 years because the alternative flame retardants were not fully available commercially at the time of listing. It is necessary to highlight that the specific exemption granted allows the production of HBCD containing polystyrene insulation materials only for buildings, but not for packaging, ground frost insulation or civil engineering applications. Thus, despite the transition period, some major uses of EPS and XPS as well as the use in textiles and HIPS will need to be phased out immediately upon ratification.

Several alternatives to replace HBCD have been commercialized, and it is expected that at least one alternative will already be available in sufficient quantities in Europe, Japan and North America in 2014. In addition, there are alternative insulation materials (such as mineral wools) and construction techniques are available to replace EPS/XPS in many uses. In HIPS and textile, the list of alternatives is long. Despite the availability of the alternatives, the specific exemption meets the industry needs for additional time to adjust their production processes and certify the new products.

The available assessments estimate the environmental emissions of HBCD during the production and use to be small, compared to the release from products during their use and end of life waste. HBCD emissions to indoor air from products made from EPS or XPS during service life when installed are estimated to be low, although the estimates concerning releases during consumer use of HBCD containing articles are highly uncertain. It is clear, however, that HBCD is present in house dust.

Emissions from HBCD-containing materials will be a potential long-term source to the environment unless properly managed. Most of the produced volume of HBCD ends up in articles, mainly in polystyrene (XPS, EPS) used in the construction and building sector, but also in packaging. The likely future emissions from such articles have not been assessed. The life span of polystyrene foam in buildings is reported to be 30-50 years. The use of HBCD in insulation boards and the HBCD built into buildings and constructions is increasing, and it is likely that the release from EPS/XPS will be more significant in the future; particularly, from about 2025 onwards, as increasing number of buildings containing HBCD retarded EPS and XPS will be refurbished or demolished. This turn-over will be different in different regions, and range from 10 to 50 years.

HBCD historical and current use varies largely from country to country, thus, having a major impact on a country's obligations to deal with HBCD containing materials as POPs waste at the end of their service life. Consequently, different countries will have very different problems in managing HBCD-containing waste when buildings are demolished or renovated. For some countries, the problem will be small, and for others, in practice all polystyrene can be considered POPs waste. The listing may also have a significant impact on polystyrene recycling, as recycling of HBCD containing products will be banned upon listing. The waste problem is accumulating, and the amount of HBCD-containing waste increasing in many developed countries, since insulation materials are used for 30-50 years. Textiles, HIPS and packaging material will enter the waste management a lot sooner.

Packaging waste is a specific challenge: it is widely transported and currently also recycled and should in principle be HBCD free. However, even packaging EPS is sometimes flame retarded because of logistical reasons: the EPS raw material available on the market is predominantly made for insulation use, and, thus, the raw material used for packaging may be flame retarded just because such beads are available on the market and non-flame retarded material would be a specialty. The packaging material life-cycle is, however, relatively short and as soon as HBCD will be phased out, the packaging material steam will be cleaning from HBCD fast.

Added challenge in ensuring waste management according to the Convention is that it is not easy to distinguish HBCD-containing materials from those which are HBCD-free. In practice, the identification of POPs waste containing HBCD must be based on the knowledge of national fire safety standards, year of construction, building codes and other regulations and practices of the time, and source of polystyrene products used in the country. A new element in the Convention listing is that the companies producing HBCD-containing EPS/XPS insulation for buildings under the exemption, will need to label or otherwise make the HBCD products identifiable. This will, however, not improve the situation for HBCD containing material already on the market.

CRITICAL EVALUATION OF THE EFFECTIVENESS EVALUTION OF THE STOCKHOLM CONVENTION MEASURES

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We have a lot of problems with the state of our planet's environment, we have problems with chemicals on the planet with their often highly complex mixtures.These problems pose a risk to the long-term environment and human health. Addressing these issues requires a broad and highly effective international cooperation. Despite tremendous efforts, a number of activities and projects well done, the key question is whether the effectiveness of activity of the international community in the UN would not be significantly higher. It is extremely important to have perspectives from the current economic crisis, critically evaluate the relationship between funds spent and the results obtained. It is necessary to critically evaluate the relationship between the resources embedded in the organization of conferences, expert meetings, workshops, tours (sitting time) and resolution procedure in individual countries (resolution time). How to carry the participation of representatives of each country largely funded from international resources to solve problems in these countries. It is necessary to critically assess whether it would be possible these (sitting) resources better invested in solving problems, solving specific problems in individual countries.

GLOBAL POPs MONITORING AND CURRENT STATE IN THE CEE COUNTRIES

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Article 16 of the Stockholm Convention on Persistent organic pollutants provides the basis for the effectiveness evaluation of the Convention and the Global Monitoring Plan. Monitoring data on POPs are a major component of the effectiveness evaluation process, in addition to data from national reports submitted pursuant to Article 15 and reports on non-compliance once the procedure is adopted by the COP, as well as reports and other information provided pursuant to paragraph 2 of Article 16.

In addition to implementation aspects, the second phase of the GMP includes work on updating of the guidance document to fully address the 10 newly listed POPs and the harmonized structure for GMP data handling, evaluation and presentation. An expert group meeting was held in Brno, Czech Republic in June 2012, helping to better identify the attributes that such a GMP data handling tool needs to have. The work on the GMP data handling also aims to address the appropriateness of the GMP data for the effectiveness evaluation; similarly, the revision of the reporting format to address the suitability of the reported data for the effectiveness evaluation will also facilitate the process of evaluating the effectiveness of the Convention.

The updated guidance document[1] on the global monitoring plan for POPs properly addresses the sampling and analysis of the newly listed POPs, and provides a useful basis for monitoring of these chemicals in the second phase of the global monitoring plan, and for harmonized data collection, storage and handling. The coordination group encourages the use of the updated guidance document by the regions and communication of feedback on using the guidance via the regional organization groups. The current situation in the Central and Eastern European region will be discussed.

1 UNEP/POPS/COP.6/INF/31.

POLYGON OF TOXIC WASTE OF HEXACHLOROBENZENE NEAR KALUSH TOWN IN UKRAINE REMAINS A THREAT TO WESTERN UKRAINE AND TRANSBOUNDARY WATER BODIES

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Introduction

Kalush is a major center of chemical industry in western Ukraine, the administrative part of the Ivano-Frankivsk region. The industry was focused on Kalush chemical and metallurgical complex (KChMC), founded in 1968, near the large Kalush -Golinskaya potassium salts deposit. Potassium salts were mined by open - pit (Dombrivskii quarry) and mining methods. Dombrivskii quarry is the world's only mountain, to where salt extraction was carried out openly. During the operation period of Dombrivskii career (1967 -2000), the operated volume was 52.5 million m3. From the northern part of the quarry, 14.6 million tons of ore (depth production was 63 m) were extracted; the southern part of the quarry produced 17.3 million tons of ore and 20 million tons of recovered rock (depth of production - 127 m). At this time, the career is flooded by atmospheric and ground water to the point of 274 m. The upper layer of water in this career is salty; more than 16 million m3 of brine have been accumulated in the lower layer. External dumps and the pit itself are destroyed by salt karst.

KChMC consisted of 12 plants specializing in the production of potassium fertilizers, magnesium fertilizers and its compounds, products of hydrocarbons chlorination. Subsequently, the production was expanded and reorganized into the chemical company "Vinil chloride", later - in concern "Oriana-Galev", which lasted until October 2001 when the factory was closed.

The production of perchlorethylene and carbon tetrachloride was carried out by concern "Oriana-Galev" industrial chlorination of hydrocarbons, mainly methane. The main component of waste generated as a by-product of this process was hexachlorobenzene (HCB), the content of which in waste was 53 - 67% [1]. This substance has strong toxic properties in accordance with the list of the Stockholm Convention on "persistent organic pollutants" (POPs), refers to the class of substances banned for production and use [2].

As a result of long and ill-conceived mining activities, mining of potash ores in Kalush-Golynska field and their processing on these chemical plants near the town of Kalush and villages Kropivnik and Sivka Kalushska, environmental emergency has been developed. These areas are potentially dangerous for the life of the people because of the many failures of the earth surface, the destruction of homes and communications, salinization of drinking water sources. In the area of intensive subsidence of the earth's surface above the mine workings located about 1.3 thousand of residential units and 23 industrial plants (Figure 1). The most dangerous objects, according to experts, is spent Dombrivskii career, tailings # 1 and # 2, salt dumps on the sides of the career, sludge depository, potash mines "Kalush", "Holyn", "Khotyn", "Novo-Holyn", as well as ground solid polygon of toxic HCB waste in Kalush (the Polygon).

HCB Polygon (Figure 1), was artificially created as a result of direct production activities of concern "Oriana-Galev." Given the lack of Ukrainian technologies and manufactures of HCB recycling, it was decided that the disposal of HCB would be in the Polygon, which is 6 kilometers south-west of the town Kalush [3,4]. This Polygon is environmentally dangerous object - the only European storage of HCB toxic waste.

Operation of the Polygon as a disposal place for toxic substances was carried out from 1973 to 2001. Currently, however, there is some evidence to suggest that the dumping of HCB waste were done at other unequipped and unauthorized places near Kalush [5].

Toxic waste containing HCB were loaded into iron 200 liter drums and were disposed at the polygon, at specific sites excavated to a depth of 4 meters trenches, which were covered with plastic wrap and covered with earth. According to the Polygon passport [3], as for October 2001, when it was decommissioned, there were 11352,5 tones of waste, 11087,6 tons of which - technological waste (gummed) that contain HCB (hazard class 1); 264.9

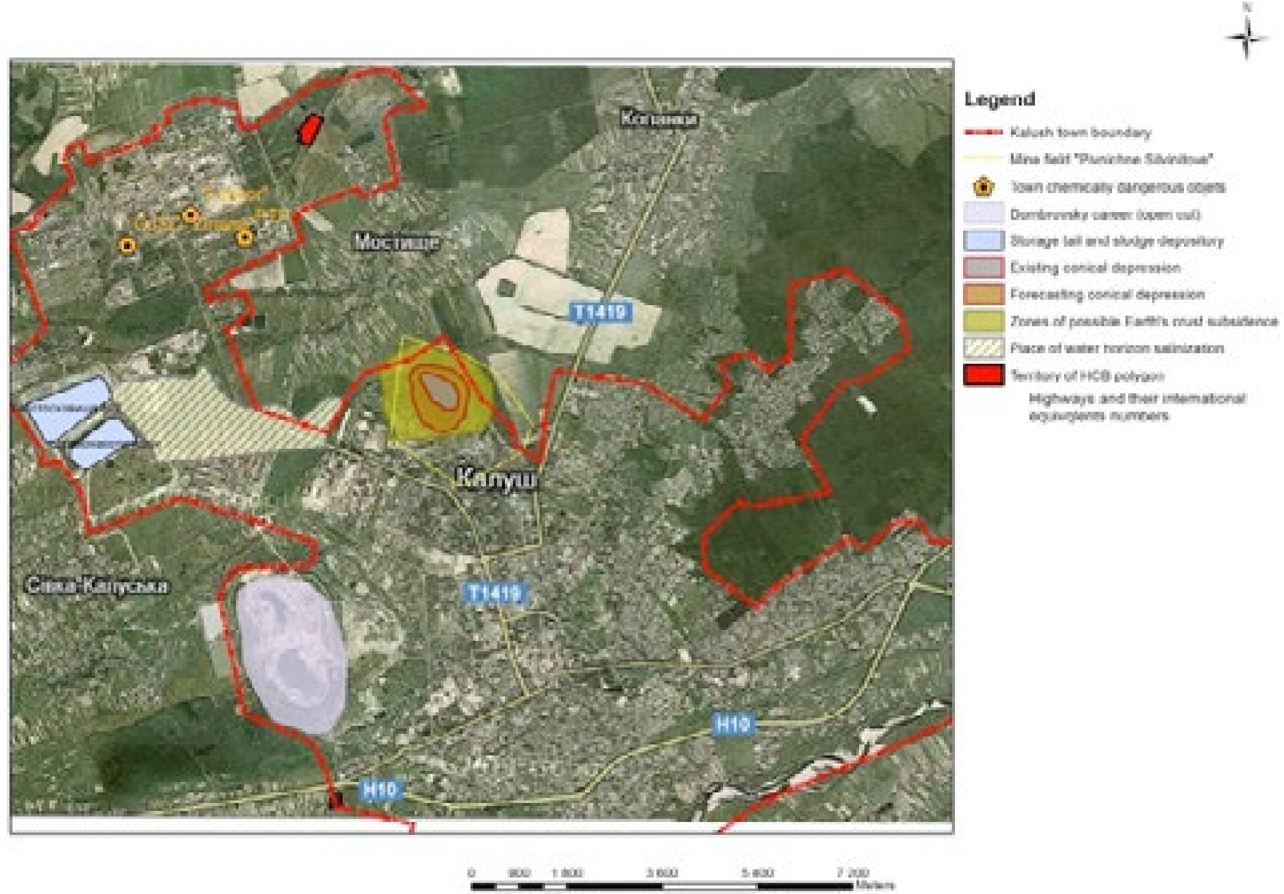


Figure 1: Areas with high environmental hazards within Kalush industrialized and urban agglomeration

tons of solid residues from the equipment (hazard class 3). Highly resinous wood - yellow crystalline substance in the form

of sand with a particle size of 1-3 mm; composition: C_2Cl_4 – 2-3%, C_2Cl_6 – 7 - 11%, C_4Cl_6 – 20 - 27% , C_6Cl_6 – 53 - 67% [1].

Because of mistakenly selected storage technology, which did not take into ac

count a high degree of flooding of the Polygon site and the aggressiveness of natural waters to metal, these barrels were quickly corroded and damaged. As a result of these processes, HCB as well as other

Date	Method	Quantity of HCB waste mixed with soils, tonnes	Notes
30.10.2001	Passport site data	11087,6	Based on the fact of waste packaging loading [2]
20.12.2010	Allocation of space burial barrels HCB using a metal detector; conversion of waste drums download area and assessing the degree of violation of tightness on the results of experimental dissection	22000,50	[7]
23.05.2011	First variant of assessment*	54236,92	soil and clay mixture with HCB [8]
	Second variant of assessment **.	*23604,29*	soil and clay mixture with HCB [8]
** calculation was made based on the contours of the charts in the HCB Polygon defined instrumentally by SE "Carpathian enterprise of geodesy, cartography and cadastre" taking into account the fact that: the barrels were buried in two rows in height, the diameter of 0.6 m, height - 0.9 m, with volume - 200l, 1 m3 of mix waste with pebbles and debris according to standard weighs 1750 kg, adopted the thickness of contaminated soil layer with destroyed 2.5m barrels*			
*** assessment was in real determining the amount of waste per 1 m^2 on the results of extraction HCB waste in 2010 with 4472, 63 m^2, which averaged 1945 kg per 1 m^2 of waste storage*			

Table 1: Preliminary assessment of stocks of toxic waste at the site of hexachlorobenzene near Kalush

toxic components got freely in the soil and groundwater and began to migrate, contaminating them. After the 2008 monitoring data have been documented cases of pollution of air, soil and groundwater in the area of polygon and near it, including in the creek of Sapogi - Limnytsia Rivers basin, a tributary of the Dniester. These data suggest that there was violation of the integrity of packaging of waste and HCB started uncontrollably enter the environment.

Taking into account dangerous situation in the area of Kalush town, by the Presidential Decree and relevant decree of the Cabinet of Ministers of Ukraine in 2010, it was decided to dispose toxic waste and to eliminate the Polygon [6, 7].

According to this decision, in 2010 - 2013, in accordance with Article 6 of the Stockholm Convention on POPs (Ukraine ratified 17.05.2004), the works on the identification and removal of HCB waste and contaminated soil to England and France for their destruction by incineration, were conducted.

Before the work started at the initiative of the Ivano-Frankivsk Regional Administration several inspections of the inventory were conducted to assess the quantity and quality of waste mixtures. However, due to the fact that the waste at the time of examination was already partially migrated, the results of these tests differed significantly (Table 1).

The qualitative composition of the mixture of waste that formed in the polygon area was investigated in December 2011 by Central Toxicology Laboratory on water transport (Odessa) [9]. Results of these studies showed that the amount of HCB waste mixture can reach 90%. The remainder of the waste also presents hazardous organic materials, namely:

– in the vapor phase in the samples of soil were: 1,1-dichloroethen; 1,1-dichloroethane; chloroform; carbon tetrachloride; trichlorethylene; 1,2,3-trichloroethane; tetrachlorethylene; 1-bromo-1,2,2-trichlorethylene; hexachloroethane; 1,3-butadiene-1,1,2,3,4,4-hexachloro;

– in water samples after extraction were identified: HCB; chloroform; 1,2-dichloroethane; carbon tetrachloride; tetrachlorethylene; hexachloroethane; 1,3-butadiene-1,1,2,3,4,4-hexachloro.

Toxicological characteristic of polygon HCB waste. According to the Stockholm Convention on POPs, HCB listed in Annex "A" refers directly to the group of the most dangerous POPs [2]. HCB prevailing in these wastes, has a high level of toxicity, is resistant to degradation, characterized by the ability to bioaccumulate, transported by air and water, and actively migrates with some kinds of aquatic organisms. HCB can be deposited at a large distance from the source of release, where they accumulate in terrestrial and aquatic ecosystems. Thus, the long-term effects of HCB and accompanying organic pollutants on humans and the biosphere objects due to extremely high environmental risks that require emergency measures to prevent its harmful effects [10,11].

Studies in the HCB Polygon in 2012 -2013 years. The authors of this publication in the period from 2012 to 2013, were invited to provide scientific support for the removal of waste from the polygon. They also conducted a study on the features of the formation of pollutants in the polygon area, the identification of new areas of unauthorized (natural) landfills, the assessment of pollution migration HCB in the environment for which information is given below.

The data on the geological conditions of HCB waste disposal within a polygon is represented in Table 2.

Groundwater levels within the polygon lie at a depth of 1.5-2.0 m

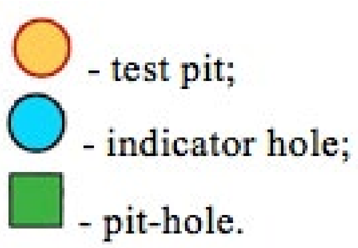
Geological section	Depth, M - m	Type of soil	Filtration coefficient, m/24hours
EGE*–1	0-1,9	vegetable layer	-
EGE –2	1,9-2,8	loam	$1,4 \cdot 10^{-3}$
EGE –3	2,8-6,0	clayey silt and peat filtering	1,1
EGE –4	6,0-7,8	loam	$2,6 \cdot 10^{-2}$
EGE –5	7,8-9,3	loam filter	1,1
EGE –6	9,3-11,0	clay	$6 \cdot 10^{-3}$
EGE –7	11,0-25,0	gravel-pebble deposits	8,9

* EGE – *engineer – geological element*

Table 2: Geological section of Quaternary deposits in the area of hexachlorobenzene polygon in Kalush

To determine the structural heterogeneity of soils, as well as to obtain the information about the levels of groundwater, in early October 2012, geophysical studies by resonant acoustic profiling (RAP) in a complex with a metal detector survey of the territory were conducted at the site, followed by geodetic coordinates referenced designated zones heterogeneity. RAP method recently entered the domestic practice of geophysics and has worked well for solving some practical problems - search and exploration geophysics, hydrogeology; engineering geology, geoscience, glaciology, mining [12 - 15].

According to the results, a refined scheme of Polygon outline maps / HCB waste storage sites was made, which is shown in Figure 2. Based on this scheme, infrastructure landfills of HCB consist of 4 sections and 10 cards. According to the archival



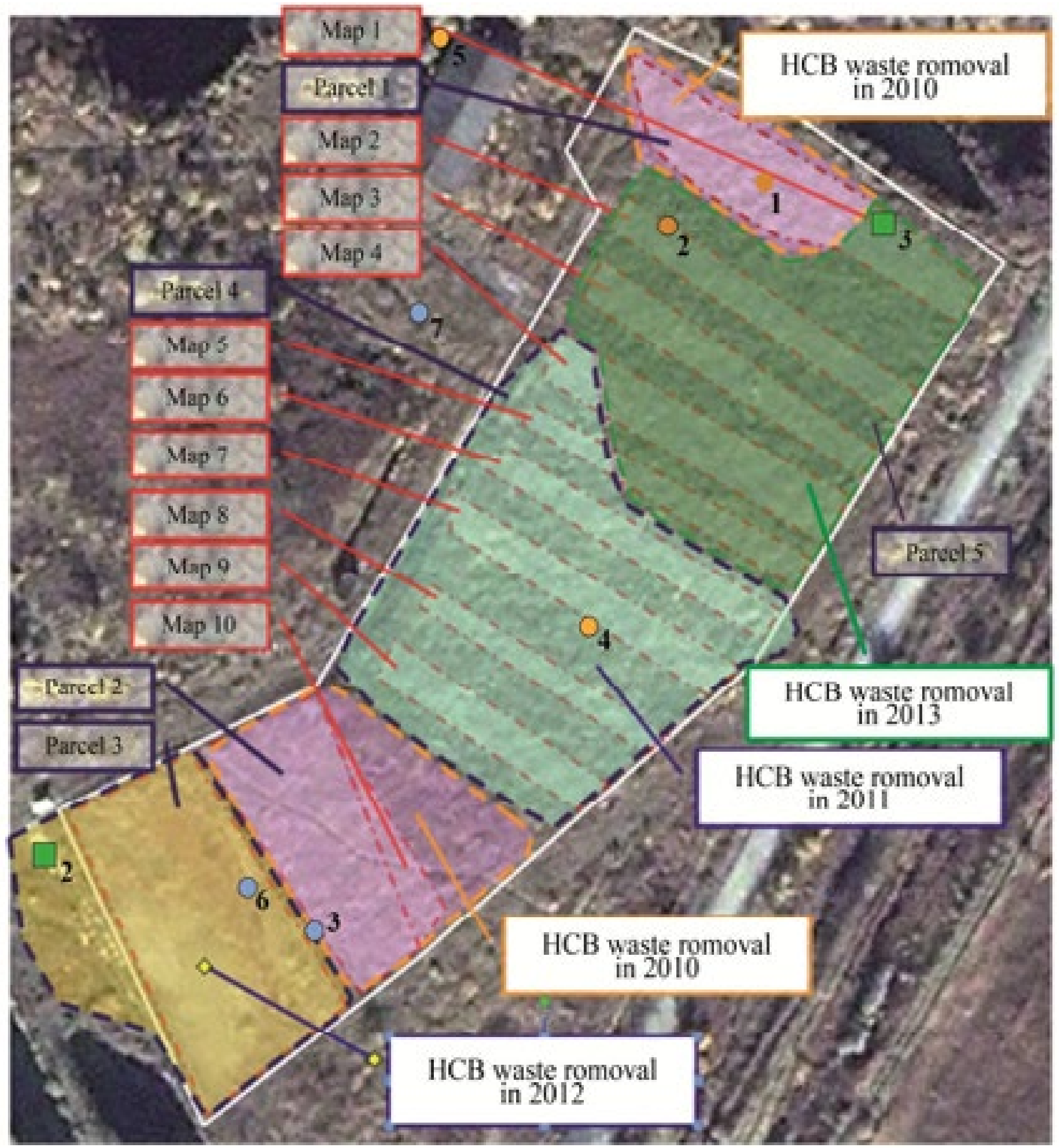


Figure 2: Scheme of HCB waste disposal site with data about the steps of their removal

documents, the bottom card was filled with clay about 0.3 m, which was covered with a polyethylene film (2 mm). The film loaded 200-liter barrels in 2-3 rows (one another), which overlap the top layer of plastic wrap and bulk clay to 0.5 m.

However, as was established in the show-down, effective protective measures to ensure the safety of barrels of HCB waste from demolition, were absent. Virtually all packaging waste was in a watered condition that contributed to the development of processes active corrosion and erosion of barrels rust. Documentary photographs (Fig. 3 a, b, c, d), clearly demonstrate the extent of destruction of container corrosion processes (greater than 50% and more). The depth of the groundwater level within the polygon was estimated as 0.15 - 1.7 m.

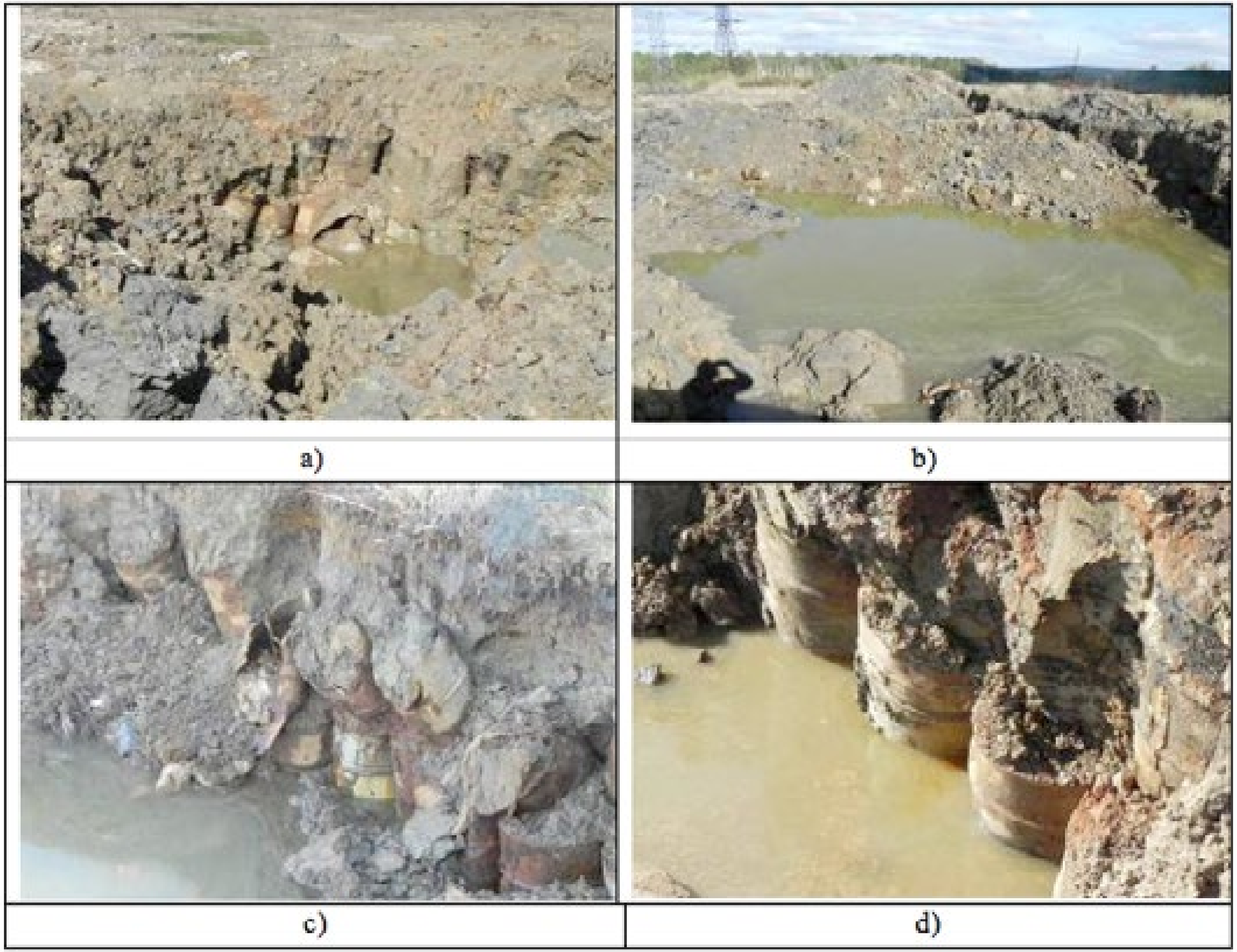


Figure 3: Documentary photographs proving unfavorable conditions for the disposal of packaging waste in the polygon of hexachlorobenzene and activity processes of its destruction

As shown in Figure 2, the infrastructure scheme of Polygon, became the working document for the gradual removal of waste from its territory in 2012-2013. This scheme contains the information about the phases of HCB waste removal from landfills, namely in 2010, was removed 8,514 tonnes of HCB waste mixture; in 2011 - 9,500 tons; in 2012 - 3,430 tons [16]; in 2013 - 8,001 tons. [17] During the period of 2010 - 2013, 29, 445 tons of HCB were removed from the Polygon. Removal and disposal of waste materials from the HCB polygon was to eliminate concentrated focus of toxicological hazard in the zone of Kalush HCB polygon. However, control geochemical soil sampling that was conducted after the removal of the bulk of HCB waste from landfills (as for 20.12.2013) showed very high levels of secondary contamination of HCB in the surface soil layer (Figure 4).

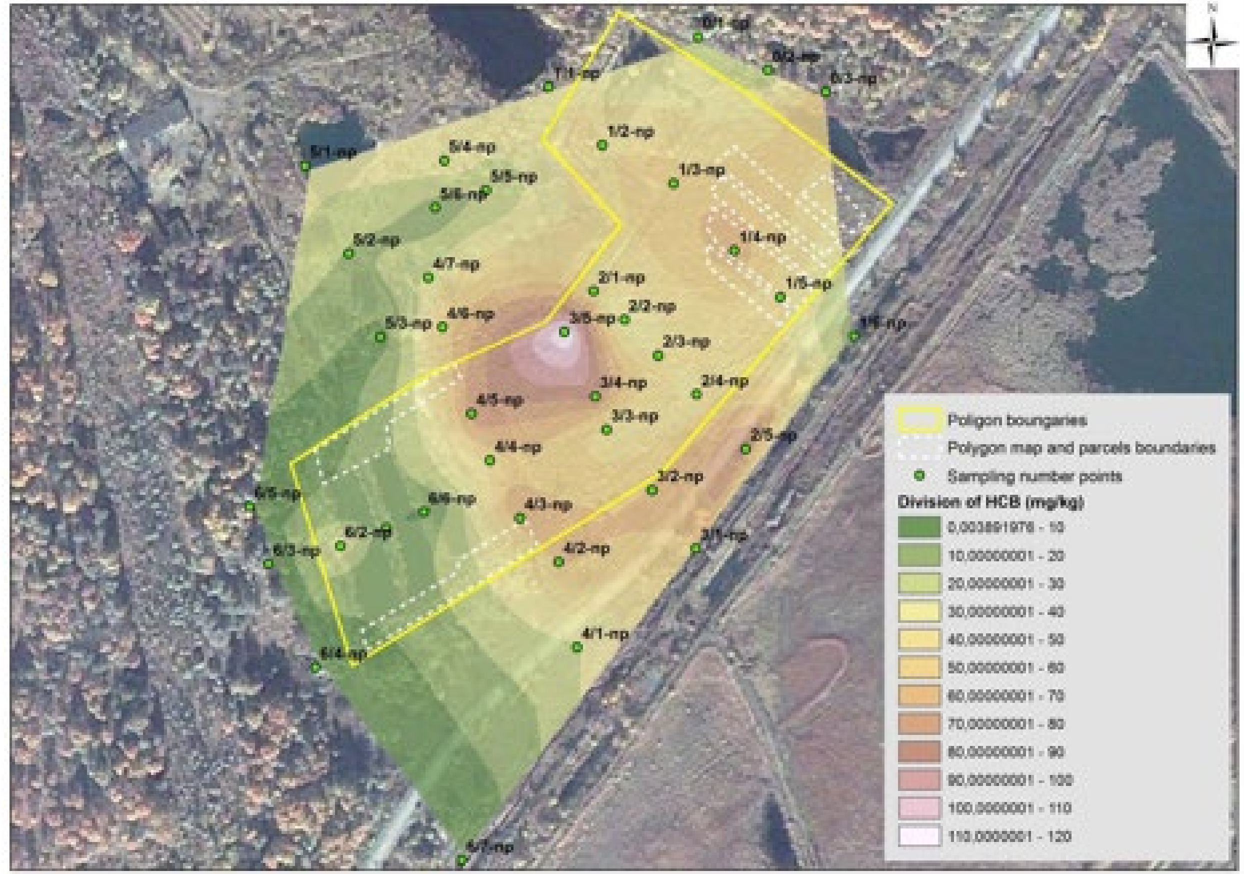


Figure 4: Scheme of the soil secondary contamination levels by hexachlorobenzene at the Polygon, after the toxic wastes were removed from its territory

The analysis of the results for determination of HCB in the control soils samples sampled in the surface part leads to the conclusion that after the removal of waste from the polygon and it was filled with clean soil the polygon continues to be contaminated with HCB at around 0.5% (5 g / kg). This means that the HCB residues in soil at the polygon in 170 thousand times higher in comparison with LAC for dry soil.

The presence of significant concentrations of HCB was also recorded in the overburden, which, according [18] to the procedure of removing, were subjected to be stored, and after their removal, these rocks were loaded into a neutralized card. Mass fraction of HCB in overburden is 1.9% (19 g / kg), which is in 6330 thousand times higher than the LAC for dry soil.

This situation clearly indicates that the development of the Feasibility Study for the project HCB waste disposal [18] did not take into account the results of its long-term migration of damaged metal barrels in the upper soil layers. This migration took place in the horizontal direction by mechanical transfer of seasonal changes in groundwater levels and in the vertical direction (upward vertical migration) due to capillary phenomena and evaporation from the soil surface. Partial contamination of overburden could also occur when reopening card operations and waste disposal, particularly when loading peeled waste inundated card overburden at recultivation.

In contrast to the horizontal migration of the sparingly soluble HCB related to its mechanical transfer by filtration through groundwater well permeable sediments, which can be traced on a small scale outside the polygon and the sanitary protection zone, vertical migration caused significant pollution of soil HCB just cut directly in the Polygon.

Conclusions

1. From 2010 to 2013, 29,445 thousand tons of toxic HCB waste was removed from the polygon.

2. Taking into account the assessment of the Polygon safety, after the waste removal, the Polygon remains ecologically dangerous object. The following steps should be undertaken:

- detailed examination to confirm the complete extraction of toxic waste containing HCB, as well as identifying new sources of HCB, which were not neutralized in the period from 2010 to 2013;
- determination of the exact boundaries of HCB contamination spreading outside the polygon;
- designing and implementation of complex rehabilitation measures aimed at localization of residual contamination of HCB within the polygon;
- Monitoring the state of the environmental situation in the polygon and its surroundings.

3. There is a need for a detailed survey to clarify the question of the presence (absence) at the Polygon not previously detected hot spots of HCB. It is based on the fact that during the work on the extraction of toxic waste, in 2010-2013, many aspects of waste disposal technology violations were recorded at the polygon. In the process of waste extraction, were obtained unconditional proof of uncontrolled disposal of waste, containing HCB. Therefore, applied for the period from 2010 to 2013, technology for waste extraction [18], which was based on the passport of the Polygon and archival documents, could not take into account all the procedures for action cases of violation of the rules of HCB waste disposal. Thus, precise performance of the works that were done by Contractor on the technological requirements of HCB waste removal (TP.04.2011-HCB), does not give an absolute guarantee that at the Polygon is not remained illegally impounded HCB waste.

4. Taking into account the fact that at the Polygon of HCB waste, after their removal and disposal, emerge an extraordinary situation caused by the secondary pollution of soil. So now it will be a great task to ask Food and Agriculture Organization (FAO) to involve foreign experts for further inspection of the Polygon. With their help, it will be necessary to justify the scientific and technical complex of rehabilitative and protective measures to minimize the migration of HCB residues beyond the Polygon site.

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PROBLEMS OF DIOXIN POLLUTION "HOT POINTS" IN RUSSIA

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Abstract

The paper makes assessment of the current state of preparation for rehabilitation of the dioxin pollution "hot point" in Ufa, Russia. Bottlenecks of the Russian legislation in the field of regulation of POPs maximum content are lightened, which is necessary for making basic decisions on cleanup measures concerning polluted soil, building material, communications, etc. An example of calculation of dioxin-containing waste hazard carried out according to the main regulation document – the Order of the Ministry of Natural Resources of the Russian Federation No. 511 "On setting criteria for relating waste to a class of hazard" is given.

Keywords

Waste, POPs, dioxins, rehabilitation, limits of clearance, "hot points".

Ratification of the Stockholm Convention by the Russian Federation in 2011 has not yet sufficiently prompted the activity in the field of cleanup of POPs polluted areas. In 2010, a project of the National Plan for realization of terms of the Stockholm Convention in the Russian Federation was presented. The source information for it was the analysis of available separate data on studies in the field of POPs and the experience of the estimated dioxin inventory carried out in Russia in 2007. It was calculated that dioxin emission into the air from different sources in Russia makes 1784.4 g TEQ PCDD/Fs. The largest contribution into the total dioxin emission is made by burning solid waste landfill sites (35.3%), ferrous and non-ferrous metallurgy (28.3%) and building material industry (13.6%). The share of chemical industry is assessed as 0.02% (!), and burning of hazardous waste – 6.72% [1].

Besides emission from stationary sources, there are dioxin polluted areas with high dioxin concentration formed due to the production of chlorophenol products, 2,4,5-T, 2,4-D and others. Most known dioxin polluted areas are in the regions of the Ural and Povolzhje, these are the plants of the net "Khimprom" in Ufa and Chapayevsk. Pollution levels of the plant territory in Ufa make about 10 ppb in the materials of buildings, to 6 ppb in soil and reach 200 ppb in slit and sludge [2]. Some of these plants have been shut down, in Chapayevsk – from 2000, in Ufa from 2004 after a bankruptcy procedure.

Now these territories present by themselves gradually dilapidating buildings with dismounted and removed equipment, and it is unknown whether cleanup from dioxins was carried out or not. In Ufa, this process has resulted in "liquidation" of the most polluted shops by their destruction and storing building breakage in a new place within the same area (Figures 1, 2).

Figure 1: The building of the shop where phenoxyherbicides were produced with incineration furnace for chloroganic waste burning prepared for destruction

As this process was going on without following the norms of protection against spreading of polluted particles with high dioxin content (1-15 ppb), the results were clearly traced by the level of snow cover pollution [3].

In the Russian Federation, the projects on liquidation of accumulated environmental damage of the past years had been developed.

These projects were included into the program “Environmental Safety of Russia”, the realization of which began in 2013.

For the plant in Ufa, a project of liquidation of the dioxin pollution “hot point” was developed. It is supposed that reclamation of the “Khimprom” territory will take over two billion rubles. The Ministry of Natural Resources of the Russian Federation obliged itself to include this plant into the program of 2014 in priority order. In Chapayevsk, the work on development of a program for rehabilitation of the polluted territory also began.

However, the present state of affairs is complicated by unpreparedness of the legislative and regulatory basis in Russia for making management and technical decisions on clearance. There are no norms of maximum dioxin content in soil of residential areas (interim standards of dioxin in soil make 0.33 pg/g), there are no MAC in the air of the working zone, permissible emissions from incineration furnaces are

Figure 2: Storing of building breakage of destroyed buildings, 2013

not regulated (in some studies EU norms of 0.1 ng/m3 are used).

However, the main problem is the absence of the notion "the limit of clearance" for soil, waste, sludge and building materials polluted by dioxins. The calculation of hazard of sludge as waste carried out according to the criteria adopted in Russia refer the waste containing dioxin (and other POPs) over 1 ppb to IV or even to V class of hazard (practically to non-hazardous, at the level of domestic waste) because of low absolute concentrations.

Thus the Order of the Ministry of Natural Resources of the Russian Federation No. 511 "On setting of criteria for relating hazardous waste to a class of hazard for the environment" contains the method of assessment of waste hazard by calculation of the hazard factor K. Five classes of hazard are singled out (Table 1).

The factor of the degree of waste hazard to the environment **K** is calculated by the following formula: **K = K1 + K2 + ……...+ Kn**, where **K** – factor of the degree of waste hazard to the environment;

K1, K2, …...Kn – factors of the degree of hazard of separate components of waste to the environment.

Degree of hazardous impact of waste	Criteria of relating hazardous waste to a class of hazard for the environment	Class of hazard of waste for the environment
Very High	The environmental system is irreversibly deteriorated. There is no period of reclamation	Class 1 Extremely hazardous
High	The environmental system is strongly deteriorated. The reclamation period is no less than 30 years after the total liquidation of the source of hazardous impact	Class II Highly hazardous
Middle	The environmental system is deteriorated. The reclamation period is no less than 10 years after reducing hazardous impact of the existing source	Class III Moderately hazardous
Low	The environmental system is deteriorated. The period of self-recovery is no less than 3 years	Class IV Low-hazard
Very low	The environmental system practically is not deteriorated	Class V Practically non-hazardous

Table 1: Classification of hazardous waste in Russia

The factor of the degree of hazard of a waste component to the environment Ki is calculated by the formula: **Ki = Ci / Wi**, where

Ci – the concentration of the i-th component in the waste (mg/kg waste);

Wi – factor of the degree of hazard of the i-th component of the waste to the environment (mg/kg waste).

Relation of waste to a class of hazard is proposed to be carried out by calculation and/or experimental methods.

19 indicators are used that characterize the degree of hazard of every component to different natural environments. Relation of the waste to a class of hazard by the calculation method according to the indicator of the degree of the waste hazard to the environment is performed in compliance with Table 2.

Some of the given values of factors of the degree of hazard (Wi) including “dioxins” are given in Table 3. Thus for “dioxins” this value makes 24.6 mg/kg, there are also “furans” for which this value is considerably higher - 359 mg/kg. Application of this method to the waste containing dioxins at the level of 1 ppb TEQ PCDD/Fs (1000 ng/kg) results in the value KPCDD/F = 4*10-6 and actually cannot influence the total value taking into consideration other components of the dioxin-containing waste (for example, wall plaster).

There are still more question to the methods. Thus it is unclear whether TEQ value is used in calculations or concentrations of congeners PCDD and PCDF.

So to be related to the 1st class of hazard a dioxin-containing waste should contain 250 g TEQ PCDD/Fs in 1 kg of waste.

With evident unacceptability it was namely this method that was used to assess the hazard of building waste from destroyed shops and waste in sludge tanks.

Class of hazard of waste	Degree of hazard of waste to the environment (K)
I	$10^6 \leq K > 10^4$
II	$10^4 \leq K > 10^3$
III	$10^3 \leq K > 10^2$
IV	$10^2 \leq K > 10$
V	$K \leq 10$

Table 2 :Classification of waste by degree of hazard

Name of component	W_i, mg/kg
Aldrin	138
Benz(a)pyrene	59.97
Hexachlorbenzene	354
Dioxins	24.6
Dichlorphenol	39.8
Dichlordiphenyltrichlorethane	213.8
Lindane	4634
Pentachlorbiphenyls	59.98
Pentachlorphenol	75.85
Trichlorbenzene	598.4
Phenol	215.44
Furans	359
Chloroform	215.4

Table 3: Factors of the degree of hazard

Besides the calculation method, the Order No. 511 gives an experimental method of assessment based on biological testing. Reaction of daphnia and/or water plants on water extract of waste sample is used. The method is a priori unsuitable for PCDD/Fs due to their extremely low solubility.

The way out, to our opinion, is excluding POPs from the list of waste, to which the effect of the document is applied, as it was done with radioactive and medicine waste.

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Amirova Z., Kruglov E., Maystrenko V., & Khizbullin F. (2006) PCDD/Fs Contamination 7 from Defoliants and Chlorinated Pesticides Production: Steps for Remediation of Stockpiles, Soil and Utilization of Contaminated Buildings Organohal. Comp, 68. 2225-2228.

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NEW LISTED POPs IN THE STOCKHOLM CONVENTION AND GUIDANCES DEVELOPD FOR THE UPDATE OF THE NATIONAL IMPLEMENTATION PLAN

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The Stockholm Convention on Persistent Organic Pollutants (POPs; http://chm.pops.int) is an international treaty aimed at protecting human health and the environment from the threats posed by POPs. The Convention goals are to restrict and ultimately eliminate the production, use, release, and stockpiles of POPs.

The Convention also establishes regulation on the international trade of POPs and their disposal upon becoming wastes. An initial twelve POPs were listed under the Convention when it was adopted in 2001.

The Conference of the Parties (COP) to the Stockholm Convention decided to list nine new chemicals in 2009 (alpha-HCH, beta-HCH; gamma-HCH/Lindane, commercial pentabromodiphenylethers (major compositions are tetra- and penta-homologues) and commercial octabromodiphenylethers (containing hexa-, and hepta- homologues); PFOS, its salts, PFOSF and PFOS related chemicals, Chlordecone and pentachlorobenzene).and additional chemicals in 2011 (Endosulfan) and 2013 (Hexabromocyclododecane (HBCD)). Therefore for the first time brominated and fluorinated chemicals have been listed which are used as industrial chemicals largely in consumer goods and for PFOS additionally in a range of industrial applications.

To assist Parties in updating their National Implementation Plans (NIPs) to address the new listed POPs listed in 2011, a set of guidance documents has been developed by the United Nations Industrial Development Organization (UNIDO) and the United Nations Institute for Training and Research (UNITAR), working in collaboration with the Secretariat of the Stockholm Convention (SSC) and the Global Environment Facility (GEF). These documents aim at supporting Parties in developing strategies to restrict and eliminate the new listed POPs, by providing guidance on establishing inventories and selecting Best Available Techniques and Best Environmental Practices (BAT and BEP) for situations when production, use, and recycling of industrial POPs are allowed by the Convention.

The following guidance documents (several of them still drafts needing approval by COP) have been prepared to assist parties with National Implementation Plan review and update and can be downloaded from the Stockholm Convention website[1] :

1. Guidance for developing, reviewing, and updating a NIP for the Stockholm Convention on POPs.

2. Guidance for the inventory of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention on POPs

3. Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on POPs

1 http://chm.pops.int/Implementation/NIPs/Guidance/tabid/2882/Default.aspx

4. Guidance for the Inventory of commercial Pentabromodiphenyl ether (c-PentaBDE), commercial Octabromodiphenyl ether (c-OctaBDE) and Hexabromobiphenyls (HBB) under the Stockholm Convention on Persistent Organic Pollutants; Draft.

5. Guidelines on best available techniques and best environmental practices for the production and use of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention on POPs

6. Guidelines on BAT and BEP for the recycling and waste disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on POPs

7. Guidance for the control of the import and export of POPs

8. Labelling of products or articles that contain POPs – Initial considerations

9. Guidance on Sampling, Screening and Analysis of Persistent Organic Pollutants in Products and Articles; Draft;.

10. Guidance on calculation of action plan costs for specific POPs

In addition technical guidelines have been developed by the Basel Convention. addressing new listed POPs including:

1) Draft technical guidelines for the environmentally sound
management of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and
heptabromodiphenyl ether, and tetrabromodiphenyl ether and pentabromodiphenyl ether (POP-BDEs).

2) Draft technical guidelines for the environmentally
sound management of wastes consisting of, containing or contaminated with perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF).
Fourth Draft. 26. November 2014.

Also other publications and materials have been developed for an overview on new listed POPs such as the "Step-by-step companion guide to the review and updating of the National Implementation Plans – 2011" or "STARTUP GUIDANCE for the 9 new POPs" and can be downloaded from the Convention Website[2].

An important activity for the National Implementation Plan update is the development of inventories of the new listed POPs which are then the basis for the development of action plans.

2 http://chm.pops.int/Implementation/NewPOPs/Publications/tabid/695/Default.aspx

THE UPDATED “TOOLKIT FOR IDENTIFICATION & QUANTIFICATION OF RELEASES OF DIOXINS, FURANS AND OTHER UNINTENTIONAL POPS UNDER ARTICLE 5 OF THE STOCKHOLM CONVENTION POPS”

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One major goal of the Stockholm Convention on Persistent Organic Pollutants (POPs) is the continuing minimization and, where feasible, ultimate elimination of unintentionally produced POPs including polychlorinated dibenzodioxins (PCDD), polychlorinated dibenzofurans (PCDF), unintentionally formed polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB) and pentachlorobenzene (PeCBz) (Article 5). Parties are required to identify, characterize, quantify and prioritize sources of releases of unintentionally produced POPs, and develop strategies with concrete measures, timelines and goals to minimize or eliminate these releases (Stockholm Convention 2013).

To support Parties in meeting these obligations, a “Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases” was first published in 2003 by UNEP and revised in 2005. The toolkit ensures that source inventories and release estimates are complete, transparent, as well as consistent in format and content. The Toolkit allows Parties to compare results, identify priorities, mark progress and follow changes over time at the national, regional and global levels (Fiedler et al. 2012; Stockholm Convention 2013).

In 2006, Parties acknowledged the need for its ongoing revision and updating, placing emphasis on key sources for which limited data were available and on providing support to developing countries in their efforts to verify their emission factors. This updated version has meanwhile been developed and has been released early 2013.

The revision process was open and inclusive, involving experts nominated by Parties as well as by nongovernmental organizations and industry associations, and in cooperation with UNEP Chemicals.

The Toolkit is the most comprehensive available compilation of emission factors for the relevant PCDD/PCDF sources. It is useful particularly in countries where measurement data are limited or are not available, enabling the elaboration of source inventories and release estimates by using the default emission factors. It is also useful in countries where national measurement data are available, as a reference document for data comparison and validation purposes.

The 2013 edition of the Toolkit contains all new information, as well as model inventories illustrating relevant releases. In addition, the entire Toolkit is now available in an interactive electronic version online (http://toolkit.pops.int/), with information structured according to the level of technical detail.

The presentation gave a short introduction to the updated 2013 toolkit and and overview on the NIP update process for unintentionally produced POPs.

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Ren Z, Zheng M (2009) Impacts of human activities on dioxins emissions at national scale. Chemosphere 76, 853–859.

NEWLY LISTED POPS AND OTHER STOCKHOLM CONVENTION ISSUES

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The presentation of Roland Weber (POPs Environmental Consulting) introduced the recent developed The Stockholm Convention guidance drafts for the inventory development and for BAT/BEP management of perfluorooctanesulfonic acid (PFOS) and polybrominated diphenylethers (PBDEs) recently listed in the Stockholm Convention.

Timo Seppala (Finnish Environment Institute) gave an overview on the key issues of the most recent Stockholm Convention listed substance: hexabromocyclododecane (HBCD).

Mihaela Claudia Păun (Ministry of Environment and Climate Change, Romania) gave an insight into the approach of Romania to update the National Implementation Plan (NIP) with emphasise on the new listed POPs.

Ivan Holoubek (RECETOX, Czech Republic) made an overview on the "Global POPs monitoring and an insight into the current state in the CEE countries". In addition, he made a critical evaluation of the effectiveness of the Stockholm Convention measures.

The last part of the session focused on dioxins and other unintentionally produced POPs. Roland Weber gave an overview of the "Updated toolkit for identification and quantification of releases of dioxins and other unintentional POPs in the Stockholm Convention" with the emphasis on the contaminated sites chapter. The last two presentations gave some details on the two examples of contaminated megasites with dioxins and unintentionally produced POPs:

Zarema Amirova (Environmental Research & Protection Centre, UFA, Russia) gave an overview of the problems of dioxin contaminated sites in UFA. Georgii Lysychenko (Director of Institute of Environmental Geochemistry, Ukraine) gave a status report on the current situation and the waste management of the HCB waste stockpile in Kalush/Ukraine.

Overall, the session provided a good insight on the key issues on new listed brominated and fluorinated POPs and also on the contaminated site challenges of Dioxins and other unintentionally formed POPs. Therefore, the session complemented other sessions (focusing largely on pesticides issues) and brought to the Conference a more comprehensive picture on the POPs challenges the world and, in particular, the countries in this region are facing.

Further reading

Guidance documents prepared to assist parties with National Implementation Plan review and update and can be downloaded from the Stockholm Convention website http://chm.pops.int/Implementation/NIPs/Guidance/tabid/2882/Default.aspx

Stockholm Convention (2013) Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention POPs. http://toolkit.pops.int/

PCB TREATMENT



12TH INTERNATIONAL HCH AND PESTICIDES FORUM

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1 Introduction

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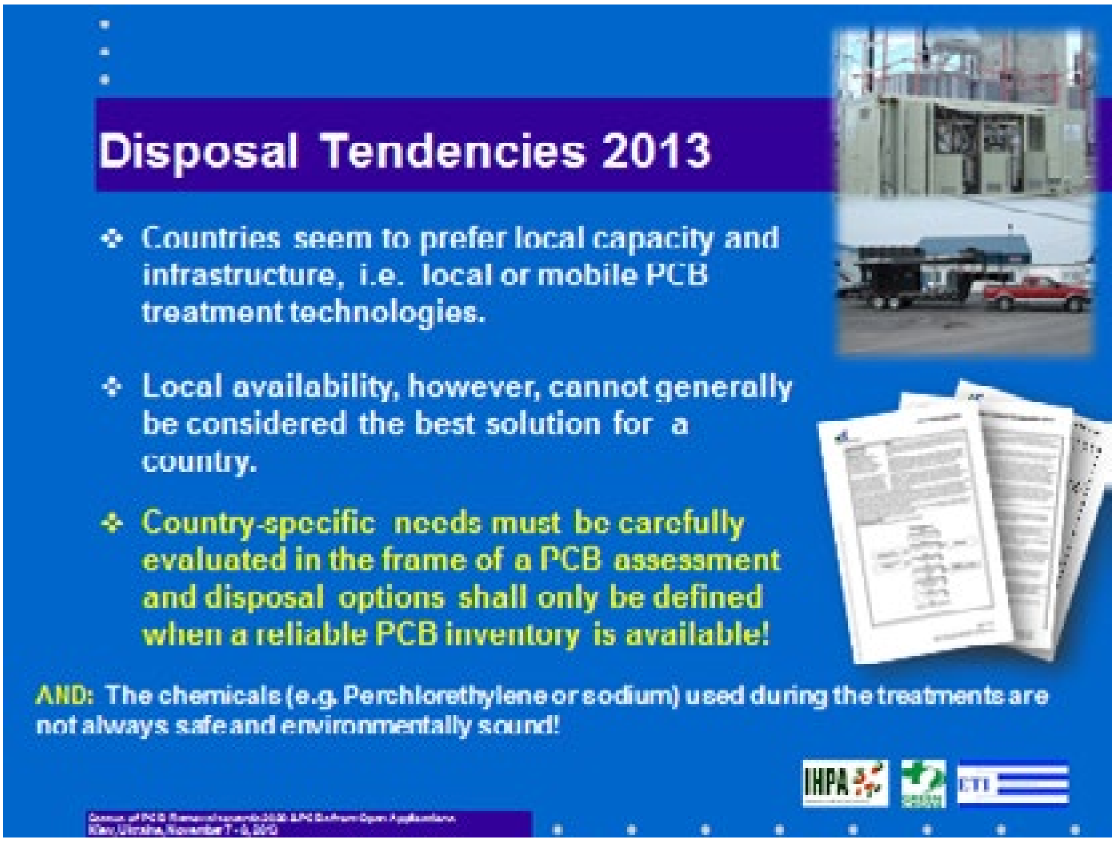
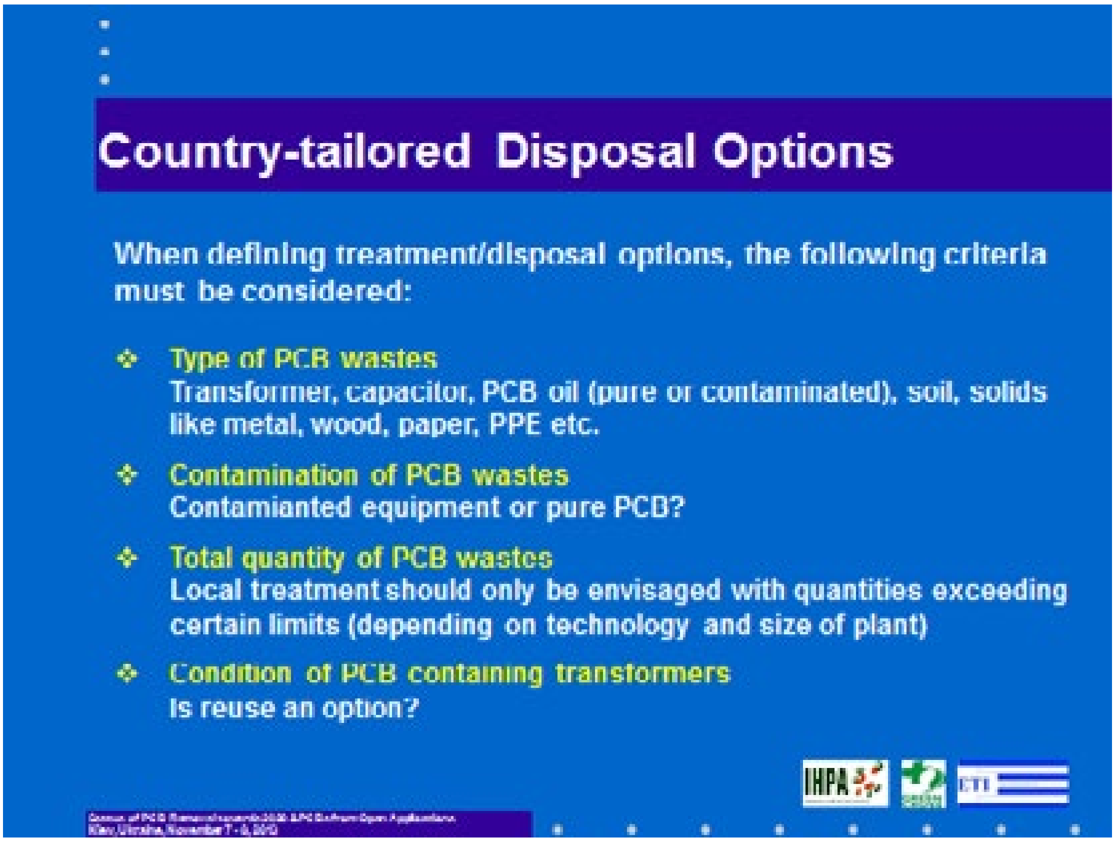
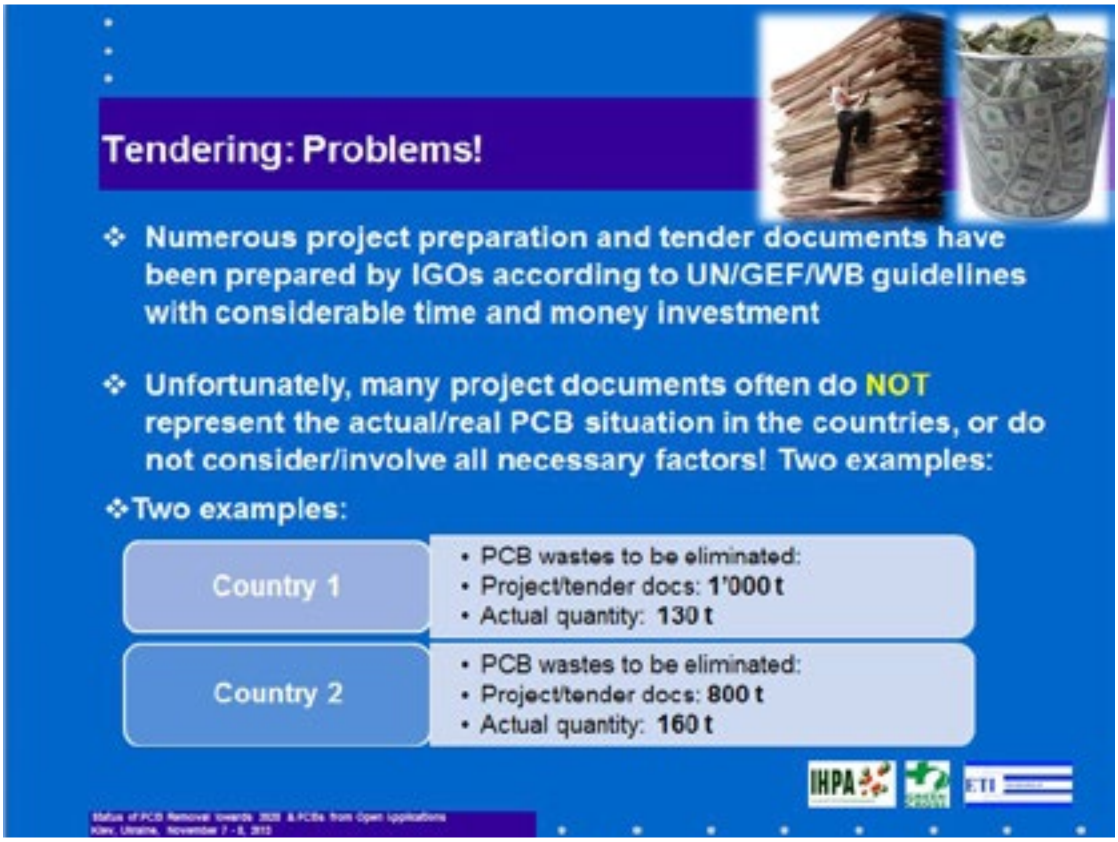
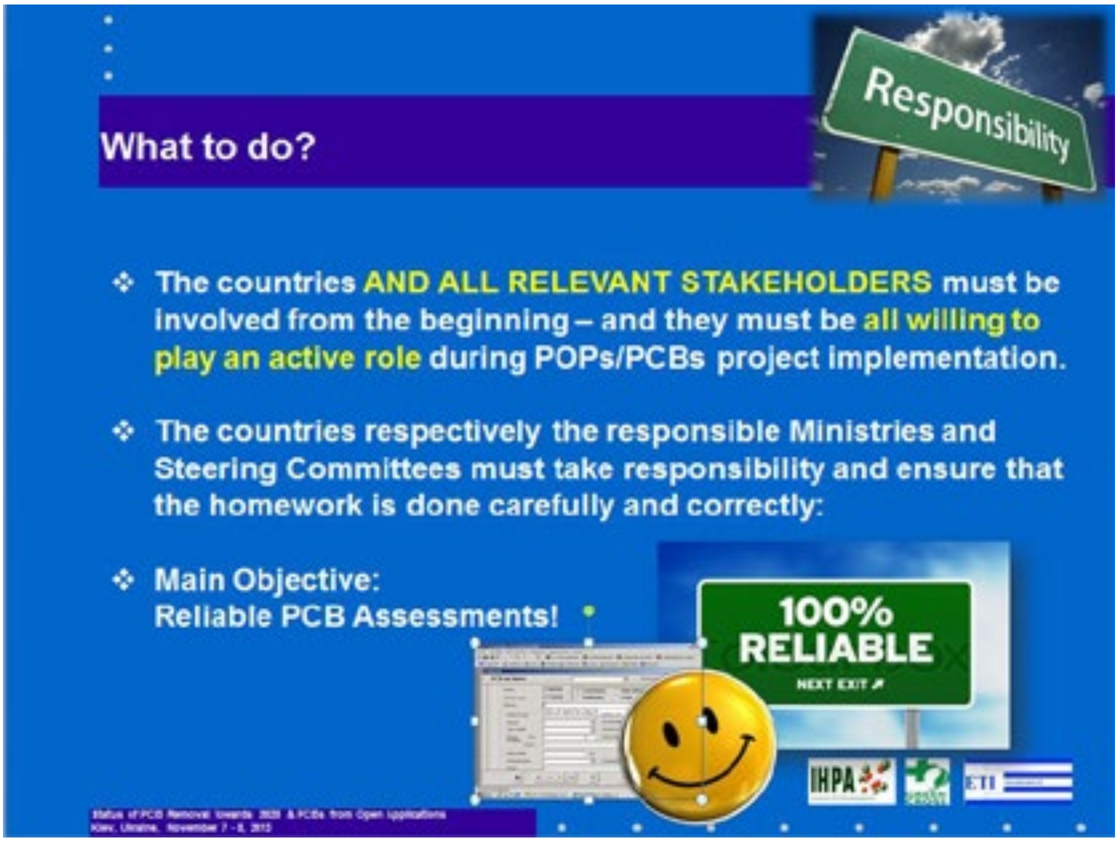
2 Summary: PCB Removal Towards 2013









The following chapters provide useful background information and describe proceedings in order to handle PCBs in an environmentally sound manner:

3 General Information and Hazard Potential of PCBs

3.1 POPs and PCBs

Persistent Organic Pollutants (POPs) have been identified by the international community for immediate international action by means of the Stockholm Convention. The pesticide DDT, highly toxic Dioxins and Furans (unintentionally formed by-products as a result of incomplete combustion or chemical reactions) as well as PCBs count among the POPs.

Polychlorinated Biphenyls (PCBs) are one of the leading members in the group of Persistent Organic Pollutants (POPs). PCBs have serious health and environmental effects, which can include carcinogenicity, reproductive impairment, immune system changes, and effects on wildlife causing a loss of biological diversity (Carpenter 2006, Hotchkiss et al. 2008, Wirgin et al. 2011).

PCBs were manufactured worldwide by a number of companies in many industrialised countries and were mostly used in closed applications such as cooling and isolating agents in transformers and capacitors, in heat transfer systems and hydraulic systems in particular in mining equipment. PCBs mixtures were, however, also widely used in open and partially open applications, for example in caulks/sealants, paints, anti-corrosion coatings, copy paper and as flame retardants.

The Stockholm Convention on Persistent Organic Pollutants (POPs) counts PCBs among the substances targeted for worldwide elimination. The challenge to implement its targets is two-fold:

The existing PCBs and all equipment contaminated with PCBs have to be eliminated in an environmentally sound manner without producing hazards for humans or the environment until 2025.

Most of the existing PCB-contaminated equipment is still in use in the developing countries. The financial burden for safe and environmentally sound replacement of the PCB contaminated equipment is very high, especially for developing countries. For this reason, alternative solutions are needed to keep the cost low. Transformers can be decontaminated and the equipment can be used until the end of its technical life-time.

The technology must comply with the highest safety and environmental standards and must be capable of reducing the PCB contamination level of those pieces of equipment suitable for re-classification below the legally permitted level of 50 ppm as well as assure that the PCB level remains below that limit.

From the technical point of view, the characteristics of PCBs were quite advantageous, thus they found a wide range of applications as mentioned above such as dielectric, cooling and hydraulic fluids as well as fluids for thermal transmission in transformers, capacitors, hydraulic machines, etc.

Only later it was realized that PCB chemicals have serious health and environmental effects.

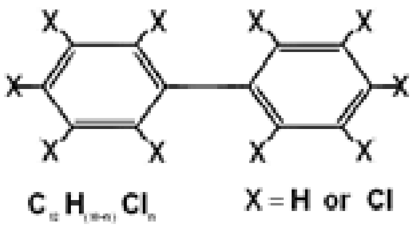
3.2 Definition and History of PCBs

Polychlorinated Biphenyls, commonly known as PCBs, are a group of chlorinated aromatic hydrocarbons characterized by the biphenyl structure (two phenyl rings $(C_6H_5)_2$) and at least one chlorine atom substituted for hydrogen. The chlorine atoms can be attached at any of the ten available sites.

PCBs are colourless liquids and a class of chlorinated organic compounds formed by the addition of chlorine to biphenyl, which is a dual ring structure comprising two carbon benzene rings linked by a single carbon bond. Depending on the number of chlorine atoms in their molecules their physical, chemical, and toxicological properties vary considerably.

A total of 209 PCB compounds with the same basic organic structure but with a varying number of chlorine substituents are possible, but only approximately 70 of these compounds have been found in commercial mixtures. PCBs are fire-resistant, have a low volatility, and are stable and persistent, making them well suited for industrial use but also problematic in the environment.

Picture 1: PCB Molecule



From the technical point of view, the characteristics of PCBs were quite advantageous.

Table 1: Characteristics of Polychlorinated Biphenyls (PCBs)

High heat stability	Only poorly soluble in water, but well-soluble in fat
Hardly inflammable (complete combustion only at > 1000 °C)	Good heat conductivity
Relatively good acid, alkali and chemical resistance	Low vapour pressure
Stable against oxidation and hydrolyse (in technical systems)	Very small electrical conductivity (good insulator)

As mentioned above, there are theoretically 209 different PCB congeners, although only about 70 of these have been found in technical mixtures. Approximately 10 of these congeners are of importance today. The 6 lead congeners are the numbers 28, 52, 101, 138, 153 and 180; and in some countries also 118. The PCB congener 118 is dioxin-like and very likely to be carcinogenic. It therefore needs special attention when for example sampling and analysing indoor air.

Polychlorinated Biphenyls were synthesised for the first time in 1866 by Schmidt and Schultz, but commercial production started in 1929 by the American company Swan Chemical under the trade name AROCLOR. The company recommended the use of PCBs as a material for protective layers, water resistance, fire protection, glues, and electric insulation. There were times when it was even envisaged to use PCBs as an additive in chewing gums.

Depending on the number of chlorine atoms in the molecule, PCBs have different physical, chemical and toxic characteristics. Polychlorinated Biphenyls are colourless liquids with strong odour. They are stable on higher temperatures. PCBs can only be combusted under extreme and carefully controlled conditions. The current regulations require that PCBs are burnt at a temperature of 1200°C for at least two seconds. PCBs are poorly soluble in water and have low volatility stability on acids and alkaline, oxidation and other chemical reactions. They are semi-degradable; their half-life time depends on the chlorination level and ranges between 10 and 15 years. They are highly soluble in lipids, hydrocarbons and organic compounds.

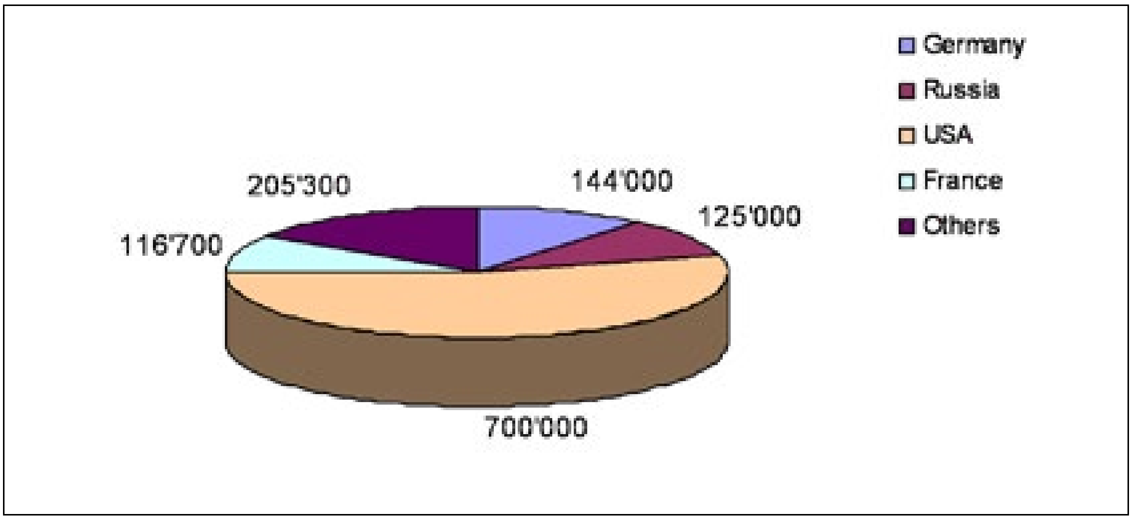
As a result, PCBs may bio-accumulate in fatty tissues of humans and other living organisms. The bioaccumulation shows up to 70'000 times higher concentrations in species at the top of the food chain.

Long-term exposure to even small concentrations can have adverse effects on human health, especially on the unborn child (Brouwer et al. 1999, Schantz et al. 2003).

In the process of the global distillation (evaporation and deposition) PCBs can be transported over long distances to regions where they have never been used or produced before. For example, traces of PCBs can be in the Arctic. This process of evaporation, movement with the air streams, condensation and deposition on the ground is well known as the «grasshopper effect».

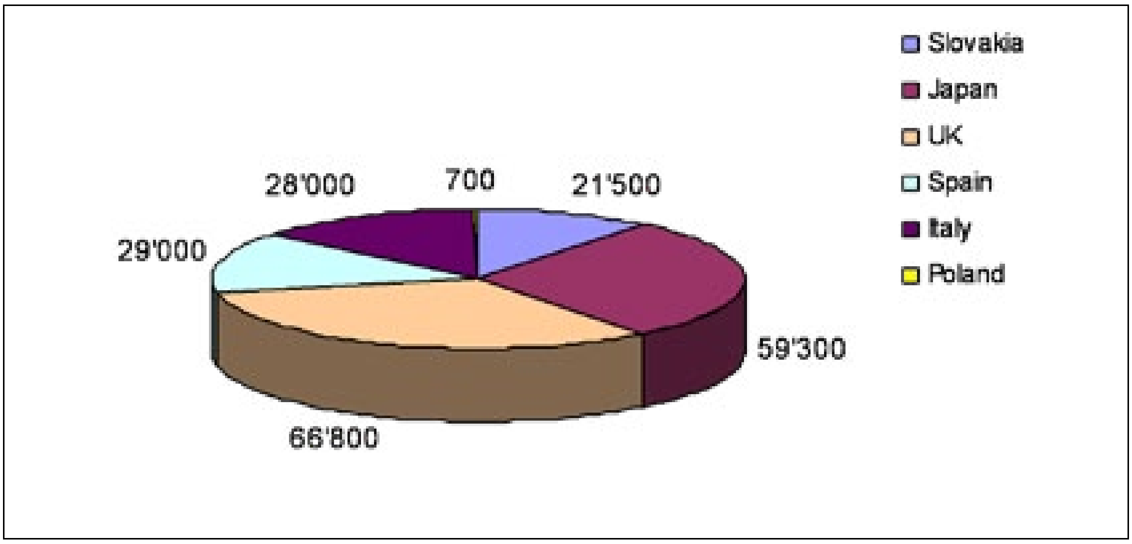
After the 2nd World War PCB production started in Europe and in the late 1960s maximum production was reached with over 60'000 tonnes produced per year. After 1983 production of PCBs was stopped in most countries, except for some Eastern European countries. The Russian Federation, for example, only stopped production between 1987 and 1993 (AMAP, Oslo, 2000). There are rumours, that PCBs are still produced in North Korea.

Chart 1: Total World Production of PCBs in tonnes I



The total world production of PCBs between 1929 and 1989 was approximately 1.5 million tonnes. After the US had banned the production and sale of PCBs in 1976, except for closed systems, it continued at a rate of 16’000 tonnes per year from 1980 to 1984 and approximately 10’000 tonnes per year from 1984 to 1989.

Chart 2: Total World Production of PCBs in tonnes II



The largest quantities of PCBs were produced in the USA, in Germany, Russia and France. Approximately 200’000 tonnes of the total world production originated from other countries like Slovakia, Japan, the UK, Spain, Italy and Poland.

The following table shows some of the brand names used for the various applications of PCBs.

Table 2: Extract of Brand Names for PCBs

Abestol (t, c)	DP 3, 4, 5, 6.5	Phenoclor (t, c) (France)
Abuntol (USA)	Ducanol	Phenoclor DP6 (France)
Aceclor (t) (France, Belgium)	Duconal (Great Britain)	Phyralene (France)
Acooclor (Belgium)	Duconol ©	Physalen
Adkarel	Dykanol (t, c) (USA)	Plastivar (Great Britain)
ALC	Dyknol (USA)	Polychlorinated biphenyl
Apirolio (t, c)	E(d)ucaral (USA)	Polychlorobiphenyl
Areclor (t)	EEC-18	Pryoclar (Great Britain)
Aroclor (t, c) (USA)	EEC-IS (USA)	Pydraul (USA)
Aroclor 1016 (t, c)	Elaol (Germany)	Pydraul 1 (USA)
Aroclor 1221 (t, c)	Electrophenyl (France)	Pydraul 11Y (USA)
Aroclor 1232 (t, c)	Electrophenyl T-60	Pyralene (t, c) (France)
Aroclor 1242 (t, c)	Elemex (t, c) (USA)	Pyralene 1460, 1500, 1501 (F)
Aroclor 1254 (t, c)	Elexem (USA)	Pyralene 3010, 3011 (France)
Aroclor 1260 (t, c)	Eucarel (USA)	Pyralene T1, T2, T3 (France)
Aroclor 1262 (t, c)	Fenchlor 42, 54, 70 (t, c) (Italy)	Pyramol (USA)
Aroclor 1268 (t, c)	Hexol (Russian Federation)	Pyranol (t, c) (USA)
Arubren	Hivar ©	Pyrochlor
Asbestol (t, c)	Hydol (t, c)	Pyroclar (Great Britain)
ASK	Hydrol	Pyroclor (t) (USA)
Askarel (t, c) (USA)	Hyvol	Pyromal (USA)
Auxol (USA)	Hywol (Italy/USA)	Pyronal (Great Britain)
Bakola	Inclar (Italy)	Pysanol
Bakola 131 (t, c)	Inclor (Italy)	Saf(e)-T-Kuhl (t, c) (USA)
Bakolo (6) (USA)	Inerteen 300, 400, 600 (t, c)	Safe T America
Biclor ©	Kanechlor (KC) (t, c) (Japan)	Saft-Kuhl
Chlorextol (t)	Kanechor	Sanlogol
Chlorinated Diphenyl	Kaneclor (t,c)	Sant(h)osafe (Japan)
Chlorinol (USA)	Kaneclor 400	Sant(h)othera (Japan)
Chlorintol (USA)	Kaneclor 500	Sant(h)othern FR (Japan)
Chlorobiphenyl	Keneclor	Santosol
Chloroecxtol (USA)	Kennechlor	Santoterm
Chorextol	Leromoli	Santotherm (Nippon)
Clophen (t, c) (Germany)	Leromoll	Santotherm FR
Clophen Apirorlio	Leronoll	Santovac
Clophen-A30	Magvar	Santovac 1
Clophen-A50	Man(e)c(h)lor (KC) 200,600	Santovac 2
Clophen-A60	Manechlor (Nippon)	Santovec (USA)
Cloresil	MCS 1489	Santowax
Clorinol	Niren	Santvacki (USA)
Clorphen (t)	NoFlamol	Saut(h)otherm (Japan)
DBBT	No-Flamol (t, c) (USA)	Siclonyl ©
Delorene	Non-flammable liquid	Solvol (t, c) (Russian Federation)
Delor (Czech Republic)	PCB	Sorol (Russian Federation)
DI 3,4,5,6,5	Pheneclor	Sovol (Russian Federation)
Diachlor (t,c)	Phenochlor	Sovtol (Russian Federation)
Diaclor (t, c)	Phenoclar DP6 (Germany)	Terpenylchlore (France)
Diaconal	Disconon ©	Therainol FR (HT) (USA)
Dialor ©	Dk (t, c) (decachlorodiphenyl)	Therminol (USA und FR)
Diconal	Ugilec 141, 121, 21	Therpanylchlore (France)

3.3 PCB Production in the Former USSR

PCB production in Russia was terminated between 1987 and 1993. There is no calculation of the total amount of PCB production and use in the former USSR available. PCB was produced at two sites. The largest facility was the «Orgsteklo» Ltd. Production Amalgamation (located in Dzerzhinsk in Nizhni Novgorod Oblast, approximately 300 km east of Moscow); and the second was the «Orgsintez» Ltd. Production Amalgamation (at Novomoskovsk in Tula Oblast, ca. 200 km south of Moscow). PCB was produced under three brand names:

Table 3: Trade names of PCBs produced in the former USSR

➢ Sovol	A mixture of tetra- and pentachlorinated PCBs (used as a plasticiser in paints and varnishes)
➢ Sovtol	Sovol mixed with 1,2,4 trichlorobenzene; especially in the ratio 9:1, named Sovtol-10 (used in transformers)
➢ Trichlorbiphenyl (TCB)	Mixed isomers of polychlorbiphenyls, the main percentage is trichlorbiphenyl (only used in capacitors)

Minor production of special mixtures took place during the early days of PCB production.

Table 4: Trade names of special mixtures

➢ Nitrosovol'	Mixture of Sovol and nitronaphtalene
➢ Mixture of PCB with Paraffin and Cenerezin	This mixture was used to impregnate paper capacitors
➢ Hexol	Mixture of pentachlorobiphenyl with hexachlorobutadiene

Sovol and Sovtol production at the «Orgsteklo» (Dzerzhinsk) facility began in 1939. The TCB production in 1968. Sovtol-10 production was shut-down in 1987, TCB and Sovol in 1990.

At the «Orgsintez» (Novomoskovsk) facility, Sovol and Sovtol production was launched in 1971, and full-size operation started in 1972. «Orgzintez» Ltd. stopped production of Sovtol in 1990 and production of Sovol in 1993. There was no production of TCB at «Orgsintez».

Retrospective analysis of production figures showed that during the period from 1939 to 1993, the factories produced a total of about 180'000 tons of the three main PCB brands.

Between 1990 and 1993, production of PCB at these facilities ceased entirely. According to available information, the only exporter of PCB (Sovtol-10) was Orgsintez Ltd. In Novomoskovsk, which during the period 1981-1989 exported 39.5 tons to certain countries (Cuba, Vietnam, Pakistan).

Import figures are not available. One estimate sets a maximum import of 4,000 tonnes TCB annually for 1980-1983, but this number is based only on a decrease in production capacity at the Orgsteklo plant and not a documented industrial demand for TCB.

<u>Sovol</u>
The plasticiser Sovol was used in a number of industries, especially paint and varnish production as well as in the manufacture of various lubricants. No application in the production of hydraulic oil was identified.

The use of approx. 53'000 tons from the total production of Sovol was estimated as it is shown in Table 5 on page 9.

Table 5: Uses of Sovol

➢ 37’000 tons	Used in the production of varnish and paint
➢ 10’000 tons	Used in the production of lubricants
➢ Approx. 5’500 tons	Used in defence-related industry plants and other industrial enterprises not otherwise included in the inventory

According to estimates, the remaining 127’000 tons of PCB were used as follows:

Table 6: Uses of Sovol

➢ Approx. 57’000 tons of Sovtol-10	Used as a dielectric fluid in transformers
➢ Approx. 70’000 tons of TCB	Used as a dielectric fluid in capacitors

TCB

TCB was used exclusively for capacitor production. Four enterprises produced capacitors in the former USSR. The amounts used, relative to the total TCB produced at «Orgsteklo» (70’000 tons), were approximately:

Table 7: Use of TCB

➢ 38 % in Ust-Kamenogorsk, Kazakhstan
➢ 43 % in two factories in Kamairi (Leninakan), Armenia
➢ 19 % in Serpukhov, Russia

Of the total produced 70’000 tons TCB, 40’000 tons were used for production of industrial capacitors. The remaining 30’000 tons were used for production of non-industrial capacitors (e. g for household appliances), which were produced only in Armenia. The non-industrial capacitors have not been traced.

According to data received from capacitor production enterprises, approx. 60% (24’000 tons) of TCB used for capacitors were delivered to Russian Companies. Of these 24’000 tons, it is estimated that some 14’000 tons of TCB are in industrial capacitors still in Russia today, whereas 10’000 tons have already been released into the environment by improper disposal.

Capacitors

An average amount of PCB in capacitors was estimated from questionnaire responses where this information was provided. These capacitors had an average TCB content of 17.2 kg.

3.4 Applications and Remobilisation

Due to their characteristics PCB mixtures (either pure or together with other substances) have been used in open and closed systems.

Table 8: Extract of Applications in «Closed Systems»

➢	Insulation and/or cooling fluid in transformers
➢	Dielectric fluid in capacitors
➢	Hydraulic fluid in lifting equipment, trucks and high pressure pumps (mining industry especially)

Picture 2: Closed Systems, Transformer

Picture 3: Closed Systems, Capacitors

PCBs were also used in «open applications» such as in paints, in the car industry, sealants in the construction industry, etc.

Table 9: Extract of Applications in «Partially Open applications»

➢	Heat transfer fluids
➢	Hydraulic fluid
➢	Vacuum pumps
➢	Switches
➢	Voltage regulators
➢	Liquid filled electrical cables
➢	Liquid filled circuit beakers

Picture 4: Partially Open applications, Vacuum Pump

Picture 5: Partially Open applications, Liquid Filled Cables

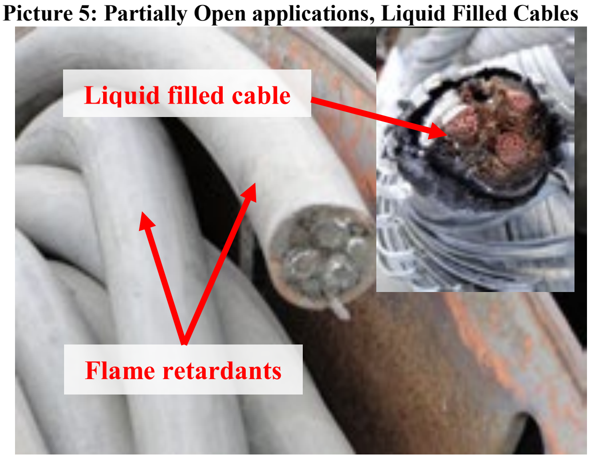


Table 10: Extract of Applications in «Open applications»

➢	Caulks/sealants in buildings
➢	Paints and plaster
➢	Anti-corrosion coatings (indoors and outdoors)
➢	Surface coatings (e.g. floors)
➢	Cables and cable sheaths
➢	Lubricating fluid in oils and grease, cutting oils
➢	Flame retardants and impregnating agents
➢	Adhesives
➢	Carbonless copy paper
➢	Pesticide extenders
➢	Inks

As these materials are not usually defined as hazardous waste at the time of disposal, PCBs often find their way into the environment.

Picture 6: Open applications, e.g. Sealants

Picture 7: Open applications, e.g. Corrosive Protection

3.4.1 The Problem of PCBs in Open Applications

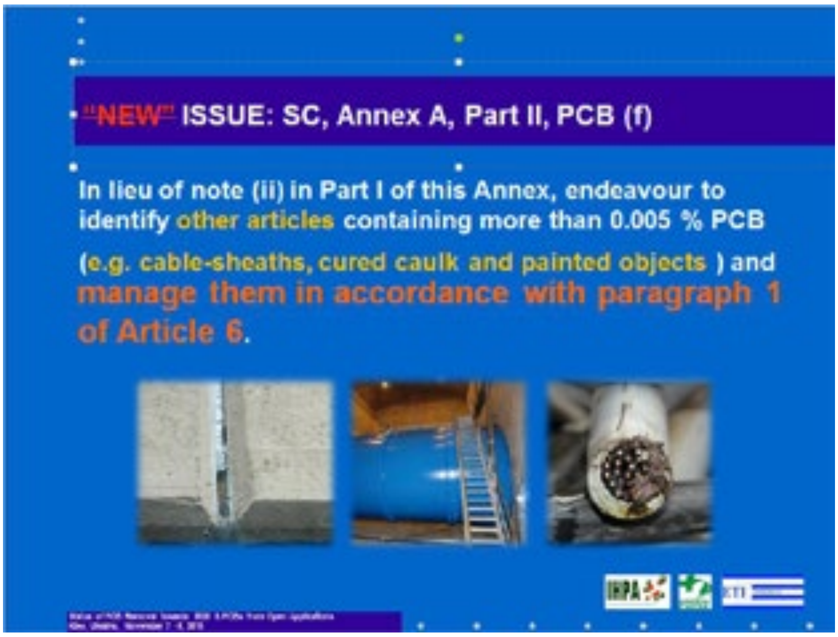
The Stockholm Convention requires in Annex A, Part II (f) that efforts should be made to identify other articles containing more than 0.005 % PCBs (e.g. cable-sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 1 of Article 6.

Apart from Annex A, Part II (f) of the Stockholm Convention, the handling, remediation, removal and disposal of open applications of PCBs are not regulated by any international guideline yet.

Whereas the Stockholm Convention and the PCB Elimination Network (PEN) still focus on closed systems in developing countries and countries in transition, some European countries and the US have been tackling the more complex problem of open applications of PCBs for several years.

To this day, awareness of closed applications of PCBs (capacitors and transformers) is still low in some countries – and awareness of open applications is generally non-existent.

In the past, it was generally believed that expensive products like PCB containing caulks and coatings had not been imported to developing countries because they were rather expensive. Today we know that PCBs have been respectively are still in use worldwide due to development aid projects, and imports of products which were once considered harmless.



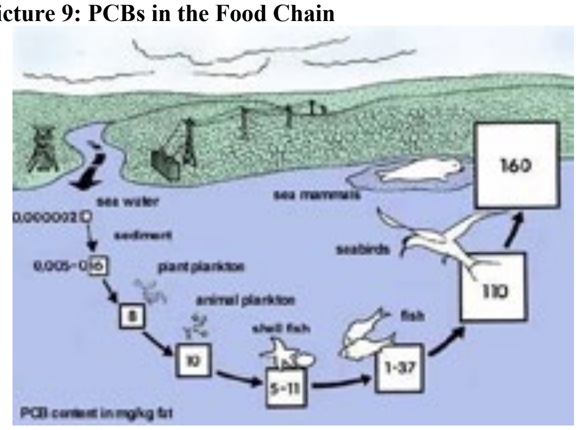
Be aware of hidden sources of PCBs
The largest single hidden PCB source resulting in improper disposal is transformer bushings. The dielectrics in bushings have no fluid connections with the dielectrics in the transformers to which they are attached so analysis of the transformer dielectric will not reveal anything about PCBs in the bushing. "Pot heads," cable termination apparatus that connect transformers to incoming power sources, can be filled with a tar-like material that can contain very high concentration PCBs. Any tar-like or asphalt-like material used as an insulator or dielectric should be suspected of containing PCBs. Small motors often require starting capacitors that can contain PCBs. Voltage regulators and substation transformers can contain load tap changers operated by small motors that contain PCB starting capacitors. Small motor capacitors can leak, contaminating the dielectric fluid. Asphalt material in fluorescent light ballasts, along with lubricants and caulks, are other potential sources. Air compressors have been serviced with PCB containing lubricants. Oil-filled switches, circuit breakers, and enclosures should also be suspect.

Although the release of PCBs into the environment has taken place in very limited areas, global atmospheric and ocean currents have dispersed the substance throughout the whole planet. PCBs can be found in air, water, soil, plants, animals, and humans.

Due to its chemical and bio-chemical stability and its high solubility in fatty tissue, the substance has entered the food chain as a bio-accumulator. As a result, animals at the top of the food chain i.e. predators or humans often show a far higher contamination than plants or water.

Picture 8: PCB Pollution in Glaciers

Picture 9: PCBs in the Food Chain



3.5 PCB in the Mining Industry

In many countries the mining industry regardless of underground mines or open pits is an industrial sector which needs special attendance a regarding PCB.

Abandonment of Polychlorinated Biphenyl (PCB)-containing electrical equipment in surface or underground mines can result in PCB contamination of ground and surface waters which can contribute to local human health hazards and to the already existing PCB contamination of the ocean which is considered to be the final sink for PCBs. PCBs used as dielectrics in transformers, capacitors, and fluorescent light ballasts are common throughout industry worldwide.

PCBs are not the only chemicals used in mines. Underground repair facilities have used chlorinated solvents such as trichloroethane, tetrachloroethene, and methylene chloride for cleaning and degreasing equipment. The release of these solvents, in addition to constituting their own threats of ground water contamination, can mobilize PCBs. Some mines maintain their own landfills which contain improperly disposed PCBs and solvents.

Underground and surface mines and the attendant crushing, milling, and smelting facilities may use PCB-containing electrical equipment. PCBs transformers are usually grouped in substations underground. PCB capacitors are in similar locations. PCB capacitors can be in electric locomotives. In coal mines, PCB capacitors can be in wheel or skid-mounted power centre.
The extent and complexity of underground mines present opportunities for abandonment or illegal disposal of hazardous wastes. The presence of hazardous wastes may not be evident until they are found in the local ground water. Abandoned underground electrical equipment may remain intact and not release PCBs for a very long time. Testing waters issuing from abandoned mines may not indicate whether or not PCBs are present in intact electrical equipment.

In the mining sector, PCBs are most likely to be found in such electrical devices and applications:

Transformers	➢ Grouped in permanent substations ➢ Located singly ➢ Mounted on mine cars that can be transported throughout the mine
Capacitors	➢ Grouped in permanent substations ➢ Located singly ➢ Mounted on mine cars ➢ In electric locomotives ➢ In wheel or skid-mounted power centres
Small Capacitors	➢ Fluorescent light ballasts
Used PCB oils	➢ Drums of used transformer oil / lead cables
Hydraulic oils	➢ Trucks ➢ Cables, Lines

Lot of the closed and open applications are still in use in the mining industries.

Picture 10: Electrical Devices in Mining Locomotives

Picture 11: PCB Ballasts in Fluorescent Lamps

3.6 Impact of PCBs on the Human Health and the Environment

PCBs have a long and documented history of adverse effects in wildlife. They have been associated with poor reproductive success and impaired immune function. An example of this can be seen with captive harbour seals in the Arctic. A major flood in the Saginaw River basin in Michigan in 1986 allowed PCB contaminants to spread through the ecosystem and the following year's hatch rate of Caspian terns in the area dropped by more than 70 per cent. Hatching chicks showed developmental deformities, and none survived more than five days [WFPHA, 2000]. In Switzerland, the otter became extinct because of PCB induced infertility.

How do PCBs get into the human body?
PCBs are mainly taken in via the stomach-intestine tract. In Switzerland, the average PCB intake through the mouth (food and drink) is 3-4 µg per day and person. The tolerable daily intake (TDI) established by the WHO (World Health Organization) for humans is 30-60 µg PCBs, i.e. even a lifelong intake of 30-60 µg PCBs should not cause any damage (based on a person's weight of 60 kg). Furthermore PCBs are absorbed through the skin and the lungs.
Human exposure to PCBs may occur through ingestion of contaminated food and/or water, inhalation of PCB vapors in the air and through direct dermal contact. After absorption, PCBs circulate in the blood throughout the body and are deposited in fatty tissues and a variety of organs, including liver, kidneys, lungs, adrenal glands, brain, heart and skin.

Are PCBs acutely toxic?
Generally immediate risks posed by PCBs are very rare. PCBs are not acutely toxic, i.e. high quantities have to be taken in until immediate effects can be noticed. However PCBs bio accumulate in the human body and are only excreted to a very small extent even over many years. Therefore extensive safety measures must always be taken when handling PCBs.

What are the hidden (latent) risks of PCBs?
It is difficult to estimate the long-term effect of a chronic PCB contamination in small doses. Influences on the thyroid hormones and possible effects on the development of the brain are discussed. Large doses of PCBs in the human body can cause damage to liver, kidneys, and brain. In addition PCBs are thought to influence the reproductive system and cause deformations to unborn children

Are PCBs carcinogenic?
Carcinogenic effects of PCBs on rodents have been proven, however have not yet been confirmed in humans. Based on this research PCBs are generally categorised as carcinogenic (World Federation of Public Health Associations, May 2000).

What are the symptoms of an acute poisoning?
Foodstuffs were contaminated with Kanechlor 400 (a PCB mixture with approx. 48 % chlorine content) during an incident in Yusho/Japan in 1968. The following symptoms were noticed: Swollen lids, chloroacne, skin pigmentations, sight defects, numbness in arms and legs, weakness and tiredness. Later also blindness, hepatitis, diarrhoea, changes in the menstrual cycle, headaches and hair loss could be observed.

Why are fires particularly dangerous?
People are particularly at risk if PCBs are exposed to heat and/or fires. Dioxins and Furans (Polychlorinated Dibenzodioxins, PCDD, and Polychlorinated Dibenzofurans, PCDF) are unintentionally formed and released from thermal processes involving PCBs as a result of incomplete combustion or chemical reactions. These substances are highly toxic, even in very small doses (also known as Seveso poison).

As a result of manufacturing processes, even some applications of PCBs can be slightly contaminated with PCDF (Furans). This applies to cooling fluids in capacitors and PCB containing paints.

Picture 12: Typical Chloracne

Picture 13: Symptom Hair Loss

Another result of the incident was a higher percentage of miscarriages or deformations. The absorption through the skin and the respiring of PCB vapours and contaminated dust particles do not cause such immediate symptoms in general. They are however the main cause of possible long-term damage.

Much of the information on acute toxicity of PCBs comes from serious food contamination incidents in Yusho, Japan, Yusheng (Taiwan) and Belgium. As PCBs are highly lipid soluble, they bio accumulate as they progress up the food chain. As a result, high levels of PCBs exposure can occur through ingestion of game animals or fish and ingestion of breast milk from mothers who draw a daily diet from game meat and fish. This risk is present among people who live near hazardous waste sites and consume game meat and fish that they catch by themselves. Some of the human health effects are associated with PCB exposures, like:

- immunotoxicity - immunosuppression, increased sensitivity towards infectious diseases, increased incidences of ear and upper respiratory tract infections, lower rate of successful immunization;
- reproductive/developmental effects – failure to conceive, decreased birth weight, impairment of neurological development;
- neurological/behavioural effects – impaired learning ability, attention and cognitive deficits, deficiencies in psychomotor development, learning and memory deficits, impaired visual recognition, and
- cancer – postulated that PCBs may be associated with liver, gastrointestinal and skin cancer

Three distinct types of human exposure to POPs and PCBs can be documented:

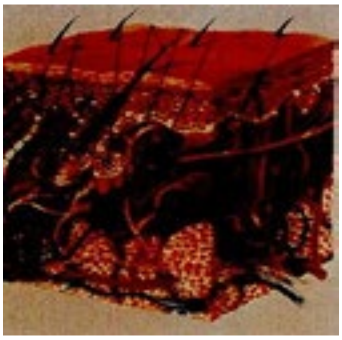
- **High-dose acute** exposure can result from accidental fires or explosions involving electrical capacitors or other PCB-containing equipment, or highly contaminated food. This can cause chloracne (a painful, disfiguring skin illness), liver damage, nausea, dizziness, eye irritation, and bronchitis.
- **Mid-level chronic** exposure is predominantly due to the occupational exposure and in some cases due to the proximity of environmental storage sites or high consumption of a POPs contaminated dietary source, such as fish or other marine animals.
- **Chronic, low-dose** exposure is characteristic for the general population world-wide as a consequence of the existing global background levels of POPs with variations due to diet, geography, and level of industrial pollution. Low level and population-wide effects are more difficult to study. People are exposed to multiple POPs during their lifetime and most people today carry detectable levels of a number of POPs in their body [WFPHA, 2000].

4 Safety

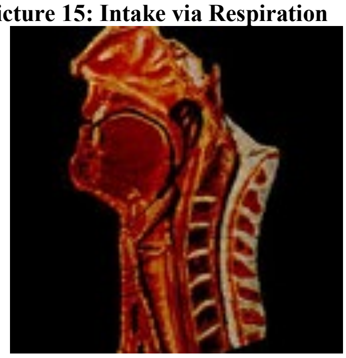
4.1 Exposure to PCBs

There are three possibilities for PCBs to get into the human body: Through stomach and intestine, through the skin and through respiration.

Picture 14: Intake via Skin



Picture 15: Intake via Respiration



Picture 16: Intake via Stomach/Intestine

4.2 Stomach and Intestine Picture

As explained earlier, a very small amount of PCBs is absorbed by the stomach and the intestine from the food we eat. When working with PCB containing equipment and PCB contaminated materials, it is vital to obey the following rules to prevent an increased intake of PCBs:

Foodstuff shall not be stored or consumed near PCB containing equipment or PCB contaminated materials. After handling PCBs containing equipment or PCB contaminated materials, hands shall always be washed with warm water and soap.

4.3 Skin

The biggest risk for people handling PCBs lies in the exposition of the skin, because it absorbs the substance very quickly. It is therefore important to avoid direct contact to PCBs by skin.

To protect skin from direct contact with PCBs, the appropriate Personal Protective Equipment (PPE) must always be worn.

4.4 Respiration

PCBs are not very volatile, therefore the danger of absorbing PCB when facing small amounts of PCB can be neglected, as long as the ventilation is sufficient. If there is a spill of a bigger size, then a respiratory mask with a filter for organic vapours and dusts should be worn.
PCBs adhere to dust though, so when the situation implies that dust (e. g. from drilling in concrete) could be contaminated with PCBs, a respiratory mask with a filter for organic vapours and dusts must be worn.

Protection with respiratory masks with a filter for organic vapours and dusts is a must when facing major spills or activities with contaminated dust involved.

Table 11: Basic Emergency Guidelines

Hazard potential of PCBs - The PCB decomposition products in fires («Dioxins») are regarded as a major hazard - PCBs are only very slightly volatile and the greatest danger is therefore that of absorption of the substance through the body surface (e.g. as a result of splashes, leakage) - PCBs adhere to dust so that this substance can enter the respiratory organs via dust particles - Since PCB accumulates in the human body and is excreted only to a very small extent, extensive safety measures should always be taken when handling PCB (protective clothing, etc.)
Basic personal protection for works with liquid PCBs - Suitable respiratory protective device - Safety goggles or eye protection in combination with respiratory protective device - Plastic or Neoprene gloves, Tyvek or other protective clothing, boots - Eyewash bottle with clean water
Immediate action during transport - Notify specialists and police or fire brigade - Move vehicle away from rivers and lakes to open ground and stop the engine - No smoking, no naked lights - Mark roads and warn other road user - Keep public away from danger area - Keep upwind
Spillage - Put on protective equipment before entering danger area - Stop leaks if possible (e.g. with SEDIMIT) - Contain or absorb leaking liquid with suitable material (absorbents or sand or earth) - Prevent substance entering sewers and work pits - Advise an expert and police
Fire - Keep equipment and/or container(s) cool by spraying with water if exposed to fire - Extinguish secondary fire, extinguish with foam or dry chemical - In case of fire, warn everybody, «Toxic hazard» - Advise an expert and fire brigade
First aid - Remove contaminated clothing immediately and wash affected skin with soap and water - If substance came into the eyes, wash out with plenty of water, require medical assistance - Person who have inhaled the gas or fumes produced in a fire or who have come into contact with the substance may not show immediate symptoms. They should be taken to a doctor with the Transport Emergency Card. Patient must be kept under medical supervision for at least 24 hours.

5 Sampling and Screening

5.1 General Sampling Procedures

Before leaving for a site inspection, it must be ensured that all relevant parties at the site have been informed, and that all sampling and safety equipment is ready. Before starting the sampling on site, the general safety rules as well as the specific precautions when working with electrical devices shall always be communicated during a specific briefing and/or personal instruction. Work may only be carried out in the presence of a local electrician.

Picture 17: Ensure having all sampling/safety material

Picture 18: Consider all Safety Precautions (Power!!!)

The main source of error in an inventory process is the sampling.

Therefore the following points must be particularly considered:

<u>Risk of Cross Contamination</u>
Contamination is easily spread from one sample to another. When using one-way material (e.g. Kleenex, pipettes, metal scoops, etc.) it must be ensured that a new product is used for every new sample. If this is not possible, the used equipment must always be cleaned before another sample is taken. If possible solvents (e.g. technical acetone) should be used for this purpose.

<u>No Confusion of Samples</u>
In order to prevent a confusion of samples, it is crucial to clearly mark the sample containers immediately when a sample has been taken. The identical data must also be recorded in a sampling report. A label must be affixed to the sampling containers.

Picture 19: Taking all records of sampled electr. devices

Picture 20: Labelling BEFORE Sampling

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Sampling Report

The sampling report must be filled in immediately. If it is completed at a later stage important information could be lost or forgotten. Take your time go gather all necessary information and perform a brief risk assessment (condition of device, any leakages, water or agriculture nearby etc.).

5.1.1 Sampling of Transformers

Safety Precautions

In order to prevent the skin from coming into contact with PCBs, one-way protective gloves must be worn. The eyes must be protected against possible oil splashes by wearing goggles.

Position of Sampling

The sample can be taken by using the drain tap, which usually is at the bottom of the transformer. If a transformer has been disconnected from power for over 72 hours the sample should generally be taken from the bottom, as PCB sinks to the lower level because of its higher density. Sometimes the gasket gets damaged when the drain tap is opened. It is therefore advisable to always have a spare gasket ready.

Alternatively transformers can be sampled via the oil filling cap by using a hand pump (consider: a new hand pump must be used for each transformer). Oil samples from the expansion receptacle cannot always be regarded as representative, because the oil does not circulate and thus it is not really mixed.

Usually, transformers are sampled when they are in use and thus when they are live. Corresponding protective measures and safety regulations must be known and considered at any time!

Extend of the Screening/Analysis

If a PCB inventory demands an analysis of the cooling fluid, the owner has the possibility to test the oil quality at the same time. This is dependent on the age and condition of the equipment. Such a preventive maintenance allows an assessment of the technical condition of the transformer and thus helps prevent possible damages/failures resulting from e.g. acidity or increased dampness.

Oil quality analyses must only be run after a negative PCB result; otherwise the laboratory equipment will be contaminated with PCB.

The following steps must be followed when sampling a transformer:

- Place a drip tray under the drain tap,
- Drain off the required amount of oil into the sampling bottle – quantity depending on the intended analysis, and
- Carefully retighten the seal.
- Then affix a label both on the sampling bottle and on the transformer with the same serial number as can be found on the eco-card. The eco card contains the following information:
    - Site (Substation)
    - Manufacturer of Transformer
    - Power (KVA) or (MVA)
    - Serial number
    - Year of manufacture
    - Date of sampling
    - Name of person in charge.

Remark: Sampling is also an opportunity to collect information for the database.

Picture 21: Place Drip Tray under Drain Tap

Picture 22: Open Drain Tap/Valve

Picture 23: Sampling

Picture 24: Control of labels and closed glass vial

If the **oil quality** shall also be tested, the following steps have to be considered:

- Sampling via drain tap: Drain off 1 to 2 litres of oil first in order to clean the drain from particles which might have accumulated in that area,
- Amount of oil required: 0.5 to 1 litres,
- Leave the oil for 24 hours, in order to allow particles and water to settle,
- Take sample from the upper third of the oil for the analysis using a pipette, and
- Return the drained 1 to 2 litres of oil back into the transformer (only if the oil filling cap is out of reach of the high voltage, otherwise shut off the transformer before refilling the drained oil)

All wastes must be disposed of in an environmentally sound manner – the disposal method always depends on the analysis result.

IMPORTANT: Experience has shown that numerous transformers that were sold as PCB free equipment actually **do** contain PCB. In the 70s transformer manufacturers and oil suppliers often were not informed about the risks and the potential of cross contamination of PCB by using identical cisterns, transport containers, pipe systems and fittings for mineral oil and PCBs. Therefore many new transformers were unintentionally contaminated by PCBs. Some transformers were also contaminated by the user during refills or maintenance work.

5.1.2 Sampling of Cooling Fluids

Sample Containers (glass vials)

If only the PCB content of the oil is analysed, 20 ml glass vials can be used provided analysis is performed on site. If the analysis is performed elsewhere and the samples have to be transported over long distances, 30 ml glass bottles should be used as sample containers because they are more robust. If a holder of a transformer also wants to have the quality of the oil tested, a 500 ml glass bottle should be used.

Often transformers have already been phased out, temporarily stored and drained at the time a PCB inventory is compiled. In such cases, it needs to be decided on site, how the sampling shall be performed. But even if a device has been drained, there should be still be some oil present in the passive part of the transformer due to the leaching in the days and week after the draining. Usually there is not enough oil to sample it via the drain tap, as the oil layer is deeper then the valve. In such cases, the device needs to be sampled through an opening in the top. Stiff tubes (e.g. glass or PE) can be used to take a sample of the oil at the bottom of the transformer.

If there is no oil at all left in the device, solid materials from the active part of the transformer could to be sampled and analysed (wood or insulation paper). However, such analysis can only be performed in a laboratory.

Due to practical reasons it might be advisable to label such drained transformers as PCB-suspected and note it accordingly in the physical site inspection report (respectively inventory questionnaire) and leave it for future investigations.

Picture 25: Sampling of oil drums (different layers)

Picture 26: Affix labels while sampling and later final one

5.1.3 Sampling/Evaluation of Capacitors

Power capacitors are built into hermetically closed containers and there is no direct access to the cooling liquid.

In many cases, the manufacturer provided information about the type of dielectric liquid, either with identification on the nameplate or with a separate tag confirming that the contents are harmful for the environment. Such capacitors do not need further investigation. They definitely contain PCBs and must be treated accordingly.

Picture 27: Identification of Capacitor Fluid

Picture 28: Tag Information on Capacitor

If a designation is missing and relevant information from the manufacturer is not available, the only way to test the dielectric liquid is to drill a hole in the casing on the top or cut the isolator and retrieve an oil sample. This can be done by (e.g.) using a pipette (using only once).

After this exercise the capacitor is unusable and as it is now damaged it must be stored in appropriate containers (e.g. in an UN-approved steel drum). Therefore it is advisable to only sample capacitors that are already out of service. If there is a series of the same capacitors, it is usually sufficient to sample only two devices out of the series.

Thus only phased out capacitors can undergo this procedure. Capacitors still in service and manufactured before 1993, with missing information about the dielectric liquid have to be labelled as PCB suspected equipment.

However, it was also said that there are no reliable information available by when the PCB production has been stopped in Countries like e.g. China and North Korea. There are rumors that in North Korea PCB are still produced nowadays.

Preferably a mixed sample originating from the two capacitors with the lowest serial numbers should be analysed. Caution should be taken if the analysis reveals PCB, even if it is only a slight contamination. Such contamination could have been caused during the production e.g. when using the same pumps for mineral oil and PCB oil. In such cases all capacitors of one series must be analytically tested.

Personal Protective Equipment (PPE)

The PPE for these activities consist of protective gloves and goggles. Respiratory protection is not necessary when taking single samples. If several samplings are carried out at short intervals light respiratory protection is recommended.

Sampling of Small Sized Capacitors

Usually capacitors of a smaller size do not contain PCB as a floating liquid in the casing, but rather as an impregnating agent of the insulation layers in the capacitor. It is therefore not possible to drill a hole in the casing and take an oil sample with a pipette.

Prepare the working place with oil carpet and a tray (metal if available). The personal protection protective equipment comprises gloves, safety goggles and in case of poor ventilation a respiratory mask. Firstly, a circle has to be cut around the top end of the capacitor casing near the contacts using a small iron saw. Once the top has been lifted, it is usually possible to pull out the active part. With a tool remove about 1 cm^3 of the insulation and conductor layers and place them in a 60 ml glass vial. The samples can then be prepared in the laboratory and analysed by gas chromatography.

All tools and materials that came in contact with the capacitors have to be cleaned e.g. with acetone, or disposed of as hazardous waste.

Picture 29: Small Sized Capacitors

Picture 30: Sampling of Small Sized Capacitors

5.2 Introduction to Field Screening Test Kits and Laboratory Analysis

PCB analysis can be divided into two categories: Specific and non-specific methods. Specific methods include gas chromatography (GC) and mass spectrometry (MS) which analyse for particular PCB molecules. Non-specific methods identify classes of compounds such as chlorinated hydrocarbons, to which PCBs belong. These non-specific methods include PCB field screening tests like CLOR-N-OIL and CLOR-N-SOIL test kits as well as the L2000 DX field analyser.

In general PCB specific methods are more accurate than non-specific methods but they are more expensive, take longer to run, qualified staff is needed, and they cannot be used on site.

Two non-specific tests are below described which are however ABSOLUTELY NOT recommended to be used due to uncertainties in results and high potential of polluting water and air!

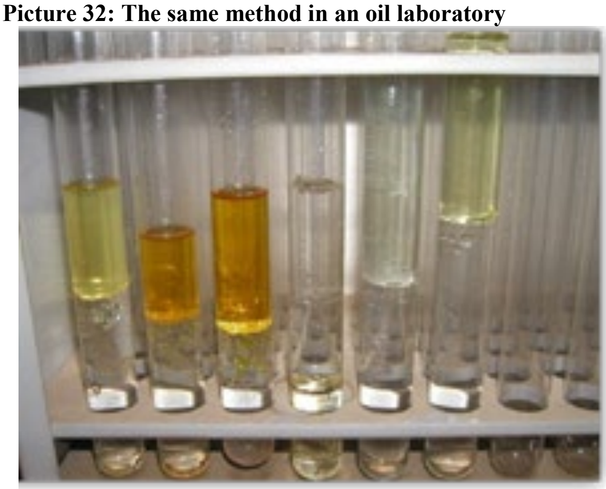
Density Tests

The easiest way to verify whether or not oil contains heavy concentrations of PCBs is a simple density test: → Use a 10 ml glass vial → pour some water into the vial → add some dielectric liquid

If the oil layer is at the bottom of the vial the density of the oil is > 1. In such a case there is no doubt that the PCB concentration is rather high. If the oil layer remains on top of the water layer; it can be assumed that it is a mineral oil with a density of < 1.

Picture 31: Density Test with oil in water on a scrap yard

Picture 32: The same method in an oil laboratory



However, a density test is only an emergency method in order to identify a pure PCB source. It cannot be recommended as a reliable tool for inventory purposes, as contaminated oil cannot be detected. Furthermore, there is a high risk of water/sewage contamination by hydrocarbons.

Beilstein Method

A piece of copper oxide fastened to a platinum wire is moistened with the oil to be tested and held in the outer zone of a Bunsen flame. As soon as the carbon has burned away, the presence of chlorine is indicated by the greenish or greenish-blue colour of the flame. This colour is produced by volatilizing copper chloride and its intensity and duration depends on the amount of chlorine present.

This test may only be performed in laboratories in chapels by experienced chem

There is a risk that highly toxic dioxins are unintentionally formed and released.

5.3 PCB Screening Test Kits

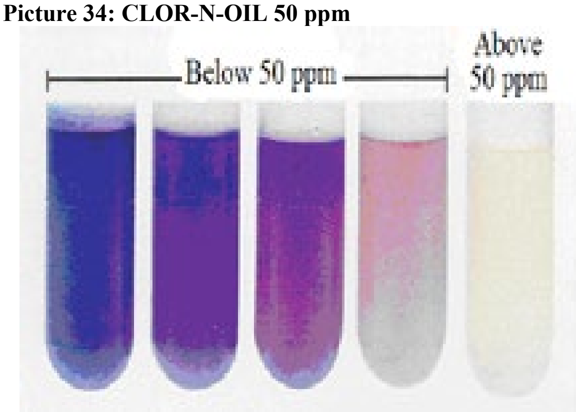
Chlorine Detection Test Kits

There are a variety of different brands of chlorine detection test kits available: Immunoassay technology ENVIROGARD by Millipore, KWIK-SKRENE by the General Electric Company and CLOR-N-OIL and CLOR-N-SOIL by Dexsil. The Dexsil test generally distinguishes between the PCB tests kits for oil (e.g. CLOR-N-OIL) and for soils (e.g. CLOR-N-SOIL).

The two Dexsil tests rely on the same principle: The chlorine atoms are chemically stripped away from the PCBs, the total chlorine concentration is determined and indicated by a colorimetric reaction. Three different test levels are available: **20 ppm, 50 ppm and 500 ppm**. Each kit is used in the same way. The end point for each has been adjusted so that it changes colour at the required level. The kit is a «GO / NO GO» type of test where the result is either positive or negative.

Picture 33: CLOR-N-OIL

Picture 34: CLOR-N-OIL 50 ppm



Instrumental Detection of the Chlorine Concentration

Instrumental detections of the chlorine concentration are methods that use instruments or analysers to determine the chlorine concentration in the samples. The L2000DX relies on the same basic chemistry as the CLOR-N-OIL test kits, however instead of a colorimetric reaction; the L2000DX uses an ion specific electrode to quantify the contamination in the sample. Sample analysis is available for transformer oils, soils, water and surface wipes. The usable measurement range for oils and soils is 2 to 2000 ppm; 20 ppb to 2000 ppm for water and 2 to 2000 µg/100 cm^2 for wipe samples.

The L2000DX Analyzer is pre-programmed with conversion factors for all major Aroclors and most chlorinated pesticides and solvents. The built-in methods include corrections for extraction efficiencies, dilution factors and blank contributions.

Picture 35: Soil Sampling of Contaminated Area

Picture 36: L2000 PCB/Chloride Analyser on site use

The L2000DX can be used in the field or laboratory by non-technical personnel. An oil sample requires about five minutes to run while water, soil and surface tests take about ten minutes each.

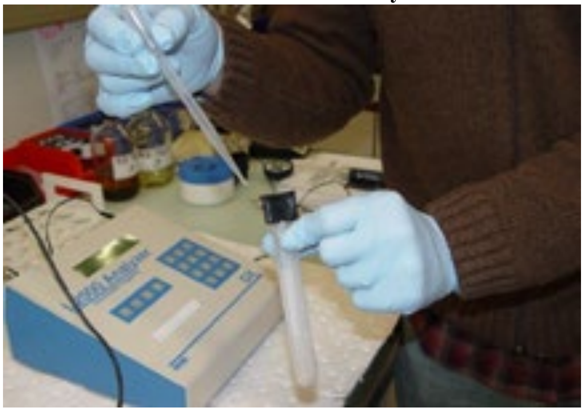
This eliminates the need to wait days or even weeks for laboratory results. Crews working at a site can take immediate action to secure equipment, isolate a site, or remove contaminated soil.

Instrument calibration is required at the beginning of each day (takes about 2 minutes). After calibrating, a reagent blank is tested to ensure the analysis is being run properly and to provide a baseline for accurate low-level results. Blank subtraction can be incorporated into the method and is automatically updated upon calibration. The preparation steps involve extracting the chlorinated organics from the soil, water or wipe material, (not required for PCB in transformer oil), and reacting the sample with a sodium reagent to transform the chlorinated organics into chloride. The resulting chloride is quantified by the L2000DX Analyzer. Several samples can be prepared concurrently, then analysed in less than a minute per sample. Samples can be prepared and analysed at a later time. One operator can complete about 65 oil tests, or 45 soil or surface wipe tests in an eight hour day.

Table 12: Advantages and Disadvantages of Field Screening Tests

Advantage	Disadvantage
➢ Time: Within minutes it is known whether the sample contains > or < than 20/50/100 ppm PCB.	➢ Can provide false-positive results (but never false-negative).
➢ Easy to use: The tests follow a simple procedure that can be performed by anyone in the field or lab.	
➢ Inexpensive: A PCB determination by test kits is less expensive than analysis in the laboratory.	
➢ Economical: Many samples do not need to be analysed by GC at all.	

Picture 37: L2000 use in the Laboratory



Picture 38: Use of Clor-N-Soil on Site

To save analysis costs and time it is advisable to use screening tests whenever applicable. Nevertheless it has to be considered that these methods test for the presence of chlorine in the sample being examined. As a result other chlorinated compounds, which can be part of the sample, could cause false positive results because the analysis method assumes all chlorinated compounds are PCBs. False negative results are not possible as if there is no chlorine present, PCBs cannot be present either.

Thus, if a test kit or the L2000 DX analyser shows positive screening results (PCB > 50 ppm) verification by gas chromatography is always necessary.

In this case the sample for gas chromatography analysis is to be kept and forwarded to the appropriate laboratory. If results of a GC analysis show a significantly lower result than the screening tests there is no reason to be alarmed. The tests are standardised for Aroclor 1242 with chlorine content of 42 %. Analyses with higher chlorinated PCB samples (e.g. Aroclor 1260 with chlorine content of 60 %) consequently show a higher result than the true PCB content. Thus the screening tests are always on the safe side.

6 Maintenance of Equipment Containing PCB

The maintenance of a device should be performed according to the procedures issued by the manufacturer and by the corresponding standard manuals of the electric industry associations. In the following, a general view of the key elements of the maintenance of PCB containing transformers and capacitors is presented.

6.1 Best Working Practices

When performing light repair or maintenance work on PCB containing equipment, the following safety precautions for the protection of the employees and the environment have to be taken:

- Direct contact of the skin with PCB contaminated materials must be avoided by wearing gloves and safety goggles. According to the type of work to be performed, protective clothing and a respiratory mask must also be put at the workers' disposal,
- The working area must be adequately ventilated,
- Spills must be prevented in every case by using drip trays or adequate plastic tarps,
- Every contact of PCBs with a flame or any other heat source over 300 °C and use of a grinder must absolutely be avoided (risk of highly toxic Dioxins and Furans),
- All used tools and other working materials that got in contact with PCBs must be disposed of as PCB contaminated waste in an environmentally sound manner or otherwise have to be decontaminated with an appropriate solvent (technical acetone). The only possible materials to be decontaminated are steel, glass, and ceramics, and
- Operations which involve draining, rewinding of coil, etc. may only be performed by companies approved for such task.

Picture 39: Transformer Maintenance

Picture 40: Active transformer part in service station

Furthermore we have to ensure that workers are aware of the PCB's, they shall respect the harm but not be afraid. They shall follow the hygiene rules and of course the respective tools and materials must be available to handle PCB-containing electrical devices.

7 Temporary Storage Considerations

PCB containing wastes should generally not be stored on sites that are not specifically designed for interim storage of hazardous wastes. Usually, there is no appropriate infrastructure to guarantee a safe storage. Uncontrolled and inexpert interim storages as shown in the pictures below endanger people and the environment, and result in unnecessary additional costs.

Picture 41: Bad Example I (open air storage)

Picture 42: Bad Example II (no tip trays)

PCB containing devices should be packed safely and in compliance with the applicable laws as soon as they have been phased out, even if their disposal takes place at a later stage. Irrespective of the quality of the temporary storage, the final and environmental sound disposal of the waste must be scheduled and coordinated that storage will not exceed twelve months. Generally, electrical equipment should only be phased out and stored, once an appropriate method of disposal has been chosen.

When setting up a temporary storage for PCB wastes it is important to choose an appropriate storage site/area. Locations close to rivers, groundwater, residential or farming areas, and ecological reserves or for example food processing industries CANNOT be considered suitable. If possible, the interim storage should be specifically designed for PCB containing equipment and wastes.

The Basel Convention recommended procedures for the storage of PCB waste are:

- Storage sites inside multi-purpose buildings should be in a locked dedicated room or partition that is not in an area of high use.
- Outdoor dedicated storage buildings or containers (often shipping containers are used) should be inside a lockable fenced enclosure.
- “Sensitive sites” such as hospitals or other medical care facilities, schools, residences, food processing facilities, animal feed storage or processing facilities, agricultural operations, or facilities located near or within sensitive environmental sites should not store PCBs, PCTs and PBBs on the premises if possible. If transfer to another location or immediate destruction is not possible then the storage site should be a dedicated storage building situated as far away from the high-traffic and operational areas of the property as possible.
- PCBs, PCTs and PBBs may be stored together but should not be stored with any other materials including other types of hazardous wastes. The exception to this rule is that other chlorinated organics similar to PCBs, PCTs and PBBs awaiting destruction and any materials resulting from the cleanup of PCB spills or fires may be stored in the same site with the approval of the appropriate government agency.
- Storage rooms, buildings and containers should be ventilated to the outside air or should be completely sealed to prevent any escape of volatile contaminants. These are distinctly different options and the choice of option depends on local and national law and policy, local health and safety policy and concerns and site-specific variables.

- Ventilating a site to the outside air is considered when exposure to vapours for those who work in the site is a concern. Adequate ventilation ensures that the air inside the site is breathable, non-explosive, and has contaminant concentrations below applicable human health exposure limits. If mechanical exhaust ventilation to the outside air is used an organic vapour capture system (e.g. activated carbon) should be considered to minimize the release of contaminants to the environment.
- Completely sealing a site so that no vapours can escape to outside air is considered when environmental concerns are paramount and there is minimal entry into the site by humans. If a site is sealed with no ventilation then all persons entering the site must wear respiratory protection at all times and may need to use supplied air. In a sealed site the oxygen level, contaminant level and explosive atmosphere must be determined before each entry. An entry system may need to be installed that prevents the escape of inside air when the site is accessed. An internal air treatment system may be used to reduce the build-up of contaminant and explosive vapours.
- Dedicated buildings or containers should be in good condition and made of hard plastic or metal, not wood, fibreboard, drywall, plaster or insulation.
- The roof of dedicated buildings or containers and surrounding land should be sloped so as to provide drainage away from the site.
- Dedicated buildings or containers should be set on asphalt, concrete or durable (e.g. 6 mil) plastic sheeting.
- The floors of storage sites inside buildings should be concrete or durable (e.g. 6 mil) plastic sheeting. Concrete should be coated with a durable epoxy.
- Storage sites should have a fire alarm system.
- Storage sites inside buildings should have a fire suppression system; preferably a non-water system. If the fire suppressant is water then the floor of the storage room should be curbed and the floor drainage system should not lead to the sewer or storm-sewer or directly to surface water but should have it's own collection system such as a sump.
- Liquid wastes should be placed in containment trays or a curbed, leak-proof area. The liquid containment volume should be at least 125% of the liquid waste volume taking into account the space taken up by stored items in the containment area. The curbing or sides of the containment must be high enough, or the wastes kept back from the edge of the curbing far enough, that a leak in any drum or container would not "jet" over the edge of the curb or side.
- Contaminated solids such as lamp ballasts, small capacitors, other small equipment, contaminated debris, contaminated clothing and spill cleanup material and contaminated soil should be stored in containers such as barrels or pails, steel waste containers (logger boxes) or in specially constructed trays or containers. Large volumes of soil or other contaminated material may be stored in bulk in dedicated shipping containers, buildings or vaults as long as they meet the safety and security requirements as described herein.
- A complete inventory of the PCB, PCT and PBB wastes in the storage site should be created and kept up to date as waste is added or disposed. A copy of the inventory should be kept at the site, another copy kept in the corporate offices and a copy filed with the emergency response plan.
- The outside of the storage site should be labelled as a PCB, PCT and/or PBB site. Specific labelling requirements vary by jurisdiction but the intent is to notify anyone approaching the site of the contents of the site.
- All containers of materials in the site should be labelled with hazard labels that clearly indicate the contents of the container.
- The site should be subjected to routine inspection for leaks, degradation of container materials, vandalism, integrity of fire alarms and fire suppression systems and general status of the site.
- Rusting or degrading drums or equipment bodies should be placed inside larger "over pack" drums instead of attempting to transfer the fluid to a new container.
- Draining of equipment or drums should only be performed by a qualified and experienced individual or company.

- All wastes created by transferring PCB, PCT or PBB wastes or by cleaning up spills or drips become wastes that must be stored for destruction or disposal.
- PCB, PCT and PBB wastes should not be diluted in order to avoid a certain type of destruction or disposal unless the resulting diluted material is to be destroyed so that the same quantity of the PCBs, PCTs or PBBs are destroyed as would have been destroyed using the more advanced or expensive technique.
- Wastes should be stored in a safe manner. Drums or pallets should not be stacked more than two high and only if this can be done safely (i.e. the drums are stackable).
- The site should have an emergency response plan and a copy of this should be reviewed and kept on file by the local fire protection agency.
- The site should have a health and safety plan if PCBs, PCTs and/or PBBs are not dealt with in the master health and safety plan for the property, company or agency.

When setting up a temporary storage for PCB wastes it is important to choose an appropriate storage site/area. Locations close to rivers, groundwater, residential or farming areas, and ecological reserves or for example food processing industries CANNOT be considered suitable.

If possible, the interim storage should be specifically designed for PCB containing equipment and wastes.

Minimum Requirements for Temporary Storage Site

Packing

- Capacitors must always stand upright. The insulators are the weakest parts. Never lift a capacitor by holding the insulators, they can easily break off.
- Capacitors must be stored on steel drip trays and leaking devices should be sealed. It is advisable to add absorbents to the steel trays.
- It is possible to put capacitors and contaminated solids into containers that are not UN approved. However, such containers must be checked for damage and leaks before use and cannot be utilized for transports. After use, the containers must be regarded as contaminated and also be disposed of as hazardous waste!

Building

- The floor of a temporary storage must be solid and tight. The storage must be walled and protected against the weather on all sides.
- All entrances to the storage must be marked with an appropriate warning, and access for unauthorized people must be forbidden.
- The area must be fenced and controlled.
- Display emergency procedures and best working practices
- The building should have some openings for permanent ventilation (ventilation systems with filters).
- Increased risks of fires must be excluded (no wooden shed, no storage of inflammable goods in the same building or in the neighborhood). A smoke and fire alarm system should be installed.
- Fire extinguishers (powder) and absorbents (e.g. sawdust) must be available and easy accessible.
- The building should be separated in different areas (reception, handling, separate storage of different waste categories, equipment, etc.)
- No food storage or food processing companies in the neighborhood.

Control

- The temporary on site storage must be authorized by the Competent Environmental Authority.
- The regional fire brigade must be informed about the temporary storage and the kind and quantity of the goods/wastes (by means of copies of storage lists).
- Depending on the size of the storage and the kind and condition of the stored goods/wastes, daily, weekly or monthly visual inspections should be scheduled.

All goods/wastes must be clearly marked giving information about the kind of waste, the date of packing, the weight, the origin and further important data. An up to date storage list must be accessible at any time.

Temporary storage CANNOT be accepted as long-term solution. Therefore it is advisable that the interim storages shall not be designed too large.

8 Disposal Considerations

To select the most appropriate technology several rateable and non-rateable criteria have to be considered. Among "non-rateable", or relative criteria, are included public acceptability, risk and environmental impacts, which depend on the specific geographic site location. The rateable criteria may include the applicability of the method (in accordance with its development status), overall cost, minimum achievable concentration, clean-up time required, reliability, maintenance, post treatment cost and ability to use soil after treatment.

The difference between technologies that only separate and/or concentrate a pollutant (e.g. solvent extractions, thermal desorption) and those which destroy the contaminant (e.g. incineration, dechlorination or biodegradation) must be considered. Those technologies that only immobilize contaminants (e.g. landfill systems, stabilization and vitrification) should also be clearly differentiated.

The technologies available cover a wide range of degree of treatment and recovery of transformer components, a factor which must be taken into account in comparing technologies. Decontamination is never completely applied to all components, and this means that a residue remains which must be incinerated. In the best case this will be just the porous parts (wood and paper) unless the solvent technique is applied for long process times, and a product finally obtained which may be sent for land filling if the residual PCB levels are legally acceptable. In other words, the total cost of treatment, including the cost of final disposal of residues, must be taken into consideration.

Whatever technology is chosen, it has to be performed by a company which is approved for this task by the respective authority, respectively, if the PCB waste is exported, approved by the competent authority in the concerned country.

In December 2004, the United Nations Environment Programme published an updated version of the inventory of worldwide PCB Destruction Capacity. It can be downloaded from the Internet: http://www.chem.unep.ch/pops/pcb_activities/pcb_dest/PCB_Dest_Cap_SHORT.pdf

„POPs Technology Specification and Data Sheets" providing detailed information on various decontamination/disposal methods are being prepared at the moment and should be available by the end of 2013. At the moment the provisional data sheets can be downloaded at: http://www.ihpa.info/resources/library/

There are a number of emerging technologies, which are not presented in the frame of this handbook. There is a GEF supported "review of emerging, innovative technologies for the destruction and decontamination of POPs and the identification of promising technologies for the use in developing countries" available in the internet: http://www.chem.unep.ch/pops/pcb_activities/PCB_proceeding/Presentations/PCB%20Global%20McDowall.pdf and http://www.chem.unep.ch/Pops/pcb_activities/default.htm#Guidance

9 Glossary

ADR	European agreement on the international road transport for hazardous goods
Askarel	Trade name of PCB cooling fluid (USA, Monsanto)
BAT	Best Available Technique
BEP	Best Environmental Practice
Capacitor	Equipment or unit to supply lagging kilovars for power factor correction of an electric system; some capacitors were manufactured with PCB as cooling fluid
Capacitor Bank (General)	Practically there are three different ways of power factor (PF) correction: Capacitors for "individual" PF-correction; the capacitor is directly connected to the terminals of an equipment (motors, welding machine etc.) producing the "lagging kilovars"
Capacitor Bank (LV)	Capacitors for "group" PF- correction; the capacitor(s) is (are) connected to the LV-busbar of a transformer station, which feeds a number of consumers with individual motors, welding machines etc.
Capacitor Bank (MV)	Capacitors for "central" PF-correction; Large capacitor installation connected to the Middle- or High Voltage busbars of a substation where many individual electrical appliances (motors etc.) of various size operate at different times and periods.
Closed applications	Capacitors and transformers, where the PCB itself is in completely closed containers; PCBs rarely emit from closed applications (in good condition)
Congener	Depending on the number and position of the chlorine atoms in the Biphenyl molecule, 209 isomers and homologue Chlorine Biphenyls are theoretically possible. A single compound from this group is called PCB congener.
Container 20'	Internationally used expression for Transport or Storage Containers with the Standard size of 2 x 2 x6 meters (40' Container – 2 x 2 x 12 meters)
Container Box	There are various types of 20' and 40' Containers available, the most common is the Box Container with a front door, from an open top Container the roof can be removed for loading and off-loading activities (e.g. ideal for transformers)
Cooling Fluid	Dielectric fluid
DIN	Deutsches Institut für Normung (German Institute for Standardisation)
ECD	Electron Capture Detector; Detector for GC
ELV	End of the life-vehicles
ESM	Environmentally Sound Management
ETI	Environmental Technology International Ltd., Chur / Switzerland
EU	European Union
GC	Gas chromatography; Procedure for the determination of evaporating substances
GEF	The Global Environment Facility (GEF) is an international financial entity with 177 countries as members
HV	High voltage
IATA DGR	IATA regulations on the transport of hazardous goods / transport by air
IMDG	International maritime dangerous goods code / transport by sea
kV	Kilovolts
kVa	Kilovolt ampere
kW	Kilowatt
LRTAP	Long-range Transboundary Air Pollution

LV	Low voltage (230/400 V)
µg	Microgram
mg/kg	Milligram per kilogram
MV	Medium voltage (Normally in the range between 11 and 66kV)
MVA	Megavolt ampere
NAP	National Action Plan
ng	Nanogram (1000 ng = 1 µg)
NIP	National Implementation Plan
OECD	Organisation for Economic Cooperation and Development
Open applications	Applications where PCB is consumed during its use or not disposed of properly after its use or after the use of the products that contain PCB; Open applications emit PCB directly in the environment (e.g. softeners in PVC, neoprene and other rubbers containing chloride)
PBB	Polybrominated Biphenyl
PCB	Polychlorinated Biphenyls
PCDD	Dibenzo-p-dioxins or dioxin; Highly toxic by-product of PCB
PCDF	Dibenzofurans or furan; Highly toxic by-product of PCB
PCT	Polychlorinated Triphenyls
Persistent	Very slightly degradable in the environment
PIC	Prior Informed Consent
POP	Persistent Organic Pollutants
PPE	Personal Protective Equipment
ppm	Parts per million (mg/kg)
Primary source	A product to which PCB was added voluntarily to influence the product's characteristics (e.g. cooling fluids for transformers like Sovol, Sovtol, Askarel, Pyralene, Clophen, etc.). Such products emit PCB continuously
RID	Regulation for the international transport of hazardous goods / transport by rail
Secondary source	A product that originally was free of PCB, but later contaminated by PCB emitting from primary sources (e.g. by emission from primary sources or use of contaminated pumps, hoses, etc.). Such products also emit PCB
Seveso	Place near Milan/Italy, where dioxin was released in 1976 during an accident and consequently contaminated wide areas of the region
TCDF	Tetrachlorodibenzofuran
TDI	Tolerable daily intake
Transformer	Equipment used to increase or reduce voltage; PCB containing transformers are usually installed in sites or buildings where electricity is distributed.
UN-approved	Equipment that fulfils the specific United Nations testing procedures
UNEP	United Nations Environment Programme
WEEE	Waste electric and electronic equipment
WHO	World Health Organisation

10 Useful Links

Basel Convention	➢ www.basel.int
Basel Convention Leaflets	➢ http://www.basel.int/pub/leaflets/index.html
Capacitor Register, ANZECC	➢ www.pops.int/documents/guidance/NIPsFinal/eagov.pdf
ETI Environmental Technology Ltd.	➢ www.eti-swiss.com
PEN – PCBs Elimination Network	➢ http://chm.pops.int/Programmes/PCBs/PCBsEliminationNetworkPEN/tabid/438/language/en-US/Default.aspx
Rotterdam Convention	➢ www.pic.int
Stockholm Convention	➢ www.pops.int
Stockholm Convention Training Tool	➢ http://chm.pops.int/Portals/0/flash/popswastetrainingtool/eng/index.html
UNDP – United Nations Development Programme	➢ www.undp.org
UNEP - United Nations Environment Programme	➢ www.unep.org
UNEP Chemicals	➢ www.chem.unep.ch
UNEP Chemicals Manuals on PCB	➢ www.chem.unep.ch/pops/newlayout/repdocs.html
UNEP Chemicals Manuals on POPs	➢ www.chem.unep.ch/pops/newlayout/repdocs.html
UNIDO - United Nations Industrial Development Organization	➢ www.unido.org
UNITAR - United Nations Institute for Training & Research	➢ www.unitar.org

Guidance documents for identification, management and destruction of PCB

- Destruction and decontamination technologies for PCBs and other POPs wastes under the Basel Convention. A training manual for hazardous waste project managers Secretariat of the Basel Convention
  http://archive.basel.int/meetings/sbc/workdoc/TM-A.pdf
  http://archive.basel.int/meetings/sbc/workdoc/TM-B.pdf

- Guidelines for the identification of PCBs and materials containing PCBs
  UNEP Chemicals
  http://www.chem.unep.ch/Publications/pdf/GuidIdPCB.pdf

- Inventory of World-wide PCB Destruction Capacity
  UNEP Chemicals
  http://www.chem.unep.ch/pops/pcb_activities/pcb_dest/PCB_Dest_Cap_SHORT.pdf

- PCB Transformers and Capacitors - From Management to Reclassification and Disposal
  UNEP Chemicals
  http://www.chem.unep.ch/Publications/pdf/PCBtranscap.pdf

- Provisional POPs Technology Specification and Data Sheets
  Secretariat of the Basel Convention
  http://www.ihpa.info/library/2009/08/02/pops-technology-specification-and-data-sheets/

- Selection of Persistent Organic Pollutant Disposal Technology for the Global Environment Facility
  A STAP advisory document
  http://www.thegef.org/gef/pubs/STAP/selection-persistent-organic-pollutant-disposal-technology-gef

- Survey of Currently Available Non-Incineration PCB Destruction Technologies
  UNEP Chemicals
  http://www.chem.unep.ch/Publications/pdf/SurvCurrAvNIncPCBDestrTech.pdf

- Updated general technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (POPs)
  Basel Convention
  http://chm.pops.int/Portals/0/flash/popswastetrainingtool/eng/All_technical_guidelines_on_POPs_4.pdf

- Updated technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs)
  Basel Convention
  http://archive.basel.int/pub/techguid/tg-PCBs.pdf

- Draft guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C Stockholm Convention
  http://www.pops.int/documents/guidance/batbep/batbepguide_en.pdf

11 Capacitor Registers

11.1 List on PCB Capacitors Codes of Products from the Former USSR

БКС250/40030/3,3; БКС250/40060/4,7; **ГСТ**-1-50;

ИС-16-0,8; ИС-2,8-300; ИС-20-0,5; ИС-20-6,65; ИС-25-13; ИС-2-52; И[illegible]; ИС-5-200;ИС-6-200; ИС-6-5,5;

КС-0,5-19; КС0-0,22-4; КС0-0,38-12,5; КС0-0,66-12,5; КС0-10,5-25; КС0-3,15-25; КС0-6,3-25; КС1-0,22-6; КС1-0,22-8; КС1-0,23-6; КС1-0,23-9; КС1-0,24-10; КС1-0,38-14; КС1-0,38-16; КС1-0,38-18; КС1-0,38-20; КС1-0,38-22,5; КС1-0,38-25; КС1-0,40-14; КС1-0,40-16; КС1-0,40-22,5; КС1-0,415-14; КС1-0,415-20;КС1-0,4-15-ОМ4; КС1-0,4-30-ОМ4; КС1-0,44-14; КС1-0,44-16; КС1-0,44-22,5; КС1-0,50-14; КС1-0,50-16; КС1-0,50-18; КС1-0,66-16; КС1-0,66-18; КС1-0,66-20; КС1-0,66-22,5; КС1-0,66-25; КС1-1,05-30; КС1-1,05-34; КС1-1,05-37,5; КС1-10,5-30; КС1-10,5-34; КС1-10,5-37,5; КС1-10,5-50; КС1-11-34; КС1-11-40; КС1-3,15-30; КС1-3,15-34; КС1-3,15-37,5; КС1-3,15-50; КС1-6,3-30; КС1-6,3-34; КС1-6,3-37,5; КС1-6,3-50 КС1-6,6-40; КС2-0,22-12; КС2-0,22-16; КС2-0,23-12; КС2-0,23-18; КС2-0,24-20; КС2-0,38-28; КС2-0,38-32; КС2-0,38-36; КС2-0,38-40; КС2-0,38-45; КС2-0,38-50; КС2-0,40-28; КС2-0,40-32; КС2-0,40-45; КС2-0,415-28; КС2-0,415-40; КС2-0,4-15-ОМ4; КС2-0,4-30-ОМ4; КС2-0,44-28; КС2-0,44-32; КС2-0,44-45; КС2-0,50-28; КС2-0,50-32; КС2-0,50-36; КС2-0,66-32; КС2-0,66-36; КС2-0,66-40; КС2-0,66-45; КС2-0,66-50; КС2-1,05-30; КС2-1,05-60; КС2-1,05-67; КС2-1,05-75; КС2-10,5-100; КС2-10,5-60; КС2-10,5-67; КС2-10,5-75; КС2-11-67; КС2-11-80; КС2-3,15-100; КС2-3,15-60; КС2-3,15-67; КС2-3,15-75; КС2-6,3-100; КС2-6,3-60; КС2-6,3-67; КС2-6,3-75; КС2-6,6-67; КС2-6,6-80; КС2-3,15-60; КС2-3,15-75;

КСК-0,5-38; КСК1-0,66-40; КСК1-1,05-63; КСК1-10,5-75; КСК1-3,15-75; КСК1-6,3-75;КСК2-0,66-80; КСК2-1,05-125; КСК2-10,5-150; КСК2-3,15-150; КСК2-6,3-150; КСКФ-4,4-150;КСКФ-6,6-150; КСКФ-7,3-150;

КСП-0,66-40; КСП-1,05-120; КСП-1,05-75; КСТС-0,38-9,4;КСФ-6,3-50; КСШ-6,3-50; КСШК-6,3-100; КСЭ-1,05-75; КСЭК-1,2-150;

ПС-0,3-0,4; ПСК-0,4-30; ПСК-0,4-90; ПСК-0,65-36; ПСК-0,7-20; ПСК-0,7-30; ПСК-1,25-200; ПСК-1,6-100; ПСК-4,5-4; **РСТ**-2-2,12; РСТ-2-4; РСТО-2-6,15;

ФС-1-600; ФСТ-0,75-300; ФСТ-2,1-160; ФСТ-4-40;

ЭС1000-0,5; ЭС1000-1; ЭС1500-0,5; ЭС1500-1; ЭС2000-0,5; ЭС400-1,5х3; ЭС500-1; ЭС750-0,5;ЭС750-1УЗ; ЭСВ-0,5-10; ЭСВ-0,5-2,4; **ЭСВ**-0,5-4; ЭСВ-0,8-0,5; ЭСВ-0,8-1; ЭСВ-0,8-10; ЭСВ-0,8-2,4; ЭСВ-0,8-4; ЭСВ-1,0-0,5; ЭСВ-1,0-1; ЭСВ-1,0-2,4; ЭСВ-1,0-4; ЭСВ-1,6-0,5; ЭСВ-1,6-1;ЭСВ-1,6-2,4; ЭСВ-1,6-4; ЭСВ-2,0-0,5; ЭСВ-2,0-1; ЭСВ-2,0-2,4; ЭСВ-2,0-4; ЭСВК-0,5-10;ЭСВК-0,5-2,4; ЭСВК-0,5-4; ЭСВК-0,8-0,5; ЭСВК-0,8-1; ЭСВК-0,8-10; ЭСВК-0,8-2,4; ЭСВК-0,8-4;

ЭСВК-1,0-0,5; ЭСВК-1,0-1; ЭСВК-1,0-2,4; ЭСВК-1,0-4; ЭСВК-1,6-0,5; ЭСВК-1,6-1;ЭСВК-1,6-2,4; ЭСВК-1,6-4; ЭСВК-2,0-0,5; ЭСВК-2,0-1; ЭСВК-2,0-2,4; ЭСВК-2,0-4; ЭСВП-0,8-10; ЭСВП-0,8-2,4; ЭСВП-0,8-4; ЭСВП-1,0-2,4; ЭСВП-1,0-4.

11.2 Extract of Capacitor Register / 1997 Australian and New Zealand Environment and Conservation Council (ANZECC)

http://www.pops.int/documents/guidance/NIPsFinal/eagov.pdf

12 PEN Application Form / PEN Magazine

БЛАНК ЗАЯВЛЕНИЯ НА ВСТУПЛЕНИЕ В ЧЛЕНЫ СЕТИ ПО ЛИКВИДАЦИИ ПХД

1. Персональная информация

Я желаю зарегистрироваться в качестве: ☐ учреждения ☐ физического лица

Учреждение			
Имя		Титул (г-н/г-жа, д-р)	
Фамилия			
Должность			
Почтовый адрес		Почтовый индекс	
Город		Страна	
№ телефона	(просьба указать международный код)	№ мобильного телефона	(просьба указать международный код)
№ факса		Эл. почта	

2. Дополнительная информация

Просьба указать, к какой категории участников вы принадлежите:

☐ Правительство (министерства, госучреждения, природоохранные инспекционные органы и т.п.)
☐ Отрасль промышленности, связанная с ПХД (хозяйствующие субъекты, оказывающие услуги по техобслуживанию, обработке или уничтожению ПХД)
☐ Владельцы ПХД (частные или государственные предприятия, владеющие загрязненным оборудованием или маслами)
☐ Международный эксперт (консультанты, заинтересованные физические лица, региональные центры)
☐ Межправительственная организация
☐ Донорская организация
☐ Неправительственная организация
☐ Научно-исследовательские/учебные учреждения

Просьба кратко описать в нижеприведенном поле вашу работу с ПХД.

Я заинтересован в следующих областях, относящихся к ПХД (можно поставить галочку в нескольких клетках):

☐ Перечень ПХД
☐ Техобслуживание оборудования ПХД
☐ Незаконное использование ПХД
☐ ПХД в открытом применении
☐ Удаление ПХД
☐ Хранение оборудования ПХД
☐ Трансграничные перевозки
☐ Прочее: ____________
☐ Технологии уничтожения

3. Заявление

Настоящим заявляю, что я буду принимать решительные меры по обеспечению экологически обоснованного регулирования (ЭОР) ПХД. Я согласен, что вся представленная информация может быть открыта для всеобщего доступа.

Дата: ____________ Подпись: ____________

Просьба направить заполненный бланк по электронной почте, факсом или обычной почтой на имя секретаря СЛП по следующему адресу:
Secretary of the PEN, Secretariat of the Stockholm Convention
11-13 Chemin des Anémones
CH-1219 Châtelaine, Geneva, Switzerland
Факс: +41 22 917-8098; Эл. почта: pen@pops.int

The PEN Application form (in Russian) can be downloaded from:
http://chm.pops.int/Implementation/PCBs/PCBsEliminationNetwork%28PEN%29/PENMembership/tabid/567/Default.aspx

The PEN Magazine (in Russian) is available from:
http://chm.pops.int/Implementation/PCBs/PCBsEliminationNetwork%28PEN%29/PENmagazine/tabid/738/Default.aspx

13 Personal Notes

PCB PROJECTS IN EMERGING ECONOMIES: ENVIRONMENTAL AND ECONOMIC BALANCE BASED ON CORPORATE SOCIAL RESPONSIBLE INNOVATIONS

D. J. Hoogendoorn
CEO, Orion b.v., the Netherlands

About Orion

Orion B.V. is an internationally operating company specialized in the treatment and handling of Polychlorinated Biphenyl's (PCB's). Orion was founded in 1985.

Orion's mission is to be recognized as a reliable partner in safeguarding the environment by safe and cost-effective removal and destruction of PCB containing equipment.

Our procedures foresee in packing the PCB-waste on location and sending it in containers to the Netherlands for destruction in our treatment facility in Drachten.

Of course Orion is not unique in providing this kind of service, and as a dedicated and specialized company, we have (a need for) a unique and different philosophy.

Our vision is to transfer know-how and expertise to local partners aiming to enable each country to have a company trained in the handling of PCB waste. In our experience, the advantages are as follows:

• "In country" competence to offer transformer life cycle management and to handle PCB waste and PCB calamities;

• Trust, understanding and good communication between the local company, the environmental authorities, the owners of the PCB waste and Orion;

• Much employment and revenues remain in the local economy;

• Local temporary storage is created, so PCB waste disposal is also available to the owners of small PCB waste amounts;

• Fast and professional domestic intervention in case of a calamity;

• Local co-processing in licensed cement kilns or high temperature rotary kilns of PCB liquids and solids like PPE and absorbents assures that 95% of hazardous substances do not have to be exported;

• Combination of "end of life" treatment with "life cycle management" for transformers in order to re-use as much resources at the highest level as possible in the "Waste Hierarchy":

Finding a local partner

Orion looks for partnership with existing local companies in the area of hazardous waste collection and treatment. This way, we use the local expertise and capacity in a country and we avoid to disturb the local market.

When Orion starts business in a new country, we introduce our company to the local government (Competent Authorities) and ask them for a list of suitable and licensed organizations for the treatment, collection, storage and transport of PCB containing waste. Most of the time, the Dutch government is able to support Orion during this introduction.

The next step is to ask PCB-waste owners, like the local power companies and the industry, for recommendations of PCB-waste collectors. By matching these lists, we aim to find licensed and service-oriented partners in each country outside the Netherlands.

The type of company that we usually form partnership with are the industrial & hazardous waste collectors, PCB waste treatment companies or transformer-service companies.

Cooperation between Orion and her local partners

The local partner is supported by Orion when needed. Mostly this will be in the field of marketing, technical support and logistic services. During the first projects, Orion will send a specialist to assist the local partner. When the local partner has demonstrated sufficient know how and technical skills, the projects will not be supervised by our specialists.

The period of extra support is typically 1 to 3 projects. This depends on the level of existing experience at the local partner and the speed of the market development.

Also personnel from the local partners come for training to Orion's facility.

Export documents

TFS documents

Orion opens Trans Frontier Shipment (TFS) Documents for a country for one year from our local partner to Orion. The procedures for obtaining these documents are very familiar to Orion and our requests have been rewarded by all the different competent authorities up till now.

Duly Motivated Request

To obtain the TFS documents for a project, the competent authorities have to give their written statement, in which they allow export of PCB-waste to the Netherlands, because there is no capacity for destruction of PCB-waste in their own country. To obtain this statement, the assistance of the local partner is very welcome.

Example from Bulgaria – working with a local partner

In 2004, to prepare for the enlargement of the EU the Dutch trade minister visited all the potential new country-members of the EU, including Bulgaria.

During this visit, Orion, among other Dutch exporting companies, joined the minister. In this week we were introduced to the Bulgarian ministry for environment. The ministry has introduced us to Balbok. After two more visits to Bulgaria, Orion signed the contract for partnership with Balbok in 2005 and the first PCB-project was finished in 2006.

Balbok is specialized in hazardous waste in Bulgaria. For PCB-waste, they did not have a partner with the recycling options Orion could offer.

During the last 3 years, Orion and Balbok developed a very nice cooperation. Exchange of logistic and technical knowledge, both ways are working out very nicely. Orion assisted Balbok during the first project with a sales visit at the client and supervision of the first PCB-project at the client's factory.

Balbok assisted Orion in obtaining the TFS documents and the transport permits.

Balbok works according to the high international standards for the handling, treatment and storage of hazardous waste. Because of their impeccable reputation, the PCB-project runs very smoothly, and the level of confidence of the clients and the authorities is very high.

This partnership helps to strengthen the reputation and the services of both partners.

Both companies are very enthusiastic about this partnership and both the economy and the environment of Bulgaria and The Netherlands benefit from this cooperation.

PCB treatment and transformer life cycle management

To build and to operate our treatment technology costs are comparatively low. Orion has already been using this technology for over 20 years. One of Orion's unique features is to use no heating for the rinsing/washing nor for the distillation of the solvents. This is safe, easy to use and very cost effective. In cooperation with our partners, we also offer insulating oil treatment technology and services for transformers in-use.

Transformers during use stage

Since 2012, we cooperated with transformer oil analyses laboratories and transformer oil (mobile) treatment solution providers at an international level in order to offer life cycle management for mineral oil transformers during the use stage. Life cycle management is not restricted to PCB contaminated oil transformers. It is applicable to all mineral oil transformers and allows the transformer owners to monitor the quality and remaining thermal life of their capital equipment using all the data and experience available today. Modern life cycle management allows the owners to better assess the quality and reliability of their transformers and make the optimal investment and maintenance decisions.

If a transformer owner and/or a governmental organization perform a PCB inventory study much money and effort is required. In that case it makes sense for transformers which are in use in order to:

1. collect additional technical data about the transformer, and

2. do additional analyses (not only PCB content but also quality parameters) on the oil samples

to assess the quality and remaining thermal life of the transformers. Based on that information, a life cycle management plan can be drafted.

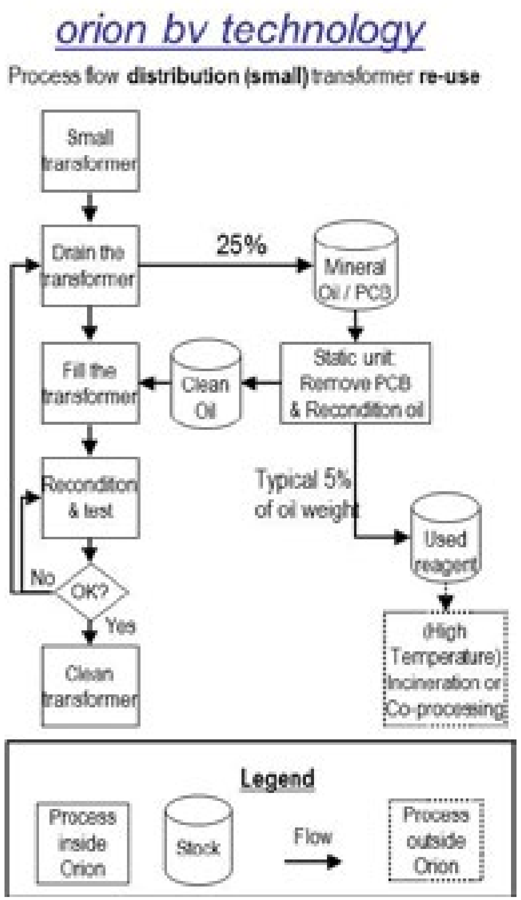
Low PCB contaminated oil transformers can be treated by retro-filling for small oil transformers or direct treatment for large transformers with more then 15 000 liters of oil inside.

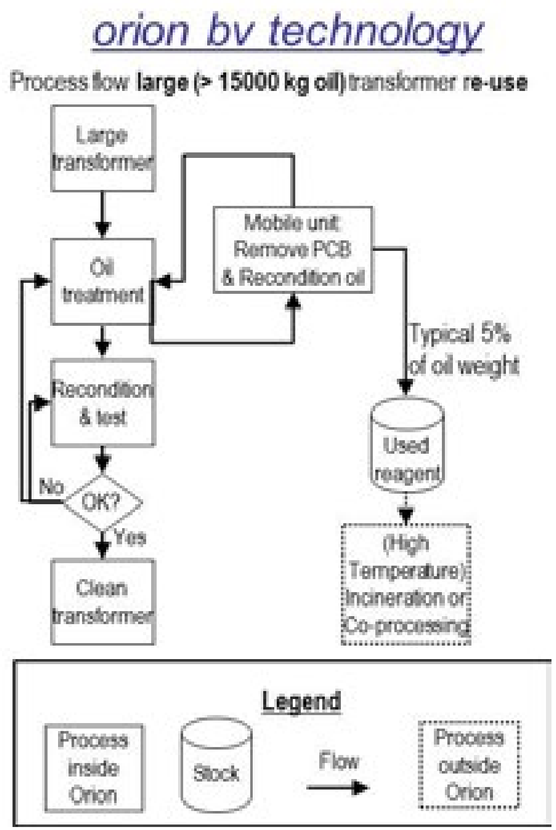
In case of high shut-down costs, it is also possible to do the direct oil treatment on-load (energized) with only a short shut down time of 2 to 4 hours to connect the oil treatment equipment. This option is used often at power generation plants where a shut-down of 1 line can cost 400 000 Euros per day. Also, in industries without sufficient backup capacity, the on-load option may be used. Treatment time on-load is typically 2 to 3 times as long as off-load due to the reduced oil flow rates.

When PCB is removed from the oil, the oil quality is also improved as all the other parameters (water, particles) are treated at the same time and also problems like corrosive sulfur are eliminated.

For transformers without PCB contamination but other oil quality and thermal life issues the same oil treatment procedure can be applied where necessary.

In the next figures the process flow for oil treatment for small and large transformers is shown:





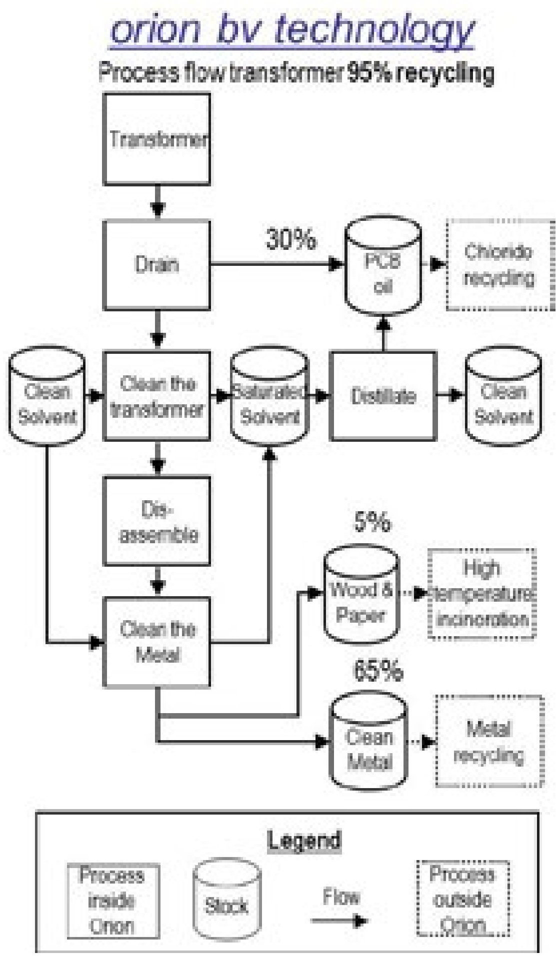
Transformers in the waste stage
If a transformer cannot be used anymore, it is in the waste stage. At this stage, oil treatment is typically more expensive than dismantling and cleaning for several reasons:

1. Oil treatment creates additional waste like used reagents and in the case of washing with oil extra contaminated oil

2. If the transformer is not in use during or after the treatment, the internal (active) part / core material will not be cleaned and will retain the high PCB-levels. The core contamination will only be reduced after some months of use (typically 3 to 6 months) after the oil treatment where the PCB level in the oil will rise again from < 2 ppm to higher levels. The final level will depend on the original PCB contamination level.

3. Even if we take the transport cost and the scrap (copper / iron) revenues into account, the dismantling treatment is less expensive than the oil treatment. The economic advantage of the oil treatment is only when the transformer can be re-used because it saves the cost for a new transformer and its installation

The PCB transformer dismantling treatment is done as follows: PCB-containing transformers are drained, and the inside is cleaned with solvents. After this cleaning operation, the transformer is opened, and all the parts separated. Copper, aluminum and sheet metal are rinsed with fresh solvents. The cleaned metal parts are sent to smelters as base materials for new metals, and the solvents are cleaned by vacuum distillation. We can recover approximately 95% of all materials, the only exception being insulating materials, which cannot be cleaned.



Capacitors
PCB-containing capacitors are recycled in a similar fashion to transformers. The capacitors are drained and opened, after which, the metal case is rinsed with solvents. Approximately 50% of the materials are recovered. The remaining 50% consist of insulating materials and aluminum foil, which cannot be cleaned.

Technology and know-how that Orion licenses or sells:

Orion has developed a mobile solution in cooperation with one of our technology partners for on-site dismantling for low contaminated transformers if export is not possible, and quantities are limited (between 5 000 000 and 10 000 000 kg).

For higher quantities and pure PCB transformers, a fixed installation can be offered in case export is not feasible. However, including amortization of the capital expenditure required, the total treatment costs per kg are typically higher than if the PCB waste can be exported to the EU. This is mostly caused by the fact that the EU treatment centers have already absorbed the capital expenditures in the past en are now operating at variable cost plus revenue only.

Orion's technology as it is used in our plant at Drachten for dismantling of transformers, capacitors and cleaning of the metal parts

1) Access to Orion's proven and approved technology and know-how for the following facilities:

• Specifications for liquid proof and PCB resistant floors as used at our plant;

• Specifications for construction of cranes as used at our plant;

• Specifications for ventilation and air treatment systems as used at our plant;

• Specifications for Fire protection measures and detection systems as used at our plant;

• Lay-out of our treatment centre with area's for:

o PCB-waste reception,
o draining and rinsing,
o (intermediate) storage for liquids, metals and solids,
o dismantling,
o solvent distillation,
o offices,
o locker rooms, showers and restrooms for workers;

• Specifications of required personal protection equipment as used at our plant;

• Specification of the equipment and materials we use at our plant in Drachten like:

o shredders and separators
o shears
o cutters
o tap-sets
o pumps
o hoses
o sawing machines
o vacuum chambers
o solvents
o distillation equipment for solvent recuperation
o monitoring systems
o tanks
o containers for storage and ADR transportation
o etcetera's

• Safety plans and procedures for environmental protection as used at our plant;

• Safety plans and procedures for worker protection as used at our plant;

• Emergency and contingency plans and procedures as used at our plant;

• Quality control plans and procedures as used at our plant;

2) Education, training and visits to Orion's dismantling facility at Drachten, the Netherlands. Travel and housing expenses to be paid by the client.

3) 200 hours of advice during the first year after purchasing the license are included for each client. Travel and housing expenses to be paid by the client.

SODIUM TECHNOLOGY – THE CHOICE FOR TREATMENT OF POP`S

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Abstract

The Sodium Technology was initially developed for the treatment of PCB-contaminated oils, such as transformer oils.

The Sodium Technology involves the complete mineralization of organic chlorine containing compounds (such as PCBs and further POP`s) by sodium.

POP`s in liquid or dissolved form are destroyed, and only non dangerous compounds such as rock salt and organic polymers remain as final products.

The efficiency of the Sodium Technology is at > 99.9999%.

There is no fear of formation of dioxins and furanes as compared to incineration. Further advantages are as follows: the low investment costs, the inexpensive nature of reagent sodium, the likelihood of stationary as well as mobile detoxification units.

Keywords

Sodium, PCB-destruction, POP-Destruction, operating temperature, mobile unit, approved technique, high efficiency.

Introduction

The handling of sodium is well-understood from industrial application since many decades. The annual consumption of sodium is more than 100,000 mt worldwide. In the field of environmental technology, sodium is used for the dechlorination especially for PCB-destruction in transformer oil. Due to the high reactivity, additional fields, such as treatment of any of the POP`s up to chemical warfare agents of application, can be identified .

Both stationary and mobile units can be set up and operated with very high efficiency.

Basis

The chemical principle in any reaction with sodium is the cleavage of the C-Cl-bond to yield sodium chloride and a mixture of organic molecules without any chlorine.

The overall chemical reaction of halogenated compound with sodium will follow

$$2\,R-X \;+\; 2\,Na \;\rightarrow\; R-R \;+ 2\,NaX$$

$$X = F, Cl, Br$$

and is valid for any kind of halogenated organic compound within the POP`s and all other organic chemical compounds. Even halogenated gases can be treated in a modified way of the sodium treatment process.

The required efficiency of > 99.9999 % can be achieved in any case, when:

operating temperature meets the requirements (approx. 120-150°C)
sodium-dispersion in sufficient quantity is offered

Preconditions for the success are the following:

1. POP dissolved in mineral oil, or
2. grinded and mixed with mineral oil

Our objective: Make it simple and efficient!

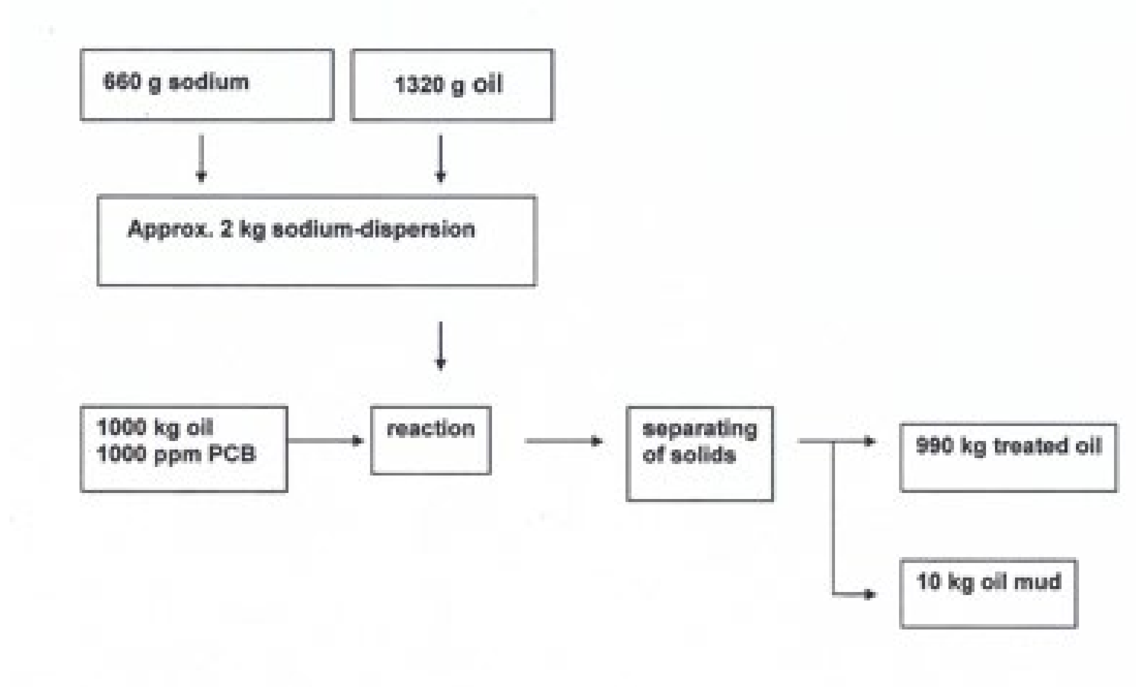
General operation path

Pre-treatment:

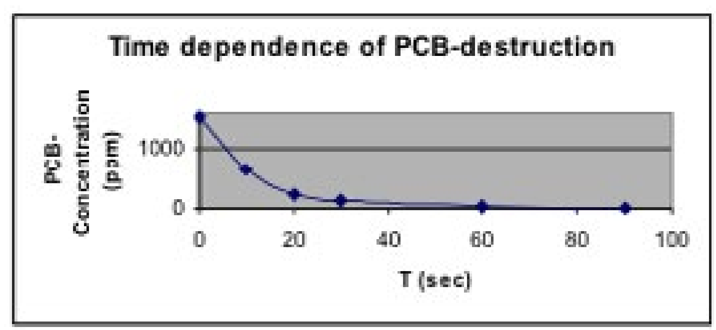
Pre-treatment includes filtering and de-watering to avoid violent reactions with metallic sodium. Drying of oil/organic solvent is sufficient if moisture content is about 100 ppm.

The Sodium Technology is applied by adding the sodium dispersion to the oil stream (particle with a diameter of approximately 2 to 10 µm) at low temperatures. Generally the operating temperatures vary from 100°C to 150°C, depending on the compound being destroyed, with temperatures of 130°C to 140°C being more typical. This relatively low temperature provides an important safety feature for application of the technology, since the formation of reaction heat can be quickly reduced in an emergency case by removing the applied heat and cooling the treatment vessel. The technology operates at atmospheric pressure.

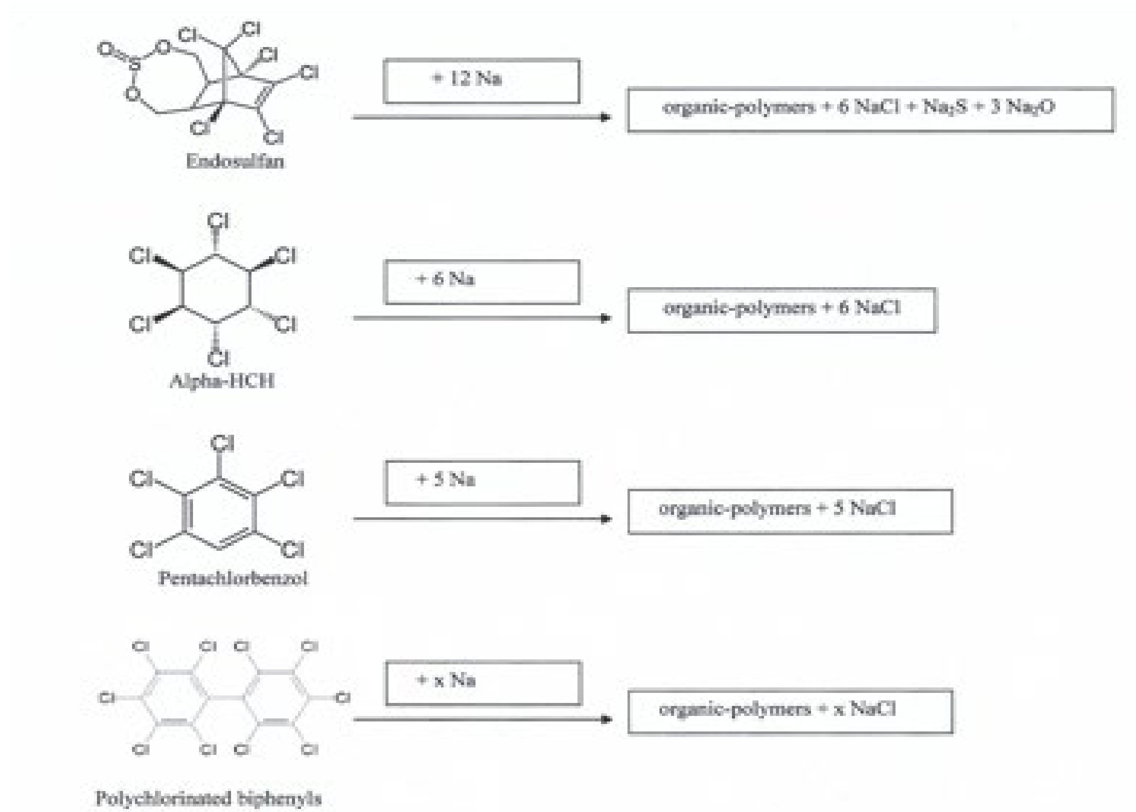
In the flow diagram illustrated below, the general procedure for the sodium treatment is depicted on the base of contaminated oil:



The efficiency of the process is revealed in the diagram depicted below:



Some examples for the chemical equations are given below:



Practical experience

Operating units have been set up in Germany, the Netherlands, France, the United Kingdom, Czech Republic and South Korea.

The size of the unit can be adapted to the specific requirements and can be realised either in stationary or mobile units.

The most experienced industrial operation unit has been in process since 1989 until today without any alterations in mechanical equipment. In all cases, the operating company was able to guarantee a limit of < 2 ppm for their clients. More than 20,000 tons of transformer oil have been processed up to now.

A semi-continuous plant in the U.K. was able to treat 5 m³ per batch a total quantity of 10,000 tons of transformer oil processed with a limit of < 2 ppm after treatment with sodium.

In South Korea, Seoul, the limit of < 2 ppm has been approved by the Ministry of Environment in as well as the South Korean Institute for Science and Technology (KIST) at the day of the first start of the unit covering a capacity of 1000 lt/h. The unit can operate 24 hrs per day.

Even the very low Japanese limits of < 0.5 ppm can be guaranteed.

Vast own experience has been made with POP`s from effluents of a local landfill in Hamburg. A wide range of POP`s have been found in the effluent in high concentrations. After the treatment with sodium, no organic compound with chlorine could be found.

The cumulated results are given in the table below:

Compound	Before	After Treatment
PCB	80 ppm	< 0,1 ppm
PCDD	17 ppm	< 0,0002 ppm
PCDF	8 ppm	< 0,0002 ppm
HCH	2000 ppm	< 0,1 ppm
Chlorobenzene	30000 ppm	< 0,1 ppm
Chlorophenole	900 ppm	< 0,1 ppm

Concentrated POP`s have to be diluted to keep the heat evolution of the exothermic reaction under continuous control.

The steps for concentrated POP`s will include the following:

- heating oil to 160 °C

- adding POP`s to get concentration not greater than 5%

- treating with sodium dispersion

- separating solids

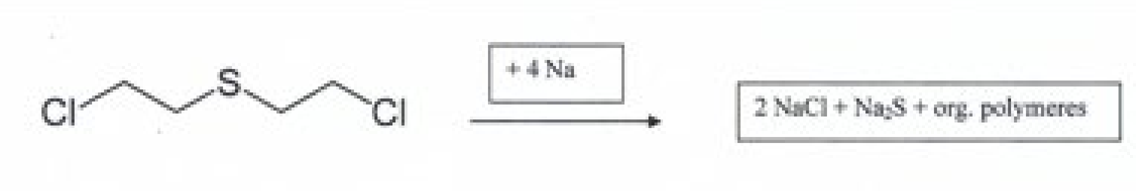
- returning the oil for additional use

Chemical warfare agents:

The Sodium Technology can also be applied for the destruction of chemical warfare agents.

In approved laboratories, it was possible to demonstrate that Adamsite (an arsenic containing molecule) can be destroyed down to below detection limit within one hour at 60 °C

Later in other licensed laboratories more warfare agents such as S-Lost, Clark1, Pfiffikus Phenylarsindichlorid and Triphenylarsin have been treated successfully. This work was done on the lab scale.



Example

Conclusion

The Sodium Technology is a straightforward and widely approved method for the safe decomposition of any kind of POP's with final products that are easy to handle. Due to long lasting experience in handing of sodium specific solutions for the decomposition of POP's can be evaluated and realised.

BAT/BEP – LCM: INVENTORY, CONTROL, MANAGEMENT, INTEGRATED DECONTAMINATION & DEHALOGENATION OF PCBS & OIL AND TRANSFORMERS - SOME CASE HISTORIES

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Abstract

This paper describes the "state of the art" for inventory, control, management, decontamination of electrical equipment and insulating liquids containing PCBs &POPs.

A new diagnostic method (developed by Sea Marconi-patent pending), called "Total Chlorine and PCBs screening -TCPs", to quantitatively determination of Total Chlorine and PCBs screening in the oil, is described. The best available techniques (BAT) and best environmental practices (BEP) for life cycle management (LCM) of electrical equipment impregnated with insulating liquids, according to the prescriptions of the Stockholm Convention on Persistent Organic Pollutants (POPs) entered into force on May 17th 2004, are presented.

The paper offers a review of the standards: *IEC 60296 Ed.4-2011"unused mineral insulating oils for transformers and switchgear";IEC 60422 Ed.4-2013"mineral insulating oils in electrical equipment-supervision and maintenance guidance"; CENELEC CLC/TR 50503 February 2010 "Guidelines for the inventory, control, management, decontamination and/or disposal of electrical equipment and insulating liquids containing PCBs."; CIGRE 413 Working Group D1.01(TF 12)April 2010"Insulating Oil Regeneration and Dehalogenation".*

The most recent decontamination and dehalogenation technique ("CDP Process patented by Sea Marconi) in continuous mode by closed circuit process, uses a solid reagent consisting of a higher molecular weight glycol mixture, a mixture of bases and radical promoter or other catalyst for chemical conversion of organic chlorine in inert salts, on a high surface area particulate support. This process normally runs at 80-100 °C and has the capability to decontaminate equipment on-site through continuous circulation of the oil a closed system (without draining the oil or using auxiliary tanks) using the solvent capability of the oil for continuous extraction of PCBs from solid materials inside the equipment. This solution prevents the critical reactions (reaction with Sodium at 150-300 °C and risks of explosion and fire; reaction with KPEG at 130-150 °C), ensuring at the same time, higher efficiency and lower operating costs. They are also capable of working on-site, both on large transformers and medium/small size ones, and when accessibility to the site is difficult, by using compact decontamination mobile units (DMU). In the specific case of chemical dehalogenation of PCBs, the change of oil and the creation of PCBs classified wastes are prevented.

The countermeasures available to prevent and or mitigate the effects of PCBs & POPs are reported hereby, with regards to their effectiveness. The case history of decontamination and dehalogenation of PCBs by mean of on-load and off-load

"CDP Process" is compared with other techniques.

Keywords

Transformer, Mineral insulating oil, Additive, PCBs, Diagnosis, Countermeasure, CDP Process, Dehalogenation.

ntroduction

This paper reports on the results of a four decades long expertise by Sea Marconi, an independent third party company with respect to electrical equipment and insulating fluid manufactures, in the field of diagnostics for the prevention of failures and integrated treatments of insulating liquids for Life Cycle Management of transformers.

The identification of PCBs, as harm to the environment, is symptomatic of a typical application scenario common to many other synthetic chemical compounds (i.e. POPs – Persistent Organic Pollutants). The time characterising the "PCBs Problem", spans over three centuries (1867 – First lab synthesis by Griefs in Germany). The PCBs are characterised by extraordinary features that resulted in a large commercial application (1927. First industrial application by Swan in USA). Later on, the discovery of its incompatibility with the biosphere resulted in their designation as an environmental pollutant and the "PCBs Risk" was recognised as a global problem over three decades (1966 First discovery in the environment by Jensen in Sweden), (1969 – First serious accident in Yusho – Japan, where 31,180 persons were involved by intoxication with 26 deaths, as a consequence of a leak of PCBs from a heat exchanger into rice oil).

The risks generated by PCBs in the ecosystem resulted in the promulgation of numerous rules at international level on the prohibition and use of these substances (1976 – EEC Directives 76/405 and 76/769; USEPA 1979 40 FR Part/761). Also, international agreements were reached finalised toward the elimination of these toxic and persistent compounds within the established time limits. These include the water resources of the Great Lakes Region (18% of the global reserve of drinking water) several European Directives [1] [2] and the Protocol of Stockholm of May 2001 on POPs.

It must be noted that the term "PCBs" as defined in article 2 of Directive 96/59 EC [2], for the first time also includes other halogenated compounds, besides the 209 possible congeners of the Polychlorinated biphenyls. They are the PCTs equivalent (8557 possible congeners) and PCBTs (several thousand congeners) with a concentration exceeding the limit of 0.005% by weight (50 mg/kg or ppm). These compounds are classified as dangerous, persistent and bio-accumulable, creating an unreasonable risk for the environment and Human Health (such as contamination of food, as occurred in June 1999, in Belgium, France and Italy).

In the event of uncontrolled thermal oxidation, during the operation of transformers (hot spots > 150-300 °C) or in the case of failures (arching of electrical systems) with explosions and fires, significant concentrations of very dangerous compounds occur, such as PCDFs- Furans (135 congeners) and PCDDs-Dioxins (75 congeners).

The use of PCBs as insulating liquid in electrical equipment, particularly transformers and capacitors, caused a significant contamination of the environment. It is estimated that about 30 million of such units are in operation world-wide. This equipment represents an enormous contaminating load; the mass of contaminated oil, just in the OECD Countries, is estimated in several million tons. The equipment and materials contaminated represent a high strategic and investment value of several billion dollars. The obligation to eliminate and/or decontaminate such a mass of equipment and materials involves risks and costs connected with technical and logistic difficulties.

This paper analyses the PCBs problem, the technological options for the decontamination and/or disposal, the asset management options as well as the description of the performance and functional features of a continuous mode dehalogenation process designated as CDP Process ® by SEA MARCONI TECHNOLOGIES.

The efficiency of this process was demonstrated successfully on the 2,3,7,8 TCDD (dioxin) in the Seveso accident (starting from 1982), through laboratory experiments and field industrial applications (since 1989) for the dehalogenation/detoxification of PCBs/PCTs/PCBTs/PCDDs/PCDFs on electrical transformers.

Normative references-IEC & EN

The International Electrotechnical Commission (IEC) and European Standards (EN) cover terms and definitions, specification for mineral insulating oils.

Decontamination - Regulatory References:

- IEC 60422 Ed. 4 2013 Supervision and maintenance guide for mineral insulating oils in electrical equipment (Art.12.4)

- IEC 61619 – EN 12766 Insulating liquids – Contamination by PCBs, (PCBs, PCT and PCBsT). Methods of determination by capillary column Gas chromatography

- *CENELEC CLC/TR 50503 February 2010 "Guidelines for the inventory, control, management, decontamination and/or disposal of electrical equipment and insulating liquids containing PCBs.";*

- *CIGRE 413 Working Group D1.01(TF 12)April 2010"Insulating Oil Regeneration and Dehalogenation".*

Strategies and Opportunities

Life Cycle Management (LCM) of insulating Oils & Transformer has been developed, in 10 key steps, in accordance with the following objectives:

A. Prevention and/or mitigation of losses (direct and indirect) and risks for workers, assets, public health and environment, arising from human error, malfunction, or failures of the equipment that cause fires or spillage of hazardous compounds (Oils, PCA, etc.) and Persistent Organic Pollutants (POPs; PCBs, etc.);

B. Implementation of "State of the Art", IEC Standards, "Best Available Techniques" (BAT), "Best Environmental Practices" (BEP) and methodologies available for safety, whilst taking into account the surroundings and the criteria of self-sufficiency and functional recovery;

C. Technical feasibility of the activities within the prescribed time schedules, according local regulations, based on cost/benefit analysis and economical feasibility. (CENELEC CLC/TR 50503 – February 2010, etc.)

LCM: Key Stepr for Oils & Power Transformer

LCM according with IEC Standards, CIGRE Guidelines, local Regulations and specific requirements:

I. Inventory of oils and electrical equipment filled with insulating liquids.

II. Requirements and General Specifications **Acceptance**: Tests of unused insulating oils & fluids

III. Factory Test

IV. Commissioning and Prior Energisation

V. Energisation

VI. Infancy: Control, Diagnosis, Prognosis and Solutions for Insulating Oils & Equipment

VII. Operation – Oils & Fluids Maintenance: Integrated Treatments & Processes

On-Load/Off-Load (physical decontamination/reconditioning; selective depolarisation-DBDS, metal dissolved, acid and polar compound/reclaim; dehalogenation/ detoxification of PCBs & POPs; transformer drying; transformer desludging; additives; etc.), electrical maintenance, etc.

VIII. Aging

IX. End of Life - Post Mortem: decontamination, material recovery and waste disposal, etc.

CDP PROCESS: Scope and Applications

The Chemical dehalogenation process (CDP ®) in continuous mode by closed circuit ,integrated in Decontamination Mobile Units (DMU), is the BAT / BEP technique (Italian Ministry of Environment, D.M. 29/01/2007 - G.U. no. 133 of 7/06/2007 art. D.2.2.2.3 and art. E.3) applicable for transformers and electrical equipments on site and in operation filled with mineral insulating oils contaminated by PCBs.

The [1] CDP & DMU solution is capable to re-classify as "NO-PCBs" the oil & transformer and restore the best environmental and functional conditions in compliance with the local regulation, international standards and technical guidelines. This solution satisfies the European regulations and standards in terms of BAT/BEP and sustainability (technical feasibility, economic-cost/benefits, environmental benefits and social-green jobs), safety (for workers, public health and environment-emissions CO2 etc.),proximity, self-sufficiency and functional recovery through the multifunctional treatment (off load and on load conditions) for life cycle management (LCM) of insulating liquids & transformers and includes the following key aims:

a) Dehalogenation & detoxification of PCBs in oil below the limits prescribed by local regulations or internal specifications (< 50; < 25; < 10; <2 mg/Kg of PCBs, determined with IEC 61619 Ed.1-1997). This process uses a solid reagent (S/CDP) consisting of a high molecular weight glycol mixture, a mixture of bases and radical promoter or other catalyst for chemical conversion of organic halogen to inert salts on a high surface area particulate support. This process normally runs typically at 80-100 °C and has the capability to decontaminate equipment on site, through continuous circulation of the oil in a closed system (without draining the oil or using auxiliary tanks), using the solvent capability of the oil for continuous extraction of PCBs from solid materials inside the equipment

(IEC 60422 Ed.4- 2012 art.11.4.3;CENELEC CLC/TR 50503 – 2010 art. 8.4.2.3; CIGRE 413 – 2010 art. 10.1.4.);

b) Selective depolarization of oil, with the reagents S/CDP & S/CHED, through elimination of oxidation by products, corrosive sulfur compounds-DBDS and organic-metal compounds with the improvement of oil properties (electrical, physical and chemical according IEC 60422 Ed. 4 2012; § Table 5);

c) Decontamination of transformers and electrical equipments (extraction of PCBs, DBDS, moisture, sediments and sludge from solid materials inside the equipment).

Main function	Physical decontamination	CHEDCOS depolarisation	CDP PROCESS® dehalogenation
Recovery of dielectric properties	●	●	●
Recovery of the chemical properties of the oil (acidity, delta tg, colour)		●	●
Elimination of **DBDS** (main responsible of **corrosive sulfur** problem)		●	●
Elimination of dissolved organo-metallic contaminants		●	●
Dehalogenation / Detoxification of **PCB**/PCT/PCBT, POPs, compounds etc.			●

DMU (Decontamination Mobile Unit) for Multifunctional Integrated Treatments & Process

CDP & DMU - Process Description

The performances of the CDP & DMU are the result of experience matured (since 1968), of the use of multi-function Decontamination Mobile Units (DMUs) developed (designed and made by Sea Marconi) and of the formulation of specific reagents (S/CDP and S/CHED etc.) used on the basis of different operational scenarios. The CDP Process® developed by Sea Marconi Technologies – Italy, since 1982 (first patent), has been successfully used for the for the complete dehalogenation /detoxification of the 2,3,7,8 TCDD (Dioxin of the "Seveso Case" in the 1983)

The CDP & DMU technique was classified as BAT/ BEP by the Italian Ministry of the Environment, the Territory and the Seas Decree 29/01/2007 – Published on the Official Gazette n.133 titled Guidelines for the identification and utilisation of the Best Available Techniques on Treatment of PCBs, apparatuses and wastes containing PCBs and stocking systems:

"E.3 General comparative evaluation

A comparative evaluation of the various technologies available for the decontamination of PCBs is proposed on the basis of the following factors:

a) safety of workers;

b) environmental safety ;

c) functional safety;

d) eco-balance and emissions;

e) cost/benefit ratio.

METHODS	Functional Safety	Environmental safety	Operator Safety	Eco-balance and Emissions	Global Cost/Benefit Ratio
Retrofilling	***	**	***	*	**
Sodium, Lithium and Derivates	*	*	*	**	*
KPEG	**	***	***	**	**
Continuous Closed-Loop Dehalogenation (CDP Process®)	***	***	***	****	****

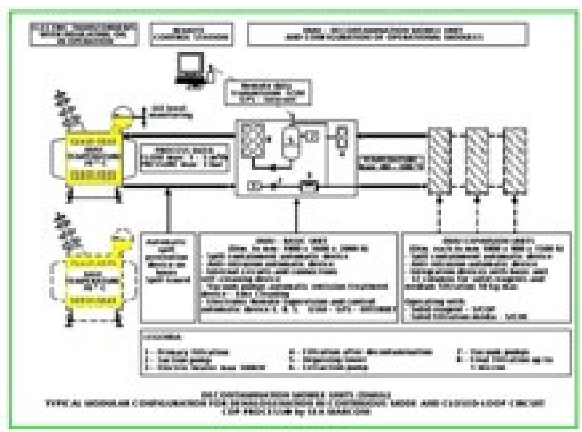
CDP and DMU- BATCH mode diagram

**** = OPTIMUM; *** = GOOD; ** = AVERAGE; * = CRITICAL

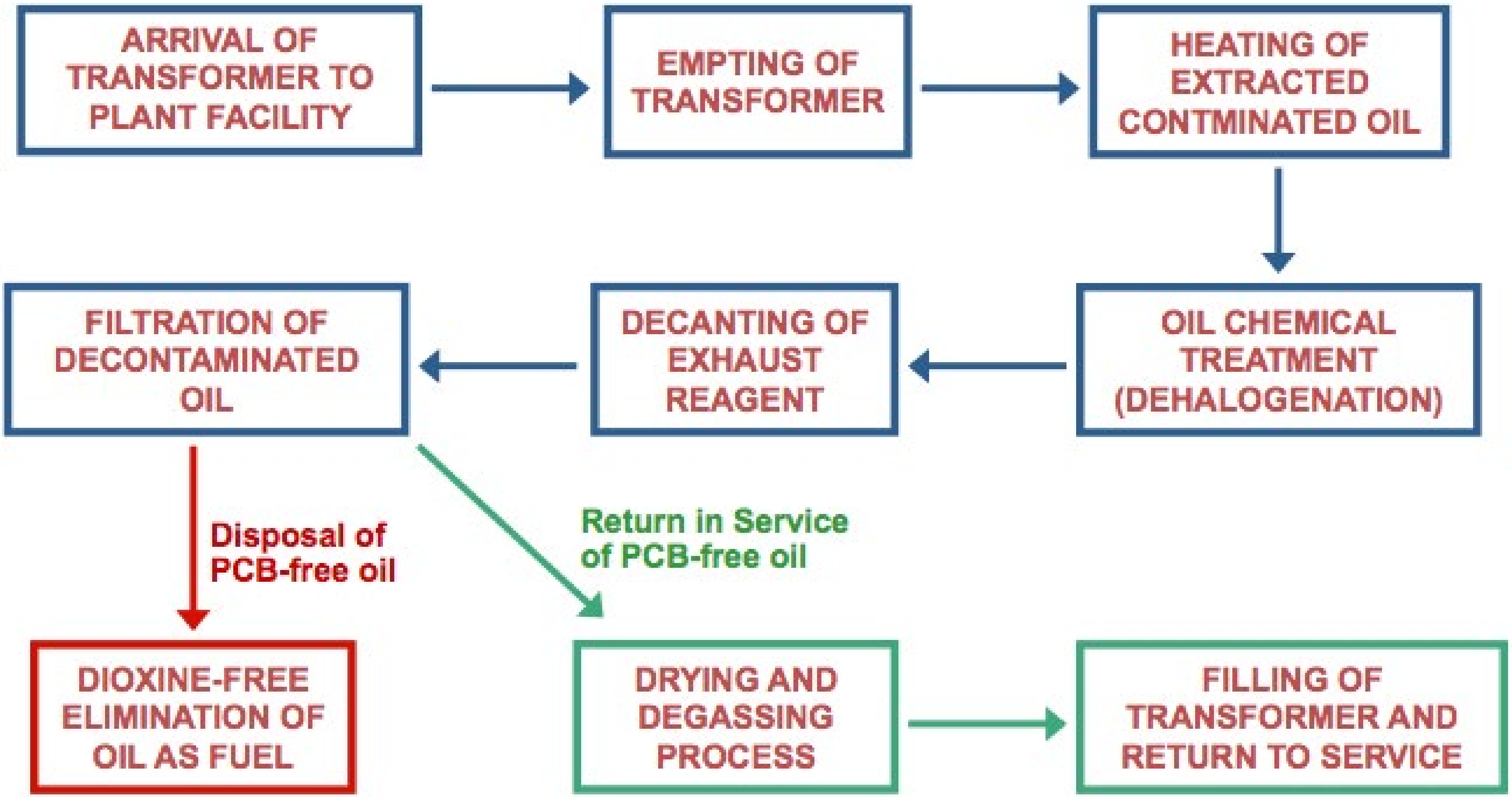
Table E3 – Decisional matrix for the various available techniques

CDP and DMU – Generic scheme

DMU of multifunctional process is performed in a continuous manner by the closed-loop circulation of the oil, without draining the contaminated equipment; the latter is simply connected to a decontamination mobile unit (DMU), with a variable flow from 500 through 5.000 l/h. These mobile units are modular systems with compact dimensions equipped with automatic safety and process control systems capable of operating under all operational conditions (power generating stations, primary and transformation cabins, bunkerised substations etc.).

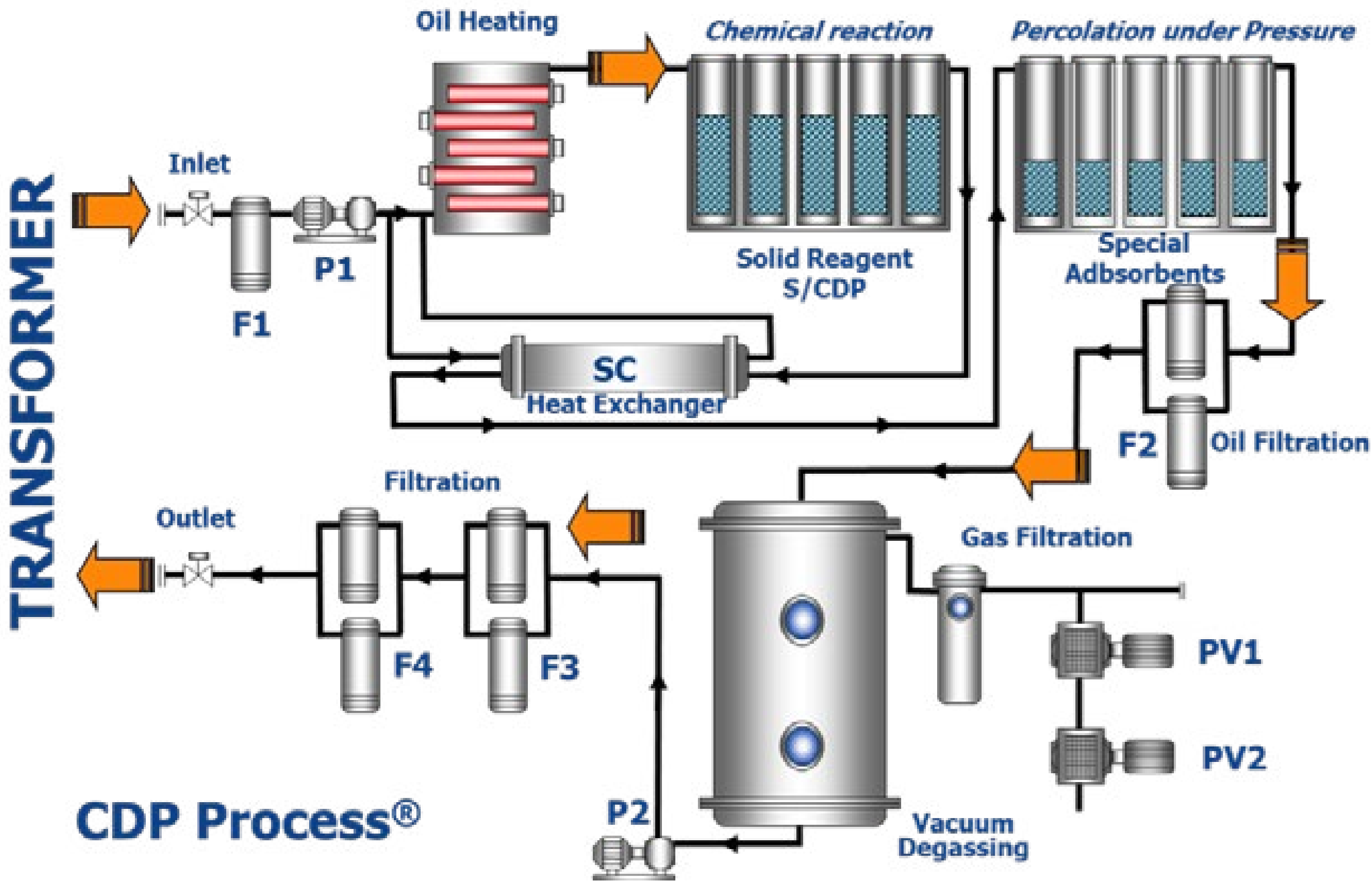


CDP and DMU - Dehalogenation in continuous mode diagram

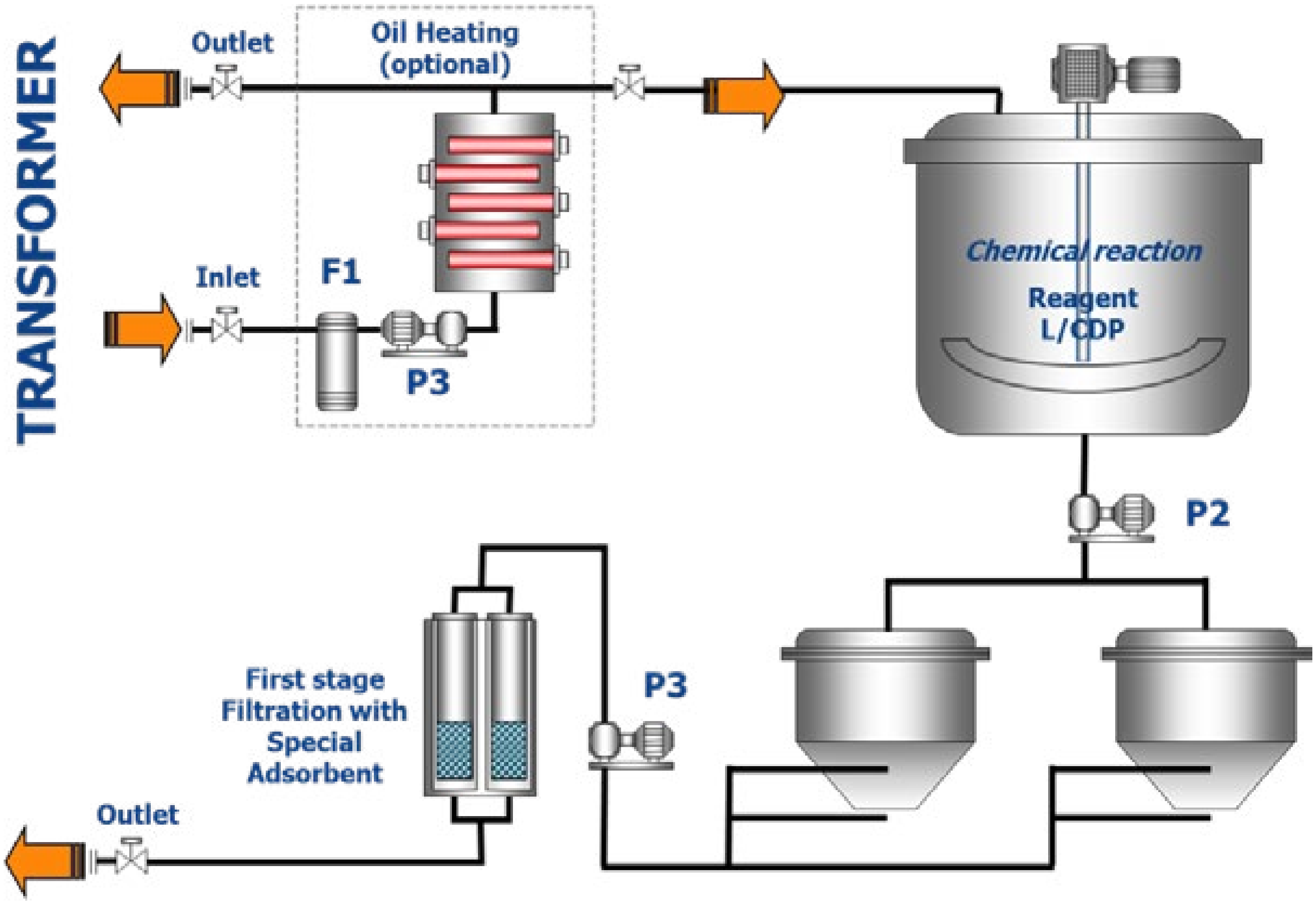


For the non-continuous technique (Batch process) the reagent is mixed with the oil in a reactor, the mixture is heated at 100 °C and stirred during the chemical reaction.

Typical configuration and pictures



CDP and DMU-Plant flow diagram



CDP and DMU -Typical configuration rendering and pictures

Typical Configuration and Pictures

CDP and DMU- Containerized unit connected with shunt reactor (500 kV) on-load treatment (Brazil 2010)

CDP and DMU- BATCH Typical Modular configuration rendering and picture

Sea Marconi Integrated Treatments" vs "Replacement of Oil"

Key Factors	Sea Marconi Closed loop treatment*	Replacement of Oil
On-Load Operation	Yes ✔	✖ No Off-Load for Draining and Refilling
Requirement of Unused Oil	No ✔	✖ Yes 125%/150% of original mass of oil**
Compatibility of Unused Oil vs original	Safety ✔	⚠ Warning base Oil, additives, others**
Recovery: Physical Properties KV, DGA, H_2O	Yes ✔	⚠ Warning*** only after reconditioning of Unused Oil in closed loop §11.2.3 (IEC 60422 Ed. 4 2013)
Recovery: Chemical Properties TAN, DF, IFT	Yes ✔	⚠ Warning*** only after reconditioning + reclamation treatments of Unused oil in closed loop §11.3 (IEC 60422 Ed. 4 2013)
Removal: DBDS & Corrosive Sulfur	Yes ✔	⚠ Warning*** only if initial DBDS is < 80 mg/Kg or reclamation with special adsorbent
Desludging & Dehydration Solid Insulation	Yes ✔	⚠ Warning*** only after reconditioning + reclamation of Unused oil in closed loop §11.3 (IEC 60422 Ed. 4 2013)

Sea Marconi Integrated Treatments" vs "Replacement of Oil"

Removal: DBDS & Corrosive Sulfur	Yes ✔	⚠ Warning*** only if initial DBDS is < 80 mg/Kg or reclamation with special adsorbent
Desludging & Dehydration Solid Insulation	Yes ✔	⚠ Warning*** only after reconditioning + reclamation of Unused oil in closed loop §11.3 (IEC 60422 Ed. 4 2013)
Decontamination: Dissolved Metals	Yes ✔	⚠ Warning*** only after reclamation with special adsorbent if initial value is 8/10 times higher than the target limit
Dehalogenation: PCBSs/POPs in Oils	Yes ✔	⚠ Warning*** only if initial PCBs is 8/10 times higher than the target limit
Self-cleaning unit from: DBDS, PCBs/POPs	Yes ✔	✖ No cross contamination***
Cross contamination by DBDS, PCBs/POPs	Safety ✔	⚠ Warning depending upon the used oil impregnated mainly in the solid insulation
Partial Discharges: bubble air & moisture inlet	Safety ✔	⚠ Warning especially for wet insulation
Environmental Risks for Oil handling	Safety ✔	⚠ Warning high logistical impact
Oil & PCBs Waste disposal	No ✔	✖ Yes especially if PCBs is higher than limit

SM Integrated Treatments" vs "Fuller Earth treatments

Key Factors	DMU & Integrated Treatments* Sea Marconi Patented	Treatment with typical Fuller Earth	Treatment with typical Fuller Earth and regeneration > 600-700 °C
Recovery: Physical Properties KV, DGA, H_2O	Yes	Yes	Yes
Recovery: Chemical Properties TAN, DF, IFT	Yes	Yes	Yes
Removal: DBDS & Corrosive Sulfur	Yes	No	No
Decontamination: Dissolved Metals	Yes	No	No
Dehalogenation: PCBs/POPs in Oils	Yes	No	No
Classification: BAT/BEP - Best Available Techniques/Best Environmental Practices (PCBs/POPs)	Yes	No	No
Self-cleaning unit from: DBDS, PCBs/POPs	Yes	No	No
Cross contamination by DBDS, PCBs/POPs	Safety	Danger	Danger
Corrosion by Sulfur Degradation byProducts (SDBP) as H_2S, Mercaptans, etc. due to high temperature (> 370 °C – typical 600-700 °C)	Safety	Safety	Danger
Dioxins Emissions (PCDDs, PCDFs) due to high temperature degradation byproducts from PCBs/POPs and halogenated contaminants in Oils	Safety	Safety	Danger

TYPICAL CASE HISTORY:

PCBs/POPs Free & Environmental Protection

CYPRUS 1997

Elimination of PCBs from the insulating oil of distribution transformers - Electricity Authority of Cyprus

Total Transformers = **520**

Solutions: DMU & PCBs Dehalogenation (CDP Process®)

Power max [KVA]: 10 - 1000
Voltage max [KV]:
Mass of contaminated oil [Kg]: 94,000
PCBs max [mg/Kg]: **15,000**
PCBs target [mg/Kg]: **< 10**

Result: **saving of 2 million USD**
(avoided transformer replacement and waste disposal)

CDP and DMU- Typical applications for distribution transformers on-site (Case History Cyprus - 1997)

TYPICAL CASE HISTORY:

PCBs/POPs Free & Environmental Protection
FRANCE 2004-2012

Utility – Power transformer of generation (nuclear, thermal, hydro), transmission and distribution

Total Transformers = 1,093

Solutions: DMU & PCBs Dehalogenation (CDP Process®) + Selective Depolarisation (Chedcos®) On Load/ Off Load

Power max [MVA]: 760
Voltage max [KV]: 400
Oil Mass [Kg]: 75,000 each
PCBs max [mg/Kg] = **5,000**
PCBs target [mg/Kg] = **<20** (after 90 days)

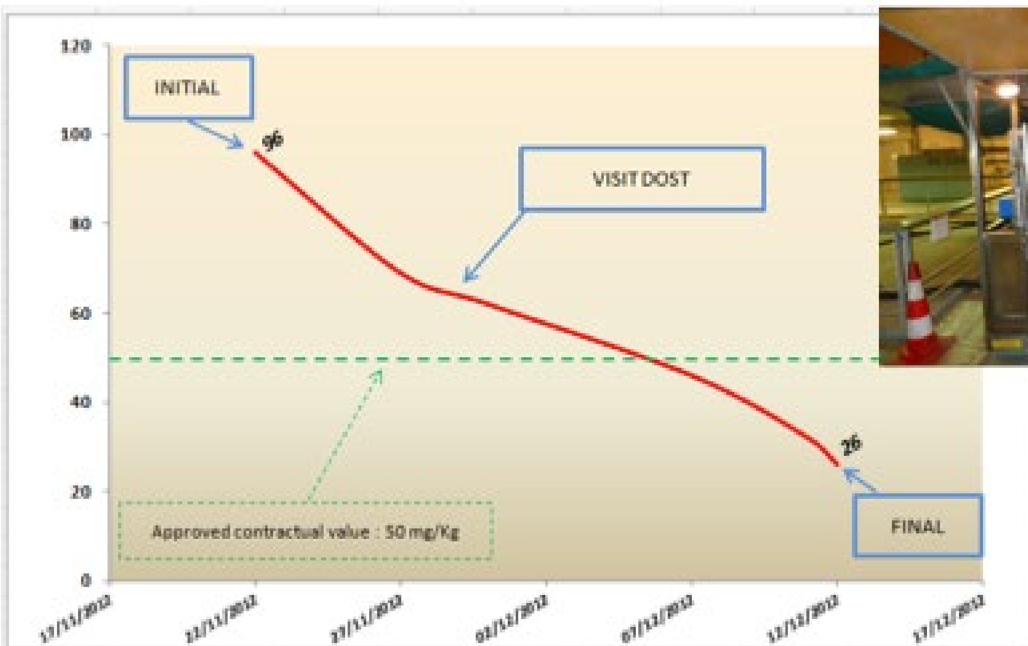
CDP and DMU- Typical applications for power transformers on-site (Case History France - 2004/2012)

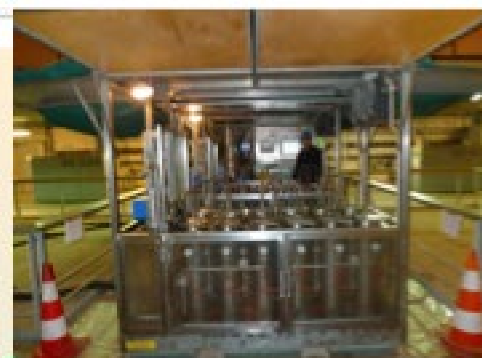
TYPICAL CASE HISTORY:

PCB + «C2 - NON DBDS & Corrosive Sulfur» FRANCE 2012

Hydro Power Plant: 3 GSU Transformers

Solutions: DMU & PCBs Dehalogenation (CDP Process®) + Selective Depolarisation (Chedcos®) On Load





CDP and DMU- Typical applications for power transformers on-site and on-load (Case History France - 2012)

TYPICAL CASE HISTORY:

PCBs + «C1 - DBDS & Corrosive Sulfur» SWEDEN 2012

Primary alluminiun factory: 8 Rectifier Transformers

Solutions: DMU & PCBs Dehalogenation (CDP Process®) + Selective Depolarisation (Chedcos®) On Load

Manuf.: Brown Boveri
Year: 1930
Power [MVA]: 19
Voltage [KV]: 13
Oil Mass [Kg]: 15,000
Oil type: mineral blended

	PCBs [mg/Kg]	DBDS	IFT [mN/m]	CCD test	TAN [mg KOH/g]	DF
Before treatment	**29**	**18**	**24**	**corrosive**	**0,34**	**0,230**
After treatment	**0,37**	**< 5**	**42**	**non corrosive**	**0,01**	**0,002**

GUARANTEE: PCBs < 2 mg/Kg

CDP and DMU- Typical applications for power transformers on-site and on-load (Case History Sweden - 2012)

Manufactures	Jeumont Schneider
Year	1969
Power	105 MVA
Voltage	225 KV
Oil Mass	29.000 Kg
Total Mass	126.000 Kg
Oil Type	Mineral

OIL PROPERTY (IEC 60422 ed. 4 2013-01)	BEFORE	AFTER
Colour (ASTM D1500-07)	> 8	2,7
Breakdown Voltage (kV)	73,1	75
Water content (mg/Kg)	6	2
Acidity (mg KOH/g)	0,294	< 0,01
Dielectric Dissipation Factor at 90°C	1,023	0,09211
TCS - Total Corrosive Sulfur - DBDS equivalent (mg/Kg)	69	8
Interfacial tension (mN/m)	18,8	33,3
2-FAL (mg/Kg)	0,583	< 0,05
Total PCB content (mg/Kg)	71	25
Copper dissolved (mg/Kg)	64	2
Particles (ISO 4406:1999)	23 / 20 / 14	17 / 15 / 10
Note: PCBs Garantee < 50mg/Kg		

CDP & DMU-FIELD SCREENING TEST & DIAGNOSTIC IN LABORATORY

The CDP & DMU use the preliminary determination of the content of total chlorine, trough SM-TCPs KIT ; SM-TCPS test kit by Colorimetric; SM-TCS Test Kit; Sea Marconi and total acid number SM-TAN KIT by Sea Marconi.

Some representative samples of insulating liquids to be taken before, during and after the treatments to be analyzed in accredited Laboratory (SEA MARCONI has the accreditation N. 0899 by ACCREDIA). Test for total PBSs, Acid number, gases, breakdown voltage, dissipation factor, particles, moisture, DBDS, additives content, etc. according to IEC 60422 and diagnostic reports to be reclassified "NO PCBs Oil & Transformer".

Kit for Total Chlorine/PCB

The scope of this SM - TCPs - Colorimetric kit is to provide, a quantitative Smart Field Test (SFT) for non-chemist, for the Life Cycle Management (LCM) and the related activities of inventory, control, management, decontamination and/or disposal of electrical equipments and containers with insulating liquids (such as mineral insulating oils) containing PCBs, in compliance with the European Council Directives (96/59/EC) using Best Available Techniques – BAT – (96/61/EC), Best Environmental Practices (BEP), Commission Decision (2001/68/EC), according to Stockholm Convention on Persistent Organic Pollutants (POPs)-2001, IEC 60422 Ed.4-2013, CENELEC CLC/TR 50503 February 2010, CIGRE 413 April 2010, other technical standards and/or national or local regulations.

Conclusion

The Sea Marconi solutions for Loss Prevention LCM O&T can prevent and/or mitigate the potential losses and unreasonable risks for the asset, workers, public health and environment.

These solutions are targeted for protection of specific fleet of strategic electrical equipment filled with insulating fluids.

This approach guarantees knowledge added value for Customers, Holders and Partners in terms of best innovative technologies, reliability, quality control, traceability, economics, environmental protection, social and stakeholders' relationship.

Life Cycle Management (LCM) for insulating liquids and electrical equipment PCBs contaminated based on state of the art, IEC & CENELEC standards, Best Available Techniques (BAT) & Best Environmental Practice (BEP):

- PCBS INVENTORY
- PCBS CONTROL
- PCBS DECONTAMINATION AND/OR DISPOSAL

References

[1] EN 12766-1 Petroleum products and used oils - Determination of PCBs and related products - Part 1: Separation and determination of selected PCB congeners by gas chromatography (GC) using an electron capture detector (ECD);

[2] EN 12766-2:2001 Petroleum products and used oils - Determination of PCBs and related products - Part 2: Calculation of polychlorinated biphenyl (PCB) content EN 12766-3 Petroleum products and used oils - Determination of PCBs and related products - Part 3: Determination and quantification of polychlorinated terphenyls (PCT) and polychlorinated benzyl toluenes (PCBT) content by gas chromatography (GC) using an electron capture detector (ECD);

[3] EN 50195 Code of practice for the safe use of fully enclosed askarel-filled electrical equipment;

[4] EN 50225 Code of practice for the safe use of fully enclosed oil-filled electrical equipment which may be contaminated with PCBs;

[5] EN 60567 Oil-filled electrical equipment - Sampling of gases and of oil for analysis of free and dissolved gases - Guidance (IEC 60567);

[6] EN 60599 Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis (IEC 60599);

[7] EN 61198 Mineral insulating oils - Methods for the determination of 2-furfural and related compounds (IEC 61198);

[8] EN 61619 Insulating liquids - Contamination by polychlorinated biphenyls (PCBs) - Method of determination of PCBs by capillary column gas chromatography (IEC 61619);

EN 62535 Insulating liquids - Test method for detection of potentially corrosive sulphur in used and unused insulating oil (IEC 62535);

[9] EN 60296 Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear (IEC 60296);

[10] EN 60422 Ed.4 -2013 Mineral insulating oils in electrical equipment - Supervision and maintenance guidance;

[11] EN ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025);

[12] EN 60666 1) Detection and determination of specified anti-oxidant additives in insulating oils (IEC 60666);

[13] EN ISO 12185:1996 Crude petroleum and petroleum products - Determination of density - Oscillating U-tube method (ISO 12185:1996);

[14] ISO 3016 Petroleum products - Determination of pour point;

[15] EN ISO 9001 Quality management systems - Requirements (ISO 9001);

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HIGH VACUUM DESORPTION PROCESS FOR DECONTAMINATION OF EQUIPMENT AND MATERIAL CONTAMINATED BY PCBs

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Abstract

Vacuum Technology is the term applied to all processes and physical measurements carried out under conditions of below normal atmospheric pressure.

High vacuum desorption is a decontamination process which extracts the liquid phases, include PCBs, from contaminated materials.

In 2006, after 5 years of R&D, APROCHIM adapted the vacuum technology for its decontamination process of equipment and materials contaminated by PCBs.

It allows the treatment of full transformers without prior intervention, unlike other methods of decontamination. Thus, the contaminated transformers are not dismantled prior to treatment, which allows operators not to be in a direct contact with contaminants and to guarantee a better respect of strong requirements in the field of environment protection.

It is mainly applicable for transformers and other contaminated equipment and solid materials (including: electro magnets, breakers, relays, ballasts, cables, radiators, drums, piping, vessels, valves and debris).

Keywords

PCBs, oil contaminated, contaminated materials, decontamination process, high vacuum technology, working conditions.

A.General description:

APROCHIM is a French company created in 1988, which is specialized in management and treatment of wastes contaminated by PCBs.

APROCHIM is authorized by the French authorities to process PCBs contaminated equipment in his facility in France (capacity: 30 000 tons/year).

Figure 1: APROCHIM decontamination plant in France

Until 2006, like many of its competitors, APROCHIM used autoclaving technology with solvent (perchloroethylen - PER) for decontamination of electrical transformer and materials contaminated with PCBs.

Decontamination with solvent (PER) is an efficient decontamination though it has three drawbacks, i.e.:

• Implementation of a management plan for used solvent

• Control emission of volatile organic components due to the solvent use

• Risks of contact for operators with contaminated materials during phase of preliminary-dismantling of equipment

In order to respond to these drawbacks, the high vacuum technology has been exclusively adapted by APROCHIM for his decontamination process. The principle is to make the evaporation of PCBs from materials by vacuum and temperature easier.

This process has permitted to make a treatment without use of solvent (principle of "wash without detergent") and to avoid a preliminary partially dismantling of contaminated equipment (devatting) before the decontamination process.

B. Description of method:

Electrical transformers and equipments are usually delivered completely or partially filled with PCB liquid or mineral oil polluted by PCBs.

Preliminary phases:
The phases before the decontamination process are as follows:

- Control of weight;
- Pumping and draining of PCB liquid or oil contaminated from the equipment; and
- Dismantling of the electrical bushings (this phase permits a better extraction of PCBs from the transformers during the process).

6 high vacuum chambers are used for the decontamination process.

The duration of treatment on average accounts for 30 hours.

Figure 2: High vacuum chambers

The method for decontaminating polluted materials is divided into the following steps:

1) **Loading** the material to be treated into a chamber capable of being placed under high vacuum;

2) **Inerting**: the chamber is placed under a first vacuum of less than 20 mbar, and then an inerting gas is injected, particularly nitrogen, until the pressure in the chamber rises back up above approximately 950 mbar;

3) **Heating** the contents of the chamber under forced convection, to a temperature that is kept under or equal to approximately 200°C;

4) **High vacuum and pumping**: the chamber is again placed under vacuum, up to a residual pressure of approximately 0.1 mbar, and the heating is continued; then an inert gas, in particular nitrogen, is injected, until the pressure rises back up to approximately 950 mbar. During this phase, PCBs or oils contaminated move from liquid form to gaseous form. The gas is pumping outside and hand it in liquid form by condensation. The extracted polluting/contaminating substances are removed in the form of a distillate.

5) **Cooling the content** of the chamber by circulating glycol water at 5 ° C in a network of finned tubes.

6) **Unloading**: Polluted devices are PCB free and can be unloaded for being first analysed and dismantling.

After decontamination and control of PCB rate, transformers are totally dismantled and each material is recycled and has a second life (steel, copper, magnetic ferro-silicon plate, ceramic...). This step helps significantly to reduce the cost of treatment. Only, papers and woods are incinerated with energy recovery heat.

The extracted liquids are stored in tanks awaiting shipment toward authorized installation for material valorization (hydrochloric acid) or energy recovery (high temperature incineration).

The process enables the decontamination of solids contaminated with PCBs without producing dioxins or furans: Indeed, PCBs have a high thermal stability, and these latter increases as the chlorine content increases. They decompose at temperatures above 300°C. Pyrolysis of PCBs (between 300 ° C and 1000°C) in the presence of oxygen leads to the formation of small quantities of Polychlorinated dibenzofurans (PCDFs) and Polychlorinated dibenzodioxins (PCDDs) compounds.

Figure 3: High vacuum process adapted for materials contaminated by PCBs

To avoid degradation of PCB, treatment in high vacuum chambers is done without oxygen (nitrogen inerting) and is strictly limited to temperature of 250 ° C maximum.

C. summary characteristics of high vacuum technology (pros and cons):

Advantages of the technology:

- Technology adapted for materials contaminated with pure PCBs or high rate of PCBs.

- PCB rate in recovery products is always under 20ppm after decontamination.

- Drop in waste generation after treatment (no used solvent).

- Energy costs have been reduced.

- Improved working conditions: operators don't have contact with contaminated materials because equipments are completely dismantled after decontamination.

	Limit values	Average analyzes on two years (May 2011-May 2013)
Magnetic plates in ferrosilicon	< 50ppm (indicator PCB - PCBi)	6.9 ppm
Scrap metal	< 50ppm (PCB_i)	5.7 ppm
Crushed copper	< 50ppm (PCB_i)	3.5 ppm
Ceramic	< 50ppm (PCB_i)	4.1 ppm
Aluminium	< 50ppm (PCB_i)	5.9 ppm
Red copper	< 50ppm (PCB_i)	7.0 ppm
Alloy (brass etc..)	< 50ppm (PCB_i)	14.8 ppm
Recovered oil	< 50ppm (PCB_i)	19.2 ppm

Table 1: Results of an analysis of recovery products

Figure 4: Air filtration system and wastewater treatment plant on site of APROCHIM

Drawbacks of the technology:

- No mobility: the high level of requirements in the field of environmental protection doesn't allow to this technology to be implemented in mobile processing units.

• To meet the limits of gas emissions values, a set of processing devices has to be established like absorption of gaseous component on activated carbon and capture of dust.

• To meet the limits of wastewater emissions (storm waters), a water treatment plant is needed.

In order to respond to this drawback, APROCHIM has developed a full service from administrative support to logistic solutions in accordance with Basel convention, international and national regulations for the transportation of hazardous goods (ADR – IMDG- RID and European regulations).

- Strong technical training for operators and maintenance workers due to the technicity of the process.

Other applications for this technology:
This decontamination technology is adapted for decontamination of waste contaminated by pure PCBs and by oil contaminated by PCBs.

It isn’t a destruction method, but it permits to extract pollutants from organic and inorganic wastes and allows reused of decontaminated materials (copper, steel..).

It should be noted that all other pollutants and/or contaminants with similar volatility or comparable to PCBs can also be extracted and collected by the process. As non-limiting examples of such pollutants / contaminants: complexes halogenated or non-halogenated vacuum distillable compounds; chlorinated and/or brominated volatile.

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CO-PROCESSING PCB & OTHER POP'S IN CEMENT KILNS

- A LOCAL SOLUTION

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Managing Partner Alternate Resource Partners
The Netherlands

About ARP

The main priority of Alternate Resource Partners is to aid industry and government in their effort to efficiently recover valuable resources from their waste guided by the Waste Hierarchy using strict environmental and safe practices.

A growing attention of the public over the effects of climate change, the search for alternative energy sources and the drive towards sustainable development has led to great improvements in the recycling of waste materials. However, there are numerous sources of residual waste from fabrication processes that await transformation into useful energy and materials which will allow for a significant reduction in the requirement of fossil fuels and other raw materials.

To allow this transformation to happen, it is essential that a different approach is taken towards waste. Instead of thinking of waste as useless and disposable material, there should be a mindset of investigating possible uses of waste and application of found possibilities.

To accommodate such a re-setting of minds, it imperative that a three layered approach is used:

- Education of the government, industry and investors;
- Identification of the opportunities for possible reuse or recycling of waste; and
- Implementation of the identified opportunities with or for the customer.

As a consultant, coach or sparring partner Alternate Resource Partners is well-positioned and experienced to provide you with the right approach and tools.

Manufacturing of cement

Manufacturing of cement has 3 different phases:

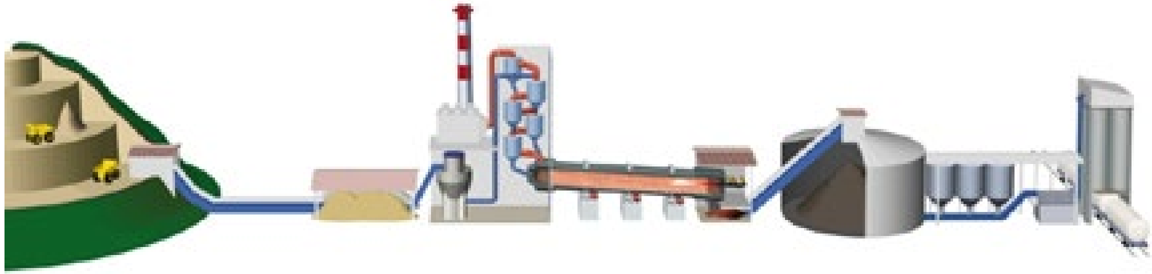
- Preparation of raw materials into raw meal
Extraction – Crushing – Pre-homogenisation - Dosing – Grinding - Homogenisation

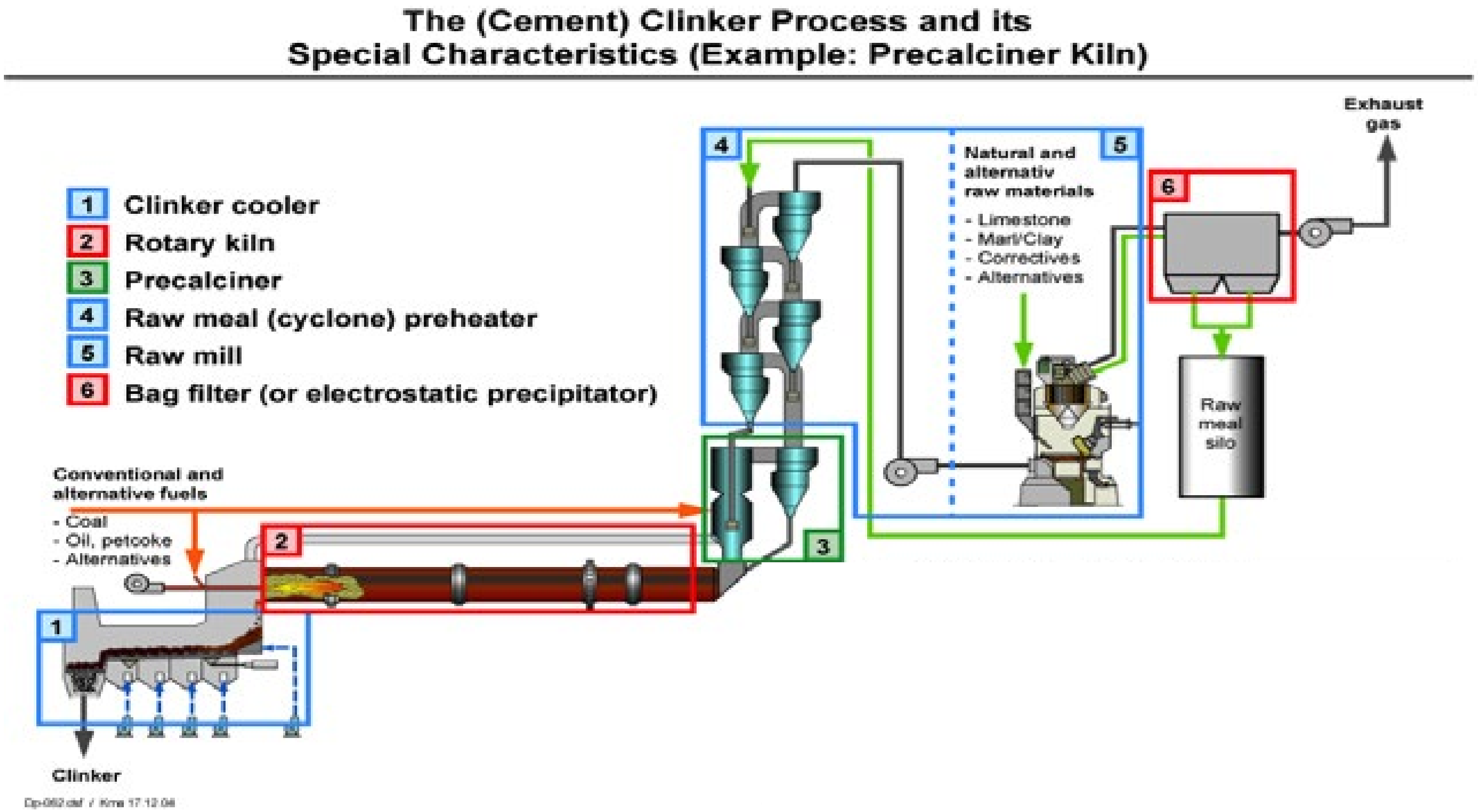
- Clinker production – pyro-processing of raw materials
Calcination of the raw meal into the rotary kiln – energy supplied by burning fuels

- Cement production
Grinding of clinker and mineral components to obtain cement

In the figure represented below, you can see the different components of a cement kiln and the introduction points for raw materials and Alternative fuels. The table contains the various temperatures in the different stages of the manufacturing process.

Schematic picture of the 3 phases of cement manufacturing





Equipm.	Temperatures Gas	Temperatures Mat.	Resid. Times Gas [sec]	Resid. Times Mat.[min]	Remarks
1	20-1000	1200-100	3-5	10	
2	2000-1050	850-1450	3-5	20	All organics burnt, Ash=raw mat.,incorporated in cli
3	1200-880	750-850	2-6	0.1-0.2	SO_2 and HCl trap due to presence of CaO
4	880-350	80-750	10-15	0.2-0.3	Acts as a 5 -stage dry scrubber for combustion gases
5	350-100	20-80	5-10	0.2-0.3	
6	100	100	10-15	0.2-0.3	99.999 % dedusting efficiency

Co-processing in cement kilns

What is co-processing?

Co-processing is the use of waste or by-products from one industrial process, as fuel or raw material substitutes in another manufacturing process.

In the cement community, these materials are referred to as alternative fuels and raw materials or AFR.

In the following industries, co-processing could be applied:

- Cement manufacturing
- Thermal power industry
- Steel industry
- Lime production
- Ceramics, bricks, glass
- Chemical industry
- Petroleum industry

What are the benefits of co-processing?

Benefits of co-processing are as follows:

- Provides a permanent solution to waste management problems
- Lessens reliance on fossil fuels
- Preserves natural resources
- Reduces emissions and greenhouse gases
- Saves on fuel costs

In short . . .

Co-processing is the environmentally-friendly alternative for responsible industries and communities

Co-processing (treatment) of POP's in cement kilns

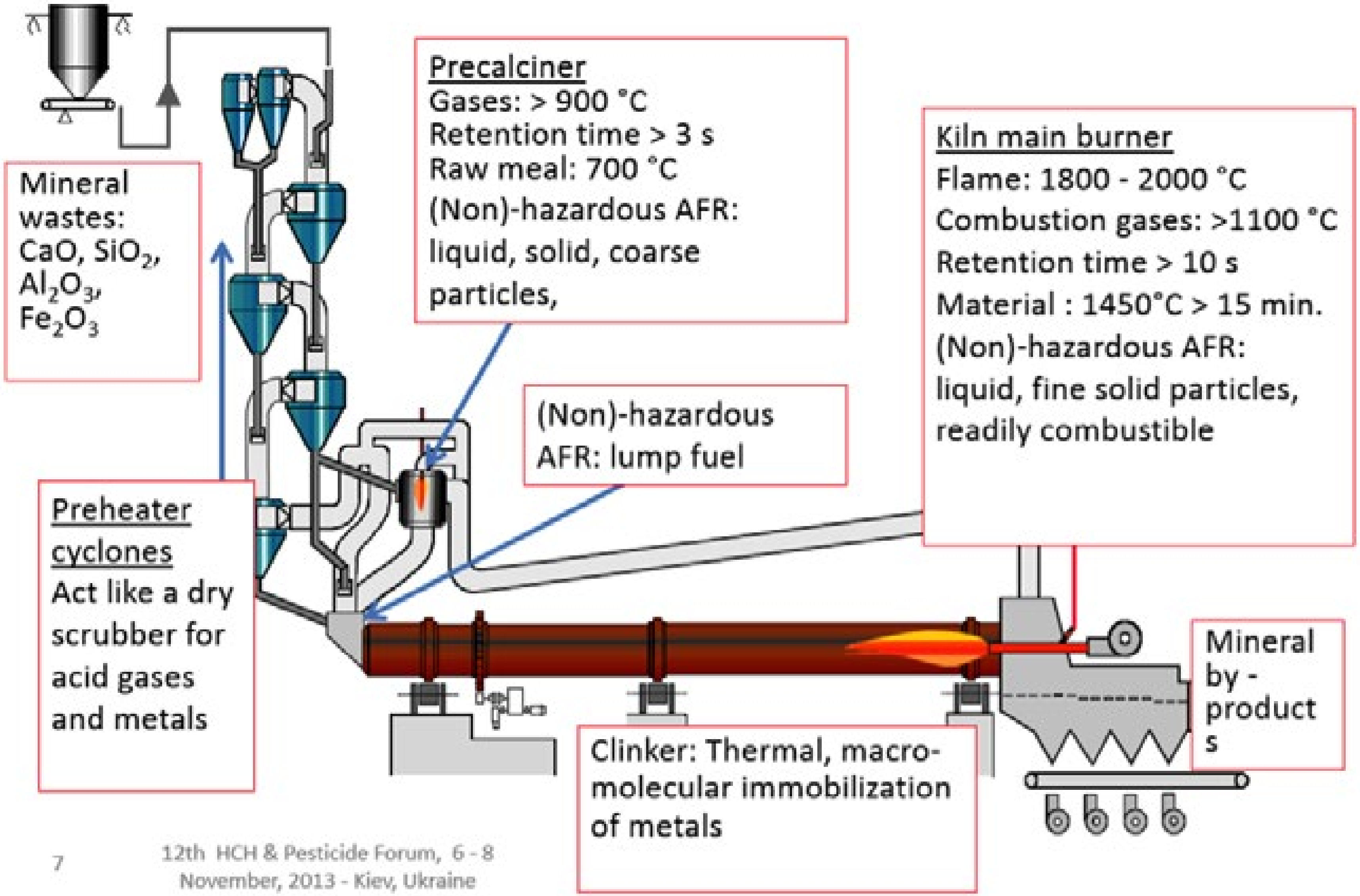
Technical characteristics of cement kiln

In the figure illustrated on the next page, you find the details on characteristics and feeding points of the various AFR – hazardous and non-hazardous, lump and fine, fuels and raw materials of :

- Pre-calciner
- Pre-heater
- Kiln main burner
- Feeding of nonhazardous lump fuels
- Feeding of (non) Hazardous liquids, solids

Furthermore, you will find the temperatures of gas and materials in the kiln stages as well as be able to understand what is actually happening in these parts of the kiln.

POP's, depending on their chemical and physical properties, will be fed to the kiln at the appropriate feeding points.


Mineral wastes: CaO, SiO_2, Al_2O_3, Fe_2O_3
Precalciner
Gases: > 900 °C
Retention time > 3 s
Raw meal: 700 °C
(Non)-hazardous AFR: liquid, solid, coarse particles,
(Non)-hazardous AFR: lump fuel
Kiln main burner
Flame: 1800 - 2000 °C
Combustion gases: >1100 °C
Retention time > 10 s
Material : 1450°C > 15 min.
(Non)-hazardous AFR: liquid, fine solid particles, readily combustible
Preheater cyclones
Act like a dry scrubber for acid gases and metals
Mineral by - product s
Clinker: Thermal, macro-molecular immobilization of metals
7
12th HCH & Pesticide Forum, 6 - 8 November, 2013 - Kiev, Ukraine

In the acceptance procedures for the AFR, the necessary analyses are made on both chemical and physical properties to have enough information to judge which feeding point to use, in the next part of this paper we will also explain more on the trial burns which might be part of the acceptance procedures if not enough information is available on the destruction behavior in the specific kiln where the POP's are being treated.

Main test results of co-processing PCB's

When PCB's are treated in a cement kiln for the first time and not enough data on the destruction efficiency is available, trial burns will be made.

In all kilns that co-process AFR an Emission monitoring and reporting scheme(EMR) has to be installed, the EMR should, at a minimum, contain the following components:

- **Implementation of continuous emission measuring equipment** for dust, SO2, NOx and VOC (and O2) on all cement kiln stacks

- At least a **once per year measurement** of HCl, NH3, C6H6, PCDD/DF and heavy metal emissions

- At least a **once per year calibration** of the CEM equipment

- The **yearly report** of results in a CSR report in a standardized form (Normal conditions, 10% O2, dry)

PCB Trial burn

A (PCB) trial burn testing scheme takes typically 3 days.

Day 1 Baseline emission testing in Compound mode of operation (with raw mill on) & no PCB
Day 2 AFR trial burn emission testing in Compound mode of operation (with raw mill on) and Burning of PCB, 2 ton/h (approx.10% fuel replacement) at main kiln burner
Day 3 Baseline emission testing, Direct mode of operation (with raw mill off) and no PCB.

During the trial, burn the following parameters need to be collected:

Besides the abovementioned parameters, the following operational parameters need to be collected:

- Temperature in kiln inlet
- CO content in kiln inlet
- O_2 content in kiln inlet
- Waste feed rate, energy and chlorine content
- Energy efficiency
- Primary combustion air flow rate
- Total fuel feed rate
- Raw meal consumption, clinker production, quantity and quality

Parameter	Unit	How the value is obtained
Mass flow rate concentration of PCB	g/min	Measured during test & calculated from flow and density
Flow volume of PCB	l/min	Measured during test
Density of PCB	g/ml	Density analysis from lab
Concentration of compound in stack sample	Nm3	Calculation from sample train
Stack flow volume	Nm3/h	Normative and current values

With respect to the Baseline emission testing, the table depicted below is giving the necessary information on the parameters.

Parameter	Mode of Operation	Note
Heavy Metals	Direct & Compound	
HCl, NH3, C6H6	Direct & Compound	(1)
PCDD/PCDF	Direct & Compound	(2)

Notes:

(1) Generally the emission of these substances is higher in direct operation.

(2) The PCDD/PCDF emission of a dry kiln is very low.

Sampling solids during PCB trial burn:

The following solid materials samples need to be taken during the trail brum

• Raw meal

• Clinker

• Coal (fine)

• EP dust

• Cement (from bag filter)

These samples have to be analyzed on the following parameters:

• PCB's

• Heavy metals (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Sn, Tl, V, Zn)

• Cl, F, K, Na, NH3

The samples have to be taken during

• Baseline testing 1 – No PCB, raw mill on

• Trial burn – With PCB, raw mill on

• Baseline testing 2 – No PCB, raw mill off

Some pictures on a trial burn at a cement plant & Results in local plant

Emptying PCB drums for trial burn

Trial burn of PCBs -Pyralene oil with 56-62% of PCB's, 33-38% tri-chloro-benzene, 5-6% tetra-chloro-benzene

Results of trial burn
DRE
>99.99999998% & 99.999999995%
In 2 different scenarios
Emissions not effected by PCB

Notes: these results respect BAT/BEP guidelines of Stockholm Convention and Basel Convention, i.e. a DRE of 99.9999%.

Emission testing facility on kiln stack

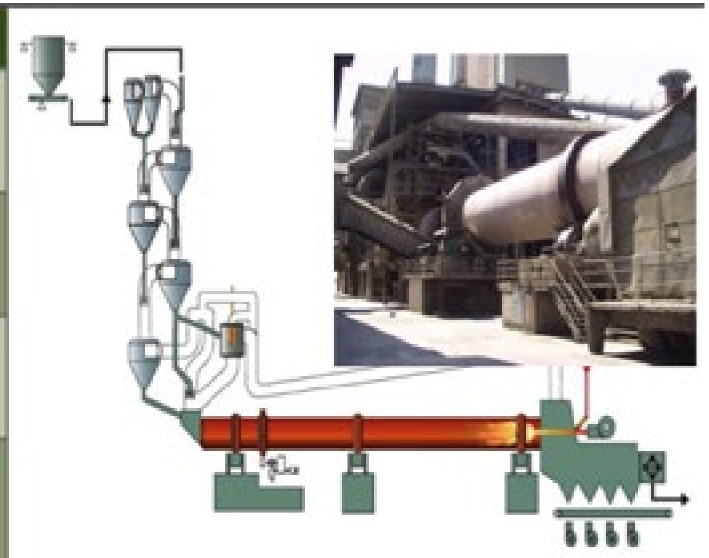
Main Conclusions

- Burning of AFR does not significantly affect the emission of the cement kiln
- The hazardous wastes destructed well in the kiln
- No additional pollution generated with burning of AFR
- Quality of clinker and cement products not changed

International development & recognition of solution

- GTZ – Holcim Alliance : Co-processing Guidelines, more info on www.coprocem.org

Characteristics	Temperature and time
Temperature at main burner	>1450°C: material >1800°C: flame temperature.
Residence time at main burner	>12-15 sec and >1200°C >5-6 sec and >1800°C
Temperature at precalciner	>850°C: material >1000°C: flame temperature
Residence time at precalciner	>2 - 6 sec and >800°C



International Technical Guidelines
- Basel Convention

UNITED NATIONS

UNEP

BC

UNEP/CHW.10/6/Add.3/Rev.1

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BASEL CONVENTION

Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Tenth meeting
Cartagena, Colombia, 17–21 October 2011
Item 3 (b) (i) of the provisional agenda*
Matters related to the implementation of the Convention: scientific and technical matters: technical guidelines

Technical guidelines

Note by the Secretariat

Addendum

Technical guidelines on the environmentally sound co-processing of hazardous wastes in cement kilns

At its tenth meeting, the Conference of the Parties adopted, as amended, the technical guidelines on the environmentally sound management co-processing of hazardous wastes in cement kilns on the basis of the draft contained in document UNEP/CHW.10/6/Add.3, which was prepared by the Government of Chile. The text of the final version of the technical guidelines is set out in the annex to the present document.

For full tekst of guidelines visit website
www.basel.int/TheConvention/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

Observations & Conclusions on way forward

- The cement kiln offers a highly advantageous system for co-processing because…..
• high gas and material temperatures in addition to long residence times in the kiln, virtually destroy all organic materials potentially present in alternate fuels, and
• alternative raw materials supply necessary chemical constituents of cement (calcium carbonate, silica, alumina, and iron).
- Cement companies have a local sustainable solution for PCB containing liquids & contaminated solids like PPM's, cleaning materials etc.),
- No long transport routes with these waste materials lower risk and lower cost or bigger volumes for same budget
- No investments needed in waste disposal infrastructure so budget can be used for other also much needed infrastructure in emerging countries materials.

Take home messages

- There is a great and urgent global need for the services of the cement industry based on general sustainability principles but in particular for hazardous waste co-processing in emerging countries

- The principles and philosophy/policy developed & adopted by Holcim on AFR practices are currently among the most responsible and advanced in the industry

- The "only" way forward is to document and publish the performance and practice, especially from well-designed studies in emerging countries.


Pre-processing
Liquids
Solids
Social
Co-processing
Economic
Environmental

PCB TREATMENT IN THE FUTURE

J. Ledure & T. Dawance
SITA Decontamination

Abstract

2 different problems will have to be tackled in the future:

- PCB containing equipment

- PCB light contaminated equipment

This paper has as objective to highlight the challenges the society are being faced with with regard to those problems. Proven technologies exist. No one solution can cover all aspects. Combination solutions have to be offered to be at the same time environmentally friendly and economically viable for the holders of contaminated equipment.

Indeed, different approaches and philosophies have to be adopted, maximizing local content and involvement.

SITA Decontamination has developed a cooperative approach with partners to offer those global solutions including local content.

Keywords

PCB; future challenges; cooperative approach; local content.

Article

The aim of this paper is to share some thoughts about the development of the PCB elimination into the future.

Europe is almost done with to the final elimination of its PCB waste, with a deadline for most countries to the end of 2010. Existing facilities have been used up to now to decontaminate not only PCB filled equipment, but also equipment filled with light contaminated oil.

Previously, because land transport was the cheapest and easiest way, most of the equipments to be decontaminated were shipped in drip trays, but filled with liquid. Thus, all of the operations were done on a single location. By now, these existing facilities need to use sea transport which requires equipment to be shipped drained and liquids to be shipped in UN approved containers following strictly the IMDG norms (containers well labelled, the material attached, absorbent, etc.).

The world of PCB is evolving. In the future, we will have to focus on the three following themes:

1. There is a significant difference in the approach between PCB containing equipment and PCB light contaminated equipment.

2. Local content and possibilities have to be developed, taking into account sometimes limited tonnages to be found in some countries.

3. Respect of a Quality Chart about the health of the workers, the emissions of PCB and the quality of the recycled material.

Let me now develop these themes.

1. PCB equipment

The source of all the troubles we are facing is at the start of the filling of electrical equipment with what at the time seemed to be a wonderful synthetic fluid: PCB sold with various compositions under a variety of nice commercial names: Askarel, Chlorophen, etc…

For those equipments filled at the origin with that type of liquid, whatever has been said or will be said at this conference, there is no other ecological, economical, respectful of human health way to dispose of those equipments, and recycle the valuable materials in those, than what has been done up to now: thorough decontamination of the equipment in closed vessels, dismantling of the equipment and thermal treatment of the liquid and solid residues.

Chemical treatment of the residue is both very expensive (cost of the consumables) and produces residues, which have to be disposed of.

There is no oil to recycle, and the paper/wood fraction is expensive and difficult to treat, as well as non-recyclable.

There is also no possibility (and it is forbidden by the Stockholm convention) to flush clean PCB filled electrical equipment and to reuse it afterwards.

2. PCB light contaminated equipment

The situation is totally different with equipment filled with mineral oil, which has been accidentally contaminated with PCB.

The reasons are as follows:

- Effective and environmentally sound techniques do exist for flushing the electrical equipments. They could even be utilized while transformers are in operation (mainly for big power transformers). For smaller ones, workshops could be installed where those operations take place.

- Equipments such as transformers could be reused after flushing and close monitoring of the oil quality.
- After decontamination, the oil can be recycled (or used as substitute fuel) locally. There is no need for export to dangerous waste incinerators.

3. Development of local capabilities

In the light of what was said before, we could see local developments in two directions:

- For PCB filled equipment, except for very large tonnages, the objective should be to prepare on site the equipments for disposal in existing facilities in Europe or elsewhere, provided the necessary guarantees are given (See further Quality Chart). The main reason is the cost of the necessary investments to reach the required quality level.

To illustrate, we will give you some examples. A PCB decontamination plant, with a Year capacity of 8 – 10 kT/year would require an investment of +/- 10 M €. For an incineration plant for dangerous waste, with a plant capacity of 50 kT/year, the investment would probably be in the range of 100 M €.

- For equipment filled with light contaminated oil, alternative and affordable techniques do exist. Some have been presented here. The main advantages are the following:

- The needed investments are much lower than the figures mentioned above
- Many equipments could be reused after adequate treatment, minimizing replacement cost.
- The shop could be linked to e.g.. a transformer repair shop, maximizing local content and using local skilled labor.
- The treated oil could be reused or recycled locally.

4. Quality Chart

The treatment of PCB filled equipment is a tricky business. The quality of this molecule : its stability. Furthermore the long presence of the fluid in the equipment makes it difficult and costly to decontaminate the recyclable materials.
All this has to be done respecting closely the three aspects which are critical in all respects:

- The health of the workers should be protected. They should not be unduly exposed to PCB or other health dangerous substances;
- The emissions of PCB to the environment should be limited to the minimum and closely monitored;
- The quality of the recycled material should be such as to guarantee a concentration of max 50ppm (lower for some countries) on the metal.

To guarantee this, a few years ago, SITA Decontamination undertook to follow this way to work as if it was part of a “Quality Chart” to be complied so that we demonstrate that we respect all the necessary norms to guarantee the safeguarding of the Environment and the Health of the Workers. This is our daily work and our desire to move in that direction. This allows us to display today a triple certification (ISO 9001, ISO 14001 and OHSAS 18001).

This is a clear sign to all authorities and customers that a strict control is needed, that it is implemented, and that it gives confidence to everyone that the treatment is done correctly, safeguarding Human Health and Environment.

PACKAGING, TRANSPORT AND DISPOSAL OF PCB AND PCB CONTAINING EQUIPMENT

C. Rittersberger & T. Vandenbroucque
Tredi, Groupe Séché Environnement

Tredi is a hazardous waste operator from France (part of Séché Environnement) with ample experience in international POP projects since around twenty years. Regularly, Tredi executes projects on a worldwide basis with partners such as various UN agencies or government bodies.

Tredi covers the whole possible project range:

- training local teams,
- sampling & analyzing,
- packaging & conditioning,
- pre-treatment at site if suitable,
- notifications, documentation,
- transport by road and sea/rivers,
- disposal in own dedicated plants in France (Tredi Salaise & Tredi St Vulbas).

In 2010, Tredi participated in a tender by the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus (in Minsk) for the packaging, transport and disposal of PCB and PCB containing equipment. The tender was financed by GEF and supervised by the World Bank.

After a long and diligent selection process, Tredi was awarded the contract at the end of 2011 and started operations in 2012.

820 tons of PCB and PCB containing equipment were to be collected and packaged at 14 industrial sites in 9 towns of Belarus, than transported to France and decontaminated/incinerated.

Administrative tasks were heavy, as 14 notification files were necessary, meaning a total of over 2000 pages of documents and translations into English and Polish languages.

At the beginning of 2012, special packaging material was sent from Tredi St Vulbas/France to Belarus. Here, two Tredi field teams already present in the country received it. They had prepared the coming works together with the coordinators at the Ministry in Minsk and with the directors of the industrial sites where the PCB waste was stored.

The two teams consisted of specialized and experienced Tredi experts. They were supported by personnel from the PCB owners. Training the personnel on safety and technical issues was part of the tender. They started in parallel at different industrial sites the works called ‘field services’:

- training personnel from the industrial site (PCB owners) on safety
- training on technical issues
- designing a PCB works area
- packaging PCB waste
- loading to transport trucks
- organising customs and transport

After finishing at one PCB-site, a team would move to the next site according to a works plan agreed upon before with the Ministry in Minsk. Field services were finished within 6 months, keeping well below the project time frame of 15 months. They left behind clean sites where before dangerous PCB-waste was stored.

All PCB waste was transported for disposal in 2012 to the Tredi St Vulbas site in France. Here, the waste was either decontaminated or incinerated.

Decontamination by dismantling (for transformers) and autoclaving was applied to metal parts which, once cleaned, were recycled.

High-temperature incineration (1200°C) was applied for all liquid PCB-waste (including the PCB collected in the autoclaves) and for the porous parts (wood for example) from dismantling.

Tredi St Vulbas exceeds as well 99,9999% DRE (Destruction Removal Efficiency) as 99,99% DE (Destruction Efficiency). This was a requirement set out by contract conditions in the qualifying phase of the tender.

DECONTAMINATION OF PCBS (POLYCHLORINATED BIPHENYLS) - THE ITALIAN EXPERIENCE OF DELCO : THE COMBINED USE OF ASD (AUTOCLAVE SOLVENT DECONTAMINATION) AND ODR (OIL DECONTAMINATION & REGENERATION) FOR THE TREATMENT OF CONTAMINATED ELECTRICAL CAPACITORS.

M. Tonani

From an article written by Mario Coppo – Engineer and founder of D.E.L. CO. – Inveruno (MI) Italy

D.E.L.CO was the brainchild of Mario Coppo, an engineer with great experience in the field of circulating fluids such as hydraulic, quenching and heat exchangers, who in 1982 designed and patented the first prototype of Autoclave (ASD) able to extract from electrical equipment such as transformers and capacitors, PCBs (polychlorinated biphenyls and mixtures therein).

Figure 1: Mario Coppo

The innovative technology made it possible to extract and then decontaminate totally, regardless of concentration levels, the PCBs content in all parts of transformers and capacitors. This treatment has allowed the equipment contaminated with hazardous waste such as precious commodity to recycle.

In fact, the ASD method allows the total recovery of copper, iron, magnetic iron and ceramics present in transformers and capacitors. The principle of this operation is based on an intensive cleaning solvent, with Perchloroethylene or Trichloroethylene, solvents which in a controlled indoor environment and under vacuum, allow abstraction from the materials that make up transformers or capacitors around the PCB, allowing an optimal efficiency also for waste contaminated with pure PCBs.

The ASD system has evolved over the years coming now to its fifth generation and going from an average treatment time of one full day (24 hours) per wash cycle to the current time (4hours) in today's current period.

Figure 2: Global D.E.L.CO presence

Due to its effectiveness, the ASD technology quickly spread throughout the world, first in Italy then in France at the Saint Voulbas TREDI plant, Mexico, Argentina, Canada, Taiwan etc., allowing the recovery of thousands of tons of materials.

From the technological development of Signor Coppo's invention, ASD has also become an effective means for the regeneration of transformers contaminated by PCBs, allowing not only the recovery of the materials but a real and immediate reuse of the same. In fact the latest generation of ASD allow, in the event of transformers being contaminated by PCBs but still in good conditions, to recover the total transformer, reusing it perfectly decontaminated. The sophisticated process of vacuum decontamination with solvent vapours, does not damage the transformer and also allows re-use after decontamination.

Figure 3: Decontamination materials contained in transformers and capacitors

A regeneration transformers plant, based on ASD technology, has recently been built in Iseauz, France.

Figure 4: ASD

To be borne in mind at all times is the fact that the ASD technology has a considerable environmental advantage due not only to the absence of emissions into the atmosphere during the decontamination but also thanks to the continuous reuse in the solvent which is in turn regenerated and recovered, allowing use for many years without suffering any deterioration.

The particularity of the D.E.L.CO. experience in the decontamination from PCB, is not then limited only to the porous and non porous solid materials with the use of ASD, but in the 1990s has also evolved with the development of the new ODR technology, that allows the recovery and also the complete decontamination of insulating fluids in transformer content. In fact, before that the ASD technology allowed the decontamination of solids but the liquids were all sent for incineration, with a significant environmental impact and waste of energy and resources. This new idea of Signor Coppo, has allowed us to recover and regenerate even the dielectric oil contaminated.

Figure 5: Decontaminated and regenerated oil

The ODR patent can completely destroy the PCB content in the mineral oils for transformers, with concentrations of up to 10,000 ppm, but simultaneously also to regenerate the oils themselves. The regeneration level is so efficient that the organoleptic characteristic of decontaminated and treated with ODR are similar to those of the new dielectric oil.

Figure 6: Fixed ODR

ODR is designed and made in fixed and mobile versions allowing continuous treatment up to 2,000 litres per hour and with the use of different reagents.

Figure 7: Mobile ODR

The operation principle is based on the destruction of PCBs, with the aid of alkali metals such as sodium metal or sodium hydride, chemically transforming the PCBs as sodium chloride or NaCl (the general food salt) and biphenyl.

Thanks to the efficiency of its technology, it expands quickly around the world with mobile or fixed installations in Italy, France, Romania and Brazil.
D.E.L.CO. has managed over the years, thanks to the combined use of the two technologies ASD & ODR, to fulfil for its customers real centres of decontamination, with complete solutions that allow the decontamination of transformers, capacitors, cables seafood contaminated by PCBs and ballasts allowing recovery of solid materials and contaminated fluids.

The ballasts are capacitors and small transformers for neon lamps and other which are normally contaminated by PCBs. In Canada, we decontaminated by crushing after being cooled with liquid nitrogen and then sifting the crumbs of frozen PCB. This has enabled a remarkable reduction of the environmental impact of decontamination from PCBs, but at the same time, has also allowed a considerable reduction in materials intended for incineration allowing their immediate reuse in the production chain.

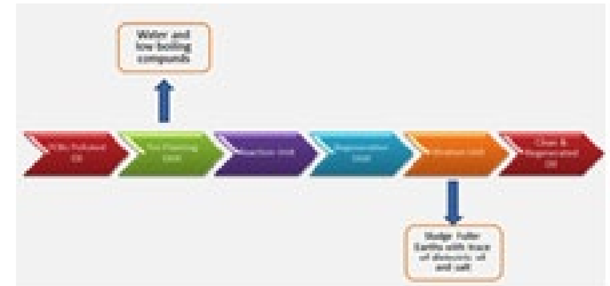


Figure 8: ODR Process

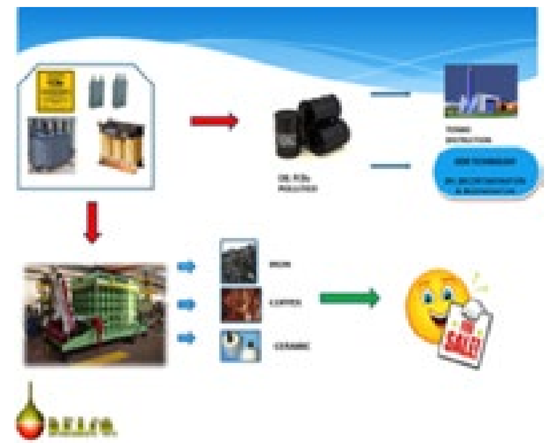


Figure 9: ASD Process of Decontamination and recycling materials

Not to be underestimated is the significant economic benefit to the end customer, that has reaped the benefit of a significant reduction of the costs of decontamination, but also a strong increase in business profitability due to the total recovery of valuable materials such as copper, iron and insulating dielectric oil.
// www.delcosrl.com

SUMMERY: PCB TREATMENT

D. J. Hoogendoorn
Orion b.v., the Netherlands

U. K. Wagner
ETI Environmental Technology Int. Ltd.,
Chur, Switzerland

Summary

1) Using existing local capacity for licenced high temperature treatment of liquid PCB's and POP's in emerging economies 80% to 95% of the PCB problem can be treated locally in many countries, with only 5% of the remaining PCB waste to be exported for treatment abroad.

2) Life cycle management and product reuse can be an important additional positive effect if inventory and sampling programs allow for additional oil quality analyses apart from PCB in oil testing. First of all, in this way, PCB free transformers may also benefit from the sampling efforts. Secondly, the stability and the reliability of the electric distribution grid can be assessed and, if necessary, improved. Thirdly, the low-PCB contaminated transformers with otherwise good technical conditions can be cleaned and re-used, thus, moving the PCB treatment up on the Waste Hierarchy.

3) Based on local and country specific needs, the general preference for 100% local treatment of PCB waste is usually not the economic and environmentally sound solution. However, an important part of available budgets is spend on (studying and coordinating) these projects without always achieving the desired outcome. Best practices and bench marks are available for feasibility scans for organizations wishing to use the available budgets effectively and efficiently.

Introduction

The session PCB treatment consists of presentations for all technologies available in the EU and in the emerging economies for PCB waste treatment and transformer decontamination. After an overview of the PCB waste related issues by Urs Wagner to set the context for a complete understanding of the subject, the following was presented: (next page)

INTERNATIONAL STATUS OF PCB REMOVAL TOWARDS 2028 & IDENTIFICATION, ENVIRONMENTALLY SOUND MANAGEMENT OF PCBS FROM OPEN APPLICATIONS	**Urs K. Wagner** ETI Environmental Technology Int. Ltd. Switzerland
PCB PROJECTS IN EMERGING ECONOMIES: ENVIRONMENTAL AND ECONOMIC BALANCE BASED ON CORPORATE SOCIAL RESPONSIBLE INNOVATIONS	**Dirk Jan Hoogendoorn** Orion b.v, the Netherlands
SODIUM TECHNOLOGY - THE CHOICE FOR TREATMENT OF POPS	**Edgar Bilger,** Klaus Seikel, Susanne Butorac Dr. Bilger Umweltconsulting GmbH, Freigericht, Germany
OILS & PCBS FREE PROGRAM 2013:BAT/ BEP-LCM FOR INVENTORY, CONTROL, MANAGEMENT AND DECONTAMINATION OF PCBS – POWER TRANSFORMERS AND CASE HISTORIES	**Vander Tumiatti**, M. Tumiatti, C. Roggero, R. Actis, R.Maina Sea Marconi Technologies S.a.s.Italy
HIGH VACUUM DESORPTION PROCESS FOR DECONTAMINATION OF EQUIPMENT AND MATERIAL CONTAMINATED BY PCBs	**Guillaume BARRIET** APROCHIM SA, France
CO-PROCESSING OF PCB AND OTHER POP'S IN CEMENT KILNS. A LOCAL SOLUTION FOR A WORLDWIDE PROBLEM	**Ed Verhamme** Alternate Resource Partners – The Netherlands
DECONTAMINATION PROCESS USING AUTOCLAVE (ASD) AND DE-CHLORINATION TECHNOLOGIES (ODR) – WORLDWIDE PAST EXPERIENCE AND FUTURE VISION.	**Michele Tonani,** Mario Coppo DELCO Srl – Italy
PCB TREATMENT IN THE FUTURE. SITA DECONTAMINATION	Jacques Ledure, **Thomas Dawance** Sita Decontamination
POPs IN IRAN - TREATMENT AND LIFE CYCLE MANAGEMENT FOR THE 21ST CENTURY: CURRENT EXPERIENCES AND SOLUTIONS	**Christoph Rittersberger** Séché Environment

It

The presentation of Urs K. Wagner gave an insight view of the status of international PCB assessment and removal activities towards the 2028 target of the Stockholm Convention, addressing both achievements and gaps.

It was concluded that countries prefer local treatment/disposal capacity and infrastructure (for example local or mobile PCB treatment plants). Local availability, however, cannot generally be considered the best solution for a country. Country-specific needs must be carefully evaluated in the frame of a PCB assessment; and treatment/disposal options can only be defined if and when a reliable PCB inventory is available! Some minimum criteria to be considered for tenders are amongst others:

Type of PCB waste	☐ transformer ☐ capacitor ☐ oil (pure or contaminated) ☐ soil ☐ solids waste (e.g. concrete, metal parts etc.) ☐ etc.
Contamination of PCB waste	☐ < 50 mg/kg ☐ > 500 to e.g. 3'000 mg/kg ☐ pure PCB
Total quantity of PCB waste	*Local treatment should only be envisaged with quantities exceeding certain limits (depending on technology/size of plant)*
Condition of PCB containing equipment	☐ in use ☐ to be reused after treatment ☐ phased out in good condition ☐ phased out and leaking/defect ☐ immediate actions necessary ☐ phased out and drained

Various environmentally sound PCB non combustion treatment and disposal technologies are available today. Local waste treatment in high temperature incinerators or approved co-processing in cement kilns can be evaluated. Treatment costs seem to be generally transparent and fair nowadays. The transport (and export) of PCB wastes to a treatment/disposal facilities, however, can be costly and risky. If ecologically and economically feasible, waste exports should be minimised and re-use of equipment/material maximised.

Current actions in the countries should focus on updating the existing PCB inventories. Only reliable and complete PCB assessments can be regarded a sufficient base for evaluating treatment/disposal options. During NIP Updates, open applications of PCBs (for example caulks, paints, anti-corrosion coatings, etc.) should be considered when inspecting buildings and sites for closed applications, and included in the PCB inventory.

The countries and the responsible Ministries and Steering Committees must take responsibility and ensure their homework is done professionally. It is vital that practical related and country specific PCB Guidelines are developed and implemented. Furthermore, PCB awareness raising and capacity building activities must be scheduled and workshops held in order to inform and train all relevant stakeholders.

Finally, PCB cross-contamination and unintentional formation of PCDD/PCDF must be prevented.

The other presentations and subjects are self-evident. Presentations and available papers may be accessed through the IHPA website.

SILENT LAND

SILENT LAND
AT THE 12TH INTERNATIONAL HCH AND PESTICIDES FORUM

J. Van den Berg
drsFILM

In September 2011, I travelled to Gabala, Azerbaijan, to show my documentary Silent Snow to the important audience of the 11th International HCH and Pesticide Forum. The film, about the consequences of pollution caused by the use of dangerous pesticides like DDT, was successfully received and later shown in over 35 countries at cinemas and international film festivals. Most importantly, it succeeded to inspire many people to take action and organize local initiatives to inform each other on a healthier way of producing food.

This fall I was therefore happy to return to the now 12th edition of the Forum in Kiev, Ukraine, which would host a preview of my first short film under the new Silent Land project: When elephants dance, the grass gets beaten. The project is a sequel to the Silent Land documentaries and has the objective to inform people about the effects of land grabbing for small local farms. In ‘When elephants dance’ we see how local farmers in Cambodia are losing their land to large multinationals and are faced with forced migration and food insecurity. Almost three quarter of the available land for agriculture in Cambodia has been sold to companies that produce for export only. As this is disastrous for the local food production, the World Food Program supports vulnerable parts of the population with food supplies. In the meantime, the exile of farmers continues. Since 2003, more than 400.000 Cambodians have been chased off their lands as a result of land grabbing. The stories I’ve heard about being an illegal migrant, the exploitation and having to work with dangerous pesticides are heart-breaking.

As I discovered on my journey to Kiev, in the Ukraine there’s also still a lot of dangerous poison just lying out in the open. Often these toxic materials are located just next to children’s playgrounds and it is very difficult to get rid of it in a safe way. It was again a great honor to be able to show my film to an audience of experts on this topic and I received very valuable feedback. The screening was held up a bit as the Communist Party held a demonstration outside the building against capitalism, while inside we discussed the dangerous left overs from Soviet Union’s development aid. Main character ‘Moon’ attended the conference through a Skype-call and was very pleased with the compliments for the film.

As for the Silent Land project as a whole; after the premiere of the first short film we will continue working on the feature length documentary, which will offer a more worldwide perspective on the same issues. Early January, ‘When elephants dance’ will be screened on a Conference for Biology teachers in the Netherlands and the official world premiere will take in Antwerp on January 22nd, in combination with an expert panel discussion on land grabbing and food security. Furthermore, the film was part of the IDFA Docs for Sale selection last fall and will be screened on international film festivals like Parnu in Estonia, Cinemambiente in Italy and Festival du Film d’ Environment in France this year. The project's educational material will also be soon available for schools, as part of the OXFAM GROW campaign.

More info on www.silentland.org
Trailer of 'When elephants dance, the grass gets beaten'

http://vimeo.com/79869713

PROGRESS AND EXPERIENCE ON POPS AND OBSOLETE PESTICIDES WASTE MANAGEMENT

EXPERIENCE IN THE IMPLEMENTATION OF GOVERNMENT CONTRACTS FOR WASTE FROM DETERIORATED PLANT PROTECTION PRODUCTS AND THEIR PACKAGING

C. Pyotr
Deputy Director of OAO "Polygon",
Tomsk, Russia

In recent years, the OAO "Polygon", which is operating the Tomsk hazardous waste landfill, is one of the main organizations in Russia engaged in the disposal of obsolete pesticides.

• For industrial wastes, the Tomsk landfill is one of the best sites in the Russian Federation. In a resolution by the Government of the Russian Federation, the Tomsk landfill was included in the federal priority programme "Waste" (1996 to 2000) as a"pilot project" for Russia on waste management;

• In a resolution by the Government of the Russian Federation, the construction of the Tomsk landfill was included in the federal program "Ecology and Natural Resources of Russia" (2002-2010)

• Funding for construction of the Tomsk landfill was included in the Federal Law № 204- FZ of 24.11.2008, № 308- FZ of 02.12.2009, and number № 357 of 13.02.2010 "On the federal budget ... " for financial years 2009, 2010, 2011 and 2012, respectively.

• At present, the share of the Russian Federation in the authorized capital of the company is more than 60 %.

• The analysis of work done under federal and municipal contracts for the disposal of obsolete pesticides showed following features :

1. Disposed pesticides are dating mostly from the Soviet era

2. 90 % of the pesticides are mixtures of chemicals of various origins

3. Pesticides are usually stored in unsuitable premises and facilities - often in the open air.

4. Information on the amount of pesticides that are passed on to the Federal Ministry of Natural Resources, underestimates the amounts on average by 30 %. Transmitted information also lacks information on the pesticides burial sites (mainly DDT) dating from the 1960-1970s.

• The current disposal option (burial) of pesticides makes its subsequent destruction very difficult.

• It is proposed - in terms of the implementation of the Stockholm Convention - to declare as a priority the establishment of waste disposal sites (landfills), where it is possible to carry out long-term, controlled storage until Russia has certified technology to destroy them.

Region	Number of contracts	Volume in tonnes
Tomsk region	6	37
Kemerovo region	1	14
Omsk region	10	132
Republic of Tyva	1	4,8
Total:	18	187,7

Table 1: Overview of contracts for disposal of pesticides implemented at the “OAO landfill in 2011

Photo 1: Overview of the Tomsk landfill facility with main installations and at the top 3 storage buildings filled with pesticides waste

Photo 2: One of the 3 storage buildings filleds with pesticides waste as indicated in photo 1

Photo 3: Waste containers for hazard class I.
These are used for storage of pesticides waste

Photo 4: Removal of chemicals from the warehouse of the Costumor

Photo 5 & 6: Obsolete Pesticides at another location were formerly stored in metal tanks and are now permanently removed, repacked and brought to one of the stores at the Tomsk Landfill

ECORESURS LLC EXPERIENCES IN MANAGEMENT OF WASTES OF I-V HAZARD CLASS ON THE TERRITORY OF KRASNOYARSK CITY AND KRASNOYARSK REGION

E. Shepelev
Director General

Ecoresurs LLC has been providing services in collecting, transporting, using, decontaminating and disposing the wastes of I-V hazard class on the territory of Krasnoyarsk city and Krasnoyarsk region for already 23 years. The Company's activity is licensed (License No 024 00101 dated 22.06.2012).

The Company's priority is to provide for the environmental safety on the territory of Krasnoyarsk city and Krasnoyarsk region.

Ecoresurs LLC owns modern production base, which includes the following:

– facilities for industrial and household wastes disposal;

– section for decontamination of mercury containing lamps;

– section for decontamination of hazardous and highly hazardous wastes;

– rapid response team to liquidate emergency situations related to mercury spillage;

– Environmental Consulting Department.

The following projects are successfully realized:

– Development of system of collecting, transportation and neutralization of the medical waste in the territory of the city of Krasnoyarsk. Work with medical institutions and the private organizations in Krasnoyarsk and nearby district of Krasnoyarsk region;

– Improvement of waste management from the territory in Krasnoyarsk and nearby cities;

– Construction of waste treatment plant for class I-IV danger class including re-use of energy. The most modern in Russia. It is put into operation of 05.06.2013. Allows to treat more than 250 types of waste;

– Development and deployment of selective waste collection system together with Head department of formation of the city of Krasnoyarsk (more than 335 establishments of Krasnoyarsk are included);

Thus, LLC Ecoresurs introduces complex system of total waste management collection at a source, packaging transportation, sorting, treatment and collection of residuals (ashes and slags).

This presentation summarizes the information on the certified waste treatment plant at high temperature. The plant is located in the existing premises on the territory of the Ecoresurs industrial wastes, located in Krasnoyarsk.

The technology is compliant with International Standards EC 2000/76.

The production facilities employ the advanced technologies of wastes incineration (optimal combination of pyrolysis incineration and wastes oxidation at the temperature of 850-900 C° in the combustion chamber; and at 1100-1200 C° in the afterburner - photo 1, 2, 3), gases filtration, which guarantees the environmental safety of the technological process.

The complex for thermal treatment of waste is intended for high-temperature treatment of the waste which as a result of operation of various infrastructures.

The technology of thermal treatment of waste in the incinerator is applied as unconditional alternative to the treatment of waste of the I-IV class of danger.

Technology advantages:

– epidemiological safety: there are no the viruses, capable to survive at t 850-900 C°;

– the ashes and slags generated belong to the IV class of danger;

– value of the maximum ground concentration of harmful substances on borders of established SZZ (sanitary protection zones) no more than 0,1 maximum concentration limits on all ingredients which are emitted at operation of installation.

High ecological safety of a complex is reached due to application of operated 2-zonal burning of waste; temperature maintenance in the first zone (the drum furnace) 900-1 000 C°и t 1 100-1 200 C°in the second zone (camera reburning), and also at the expense of the multistage system of gas purification of reactionary combustion gases including two scrubbers for cleaning of fly-ashes and from acid-forming secondary pollutants and frictional cleaning by coal nano-dispersions (photo 4,5);

– the complex works without smoke and a smell.

The Russian manufactured Processing Unit allows to decontaminate a wide range of wastes on the basis of the high temperature process: chemical, medical, biological, pesticides, herbicides, and other toxic chemicals (including unidentified), highly toxic wastes, “tails” of solid household and industrial wastes, oil slurries, contaminated soils and etc, except for the banned types of wastes.

Complex productivity:

– solid waste: more than 2 000 kg/h;

– liquid waste: more than 300 kg/h.

At thermal neutralization of waste surplus of heat which in winter time will be used for heating of all production base of LLC Ecoresurs is formed.

Since 2011, the Company commenced implementing its own project “Wastes Sorting Complex Construction” allowing for the advanced processing of solid household wastes resulting in the end product. Commissioning is planned for 2014.

LLC Ecoresurs realized the project on construction and commissioning of a waste-processing complex.

The first stage is now realized: construction and commissioning of a waste sorting complex.

Design capacity waste sorting complex – 350 thousand tons of solid household waste per year (more than 1 million m^3 of Municipal Solid Waste (MSW).

Sorting type: the semi-automatic.

The second stage construction of plant on processing of secondary raw materials and production of the final product.

It is the new project of the company which allows to reduce the saved-up ecological damage, to reduce negative impact on environment and health of the person.

Photo 1-5: Overview of different situations of the dedicated hazardous waste treatment plant

MECHANICAL CHEMICAL DESTRUCTION (MCD) OF CONTAMINANTS IN SOILS

N. Coughlan
European Representative, The Netherlands
M. Glucina
Regional Director, Environmental Decontamination,
Auckland, New Zealand

EDL Company Background

New Zealand based Environmental Decontamination Ltd was founded 1998 and backed by collaboration with the Government of New Zealand through the Ministry of the Environment, and The Foundation for Research, Science and Technology, EDL has pioneered a continuous process in the area of on-site ex-situ soil remediation through its development and commercialisation of Mechano-Chemical Destruction (MCD™) technology.

Mechano Chemical Destruction (MCD™)

The mechano-chemical destruction (MCD™) of PCBs, dioxins, pesticides and other organic contaminants in soil or soil-like mixtures is accomplished using EDL's patented multi-tube rotary ball-mill reactor. The principles of the MCD technology is based on the provision of impact energy created due to the velocity of special high wear resistant steel balls being in constant collision with each other. During this volatile activity, in a controlled environment, soil crystals rupture at the point of contact between the balls, with the resultant formation of reactive free radicals on the ruptured surface (for ex-

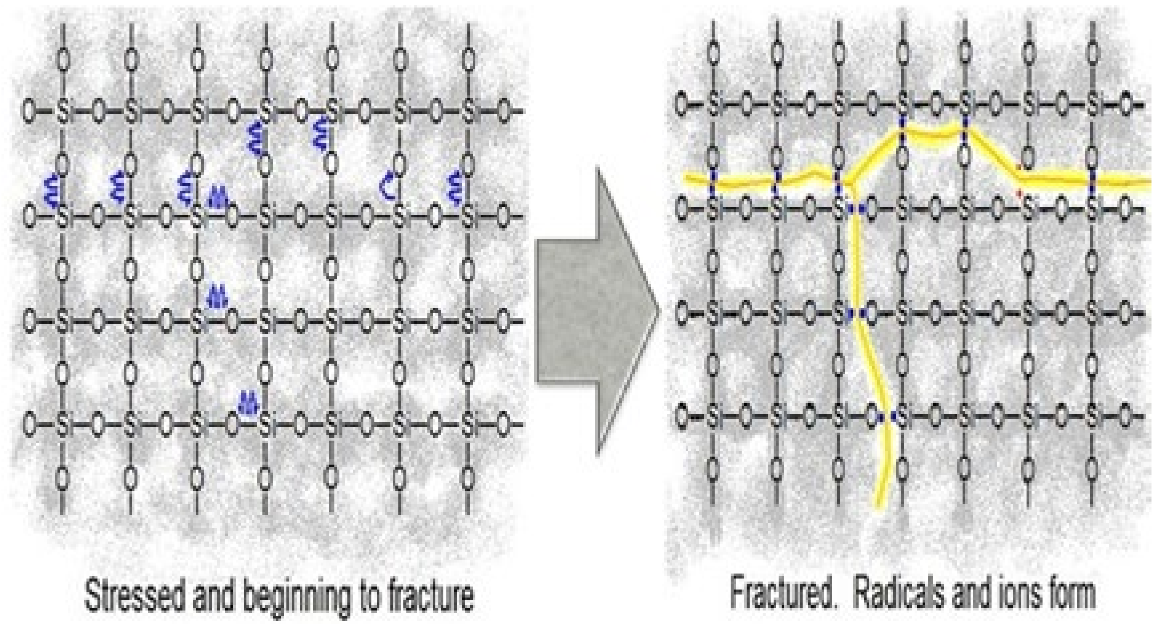


Figure 1: Radicals and ions forming

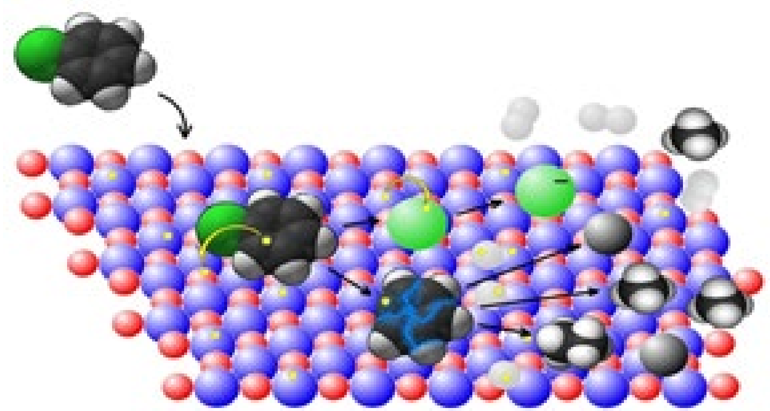


Figure 2: Chemical reaction diagram

ample 0-Si-0→≡Si· and ≡Si-0·).
This rupturing of the crystals is accompanied by the emissions of electrons and protons, and the generation of electrostatic charges. This mix is often referred to as a “tribo-plasma”. Any organic pollutant, which is present within the tribo-plasma zone becomes excited and reacts with the highly reactive free radicals, with the resultant formation of inorganic halides and graphite carbon.

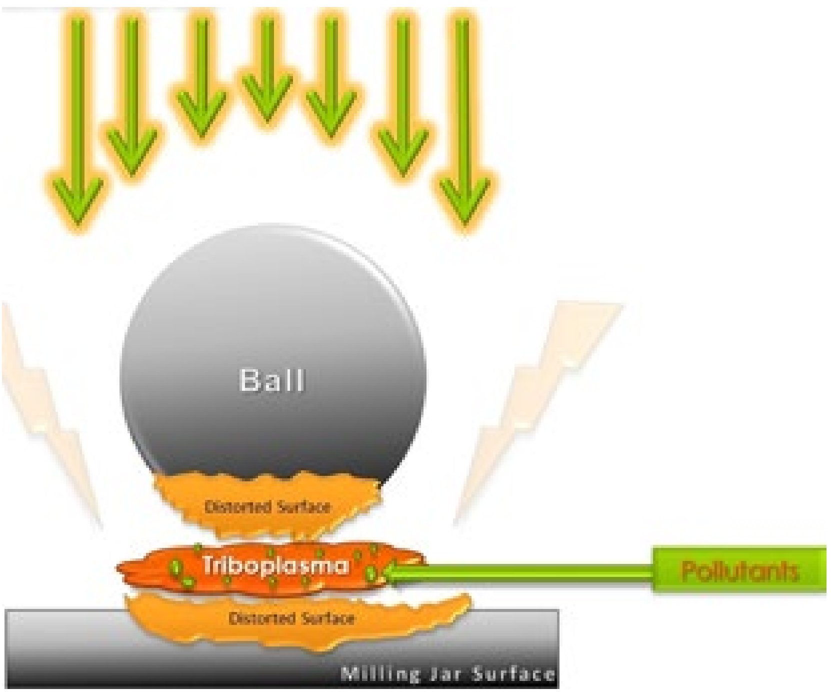


Figure 3: Tribo-plasma reaction within reactor

The MCD™ reactor adds significant amounts of energy to the milled material creating a fluidised reactive cloud of mineral particles with a large number of electrons (inorganic free radicals) and ions on their surfaces.

Since the basis of the process is fracturing solids, it works best (i.e. fastest) when the matrix is rich in hard brittle minerals. In real soils, these are mixtures of silicates such as feldspars, quartzites and the like. When a crystal fractures, the chemicalbonds may break in a number of ways. Thus, the Si-O bond can break heterolytically to give ions, or homolytically to give free radicals. Both processes leave the fracture surface rich either in charges or free electrons. Ions, radicals and neutral molecules themselves bind to the reactive fracture surfaces and undergo similar fragmentations to those undergone by the parent substrate.

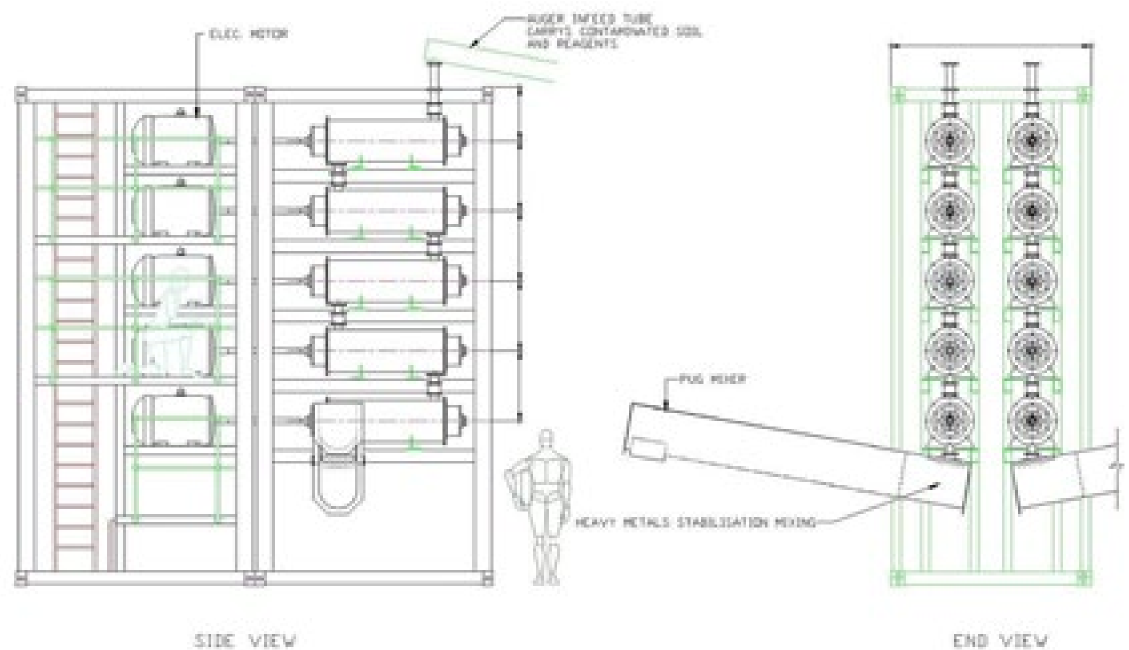
The final products are small neutral molecules including ethane, methane, carbon dioxide, hydrogen, water and carbon.

The use of mechanical energy to initiate chemical reactions is not new. Over the past few years, scientists around the world have conducted laboratory and pilot plant experiments using the fundamental principle of mechanical reaction to achieve the destruction of toxic chemicals. Various levels of Destruction Efficiency (DE) have been achieved, but the commercial application of this emerging technology has, up to now, never been accomplished.

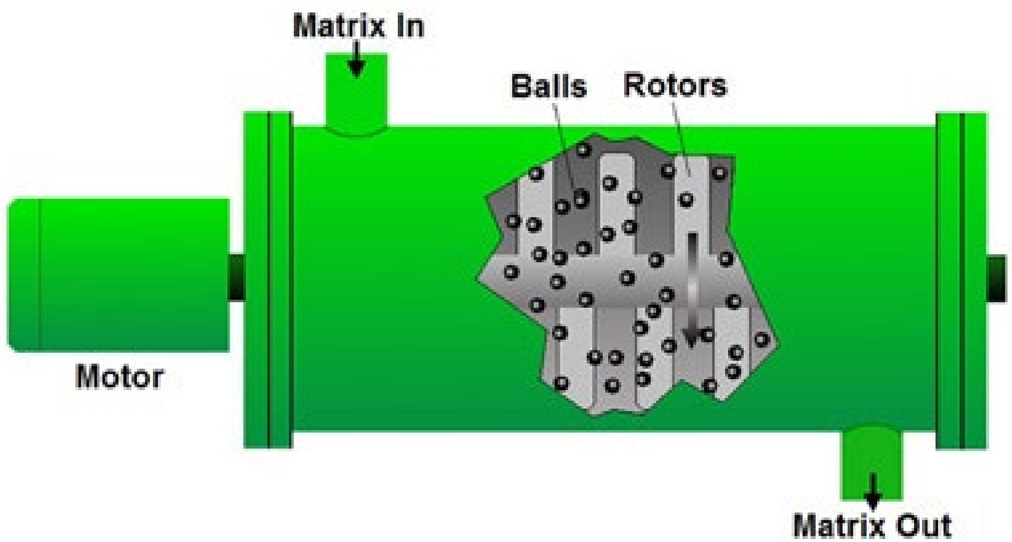
The MCD installation

Series V MCD™ plant is a non-combustion technology for the remediation of soils and soil like matrixes e.g. spent activated carbon. Operating at low temperatures, it is essentially a closed process with no risk of uncontrolled release of contaminants. The compact and containerised equipment makes transportation, deployment and maintenance of the plant straightforward. Plant throughputs and contaminant destruction efficiencies are controlled through variable retention times, additional MCD™ reactors can be linked in series for large scale remediation projects.

Prior to entering the drum, the soil is screened and dried to <2% moisture, which is facilitated by the use of a passive drying system with controlled temperatures less than 80 degrees Celsius. The soil travels from the dryer through EDL's patented, vertically stacked horizontal MCD ball mill array, then completes its process by traveling through a developed pug mill with incorporated water jets, to help cool and add moisture. In principle, the soil can be directly backfilled onto the location.



A typical plant layout looks like the diagram represented above with a relatively small plant footprint. Below a typical MCD reactor is illustrated:



Project Experience

EDL has successfully completed a number of full scale and pilot trials applying the MCD technology at different POP's contaminated sites, summarized in the chart to the right.

Date	Project	Volume of Soil	Machine	Contamination
2004	Mapua, NZ	8,650m3 full scale	Vibratory mill	DDT, aldrin, dieldrin, lindane
2006	USA, HP 1	9x10kg batch trials	1 drum	PCBs, dioxins, pesticides
2007	USA, HP 2	12x20kg batch trials	1 drum	PCBs, dioxins, heavy metals
2006	Hong Kong	4x10kg batch trials	1 drum	TPH, heavy metals
2007	China/Philippines	4x10kg batch trials	1 drum	Pesticides
2009	Japan Ministry Trial	14x10kg batch trials	1 drum	Dioxin, PCB's, BHC
2009	Alaska, USA	140m2 full scale	4 drum	PCB's
2010	Japan Osaka Trial	200 kg	2 drum pilot	Dioxins
2012	The Netherlands	1x10kg batch trial	1 drum	Dioxins
		Activated Carbon		
2012	Vietnam UNDP	100 tons full scale	4 drum	Dioxins

Project showcases

Mapua, New Zealand

The technology was in full scale operation from 2004 - 2007 at New Zealand's worst contaminated site. This contract for the Ministry of the Environment was completed in June 2007. Over 65,000 m3 of soil contaminated with DDT, DDD, DDE, aldrin, dieldrin and lindane was excavated and screened with 7,300 m3 being successfully treated to the soil acceptance criteria defined in the EIA.

Picture 1: Landfill prior excavated during operations

Picture 2: Contract completed and site regressed

Photo 1-3: Granite Mountain, Alaska

Granite Mountain, Alaska

PCB contamination at a former radio transformer station at Granite Mountain, in partnership with the US Air force. EDL completed the project by using a fully portable 4 drum plant which was flown in by an Hercules C140 aircraft. The PCB concentrations in the soil ranged from 500 to 1,200ppm, with a target acceptance criteria of <1ppm. The destruction levels up to 99% were achieved, the treated soil was backfilled to the site.

Bein Hoa, Vietnam

EDL most recent successful project was in Vietnam 2012, undertaking the project called "Environmental Remediation of Dioxin Contaminated Hotspots in Vietnam" funded by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP), for the treatment of 100 tons of highly contaminated soils at the Bein Hoa airbase. This project was awarded to EDL following

Photo 1-2: Bein Hoa, Vietnam

an international tender and expert review of over 20 different technologies by environmental experts.

The site containing extensive dioxin contamination remaining from the use of various defoliant herbicides during the period of armed conflict. The most common of these herbicides was known as Agent Orange, whose production was associated with dioxin by-products. Dioxin contamination levels in soil of 2,000 to 30,000 ppt TEQ.

The MCD technology has demonstrated the capability of destroying the PCDD/F contaminated in soils representative of the hotspot contaminated sites at Bein Hoa in the "bare bones" configuration 4 reactor pilot installation.

The target criteria for dioxin contamination was <1,000 ppt TEQ, but levels of <300 ppt TEQ were successfully achieved.

Quoted from the independent evaluation UNDP Report (Environmental remediation of dioxin hotspots in Vietnam. by Rick Cooke)

" As an overall conclusion, the MCD technology has now been demonstrated and evaluated to a significantly greater level than any other candidate technology, and, with limitations and conditions noted, is judged as generally qualified for commercial consideration in future large scale dioxin contaminated site remediation projects in Vietnam and elsewhere."

Why EDL's MCD™ Technology

• A reliable remediation solution backed by research and development in collaboration with the New Zealand Government, Universities and extensively independently evaluated by international specialists.

• Eco efficient, and cost efficient with rapid deployment, erection and decommissioning.

• A company totally focused on and committed to the ongoing refinement of MCD™ technology in soils, sediments and soil like matrixes.

• Relatively simple process is very flexible and can be tuned to the circumstances of each site

• Reactors are highly modular and very easy to service or replace. This is necessary when working in super critical situations.

• No hazardous or expensive reagents or conditions are needed.

• Soil can be in principle directly back filled onto the location.

• A wide range of organic contaminates and POP's can be successfully treated with one installation.

• A genuine alternative to incineration, thermal desorption and bioremediation.

Acknowledgements: Bryan Black and Mike Bulley
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PROGRESS & EXPERIENCE OF POPS TREATMENT SOLUTIONS IN THE FIELD

N. Morgan
Managing Director
Veolia ES Field Services Ltd.

Abstract

As a World leader in environmental services, VEOLIA has a wealth of experience in the environmentally sound treatment of hazardous waste including POPs. Our specialist International Field Services business unit based in the UK has >20 years of direct experience in handling POPs in field conditions throughout the world.

Having worked in Africa, Asia, Latin America and Eastern Europe, we have developed a successful model for the safe and effective management of POPs including safeguarding, removal, transportation and effective treatment through a network of state of the art treatment facilities. Our project model is based on a sustainable, collaborative approach, working with waste producers/holders, countries and international organisations to remove POPs safely and to provide a lasting skills legacy for the country.

Using this approach a POPs disposal project can provide an excellent opportunity to contribute to capacity building and prevention.

Background to Veolia Environmental Services

Environmental issues are a concern throughout the world, but even more so where there are no local resources or infrastructures in place to effectively manage these concerns. At Veolia Environmental Services, we are committed to delivering sustainable, responsible and economically viable waste management solutions and services, whilst protecting and caring for the welfare and development of the environment and local communities in which we operate.

Offering a truly worldwide service in specialist hazardous waste and clean-up solutions, Veolia Environmental Services has an unrivalled reputation for practical and economical solutions, with a dedicated international team to advise on the best practical environmental options and an enviable track record in the responsible handling of hazardous materials.

Our operations are delivered in the field with the utmost care for the environment, the law and the health and safety of those directly or indirectly involved.

With extensive project management experience, a range of treatment technologies and full logistical support, we provide turnkey solutions for the removal, treatment and disposal of all hazardous substances, including PCBs and pesticides, plus land and building remediation, clean up and decommissioning.

Introduction

Over a period extending back to the early 1990s, Veolia Field Services has undertaken POPs clean-up projects throughout the world including extensively in Africa, Latin America, the Far East and across the entire European area. Over this time, we have worked together with other stakeholders including waste producers, international organisations, governments and partners to foster and promote a sustainable added value solution for POPs destruction projects. Central to this approach has been a partnering strategy to ensure that as well as ensuring the safe destruction of POPs materials that there is a legacy of skills transferred from Veolia to the country from which the waste has been removed. These two aspects, i.e. destruction and skills transfer, are central to the aims and requirement of the Stockholm Convention. They are also fundamental to the strategy of Veolia Field Services in relation to POPs clean-up.

This paper will set out a basic review of POPs destruction using Rotary Kiln High Temperature Incineration and provide an insight of how a POPs clean-up project can be used as an opportunity to develop national capacity for chemical management via technical assistance.

High Temperature Incineration (HTI)

For certain categories of waste including Persistent Organic Pollutants (POPS) and confidential materials, only the highest levels of secure destruction are

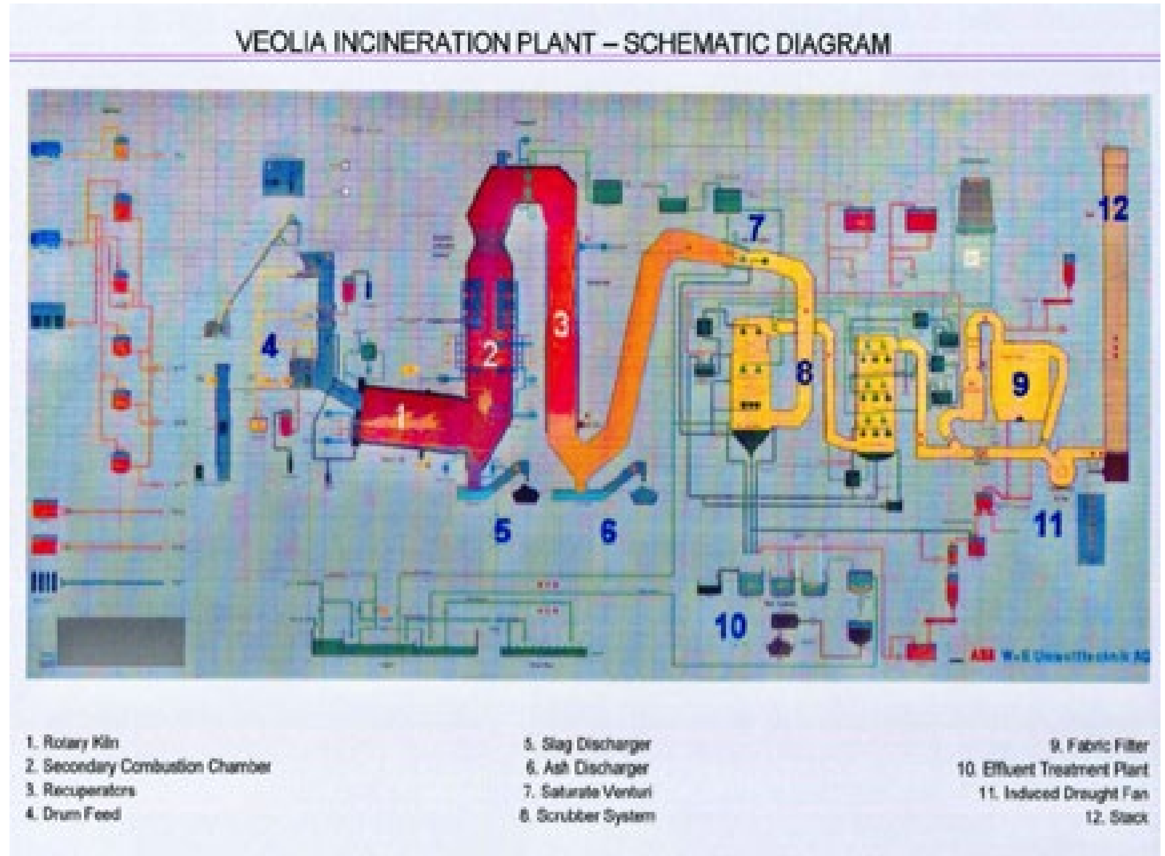

Figure 1: Schematic Diagram of HTI Facility

appropriate in order to satisfy both commercial and legislative requirements. In these cases, High Temperature Incineration is frequently the most cost-effective solution. As a proven solution for the safe disposal of persistent hazardous organic chemicals HTI is widely regarded as the best practical environmental option (BPEO) for many chemical wastes.

The process, which involves heating to temperatures in excess of 1100°C, delivers a destruction efficiency of 99.999996% and is ideally suited to the secure disposal of hazardous by-products, redundant or obsolete products, laboratory waste and agents, contaminated electrical equipment and contaminated soils. The exceptionally high efficiency of this process is matched by outstanding performance in the environmental arena. HTI uses the latest technology at every stage in order to achieve legislative conformity. Meeting all authorisations and legislative requirements whilst offering maximum flexibility for the handling and receiving of a wide range of materials, including all POPs.

Rotary Kiln

Veolia Environmental Services operates HTI plants throughout Europe and also in the USA and China. In the UK the Ellesmere Port facility uses an advanced, water-cooled rotary kiln which achieves temperatures of up to 1,200°C, ensuring complete combustion of all waste materials. It is fully automated; operational parameters and waste feed mechanisms are under computer control and safety interlocks can prevent operation where necessary. The kiln rotates between 1 and 6 revolutions per hour, allowing a waste residence time of 30 – 90 minutes and ensuring maximum burnout and volatilisation of organic materials. The resultant inert slag flows continuously into a water quench in the base of the secondary combustion chamber (SCC), where it immediately cools to form an inert glass-like solid. This can be reused or disposed of at licensed landfill sites.

Secondary Combustion Chamber (SCC)

Exhaust gases from the kiln pass into the 25m high SCC where further liquid wastes and air enter tangentially, providing a vortex. Separate lances inject aqueous, gaseous and non-compatible wastes. With a residence time after the last injection of air in excess of 2 seconds, turbulence, excess oxygen and temperature maintained at greater than 1100°C a high destruction and removal efficiency for all wastes is achieved.

Gas Cleaning

Combustion gases exit the SCC and pass through a pair of parallel gas-gas heat exchangers which reduce the temperature to around 800°C before being quenched instantaneously in a Saturate Venturi to less than 80°C. This rapid cooling to below the critical band of 250-400°C where dioxins can reform is a major design feature and accounts for the plant's outstanding environmental performance. The saturated gases are then passed through 2 scrubbing towers, these towers remove hydrochloric acid, oxides of sulphur, bromine and some of the inert particulate matter. The gases then enter a fabric filter where, with the addition of lime to aid filtration, the final particulates together with any residual acidity are removed.

Effluent Treatment

Liquid effluent from the scrubbing towers flows to the automated, computer controlled acid neutralisation plant. The fully neutralised effluent is mixed with a flocculent and discharged to settlement tanks. Clarified supernatant water is discharged to the estuary within prescribed consent standards. Sludge from the settlement tanks is thickened in a consolidation tank before dewatering, and the cake is discharged to skips for disposal off-site.

Operating to strict environmental standards

The facility's central computer monitors every aspect of the operation, providing continuous readouts of operational parameters and emissions. Additional testing for specific stack and effluent emissions is carried out to maintain efficiency. Stringent management controls together with regular monitoring carried out by the UK Environment Agency ensure the highest environmental performance standards are maintained. The facility has been authorised by the Environment Agency under the Integrated Pollution Control (IPC) provisions of the UK 1990 Environmental Protection Act. Operations are certificated to the international standards for Quality and Environment, ISO 9001 and ISO 14001. The plant consistently beats the limits for gaseous emissions under the EA and IPC procedures, now including the rigorous standards imposed by the Hazardous Waste Incineration Directive 94/67/EC.

Collaborative Project Management

Veolia Field Services has over more than 20 years worked with stakeholders including waste producers and trade organisation such as Croplife International, International Organisations such as FAO and other partners to develop and promote a collaborative approach to delivery of POPs clean-up projects. A key strategy has been to use local staff as part of the core project team at all levels including project management, technical, administrative and operational roles.

Particulate matter	0.67 mg/m3
Total organic carbon	<5 mg/m3
Carbon monoxide	<20 mg/m3
HCl	<1 mg/m3
SOx as SO2	<5 mg/m3
NOx as NO2	205 mg/m3
Hg	0.004 mg/m3
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn	0.096 mg/m3 (total)
Dioxin TEQ	<0.016 ng/m3
Destruction Removal Efficiency (DRE) for PCBs	99.999996%

Table 1: Typical emissions to atmosphere

Skills Legacy

In order to ensure that local inputs contribute fully to the safe and successful outcome of the project extensive training and on-going supervision and support is provided by Veolia. This ensures that all staff working on the project do so safely and effectively. In addition it ensures that following completion of the specific disposal operation that there is a legacy of trained, skilled and experienced national staff. This retained resource can contribute to or even act as a national focal point for responsible chemical management going forward.

The strategy of assigning local staff to active project roles ensures that they can apply the training provided in a “real world” situation which allows skills to be practiced and developed with expert support and supervision to ensure safe operations. Only by combining training with practical experience in a controlled environment can competency be achieved in the key areas of project management, administration, handling, storage and transport of hazardous chemicals including wastes.

Conclusion

Whilst Rotary Kiln High Temperature Incineration provides a proven, cost effective and environmentally sound solution for the destruction of POPs, a disposal project also provides a great opportunity to ensure a legacy of local competence in chemical management. If projects are designed and delivered applying a collaborative project management approach between key stakeholders from the private, public and international sectors they can deliver a sustainable outcome combined with secure POPs destruction. Accordingly this approach ensures that the key aims of the Stockholm Convention can be cost effectively achieved in practice.

HCB
THE DISAPPEARING POISON

D. Liszkiewicz & M. Kuciel
TVN television journalists
Poland

Introduction

The most dangerous waste in the world…

Taken from the Ukraine to prevent ecological disaster…

Brought to Gdansk in Poland by 2 ships and 500 hundred trucks...

They were meant to be irreversibly destroyed…

But they polluted the natural environment again…

Pollution transferred from the Ukraine to Poland

In the beginning, everything looked just like a legal transport of dangerous waste. However, after first transports reached it's destination and cargo was unloaded at Port Service incinerator, it became obvious that this situation was poorly handled by both polish environmental authorities and the company chosen as partner for waste disposal. Due to the lack of proper supervision, Poland has encountered serious HCB and pesticide pollution problems. Overloaded incineration plant was not capable of destroying HCB waste in a proper way. In effect, thousands of tons of partially incinerated waste were dumped illegally into a gravel pit 20 km from Gdansk and the Baltic Sea.

Luckily, one man decided to tell us the truth, though those facts that he described were really hard for us to believe in. With help and suggestions from Plant Protection Institute in Poland, we managed to confirm those serious allegations. Instructed by Mr Tomasz Stobiecki from Plant Protection Institute, we decided to take samples of water and soil from the place. The results were shocking. Many obsolete pesticides were found in those samples: HCH (alpha), HCH (gamma), HCB, DDT, and Atrazine. Concentrations of these compounds exceeded the standards for soil and water up to 550 times!

This story might not have been revealed. Year after year pollution might be spreading consequently to the environment, reaching the ground waters and poisoning water wells. It is a story of people of good will, who were brave enough to confront the dirty reality and helped us change it.

The story begins

In January 2012, we received an e-mail from a concerned citizen of Gdansk.

We called this man "The Guardsman" since he was a person who wanted to protect the environment, and local inhabitants, that might have been affected by toxic waste.

"I live in New Port district in Gdansk. There is an incinerator there, that takes thousands of tons of waste from th Ukraine. Hundreds of trucks come there daily, dropping their loads in every spot in this facility"- he wrote.

The Watchman", and other people, who live in the vicinity of this plant kept wondering why waste from the Ukraine is transported for over 1000 kilometers to our city. They could not find any information about the transports. The piles of waste kept growing every day to an unprecedented size.

"There is so much of this waste, that it's stored all over the place. It's not sheltered in any way, nor protected from rain or wild animals. The odor is hard to describe. I tried to inform local authorities, but no one wants to help. They keep ensuring us, that everything is in order. For myself and the other inhabitants of our district, I'm asking you for help. I cannot reveal my

identity, because I'm afraid of possible consequences or even losing my employment" .

We contacted him, and after confirming the facts, we decided to travel 550 km to Gdansk where we met "The Watchman" in person. He told us a story of his fight, that begun long before he contacted us. But local authorities denied him any help or attention.

Doubts and Questions

During our first visit, we managed to film large bags stored, without any shelter, all around the facility. They were leaking, torn, and covered with snow. This was not "storage". It looked like a giant garbage dump! These bags were covering every available space of the incinerator.. We kept looking for any marks or signatures to identify what is inside them. Finally, we found a place just few meters from a fence. Hundreds of bags were piled there.

I walked there with my camera, covering my face with a scarf against the overwhelming odor. We found one of the bags marked with 2 letters and 4 numbers: "UN2729". Below we found a mark, "UA", indicating that it might be from the Ukraine.

The first internet search returned with a phrase **"Hexachlorobenzene [UN2729] [Poison]"**. Further research revealed: "Toxic, persistent organic pollutant, carcinogenic, especially dangerous to water organisms, banned within the Stockholm Convention."

How was it possible, to dump thousands of tons of such substances just a few meters from the sea, without any shelter, just in plastic wraps, without any protection? How was it possible to just dump it there like that? We could not find an answer over polish internet. Not a single article on HCB, not a word about its origins. We had thousands of tons of one of the world's most dangerous substances lying all around the incinerator in Gdansk, but not a single bit of information available on the matter. Finally, we found a short article about pesticides in leaky bags being returned from the Polish/Ukrainian border. Hexachlorobenzene was one of them.We confirmed that hundreds of trucks carrying HCB and Pesticides were coming, with permission granted by the Main Inspectorate of Environmental Protection.

Breakpoint

We were stuck. We could not prove any irregularities without a strong and reliable expert, who would make us sure that we are right. No one wanted to confirm to us, that what we saw in Port Service might be against the law.

Luckily, we came across Mr. Wiesław Stefan Kuc, an IHPA ambassador in Poland, who contacted us with Mr. Stanislaw Stobiecki, from the Institute of Plant Protection

in Sosnicowice. It was right at the point, where we could not move forward with our investigation, when Mr. Stobiecki invited me to a conference in Jaworzno, where I had pleasure of meeting John Vijgen. After a short conversation with John, I had no doubts, that pesticide waste is not treated properly. Together with Maciej Kuciel, we decided to go to Gdansk and enter Port-Service with our camera.

Incinerator Plant

The president of Port Service, Krzysztof Pusz, was so confident that he took us for a walk around the incinerator plant. What we saw there was shocking. At the end of this walk, we asked President Pusz if he knows what kind of waste he stores. He said that he is not precisely aware what it is. However, he kept claiming that he had all the necessary permissions from the proper authorities, making us sure that with proper supervision from environmental officials this situation wouldn't be possible. After further investigation we discovered that this facility wasn't capable of taking that much waste without harm to the environment. It's annual capacity was set for 6000 Mg of highly chlorinated compounds, but it was allowed to bring 12,000 Mg of HCB waste. The facility's storage capacity was set at 450 square meters. When HCB was already dumped there, it was increased to 4,500 square meters, but only on paper. The permission was changed in 11 days. Nobody even checked if this facility could ensure environmentally sound management of this type of waste. All the documents were signed to legalize something that was highly illegal already. We finished our work and aired 2 reports. However, what disappointed us was the fact that Polish environmental authorities, instead of initiating a solid control, claimed at first that there is no danger, due to the fact that this waste contained just 1.6% of HCB. Luckily, the prosecutor's office in Gdansk initiated an investigation and decided to check the facts. Their investigation proved that the Ukrainian waste consists of much higher percentages of HCB, reaching up to 30%.

We received serious support from Greenpeace. They did not trust the official statements, and wanted to check if the facility operated properly, and for pollution from the incinerator. Greenpeace sent their regional toxic expert Gergely Simon from Hungary, to judge the influence of those compounds on environment. John Vijgen's and Greenpeace's involvement in this case allowed us to receive international support. Journalists from Denmark, Sweden, and Germany contacted us, offering their help in disseminating this report in those countries. Thanks to their involvement, the governments of Denmark and Sweden put pressure on polish authorities. That changed everything. Local environmental authorities were removed, and finally, a serious investigation begun.

Blum Gruppe, German owners of the Port Service incinerator plant in Gdansk, decided to sever ties with former president Mr. Pusz, making Soren Blum the new president of the company. Changes were significant. Waste was covered with tarps, the area secured, and it stopped looking like a dumping site.

But new questions arose:

Where are the ashes from incineration?

Was the incinerator capable of decomposing those compounds?

Was it under proper supervision?

Letter from "The Woodsman"

At the time when officials tried to answer those questions, we received a very worrisome e-mail from a person who called himself "The Woodsman". He claimed that he was a witness to the dumping of partially incinerated waste from Port Service into a gravel pit.

We could not believe it at first, but after the first meeting, when "The Woodsman" took us to this place, we knew we had to prove it.

After a long conversation with Mr. Tomasz Stobiecki from the Plant Protection Institute, we received instructions on how to properly acquire soil and water samples. Equipped with special bottles and containers, we entered the gravel pit. Luckily, we got there unnoticed. At the bottom of the ridge, we smelled chemicals and saw partially burnt bags. We then took the samples of ashes and water as instructed.

The results were shocking. Many obsolete pesticides were found in the samples we delivered: HCH(alpha), HCH(gamma), HCB, DDT, and Atrazine. Concentrations of these compounds exceeded the standards for soil and water up to 550 times! We had no doubt where it came from, because those same compounds were found by Greenpeace, right at the Port Service fence.

We aired 2 new reports on this matter. Yet again, all the information we revealed were confirmed. The prosecutor's office and Inspectorates for Environmental Protection officials admitted that area in the gravel pit was polluted. The area was secured immediately.

Nearly one year has passed since we revealed this fact. In another 1,5 year pollution might start spreading into ground waters, in another 3 years it can show up in local wells. Everything happened under supervision of polish environmental authorities. They agreed to bring this waste to Gdansk, they confirmed that company is capable of it's destruction, they assured us, that there is no danger for the environment. We were meant to believe it, but as journalists we started asking questions. And though this investigation was completed, there are still questions that are pushing us to find the answers:

Is it possible that ashes from incineration of "softly" polluted soil (according to official documents HCB didn't exceed 1,6 % in total waste) would produce such a pollution all around dumping site? What happened to waste that originated from Kalush, that seemed to vapourize, but only on official documents. Is it possible, that authorities did not tell us the truth about HCB concentration in Kalush waste ?

Picture: (Ełganowo gravel pit- illegal dumping spot of incinerated HCB/pesticide waste)

ALTERNATIVE METHOD FOR THE CHEMICAL TREATMENT OF METHYL BROMIDE

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The Ministry of Environment of the Government of Nepal (MoEST) and the Chemical Safety Project of the "Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ)", Germany, planned and carried out a disposal operation in Nepal in October 2011. All 75 tons of obsolete pesticides mentioned in the National Implementation Plan (NIP) of the Government of Nepal from April 2007 were collected and shipped to Germany for final disposal.

The NIP also comprised 43 steel cylinders with 4 tons of methyl bromide, which had been stored for over 30 years in two stores in the Kathmandu Valley. Due to the bad storage conditions, two of the steel cylinders corroded and the highly toxic gas escaped into the environment in an uncontrolled manner. Corrosion was also visible on the metal surface of all steel cylinders and the valves were no longer functional.

According to the international ADR/RID and IMDG standards for the transportation of steel cylinders with compressed toxic gases, these cylinders were no longer fit for transportation by road, rail or sea to Europe for destruction. Due to these circumstances, the GIZ project worked out a technically and economically viable alternative for on-site elimination of the methyl bromide through a chemical treatment process.

Hydrolysis of methyl bromide

The hydrolysis of methyl bromide is a simple chemical reaction that transforms the toxic methyl bromide into non-toxic and bio-degradable methyl alcohol and sodium bromide – which can both be released into the environment without any risks.

$$CH_3\text{-}Br + NaOH \longrightarrow CH_3\text{-}OH + NaBr$$

Experts from GIZ and a specialist company designed an apparatus for the chemical treatment of the methyl bromide and adopted a proven technology to open the steel cylinders on-site without using the valve. The chemical apparatus was designed as a mobile unit based in a 20-ft sea container. It was shipped to Nepal.

Transfer of the methyl bromide into the reactors and the chemical process

The chemical process is a two-stage process in a closed system of specially designed steel vessels with a volume of 1,000 litres each. The high-pressure reactor system consists of two steel reactor vessels, with electric stirrers and a flow-control system so that the hydrolysis takes place under controlled conditions.

Considering the fact that the original valves could malfunction and to avoid the risk that the methyl bromide might escape into the atmosphere, the steel cylinders were opened on the side walls by applying a special spot drilling technique with an 'gas-tight system'. After drilling, the methyl bromide in the cylinder was transferred into the first reactor vessel via a connected Teflon tube, forced by the gas pressure in the cylinder, supported by nitrogen.

The reaction process

A volume of 500 litres of a 25% aqueous sodium hydroxide solution was pumped into reactor 1 prior to the hydrolysis in this reactor. After that the methyl bromide from a steel cylinder was transferred into reactor 1 via the Teflon tube. Simultaneously, the electric agitator stirred the mixture to support the hydrolysis process.

The dosage of the methyl bromide was controlled, so that the pressure inside reactor 1 did not exceed a pressure of 1.5 bar. The reaction temperature did not rise over 70 °C. After completion of the chemical process the reaction products were pumped into reactor vessel 2 for the after-reaction process and cooling down.

The chemical reaction was controlled by the pressure and the temperature and was monitored through the inspection window. This was an exothermic reaction and cooling was necessary. After cooling down, and the transformation of the methyl bromide into methyl alcohol and sodium bromide, the reaction product was neutralized with acetic acid. When the methyl bromide concentration reached a level lower than 10 mg/l and a pH of 6-7, the reaction products were transported by a tank truck directly to a local sewage system for discharge.

Scientific and technical background information

The hydrolysis of methyl bromide is a batch-by-batch process executed in a closed system. The reaction is very selective and fast; no other by-products are produced. The stoichiometric composition has to be calculated in a way that the quantity of the sodium hydroxide with a 10% excess corresponds exactly to the quantity of 200 kg of methyl bromide – or the quantity of 2 steel cylinders. Continuous chemical analyses were carried out at the end of each batch in order to control the completion of the chemical reaction.

Summary

The reaction products are eminently water-soluble and have no eco-toxic effects. Methanol is 100% biodegradable (eco-toxicity LC_{50} fish 96h 10.8 g/l). Sodium bromide has no impact on water. It is an integral part of seawater (toxicity LD_{50} rat 3.5 g/kg, oral). After the neutralization of the aqueous mixture of methanol and sodium bromide, the solution was directly disposed of in the local sewage plant.

The emptied steel cylinders were free of methyl bromide residues. After testing with Draeger test tubes, the valves of the steel cylinders were torn off. The steel cylinders were then ready for recycling by one of the local steel plants as scrapped metal.

The practical work on site was carried out by specialists from a German company and by GIZ experts and supported by Nepalese counterparts.

This method is an economical, technically proven and practical on-site approach for the environmentally sound elimination of the highly toxic gas methyl bromide and can be applied in any country with identical problems to those in Nepal.

Methyl bromide

Methyl bromide, also known as bromomethane, with formula CH_3Br is an odourless, colourless and non-flammable gas produced both industrially and particularly biologically. Methyl bromide has been used as a soil fumigant and structural fumigant to control pests (insects, termites, rodents, weeds, nematodes), and soil-borne diseases.

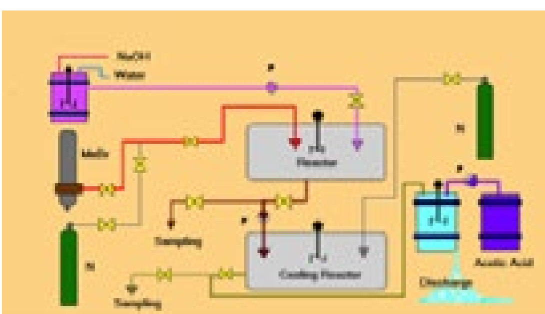
In 1999, an estimated 71,500 tons of synthetic methyl bromide were used annually worldwide (UNEP, 1 August 1999). 97% of this estimate was used extensively for fumigation purposes in the agriculture field, whilst 3% is used for the manufacture of other products, ex. as methylation agent, solvent and in fire extinguishers (halons).

Methyl bromide is an extremely toxic vapour. In humans, methyl bromide is readily absorbed through the lungs. Most problems occur as a result of inhalation and exposure effects from skin and eye irritation to death. Most fatalities and injuries occurred when methyl bromide was used as a fumigant.

Methyl bromide is recognized as an ozone-depleting chemical. As such, it is subject to phase-out requirements of the Montreal Protocol on Ozone Depleting Substances (1987).

Photo 2: The apparatus for the elimination of the methyl bromide

Photo.: W. Schimpf



Graphic: Diagram of the apparatus for treatment of the methyl bromide

Graph: W. Woywod

Photo 1: The steel cylinders with methyl bromide

Photo.: W. Schimpf

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ADR / RID - the European Agreement concerning the International Carriage of Dangerous Goods by Road and Rail; Geneva 1968

PESTICIDE DESTRUCTION USING SUPERCRITICAL WATER OXIDATION

GENERAL ATOMICS

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Project Manager, SCWO Waste Destruction

Abstract

Supercritical water oxidation (SCWO) is a destruction technology for organic compounds and toxic wastes that makes use of the unique properties of water exhibited under supercritical conditions, that is, temperatures above 374°C and pressures above 22 MPa. Typical SCWO reactor operating temperatures and pressures are 600-700°C and 23.5 MPa, respectively. The oxidant is typically high-pressure air or oxygen. Organics and oxidant are miscible with SCW, creating good conditions for oxidation with minimal mass transport limitations, thus, even the most difficult to oxidize organic materials are quickly destroyed to yield carbon dioxide and water. Heteroatoms such as chlorine, fluorine, phosphorus and sulfur, are converted to inorganic acids or to salts if sufficient cations such as sodium or potassium are present. If present, metals such as iron and nickel will produce the metal oxides.

Typical SCWO gaseous discharge composition when oxidizing organic compounds consists of O_2 depleted and CO_2 enriched air. Oxidation of nitrogenous compounds produces primarily N_2 and in some cases small quantities of N_2O. Acid gases are largely eliminated from the SCWO gaseous effluent due to the self scrubbing nature of the aqueous reaction medium during pressure let down. Similarly, particulates are self scrubbed into the process liquid effluent.

Unlike incineration, SCWO does not produce NOx or SOx as exhaust gases. Electronegative elements such as S, Cl and P are converted to water soluble anions or oxyanions, and will appear in the liquid effluent as acids or salts depending on the cationic content of the feed or additives. In general there is little if any treatment required for discharge of the products.

Solid residue in the SCWO process effluent only occurs when the influent waste stream contains or produces water insoluble materials. For example, the liquid effluent produced from an influent slurry of organically contaminated soil would be a slurry of decontaminated soil. In essence, the soil would pass through the SCWO system unaffected because it is, primarily, mineral oxides with low water solubility levels.

These characteristics including reasonable capital and operational costs, and the highly portable nature of iSCWO systems make this processing approach ideal for the treatment of the lethal obsolete pesticide and persistent organic pollutants required by the various and relevant conventions and national implementation plans.

General Atomics (GA), a leading US defense contractor and developer of cutting edge technologies has been developing SCWO technologies and delivering SCWO/iSCWO systems to the US government and commercial clientele since 1991.

This paper will review how SCWO oper-

ates, GA's experience with SCWO with a variety of applications, and how SCWO technology can be applied for the destruction of obsolete pesticides and other organic materials.

Article

Supercritical water oxidation (SCWO) is excellent for the destruction of old or obsolete pesticides, obsolete paints, petroleum product manufacturing waste streams, pharmaceutical waste, energetic materials (explosives or propellants), and contaminated waste waters.

As described in the abstract, SCWO is a destruction technology for organic compounds and toxic wastes that makes use of the unique properties of water exhibited at supercritical conditions, that is, temperatures above 374°C and pressures above 22 MPa. Under these conditions, oxidation reactions occur rapidly and to completion with by-products consisting of clean water or brine, clean gases, and inorganic ash with essentially no airborne particulates.

GA has developed a simplified, small and compact version of SCWO called Industrial SCWO (iSCWO). The iSCWO process flow diagram is illustrated in Figure 1 and an operational system is shown in Figure 2.

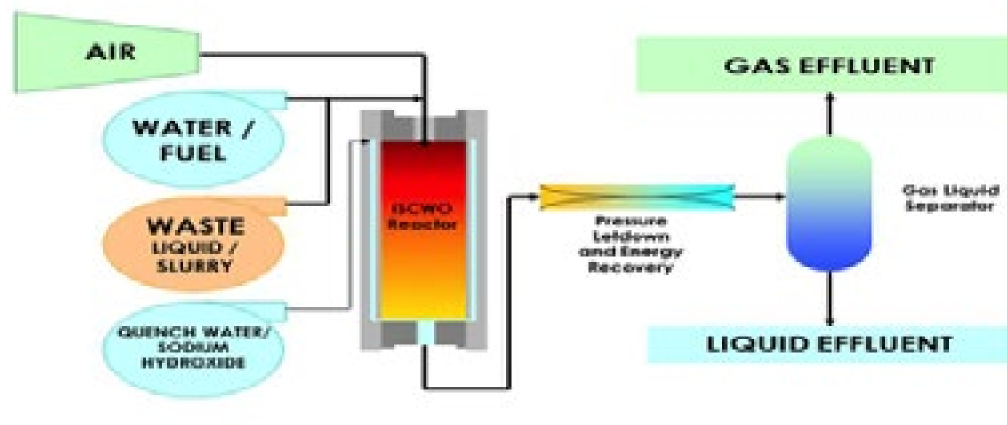

Figure 1: iSCWO Process Flow Diagram

Figure 2: iSCWO System Equipment Skid

Figure 3: Transportable iSCWO System

High pressure air along with water, fuel (if required by the specific application) and the waste liquid/slurry is pumped into the iSCWO reactor in which the high temperature and pressure will destroy the organic compounds via oxidation reactions.

Figure 4: Embedded iSCWO System

The reaction by-products exit the reactor through a pressure letdown system and discharge into a gas-liquid separator. The gases are exhausted through a stack and the liquids are discharged either into a holding tank or into a commercial sewer system.

A number of these simplified iSCWO systems have been supplied to US Government entities as well as commercial users for the destruction of various chemical and hazardous wastes. The iSCWO system is available as a compact, transportable unit (see Figure 3) or available to be installed in a new or existing facility as a final installation (see Figure 4). The benefits of utilizing SCWO far outweigh the use of alternative waste destruction approaches especially if onsite (or for transportable systems, multiple sites) use is desired. In addition, SCWO systems do not require pollution abatement systems for gaseous effluent cleanup.

GA has demonstrated the destruction of hundreds of organic compounds and mixtures with SCWO technology including pesticides. Shown below in Figure 5 is GA's test facility located in San Diego, California, which utilizes a 3gpm iSCWO system. This system can be used to test customer wastes in order to demonstrate operability and waste destruction. Effluent analysis (gas and liquid) are performed to confirm high waste destruction efficiencies. The systems built for our customers are put through rigorous acceptance tests prior to shipment. Figure 6 shows a transportable system undergoing final acceptance testing for a European commercial client.

The iSCWO system has a limited number of components which makes maintenance and operation very easy. The control system uses off-the-shelf computer components such as programmable logic controllers (PLC), variable frequency drives (VFD), gas and liquid monitors, and workstation graphic displays for automated operation (calibrate, startup, operation,

Figure 5: iSCWO Waste Test System

Figure 6: Final Acceptance Test

shutdown) complete with alarms and interlocks. The control system is highly intuitive and can be configured for English or Metric Units, and customized for specific languages.

The installed size of the iSCWO skid is 7.3 meters long by 4.5 meters high and 2.4 meters wide. For the transportable version, the iSCWO fits inside a ISO container that is 8.3 meters long by 2.9 meters high and 2.4 meters wide. Once the transportable unit is at the site, only a small number of equipment components need to be assembled before operation (e.g., heat exchanger).

To adequately treat powdered pesticides and other solid wastes, a front-end feed processing system would need to be incorporated. Preprocessing steps could include size reduction, slurrying, blending, filtering, and other waste preprocessing technologies to produce pumpable mixtures. Once in an acceptable form, the waste feed would be pumped into the iSCWO reactor as shown in Figure 1. The majority of iSCWO systems that GA supplies require some type of up-front pre-processing system to create mixtures that can be delivered to the process in a reliable manner.

Evaluating the implementation of iSCWO as either a transportable system or a fixed site system involves the identification and inventory of the pesticide and other wastes to be processed as well as logistical studies to determine the optimum remediation strategy. This includes performing a mass and energy balance evaluation along with economic, safety and feasibility studies.

The next step would be to perform tests to demonstrate that the iSCWO system can process and destroy the waste, and to collect the test data to support design and permitting activities. While SCWO destruction efficiencies typically exceed 99.999%, the actual requirement is driven by site specific needs especially if the liquid effluent is to be disposed of via the site sewer system. The collected test data will be used to characterize gas and liquid effluent compositions, determine operating conditions, and to quantify utility requirements (electrical power, water, fuel). Included in this analysis is the capital and operating costs of the iSCWO system for the specific waste(s) to be processed.

Once deemed acceptable, the final step would be the design and fabrication of an iSCWO system(s) based on the test results and specific customer requirements (e.g., safety and fabrication standards). Prior to shipment to the customer site, the system would be subjected to final acceptance tests to demonstrate operability and waste destruction efficiencies.

In summary, SCWO technology is an exceptionally clean waste destruction process suitable for processing all classes of hazardous and nonhazardous wastes especially pesticides. SCWO systems can provide onsite waste treatment at an affordable cost.

TREATMENT OF ORGANIC HAZARDOUS WASTES USING TETRONICS' PLASMA ARC TECHNOLOGY

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Tetronics DC plasma arc system can be used to treat a wide range of solid, liquid or gaseous waste streams to destroy or transform hazardous components and to recover valuable materials as by-products. To date, Tetronics has supplied more than 90 plasma systems globally, of which 27 have been for the treatment of hazardous wastes, including material containing Polychlorinated Biphenyls (PCBs), Persistent Bio-accumulative and Toxic (PBT) pollutants and Air Pollution Control residues (APCr), containing dioxins and furans alongside a range of other hazardous species, such as chlorine, sulphur and heavy metals.

This paper presents details of the application of Tetronics' DC arc technology for the destruction of persistent organic pollutants in a number of waste streams. The process develops a high temperature (>10,000 °C) plasma-arc, which is generated using either graphite electrodes or water-cooled torches, depending on the application. It results in an extremely high destruction and removal efficiency, with a performance of 99.9999% typically achieved as a result of the high temperatures and intense ultra-violet light generated by the arc, the close control of oxidation conditions and the residence time in the plasma furnace. The off gas treatment systems also ensure reformation of the organic pollutants does not occur, in order to ensure the high destruction efficiencies are achieved. In addition, the decontamination process for these wastes also produces an inert slag material (Plasmarok®), which has been approved for use by the UK Environment Agency as a secondary aggregate. Within this paper, further examples will be provided of other valuable by-products generated by the waste treatment process, such as the recovery of acid and valuable metals.

Keywords

- Tetronics International
- Organic waste destruction
- Plasma waste treatment
- Plasma technology
- Treatment of persistent organic pollutants
- Hazardous waste treatment
- Air pollution control residues

Technology Description

1.1 General description

Tetronics DC plasma arc system can be used to treat a range of waste streams to destroy and transform hazardous components and to recover valuable materials as by-products. One of the applications of the technology is the destruction of organic wastes including Polychlorinated Biphenyls (PCBs) and other types of Persistent Bio-accumulative and Toxic (PBT) pollutants at very high efficiencies across a wide range of concentrations. To date Tetronics has supplied >90 commercial plasma treatment facilities for a range of applications, of which 27 were for hazardous waste applications. These include organic wastes containing PBTs and APCr, containing dioxins and furans.

At the heart of any Tetronics plant is a DC plasma furnace shown schematically in Figure 1. The process develops a high temperature (>10 000 °C) plasma-arc by ionising a plasma forming gas, e.g. nitrogen. Tetronics' processes use either graphite electrodes or water-cooled torch systems (single or multiple torch systems) to generate plasma. Typically graphite electrodes are used for waste management applications.

A schematic process flow diagram of plasma hazardous waste treatment is shown in Figure 2.

The following points summarise the main features of the system:

- Feed material can be introduced as a solid, slurry, liquid or gas through the furnace feed port(s). The feed system is tailored to the nature of feed where possible.
- The intense temperature and ultra-violet light of the plasma is used to destroy hazardous organic components and melt the inorganic fractions of the waste material.

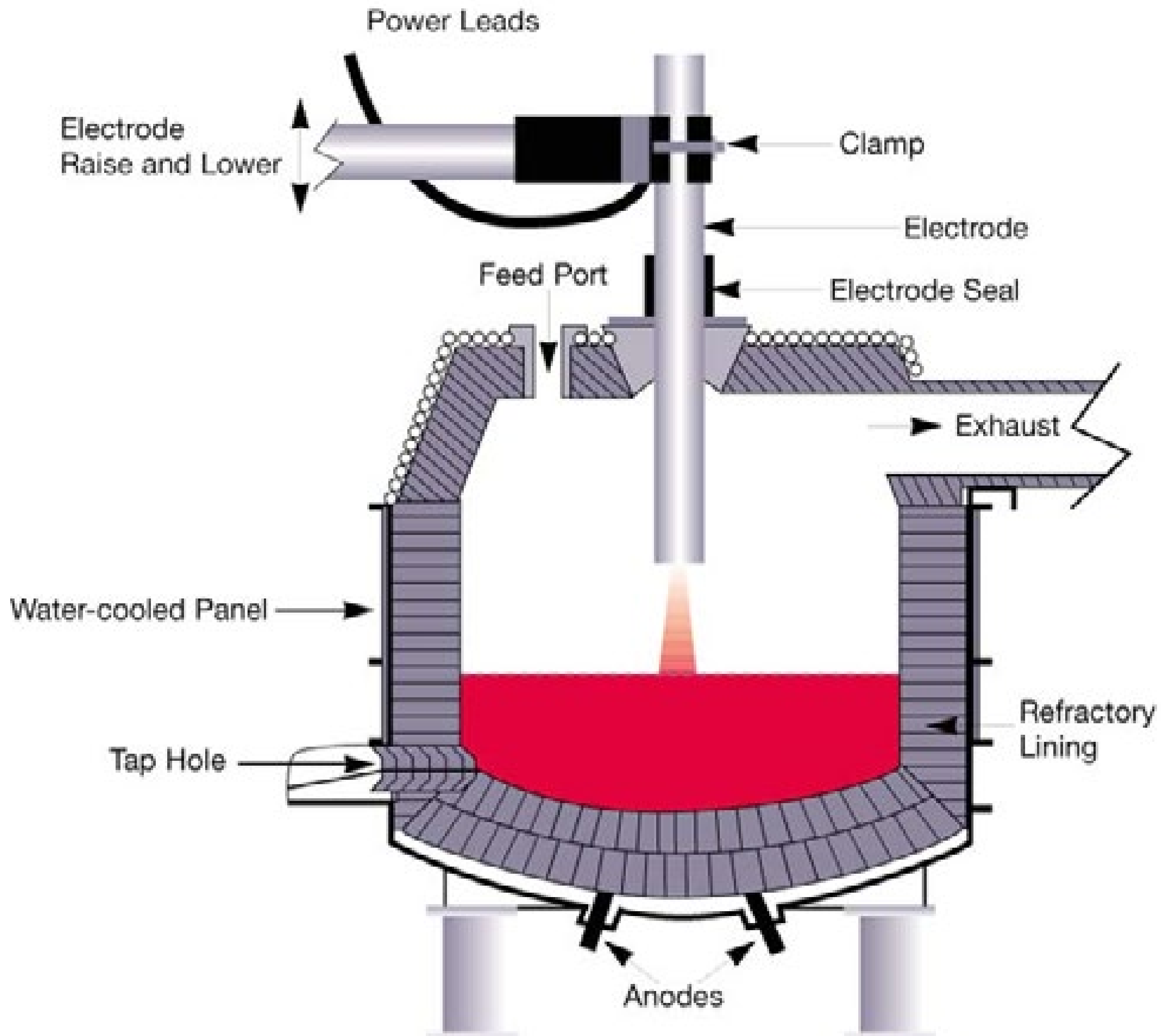

Figure 1: Main components of Tetronics' DC Plasma furnace (graphite electrode system)

- The inert slag produced from the process (Plasmarok®) can be employed in a range of applications, such as a simple construction aggregate and is officially qualified as a product in a number of territories.

- Fluxing reagents are added to ensure an inert (stable, non leaching) slag is produced and also to ensure low slag viscosity when molten. Where possible, fluxing material is sourced from waste material containing suitable fluxing agents to minimise operating costs and maximise environmental benefits.

- Valuable metals can be recovered using this process by adding, if required, suitable reducing agents and collector metal. The recovered metal segregates at the base and is tapped intermittently during operation.

- The high furnace temperatures, electromagnetic radiation (light) and oxidant injection (if required) ensure that any volatiles species are decomposed to a simple mixture of carbon dioxide, carbon monoxide, water vapour, and hydrogen gases.

- The steep thermal gradients and favourable temperature-time history also inhibits Persistent Organic Pollutants (POPs) reformation mechanisms.

- Depending on the feed chemistry, NOx and SOx may also be present. As part of the plasma treatment system and subject to project specifics, Tetronics offers an integrated off gas abatement system with energy recovery capabilities, provided the product gases have sufficient calorific value/sensible heat.

- Tetronics' processes generally produce minimal amounts of secondary waste because the by-products generated (slag, metal, fly ash and/or APC residue from the off gas cleaning system) can be used for secondary applications.

1.2 Destruction of Persistent Organic Pollutants (POPs)

This paper describes the main applications relevant to the treatment of waste contaminated with hazardous organic wastes such as dioxins, furans, PCBs and other POPs. The decontamination process for these wastes is designed to separate and destroy the hazardous components leaving an inert material with a valuable secondary use. The process results in an extremely high Destruction and Removal Efficiency (DREs) with performance of 99.9999% typically achieved.

Tetronics has installed several plants for the treatment of waste material containing hazardous organic wastes. In addition, new projects are underway for installing further plants. Tetronics has also used its Arc lab, the onsite demonstration facility (the most sophisticated of its type in Europe), to treat hazardous wastes. The following points summarise the main details of these plants, projects, and demonstrations:

- A plasma system was supplied to the GEKA in Munster, Germany, to treat soil contaminated with arsenic and chemical weapons residues.

- A plasma treatment plant including feed system and off gas treatment was designed, installed and commissioned for Centro Sviluppo Materiali (CSM) in Rome, Italy to treat a range of solid and liquid waste streams including oils containing PCBs (polychlorinated biphenyls), contaminated soils containing heavy metals and POPs, sewage sludge, Municipal Solid Waste (MSW) incinerator fly ash containing dioxins and furans, and asbestos containing material. The plant throughput is 100 kg/h.

- Tetronics has installed and commissioned 18 plasma facilities in Japan for treating fly ash and bottom ash arising from the incineration of municipal solid waste (MSW) and sewage sludge, which also contain organic pollutants such as dioxins and furans, carbon and alkaline salts.

- Tetronics are currently in the process of supplying a similar plant for a UK customer to treat 33ktpa of APCr.
- Tetronics has delivered a plasma treatment facility in Brazil for the treatment of oily sludge waste material from refinery storage tanks at a throughput of 4000tpy. This waste contains polyaromatic hydrocarbons (PAH) and other organic wastes.
- Tetronics has used its Arc lab, the on-site plasma treatment demonstration facility, to treat a simulant contaminated soil waste material. The actual waste to be treated by the client contains PCBs, oil, soil and aggregate. However, due to regulatory reasons associated with trans-boundary movement of PCBs, a simulant material was used for these demonstrations. The simulant feed material contained 1 wt% 1,4 dichlorobenzene.

The main attributes of these applications are presented in this paper by broadly categorizing the use of DC arc plasma technology to treat three waste streams as follows:

Component	Oily Sludge from Refinery Storage Tanks, Vol %	PCB Contaminated Soil, Vol %	MSW derived APCr, vol%
H_2(g)	25.9	0.1	3.9
H_2O(g)	30.8	59.8	41.1
CO(g)	28.2	0.1	16.6
CO_2(g)	8.0	32.4	33.0
O_2(g)	0.0	1.0	0.0
N_2(g)	7.2	6.6	8.4
Offgas production (Nm3/tonne of waste)	*1657.23*	*526.08*	*224.82*

Table 1: Typical furnace off gas compositions for three different waste streams (before off gas cleaning)

- Oily sludge from refinery storage tanks
- PCB contaminated wastes
- APC residues from thermal waste MSW

1.3 Process gases

1.3.1 Products of the process

The gaseous products of Tetronics' processes are mainly carbon monoxide (CO), hydrogen (H_2), carbon dioxide (CO_2), water vapour (H_2O) and inert purge gas (N_2 or Ar). Other volatile components that may be present are alkali metal chlorides (KCl and NaCl), SOx and NOx depending on the feed composition. Table 1 presents typical off gas compositions at the furnace exit for the three main waste streams discussed in this paper i.e. oily sludge from refinery storage tanks, PCB contaminated soil and MSW derived APC residue. Treatment of PCB contaminated soil generally requires excess oxygen as an additional reagent to ensure complete destruction of POPs. Therefore, partially combusted products such as H_2 and CO are lower in concentration compared to the other two streams. Chloride salts present in the off gas (due to chlorine containing APC residues) can be recovered through scrubbing.

1.3.2 Occurrence of unintentionally generated pollutants

Upon exposure to the high intensity plasma arc, long chain hydrocarbons are broken down into simpler molecules. These processes are thermally and photo-catalytically driven and addition of oxidants leads to the destruction of these species. As a result, during steady state operation, the off-gas composition follows that shown in Table 1. To minimize emissions of unintentionally generated pollutants during transient periods of operation, the plasma system is coupled with an off gas abatement system tailored to the furnace exhaust gas specification as well as the feed material composition. This off gas system is brought to temperature independently before the waste stream is introduced into the process.

This ensures that atmospheric emissions of components such as volatile organic compounds (VOCs), halogenated species, dioxins/furans, SOx, and NOx are minimised and well below the limits set out by local regulatory bodies.

1.3.3 Secondary waste stream volumes and treatment

The "secondary waste" stream from the process is the particulate drop out from the thermal oxidizer and filtration system. This contains mainly KCl and NaCl, as well as oxides and salts of other volatile metals such as Zn, Pb, Cd, Hg etc and a small amount of physically carried over species. This waste stream can sometimes be recycled to the plasma furnace with, or without, further treatment.

<table>
<tr><th></th><th>Oily Sludge from Refinery Storage Tanks</th><th>PCB Contaminated Soil</th><th>MSW APC residue*</th></tr>
<tr><td>SiO_2</td><td>187.54</td><td>-</td><td rowspan="3">Typically 100-300</td></tr>
<tr><td>Al_2O_3</td><td>-</td><td>33.87</td></tr>
<tr><td>CaO</td><td>187.54</td><td>62.26</td></tr>
<tr><td>O_2(g)</td><td>590.13</td><td>349.31</td><td>-</td></tr>
</table>

*Flux addition depends on ratio of bottom ash to fly ash. In most of the plants, cost of flux addition is minimized by using waste material containing suitable fluxing components.

Table 2: Flux and oxidant additions for three different waste streams (kg addition/tonne of waste)

1.4 Process Reagents

The process reagents depend on the feed stream chemistry. In comparison to other thermal operations, Tetronics' processes generally require lower levels of reagents such as flux, oxidants etc. for a specific application and scale of operation.

The required process reagents may include any of the following:

- Fluxing agents to provide a glassy matrix for the transformation and incorporation of the material within an inert non-leaching product while producing a low melting point phase with low viscosity when molten (typically achieved by adding SiO_2 and/or CaO and/or Al_2O_3)
- Oxidants to promote destruction of organic material and to provide additional reaction energy (typically oxygen and/or water) off-setting plasma energy requirements
- In applications involving metal recovery, reagents include reductants and collector metal in addition to fluxing agents (less applicable to hazardous waste applications)

The process is optimised to ensure such additions are minimised while achieving the required process outputs (i.e. destruction of hazardous components, vitrification of inorganic components, and recovery of valuable materials). The main additions relevant to the three processes discussed in this paper are fluxing agents and oxidants. Typical addition levels for these components, per tonne of waste treated, are given in Table 2.

Hazardous wastes with high organic fractions generally require more flux additions due to the low inorganic content and also require additional oxidants to complete the reaction with hydrocarbons. The oily sludge process is designed to produce syngas for energy recovery in a downstream process, while the PCB waste treatment process requires excess oxygen to ensure maximum destruction of the PCBs. Fluxing additions for MSW derived APC residue depend on the ratio of bottom ash to fly ash as the former is mainly inorganic material containing some fluxing properties i.e. feed streams with higher fractions of bottom ash require less fluxing. The plasma arc is more than sufficient to destroy the dioxins/furans and therefore oxygen additions are not required.

	Oily Sludge from Refinery Storage Tanks, wt %	PCB Contaminated Soil, wt %	MSW derived APCr wt%
SiO_2(l)	32.41	57.12	39.74
CaO(l)	35.23	22.14	31.36
Al_2O_3(l)	17.50	12.05	0.64
TiO_2(l)	-	-	0.16
FeO(l)	12.26	1.91	0.47
MgO(l)	1.78	4.68	0.86
Fe_2O_3(l)	0.06	0.21	0.00
Na_2O(l)	0.00	1.01	0.00
ZnO(l)	-	-	0.11
Cr_2O_3(l)	-	-	0.00
$CaCO_3$(l)	-	0.87	0.03
K_2O(l)	0.00	-	0.00
Fe_3O_4(l)	0.76	-	0.00
CuO(l)	-	-	0.06
NaCl(l)	-	-	6.27
KCl(l)	-	-	2.89
$CaCl_2$(l)	-	-	15.94
FeS(l)	-	-	0.01
CaS(l)	-	-	1.41
MnO(l)	-	-	0.04
Slag production (kg/tonne of waste)	*599.16*	*839.62*	*845.38*

Table 3: Typical composition of slag produced from Tetronics' DC Plasma technology to treat three different waste streams.

1.5 Process water

1.5.1 Secondary waste stream volumes and treatment

Water is used on a closed loop basis for cooling the furnace shell and deionised water is used for cooling the electrical components. Water is also used to cool the slag conveyor or to quench the slag if a granulation vessel is used. All cooling water is recirculated and thermally managed in a sealed system. Water is also used to quench the off-gas from the combustion chamber to below 250 °C to ensure that there is no De Novo formation of dioxins and furans. Any scrubber effluent is discharged after suitable treatment to meet compliance requirements.

Some APCr can contain high levels of chlorine. Analysis has shown that the chlorine in the feed partitions as chlorides of Na, K, and Ca in the slag and also as volatile species in the off gas. Chloride components that are present as particulates or which condense in the off gas system are collected in the baghouse, while any remaining in the gas phase if sufficient in quantity is recovered using conventional technology to produce HCl as a process credit.

	Oily Sludge from Refinery Storage Tanks	PCB Contaminated Soil	MSW derived APCr
Metal Production (kg/tonne waste)	43.80	-	3.10

Table 4: Typical metal production rate from Tetronics' DC Plasma techology to treat three different waste streams

1.6 Solid residues

1.6.1 Valuable residues

The solid residues are represented by the vitrified slag, any dust collected in the baghouse, and the recovered metal. The slag produced is an inert by-product called Plasmarok® and can be sold to be used in the construction industry or moulded into various product forms, e.g. tiles. The recovered metal fraction is generally low for the applications considered here, however any metal recovered may be resold. Dust collected in the baghouse containing KCl and NaCl may be reused. However, if scrubbing agents are used, further processing may be required. Otherwise, this stream is classified as secondary APC residue. Sometimes it is feasible to recycle the dust back to the plasma furnace.

Typical slag and metal compositions for the three applications discussed here are shown in Table 3 and Table 4 respectively along with the expected slag and metal production rates.

The metal phase consists mainly of iron with minor elements such as copper, phosphorous, silicon, manganese, chromium and zinc also being present.

1.6.2 Secondary waste stream volumes and treatment:

Secondary APC residues are produced in small quantities due to low particulate carry over with the furnace off gas. This may be as a result of physical carryover of the feed stream as well as condensation of volatile species (chemical carryover) in the cooler sections of the process downstream of the furnace. The partitioning mechanisms are complex. For solid feed streams crushed to a fine dust, physical carryover may be between 1 – 3 % of the

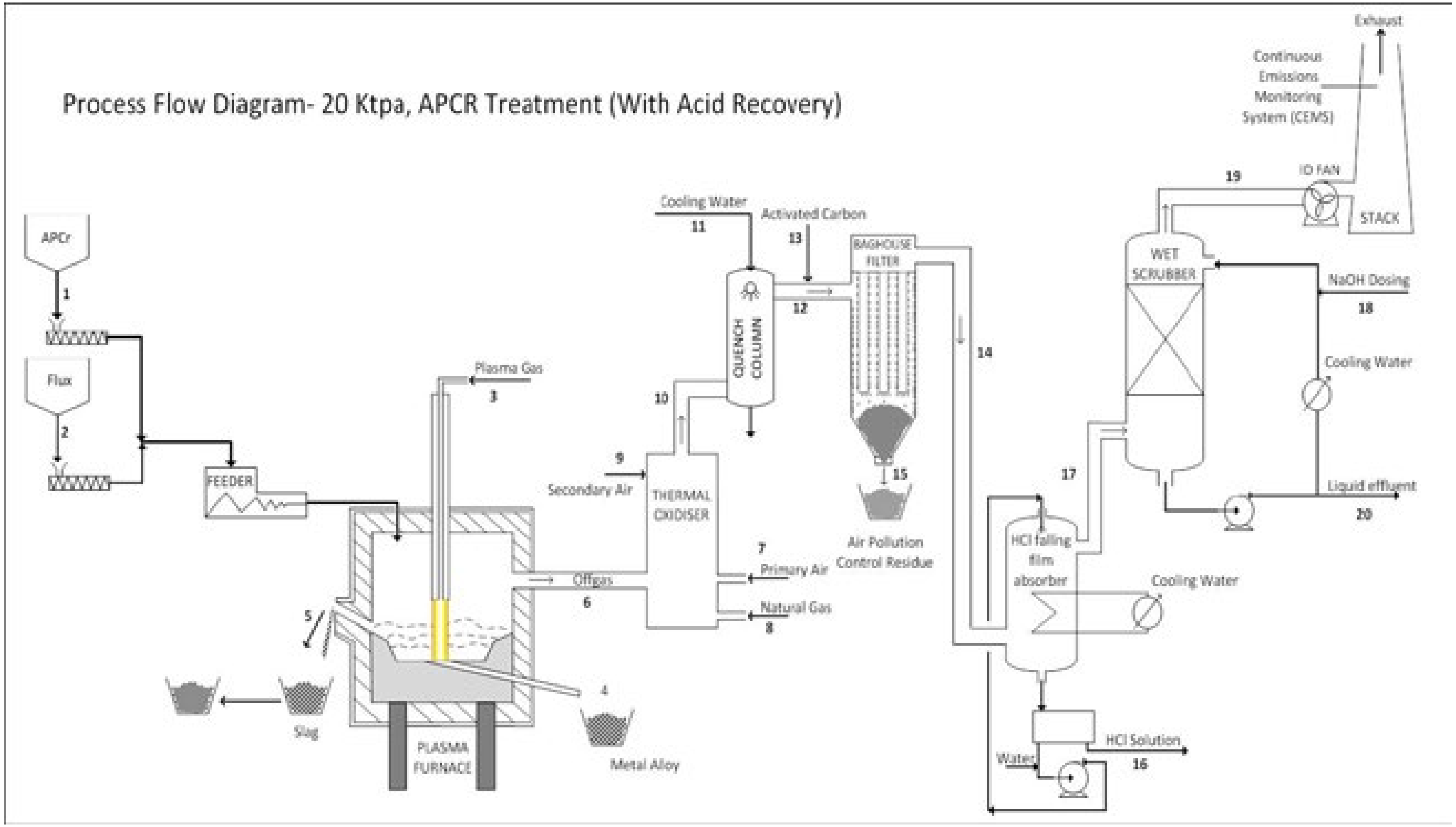

Figure 2: Schematic process flow diagram for plasme hazardous waste treatment.

total feed rate. In total, particulates collected in the off gas system amount to no more than 10% of the total feed rate which includes condensation of volatile species and spent sorbents.

The general approach is to minimize physical carryover by optimizing the furnace design. As this cannot be eliminated completely, where possible, secondary APC residue may be recycled back into the furnace. Depending on the chemistry of this particulate stream, scrubbing of the gas may be required also.

1.7 Pre-treatment

- For MSW ash, the use of a magnet and vibrating screen enables magnetic iron content to be removed prior to charging into the furnace. Drying of the feed material to <10% moisture is recommended to minimise energy consumption in the plasma process.

- Oily sludge waste material and contaminated soils may need some form of dewatering/drying and homogenization to minimise instabilities in feed.

- Liquids may also be fed into the process using a liquid/sludge injection lance system. Feed streams may require some form of pretreatment if not already of the required conveying consistency.

2. History

This section describes the history in relation to supplying the plasma systems for GEKA in Munster, Germany and Centro Sviluppo Materiali (CSM) in Rome, Italy.

2.1 GEKA

During the World Wars, Munster became the site of a testing and production facility for arsenical agents such as Clark II (DC), Mustard agent (HD) and Chloropicrin (PS). A fire broke out in a workshop; the chain of events that followed led to the explosion of a train fully loaded with shells, mines and chemical agents. In total, 48 buildings, in excess of 1 million shells, mines and tank wagons full of liquid agent were destroyed and an area of 3 km radius was contaminated. In 1956, with the take-over of the site by the Bundeswehr, the first ever systematic and controlled operation to clear the debris of both World Wars began. The site now houses Incineration plant, soil washing facilities and a plasma furnace. The system initially used a non-Tetronics plasma system; however, it was plagued by operational difficulties. Tetronics plasma systems were retrofitted to replace the original equipment, which resulted in improved reliability and process energy efficiency, enabling the facility to work as intended. This plant continues to operate successfully. Here the primary plant function is demilitarisation including destruction of chemical agents. The URL is http://www.geka-munster.de/.

The Tetronics installation provided for much improved reliability and energy efficiency, so greatly reducing the necessity for complementary fossil fuel heating of the plasma furnace previously required to supplement the original system provided by others.

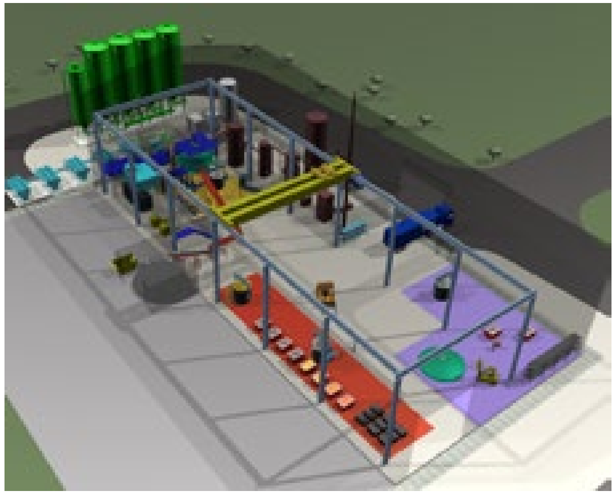

Figure 3: Plant layout for a Tetronics DC Plasma treatment facility

2.2 Centro Sviluppo Materiali (CSM)

Tetronics was approached by CSM for the treatment of hazardous solid and liquid waste with the requirement of a maximum level of flexibility including multi or single torch/electrode operation under a range of conditions, to feed both solid and liquid feed streams.

The scope of supply included the design, build, installation and commissioning of a twin 38 mm shrouded torches, 500 kW power supply, manipulation, furnace, water/gas manifolds, pump chiller unit, control system, liquid and solids feed system, off-gas treatment. The system was designed for the treatment of a wide range of waste materials including oily waste material classified as carcinongenic. This waste was sourced from cleaning of interceptor waste oil sumps and tank bottoms.

2.3 TSL Engenharia Ambiental (TSL)
TSL Engenharia Ambiental (TSL) is a multidisciplinary Brazilian based service / utility engineering company with core activities in the field of waste management. This company operates in close liaison with the state environmental authorities, CETESB (the Brazilian equivalent to the EA) and are responsible for the first commercial plasma references established in Brazil.

TSL approached Tetronics to use its DC Plasma Technology for PCBs destruction in Brazil. This technology focuses on converting contaminated soil to inert slag, a valuable construction material. Prior to establishing a commercial plant in Brazil, TSL and Tetronics carried out trials at Tetronics' Arclab facility to confirm the stability of the process in operation and the destruction and removal efficiency (DRE) of PCBs. The trials were undertaken using a series of simulants made with 1,4-dichlorobenzene, topsoil, aggregate, engine oil and water.

3. Infrastructural and organizational requirements

3.1 Infrastructure
Figure 3 shows a site layout of a typical plasma treatment facility. The controlroom, plasma power supply, feed system, cooling water pump set and manifolds services and utilities manifolds and furnace are enclosed inside a building. The furnace exhaust gas leaves the building through the exit duct and to the off gas system outside. This includes a thermal oxidizer, particulate removal system, gas monitoring system and stack as a minimum, with dry/wet scrubbing, waste heat boiler or other energy recovery system as further options.

- For a 40,000 tpy ash vitrification plant the typical building foot print of such a plant is 35m x 75m and 22m at the apex.

Parameter	Oily Sludge from Refinery Storage Tanks	PCB Contaminated Soil	MSW derived APCr
Waste Feed Rate (t/h)	0.5	0.7	2.5
Waste Calorific Value (kWh/t)	4586	4543	n/a
Heat of Reaction Released (kW)	559	785	n/a
Theoretical Electrical Energy Requirement (kWh/t waste)	47	244	400
Net Electrical Power Requirement (kW)	**24**	**180**	**1015**
Furnace Steady State Heat Losses (kW)	466	412	1000
Gross Electrical Power Requirement (kW)	**490**	**591**	**2015**
Furnace Energy Efficiency (%)	56	70	50

Table 5: Typical energy requirements to treat three different waste streams using Tetronics' DC plasma technology.

- For a 4000 tpy hazardous waste treatment plant, the typical building foot print is 25m x 48m and 11m at the apex.

3.2 Energy requirements

Table 5 summarises the energy requirements for the three different processes. Oily sludge and contaminated soil wastes both contain an organic fraction. The reaction of these components with oxidants releases energy into the process and therefore, compared to ash vitrification processes (such as MSW derived APCr treatment), the theoretical electrical energy requirement is less. The organic fraction for MSW derived APCr wastes is low compared to the other two processes and therefore any reaction energy released is considered negligible.

The furnace energy efficiency is defined as follows:

$$\text{Efficiency} = \frac{\text{Heat of reaction released + Net Plasma power requirement}}{\text{Heat of reaction released + Gross Plasma power requirement}} \times 100$$

The oily sludge process is based on a smaller furnace (4000tpy annual throughput) and hence the energy efficiency is lower than for the larger 6000tpy and 20000tpy furnaces modeled for PCB contaminated soil and MSW derived APCr

Name of city	Wastes treated	Furnace capacity (tonnes per day)	Number of furnaces
Munster, Germany	Contaminated soil	-	1
Rome, Italy	Range of organic wastes containing PCB and other POPs, asbestos and inorganic wastes	2.4	1
Chester, UK (EA Technology)	Asbestos Contaminated Material	5	1
St-Paul-Lez-Durance (CEA)	Assorted waste	2.5	1
Iwaki (MHI)	MSW incinerator ash treatment plants in Japan	40	1
Tushima (MHI)		28	2
Kouchi (MHI)		40	2
Nagoya (MHI)		35	2
Hiroshima (MHI)		48	2
Sendai (MHI)		80	2
Tochigi (MHI)		30	2
Sapporo (Takuma)		140	1
Hitachi city (Hitachi Zosen)		6	1
Kamo city (Hitachi Zosen)		30	1
Ichikawa (TSK)		5	1
Ichikawa (Takuma)		5	1
Takasago (Takuma)		24	1
Kobe (KOBE)		8	1
Fujisawa (Ebara Soken)		2.4	1

Table 6: Fixed plants for treating hazardous wastes

treatment respectively, i.e. there is an economy of scale.

3.3 Auxiliary materials/chemicals requirement
Depending on the sulphur and chlorine content of the ash, abatement additives such as lime/activated carbon injection or final wet scrubbing using sodium hydroxide may be required to remove acid gases.

4. Types of waste treated

Tetronics DC Plasma process has been implemented for a range of feed streams, including the following:

- Contaminated soils containing PCBs and other POPs
- Liquid waste streams containing PCBs and other POPs
- Air pollution control residues containing dioxins and furans
- Oily sludge from refinery storage tanks containing polyaromatic hydrocarbons (PAHs)
- Other hazardous organic and inorganic wastes eg. Wastes containing asbestos, arsenic.
- Gaseous feed streams containing long chain hydrocarbons
- Asbestos Contaminated Materials (ACM)
- Mixed bottom ash and APC residues

5. Status of commercialization

5.1 Fixed plants
Fixed plants for treating hazardous wastes have been supplied by Tetronics for several clients as shown in Table 6.
5.2 Portability
Portable facilities have not been supplied by Tetronics; however, a transportable unit is currently under development and may be supplied if required.

5.3 POPs throughput:
[POPs waste/total waste in %]
The plasma facilities supplied to GEKA in Germany and CSM in Italy are used to treat a range of waste materials. The proportion of wastes containing POPS as a percentage of total plant throughput is not publically available. The public information on the POPs concentration of wastes is also limited.

In the case of MSW fly ash treatment, where only fly ash is treated, it can be stated that all of the waste treated contains some contaminants in the form of dioxins and furans (1.1 -1.3 ng-TEQ/g). Tetronics' DC plasma technology destroys a large part of the dioxins/furans present in incinerator fly ash waste. Dioxin/furans in the slag from MHI plant were found to be between 0.0000018 – 0.0043 ng-TEQ/g. Any of these persistent organic pollutants that exit the furnace with the off gas are destroyed further in the thermal oxidizer. The combusted gas is then cooled rapidly via a quench column to prevent De Novo generation of dioxins.

POPs throughput and destruction efficiencies (slag based) are available from demonstration work conducted at Tetronics' Arclab facility as shown in Table 7.

Name of city	POP's throughput	POPs concentration in POPs waste	Units	Destruction efficiency (%)
Oily Sludge	100%	15-85	mg/kg waste	Unknowm
PCB contaminated waste	100%	5000	mg/kg waste	99.9999

Table 7: POP's throughput and destruction efficiency for oily sludge and contaminated soil waste material.

Utilities required for hazardous waste treatment

Table 8: Utilities required for a plant treating oily sludge from refinery storage tanks

Consumables	Units	Quantity per tonne of waste	Quantity per year (4000 t/y commercial plant)
Electrical Power	kWh	980	3,920,000
Electrical Power Auxiliary	kWh	121	482,352
Inert Gas (Argon)	Nm^3	118	472,231
Flux (CaO)	kg	190	760,000
Flux (SiO_2)	kg	190	760,000
Oxygen (O_2)	Nm^3	590	2,360,512
Plasmarok production	kg	342	1,367,200
Secondary APC	kg	11	45,200
Throughput of waste	kg/h	537.20	
	Tonnes/year	4000.00	
	Plant availability (%)	85%	

Table 9: Utilities required for a plant treating PCB contaminated soil

Consumables	Units	Quantity per tonne of waste	Quantity per year (5479 t/y commercial plant)
Electrical Power	kWh	804	4,404,285
Electrical Power Auxiliary	kWh	121	660,643
Inert Gas (Argon)	Nm^3	33	178,704
Flux (CaO)	kg	62	340,783
Flux (AI_2O_3)	kg	34	185,547
Oxygen (O_2)	Nm^3	249	1,362,730
Plasmarok production	kg	840	4,601,947
Secondary APC	kg	10.00	57,785
Throughput of waste	kg/h	735.77	
	Tonnes/year	5478.51	
	Plant availability (%)	85%	

Table 10: Utilities required for a plant treating APCr

Consumables	Units	Quantity per tonne of waste	Quantity per year (20,000 t/y commercial plant)
Electrical Power	kWh	794	15,885,200
Electrical Power Auxiliary	kWh	39	780,000
Inert Gas (Nitrogen)	Nm^3	24	473,000
Silicia Flux	kg	305	6,100,000
Plasmarok production	kg	664	13,280,000
Metal Alloy Production	kg	3	62,000
Secondary APC	kg	302	6,046,700
HCI Condensate Production	kg	556	11,315,220
Waste throughput	kg/h	2537	
	Tonnes/year	20000	
Plant Availability	%	90	

6. Conclusions

Tetronics DC Plasma process is an effective method of treating hazardous and organic waste materials from a range of industries. Commercial plants for the remediation of wastes and the simultaneous recovery of valuable materials have been supplied by Tetronics to companies around the world for many years. The process develops a high temperature (>10,000 °C) plasma-arc, which results in an extremely high destruction and removal efficiecy. Destruction efficiencies of typically 99.9999% are achieved as a result of the high temperatures and intense ultra-violet light generated by the arc, the close control of oxidation conditions and the residence time in the plasma furnace. The off gas treatment systems also ensure reformation of the organic pollutants does not occur, in order to ensure the high destruction efficiencies are achieved. In addition, the decontamination process for these wastes also produces an inert slag material (Plasmarok®), which has been approved for use by the UK Environment Agency as a secondary aggregate.

IMPROVEMENTS AT PORTSERVICE INCINERATION PLANT

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Because of a wrong decision taken in 2011 there were brought 15.000 Mg of pesticides on Port Service's place, which caused many problems with environmental inspectorates due to a risk of inappropriate storage and probable dangerous fume emission.

From January 2012 to June 2013 Port Service had been working hard on modernization of the Incineration Plant to make all processes connected with thermal utilisation much more safe and environmentally friendly.

The company managed to improve and secure the storage system of different fractions of hazardous waste, including pesticides. There were made special lodgings, which make it possible to storage them properly and separately.

Port Service was also successful in the reduction of fume emission by using new technologies and renovation of some elements in the Incineration Plant like electrostatic precipitator, adsorption apparatus, steel structures, etc.

All factors which may cause any dangerous implications are constantly monitored by comprehensive system of measurement control.

The Incineration Plant is still developing.

GEOMELT VITRIFICATION TECHNOLOGY ELIMINATES PERSISTENT ORGANIC POLLUTANTS AND PESTICIDE CONTAMINATION

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Abstract
Kurion's GeoMelt® vitrification technologies have been used for thermal destruction of Persistent Organic Pollutants (POPs) and pesticide contamination. This paper presents several case studies based on prior treatment projects and summarizes recent technology development work.

Key Words
GeoMelt, Vitrification, Persistent Organic Pollutants, Thermal Treatment, Kurion,

Introduction
Kurion's GeoMelt vitrification technology is based on joule melting of glass-forming materials and wastes. The melting destroys organics though thermal processes and immobilizes toxic metals in a durable glassy wasteform. Wastes treated by GeoMelt have included a wide variety of Persistent Organic Pollutants (POPs), other organic wastes, radioactive wastes, and asbestos. GeoMelt has been proven to be ideal at treating large volumes of contaminated soil as well as contaminated debris, metals, wood, plastics, rubber, and concrete. The process is robust and flexible.

The GeoMelt technology is used in two configurations: 1) In-Situ Vitrification (ISV)™ and 2) In-Container Vitrification (ICV)™. ISV is a batch treatment process that uses electricity to melt contaminated soil. Electrical power is directed to the treatment zone between graphite electrodes embedded in buried wastes. As power is applied, resistive heat is produced which results in melting of the soil. The molten soil further propagates the electrical current and heat throughout the contaminated material between the electrodes. As the electrical power is continued, the melt grows resulting in a large molten mass defined in extent by the positing of the electrodes. Melt temperatures can reach as high as 1800 °C, depending mostly on soil chemistry. Destruction of organic wastes including POPs is achieved primarily through pyrolysis and catalytic dechlorination reactions. Off-gases that evolve from the melt are collected in a steel containment hood and directed to an off-gas treatment system. Typical ISV melts treat approximately 500 to 800 tonnes of soil and wastes in a single setting. Individual melts treat an area up to approximately 80 m2 to a depth normally ranging from 3 to 9 m. Multiple melts are performed in sequence to treat a larger overall area. ISV has been used to treat approximately 26,000 tonnes of contaminated materials throughout the world.

ICV is a treatment process similar to ISV but carried out in a refractory-lined container. GeoMelt ICV is essentially identical to ISV except that wastes are instead treated in a treatment vessel or melt container, enhancing process control and allowing for treatment of wastes that are not buried. The container either is reusable or single-use. When single-use the melt container also is the disposal container.

Larger batches of waste (up to 100 tonnes) have been processed in refractory lined concrete vaults from which glass is removed for disposal by heavy equipment between melts. Typical ICV melts generally range from 10 to 50 tonnes.

Case Study #1: Wasatch Pesticide Manufacturing Site, USA

Wasatch Chemical Superfund Site in Salt Lake City, Utah, was an industrial facility involved with packaging and distributing acids, caustics, organic solvents, pesticides, herbicides, fertilizers, and other agricultural chemicals. Site operations involved transferring contaminated liquids to a concrete evaporation pond filled with engineered layers of earthen materials. The site contained high levels of dioxin, other organics, and miscellaneous buried waste and debris (Figure 1). Soil moisture content in the pond varied from 9 wt% to fully saturated.

Thirty-six GeoMelt ISV melts were performed in a 6 m x 6 m array (the melt size was constrained by the pit pond depth; smaller melts are shallower), resulting in the contents of the evaporation pond to be completely treated into a single large contiguous monolith. A total of 5,440 tonnes of soil and debris was treated. In addition to the dioxin-contaminated soil, ~2,460 L of dioxin-contaminated oily liquid waste was also treated, in a 37th melt located at the center of the pond. Analysis of post-treatment vitrified product indicated that all contaminants were detection limits for all contaminants and significantly below the regulatory limits established for the site (Table 1)[1]. Analyses of treated off-gas samples taken during treatment of the liquid dioxin waste materials and during

Figure 1: The Wasatch Pesticide Waste and Debris Before and After GeoMelt ISV Treatment

another melt indicated that all analytes (dioxins, pesticides, herbicides, and various volatile organic compounds were below detection limits.

Case Study #2: Parsons Pesticide Manufacturing Site, USA

Parsons Chemical Works was used to manufacture herbicides and pesticides from 1945 to 1979. Site activities resulted in widespread soil contamination throughout the property. The soil at the site was silty clay with some sand and contained debris such as vegetation, concrete, drum lids, plastic sheeting, tires, and cobble rock. Soil and debris (4,350 tonnes) from around the site were excavated and placed into a 5-m-deep treatment trench. GeoMelt ISV was used to treat the contents of the trench, in a series of nine 8 m x 8 m melts. Figure 2 shows the mobile processing equipment used to treat the herbicide and pesticide contamination.

Analyses of the vitrified product confirmed the absence of organic contaminants and the secure immobilization of heavy metals. Off-gases were found to be free of pesticides and other organics. Soil sampling performed on adjacent soil indicated that no detectable contamination moved from the treatment volume into the adjacent soil during processing. Table 2 provides treatment results for analyzed pesticides and herbicides.[2]

Table 1. Pre-and Post-Treatment Contaminant Levels, Wasatch Site

Contaminant	Pre-Treatment (µg/kg)	Post-Treatment, TCLP (µg/kg)	Regulatory Limit (µg/kg)
TCDD-Dioxin	11	<0.12	20
2,4-D	34,793	<20	NA
2,4,5-T	1,137	<14	NA
Total Chlordanes	535,000	<80	7,000
Heptachlor	137.5	ND	2,000
Hexachlorobenzene	17,000	ND	7,000

µg/kg = micrograms per kilogram
TCLP = Toxicity Characteristics Leaching Procedure

Figure 2: GeoMelt ISV System during Parsons Pesticide Manufacturing Plant Remediation

Case Study #3: Orica HCB Treatment Site, Australia

From 1964 to 1991 the Orica Australia Pty. Ltd. plant near Sydney produced approximately 15,000 tonnes of hexachlorobenze (HCB) wastes which are currently stored onsite awaiting destruction. GeoMelt ICV was successfully demonstrated as an alternative to incineration because there is no incinerator in Australia capable of treating the HCB.

The objective of the demonstration, undertaken in 1999, was to evaluate the treatment effectiveness of a specially adapted version of GeoMelt for destruction of HCB. The demonstration involved three melts on mixtures of soil with HCB concentrations ranging from 16.5 to 33 wt%. The melting was performed aboveground in a refractory lined steel container in a batch plant (Figure 3). The tests provided an opportunity to vary equipment and operational parameters to determine the most effective treatment configuration for the HCB waste. Batch sizes of ~2 metric tons were treated. For Test 3, the waste mixture included scrap steel, wood chips, plastic drum liners, used protective clothing, and spent filters to simulate the expected waste mixture at full-scale.

Table 2. Pre-and Post-Treatment Contaminant Levels, Parsons Site

Contaminant	Pre-Treatment Average (µg/kg)	Pre-Treatment Maximum (µg/kg)	Post-Treatment, TCLP (µg/kg)	Regulatory Limit (µg/kg)
Chlordane	<80	89,000	<80	1,000
4,4'-DDT	13,000	340,000	<16	4,000
Dieldrin	4,600	87,000	<16	80

µg/kg = micrograms per kilogram
TCLP = Toxicity Characteristics Leaching Procedure

Alumina (Al2O3) and water were added to the waste mixture to enhance the dechlorination reactions that occur in the hot soil underneath the melt. In the heated soil environment, the alumina reacts with the HCB by removing the chlorine atoms, which then destroys the HCB and result in the formation of aluminum chloride (AlCl3), carbon monoxide (CO) and carbon (C).[3] The presence of water converts the AlCl3 into alumina and hydrochloric acid (removed by the off-gas treatment system), and C into CO2, and H2. The reactions are as follows:

$$C_6Cl_6 + Al_2O_3 \text{ (solid)} \rightarrow 2AlCl_3 \text{ (gas)} + 3CO \text{ (gas)} + 3C \text{ (solid)}$$
$$2AlCl_3 \text{ (gas)} + 3H2O \text{ (gas)} \rightarrow Al_2O_3 \text{ (solid)} + 6HCl \text{ (gas)}$$
$$C \text{ (solid)} + H_2O \text{ (gas)} \rightarrow CO \text{ (gas)} + H_2 \text{ (gas)}$$

Figure 3: Concrete ICV Treatment Container Used for HCB Treatability Demonstrations

The GeoMelt process was proven effective in treating HCB waste; no detectable traces of HCB or the other organochlorines were present in the vitrified product. For all three tests, the destruction efficiencies (DEs) for the melt alone, not accounting for the off-gas treatment system, were typically 97.5% to 99.7%, indicating that most of the waste was destroyed by the melt in the first step of the treatment process. Destruction and removal efficiencies (DREs) for HCB and other organochlorines were >99.9999% for the complete system including the melt and the off-gas treatment system.[4] Treated off-gas emissions typically satisfied regulatory criteria by a factor of 10 to 100. Samples of the vitrified product easily passed the TCLP test. As a result of this project, GeoMelt was selected as an alternative to incineration.

Although Geomelt was shown to be effective for treatment of HCB, and was approved for use by regional Regulators, a final site in New South Wales with suitable infrastructure and community endorsement has yet to be identified.[5]

Agricultural Chemical POPs Treatment Facility, Iga City, Japan

GeoMelt ICV is being used to treat a wide variety of POPs in Japan under sublicense to Kurion. A summary of relevant projects is provided in Table 4.[6]

GeoMelt ICV destroys agricultural chemical POPs in a plant near Iga City, Mie Prefecture, Japan (Figure 4). The main features of this plant are 1) a pre-treatment building used for mixing wastes and glass reagents, a crusher for size-reducing debris, and conveyance for loading the ICV container; 2) a reusable 10-tonne batch ICV container, off-gas containment hood and electrode support superstructure; 3) the off-gas treatment system including filtration, wet scrubbing, thermal oxidation, and on-site water treatment of scrubwater limiting effluent discharge. POPs are stored in an adjacent building, and process control is carried out in an onsite control room.

Table 3. Treatment Efficiencies for Organochlorines, Orica Site (33 wt% HCB)

Contaminant	Pre-Treatment Average (wt%)	Melt DE (%)	Process DRE (%)
Hexachlorobenzene (HCB)	80-90	99.57	>99.9999
Hexachlorobutadiene (HCBD)	4-13	98.68	>99.9999
Hexachloroethane	1-2	99.80	>99.9999

wt% = weight percent
DE = Destruction Efficiency
DRE = Destruction and Removal Efficiency

Table 4. List of POPs GeoMelt ICV Treatment Projects in Japan

Project	POPs Treated	Quantity (tonnes)
Hasimoto	Dioxins	20
Hashimoto	Dioxin-Contaminated Soil	1056
Nagano	Pesticides	161
Nose	Dioxin-Contaminated Soil	51
Hokkai-Sankyo	Pesticides	60
Akita	Pesticides	27
Niigata	Pesticides	425
Hukushima	Pesticides	6
Miyagi	Pesticides	71
Nose	Pesticides	6

The Iga City plant is approved to treat pesticides and herbicides, and also industrial wastes including sludges, waste acids and bases, oils, and asbestos. Processing rates are generally on the order of 200 kg/hr and melt temperatures are as high as 1600 °C, depending on waste composition. Figure 5 shows agrichemical POPs wastes (DDT and Lindane [BHC]) treated at the Iga City plant for a project.

This project involved the treatment of 20.85 tonnes of DDT and Lindane, 38.76 tonnes of contaminated concrete, and 101.09 tonnes of contaminated soil. The GeoMelt ICV station at Iga City is shown in Figure 6.

Figure 5: Lindane, DDT, Contaminated Concrete, and Soil Treated at Iga City, Japan

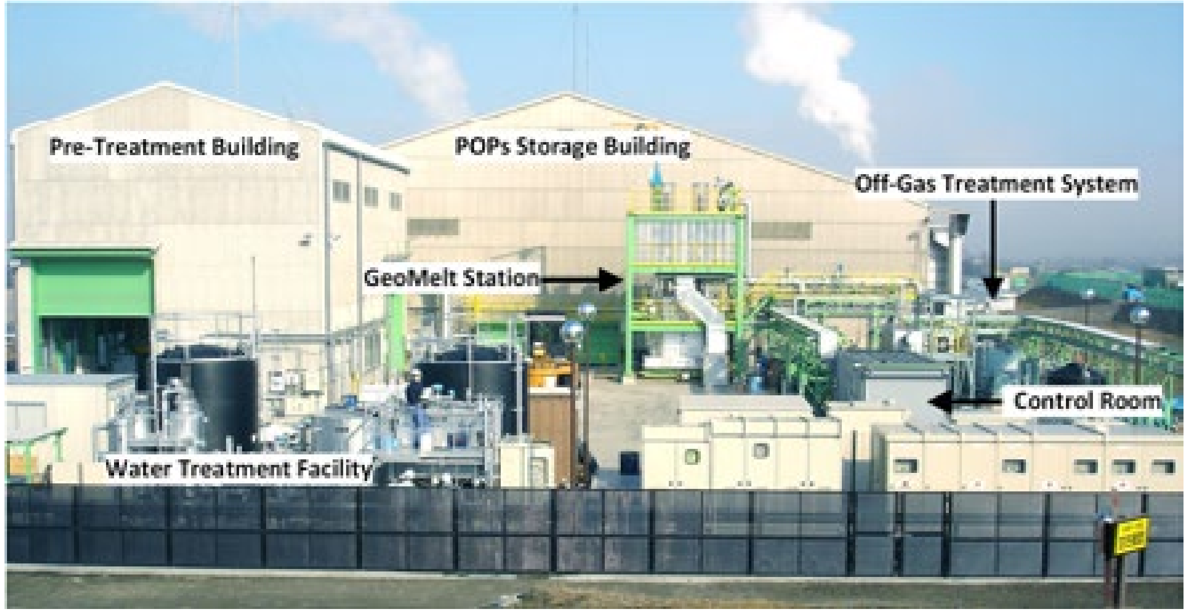

Figure 4: GeoMelt Agricultural Chemicals POPs Treatment Plant, Iga City, Japan

Figure 6: Iga City ICV Station with 10-tonne Melt Container

US EPA TSCA Permit Renewal PCB Demonstration

The GeoMelt technology has been authorized by the United States Environmental Protection Agency (EPA) for the treatment of polychlorinated biphenyls (PCBs) under the U.S. Toxic Substances Control Act (TSCA). Kurion is currently in the process of renewing this authorization as required under the regulation. Part of the permit renewal process involves conducting treatability testing every 10 years. The treatability test conducted by Kurion involved processing 68 liters of Pyranol (Aroclor 1260 in oil) at a concentration of 530,000 mg/L or 53 wt%. The Pyranol was absorbed onto soil resulting in an average of 40,000 mg/L or 4 wt% PCBs. The purpose of the soil was to adsorb the liquid PCBs and to provide glass-formers for the vitrification process. The three spiked layers were staged in a refractory-lined, 10-tonne batch ICV container at different elevations separated by clean soil layers above and below. Each layer constituted a separate test; as the melt progressed from the top of the ICV container downward, stack emissions were monitored in order to use analytical results representing treatment of individual layers to calculate DREs. The ICV container used for the demonstration is shown in Figure 7.

Figure 7: TSCA Permit Renewal PCB Demonstration ICV Container and Process Trailer

The demonstration was completed without operational difficulty. Melt temperatures up to 1400 °C were obtained from thermocouples located within the ICV container during processing. After completion of the tests and allowing time to allow the glass monolith to cool, glass samples were obtained for quantification of individual PCB congeners. Concentrations of all congeners were below the laboratory detection limits (ranging from 20 to 20 pg/g) except for several co-eluting isomers (indicating matrix interference rather than a true value). DRE values calculated using glass analytical data and isokinetic stack sampling results (Table 4) were well above the 99.9999 % permit requirement.

Table 4. Treatment Efficiencies for TSCA Permit Renewal PCB Demonstration	
Test	Process DRE (%) for PCBs
1	>99.999989
2	>99.999994
3	>99.999994
DRE = Destruction and Removal Efficiency	

The EPA has recently issued Kurion a draft permit which is in the process of finalization. The permit confirms the ability of GeoMelt ICV to meet the TSCA PCB performance standard of 99.9999% DRE equivalent to incineration and to a level below 2 parts per million (ppm), and authorizes the use of the technology to treat PCBs at the level demonstrated (i.e., 40,000 mg/L) in the United States.

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TREATMENT AND DESTRUCTION ON POPS SESSION

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The session provided the opportunity for presentations and discussion on a wide range of treatment technologies applicable to the destruction and stabilisation of POPs wastes. Various technologies were presented including thermal, chemical, physical options for the treatment of a wide range of liquid, solid, gases and contaminated materials. In each case, the technology was presented in the context of a Case Study demonstrating the practical application of the technology, its benefits and limitations.

In addition to presentations on specific technologies, a presentation was given by TVN Television, Poland in relation to issues relating to the importation of HCB wastes from Ukraine. The presentation highlighted concerns associated with controls surrounding the shipment, storage and disposal of waste exported from the Ukraine to the Port Services Incinerator in Poland. Subsequently Port Services made a statement and presented an update on the activities at the Port Services facility.

During the discussions, it was commented that with a wide range of technologies on offer it was crucial that monitoring and control of both the treatment facility and those stakeholders involved in the management chain were consistently and robustly applied. Specific issues included the following:

• Adequate and detailed characterisation of wastes prior to transport/treatment;

• Consistent online monitoring of emissions from treatment facilities;

• Accountability of regulators, waste producers, waste notifiers/brokers, transport and disposal organisations/companies involved in the treatment project lifecycle;

The session concluded that with a wide range of proven and commercially available treatment technologies there are viable solutions available now for POPs removal. There is also a responsibility amongst all stakeholders to ensure that projects are managed in order to ensure that POPs are treated to agreed and consistent standards, and that problems are not merely transferred from one location to another.


BREAKING THE INFINITE ASSESSMENT CYCLE OF POP PESTICIDES DUMPSITES


CLASSIFICATION OF POP PESTICIDE DUMPSITES

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Abstract

This paper presents a simple classification tool developed to present a holistic view on the status of a POP pesti-cides dump-site. The status ranges from uncontrolled to completely controlled or sustainable dumpsite. The sta-tus is determined by site environmental risks, awareness of stake-holders, availability of funds for sustain-able site management, and availability of remediation techniques.

Several dumpsites, such as The Volger-meer near Amsterdam in The Netherlands, The Vakhsh burial site in Ta-jikistan and Suzak B in Kyrgyzstan, are classified at different periods in site history. The Vol-germeer is an uncon-trolled dumpsite that shifted with time to a completely con-trolled dumpsite. The Vakhsh in Tajikistan and Suzak B in Kyrgyzstan, are dumpsites that were controlled in the past, but be-came uncontrolled.

POPs pesticide dumpsite classification demonstrates which initiatives should be taken to arrive at a sustainable dumpsite and presents lessons for developing and implementing sustainable dumpsite man-agement. An im-portant lesson learned is that a dumpsite needs a 'foster parent' who is aware of the environmental risks and has the power and willingness to actively develop and implement sustainable site management and is able to allocate funds for maintenance and monitoring.

Keywords

Uncontrolled and controlled dumpsite, classification, risk assessment, sustainable site management.

Introduction

To get rid of waste, four key modes of contaminant release in waste streams can be distinguished: discharge to landfills or dumpsites, discharge to aquatic systems, disposal via hazardous waste incinerators, and storage of chemical waste (Weber 2008). This also holds for obsolete and POPs pesticides disposed of in Europe, the for-mer Soviet Union republics and some countries of Indo China. In this paper, we focus on the classification of the environ-mental status of dumpsites with obsolete and POPs pesticides.

Often, dumping of obsolete and POPs pesticides into landfills started without adequate control measures to prevent mi-gration of (persistent) chemicals offsite. An exception is the dumpsites in the for-mer Soviet Union. The often construct-ed concrete bunkers for the permanent storage of obsolete, and POPs pesticides were moni-tored and maintained, but good care was aborted abruptly after the Soviet Union collapse. As a result, there are numerous landfills (all over the world) posing severe ecological and/or human risks now and in the future. These landfills are uncontrolled, which requires securing measures to prevent direct contact with on-site receptors and halt migration of chemicals offsite. Available risk reducing options for POPs pesticides dumpsite are to remove and destruct the waste, to contain in-site and treat waste on-site.

The status of a dumpsite can range from uncontrolled to completely controlled dumpsite. An uncontrolled dumpsite is a dumpsite where long-term storage is not possible without causing adverse effects on the environ-ment and human health. A completely controlled dumpsite fulfills the criteria of sustainability according to the Concept of Sustainable Development (World Commission on Environment and Development 1987). At a con-trolled dumpsite, permanent storage is possible with minimal long-term effect on the environment and human health. No direct and indirect risks are imposed to the natural environment or human health; i.e. all risk exposure pathways are intercepted. An uncontrolled dumpsite can become a completely controlled dumpsite by taking adequate remediation and control measures including maintenance and aftercare. Aftercare has to be as limited as possible.

To visualise the status of a dumpsite, a simple classification tool was developed. The tool addresses the complex-ity of remediation of uncontrolled dumpsite by summarizing the following four selected categories:

1. The status of the environmental site risks control;

2. The availability of funds to manage the site (remediation, monitoring and aftercare);

3. The awareness of all site stakeholders concerning the environmental risks;

4. The availability of techniques to control the environmental site risks.

The classification tool aims to assess why no initiatives are taken to control site risks and to raise awareness by visualizing in a simple way the constraints for stagnating remediation.

To demonstrate the use of the classification tool, the statuses of different dumpsites are assessed in this paper. One of them is The Volgermeer, a chemical landfill near Amsterdam (The Netherlands) where nowadays com-prehensive monitoring is undertaken and extensive funds are available for eventually cleaning leachates. The Volgermeer is an example of an uncontrolled dumpsite that has successfully been remediated to become a controlled dumpsite. In addition to the case of the Volgermeer, the tool is also applied to two other dumpsites: the POPs pesticide dumpsites Vakhsh (Tajikistan) and Suzak B (Kyrgyzstan), which are examples of controlled dumpsites that have become uncontrolled dumpsites because of lack of monitoring and maintenance.

Material and Methods

2.1 Methods

The input for the classification tool (see figure 2-1) is a complete site assessment that describes the site within its environment. The above four selected categories should be considered. By judging the level of the four features, an overview of the status of the dumpsite is visualised. As a result of the classification, it becomes clear which category is hampering implementation of site rehabilitation strategies, and thus why an uncontrolled dumpsite has not reached the class of a controlled dumpsite.

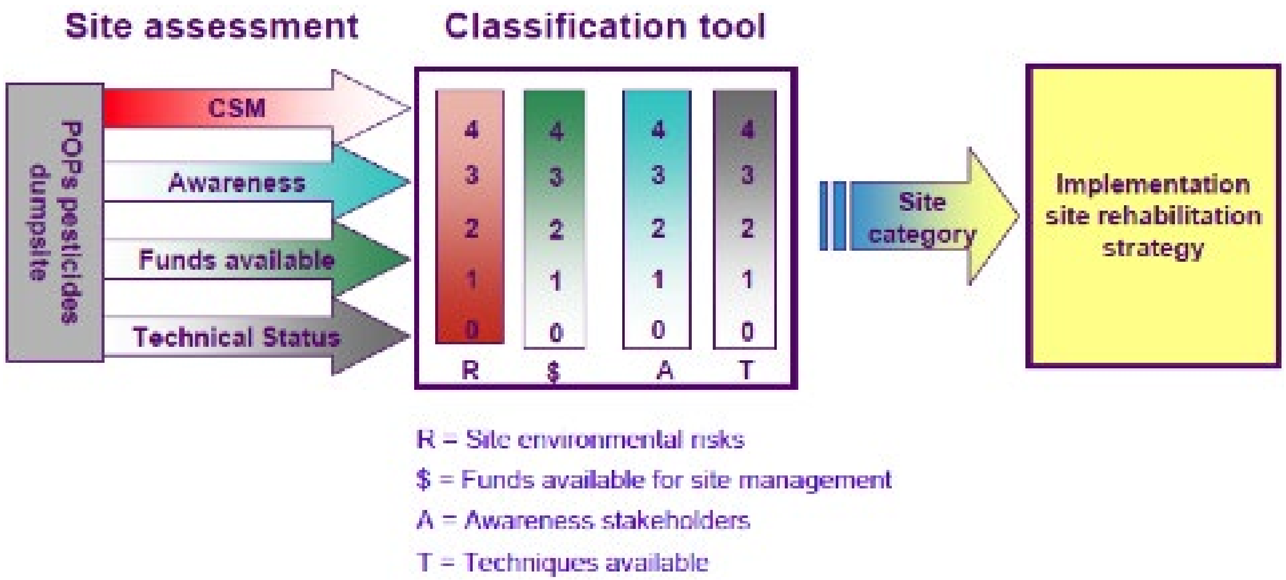

Figure 2-1: The status of a POPs pesticides dumpsite can be classified through a site assessment

2.2 Site assessment

A site assessment should be performed including the contaminant situation within the existing site topography, soils and hydrology, along with other pertinent site information such as climate and site history. An important part of the site assessment is the social description, starting site-wide and expanding to regional or country-wide analysis of involvement of stakeholders, economical status, and governmental form. The complete site assess-ment provides all information about the four site categories that classify the dumpsite.

The environmental site risks can be screened by developing a Conceptual Site Model (CSM) picturing the source zone(s) of contamination, the migration pathway(s) and the (potential) receptor(s). Designing a complete CSM is a phased process. The initial phase is the preliminary site assessment resulting in an initial CSM and a preliminary risk assessment. A gap analysis bridges the initial phase with the second phase of the site assessment. With a comprehensive site assessment the CSM can be improved or completed and relevant risks can be assessed. To define risks of the toxicological profile of the compounds at the site, and their effects on the receptor, the fol-lowing exposure can be estimated or calculated. A complete CSM and a risk assessment are the deliverables of the second phase of the site assessment.

2.3 Classification tool

Each site feature in the classification tool has five classes: the uncontrolled, minimum controlled, semi con-trolled, controlled, and completely controlled class. The classification depends on the before mentioned site fea-tures. If all four categories are at the highest level, the site can be considered as a completely controlled dumpsite. In this section and in table 2-1, an explanation of the different classes of each category is given.

Level	Class	Category			
		Risk control	Availability of funds	Awareness profile	Availability of technique
4	Completely controlled	Direct, potential and latent risks controlled	Funds available, including funds for monitoring and aftercare	All stakeholders take their responsibilities	All risk control measures are readily available and feasible
3	Controlled	Direct and potential risks controlled	Funds available on the short and mid-term	Receptors, local and national decision makers are aware of risks and responsibilities are allocated	Risk control measures can be designed site specific
2	Semi controlled	Direct risks controlled	Funds available on the short-term	Receptors and local decision makers are aware of risks	Direct risk control measures are available
1	Minimum controlled	Emergency measures implemented	Emergency block grant available	Receptors are aware of risks	Emergency measures are readily available
0	Uncontrolled	No risks controlled	No funds available	Stakeholders do not take their responsibility	Risk control measures are not available

Table 2-1: Classification of POPs pesticides dumpsite by categories risk, funds, awareness and technique

Environmental risks

The environmental site risks include human health risks, risks of off-site migration and ecological risks. These risks can be direct, potential or latent. The first risk class (level 0) is a dumpsite with uncontrolled risks. No site measures to mitigate the environmental risks are taken. The second class (level 1), minimum controlled risks and is allocated to dumpsites with emergency measures only. The third class (level 2), the semi controlled dumpsites, is for dumpsites with controlled direct risks. The dumpsites with controlled direct and the potential risks are classified in the fourth class (level 3). The fifth and last class (level 4), completely controlled, is used for the dumpsites with all direct risks mitigated, potential risks contained and latent risks monitored.

Availability of funds

Classification based on the availability of funds for site management uses the same five classes. In the lowest class, i.e. the uncontrolled dumpsites for this category, sites have no funds available for site management. This class is followed by the class used for the minimum controlled dumpsites, i.e. sites that have only funds for emergency measures. The third class in this category is used for dumpsites for which funds are available on the short-term for mitigating the direct risks. If dumpsite funds are available for mitigating the direct risks on the short-term and containing the potential risks on the mid-term, the dumpsite is classified as the fourth class. This class is called controlled. The last class, the completely controlled site, is used for dumpsites that have ple-mented all risk control measures while funds are being provided for containment of the potential risks, monitor-ing of the latent risks and aftercare.

Stakeholder's awareness

The first of the five classes used for category stakeholder's awareness, the uncontrolled class, includes the sites where stakeholders are not aware of the environmental risks or do not take their responsibilities. The second class is used for the dumpsites where only the receptors are aware of risks. These are the minimum controlled sites for this category. When receptors and the local decision makers are aware of the environmental risks, the dumpsite is seen as a semi controlled for this category. If the receptors, local and national decision makers are aware and the responsibilities are allocated, the site is a controlled dumpsite. If all stakeholders take their respon-sibility the dumpsite is classified as completely controlled dumpsites.

Availability of techniques

The five classes for the availability of the techniques for mitigating the direct risks, containing the potential risks and monitoring the latent risks, are also ranging from uncontrolled to completely controlled. If there are no techniques available to control the environmental risks the dumpsite is classified as uncontrolled. A site is minimum controlled if emergency measures are readily available. A dumpsite is semi controlled if direct risk control measures are available. The site is controlled when risk control measures can be designed site specific. If all risk control measures are readily available and feasible, the dumpsite is classified as the completely controlled.

At a completely controlled dumpsite, all the direct environmental risks have been mitigated, the potential envi-ronmental risks contained and the latent risks monitored. Funds for monitoring and aftercare have been allocat-ed. Site stakeholders take their responsibility and all risk control techniques are readily available.

3. Results and Discussion

To demonstrate the use of the classification tool, we have classified the Volgermeer, Vakhsh and Suzak B dumpsites at different periods in their site history. The classification is discussed demonstrating the coherence between the different aspects and explaining shifts from one dumpsite class to the other.

3.1 Description of the Volgermeer dumpsite

The history of the Volgermeer is thoroughly known and described below in different distinctive periods. Based on the description of the dumpsite in these periods, a classification of the Volgermeer is presented and dis-cussed.

Description history Volgermeer until 1955

The peat bog lands of Holland were the main energy resources of the Netherlands from 1.000 AD till about the beginning of the twentieth century when coal and hydrocarbons became the main energy resources. The excava-tion of peat transformed the former peat bogs into large lakes and valuable land was lost in this process. Authori-ties counteracted the loss of valuable land by permitting peat exploitation under the condition that excavations were backfilled.

Growing cities and economic development were major drivers for increased municipal solid waste volumes at the beginning of the twentieth century. The operators of one of the last bogs, the Volgermeer, realized that the isolated position of the polder and its perfect connection to Amsterdam by existing waterways provided a suita-ble disposal site that could meet the backfilling obligation. Around 1955, the peat exploitation came to an end due to decreased margins. By then, about 110 hectares of peat bog were exploited and became available for the disposal of waste.

Volgermeer 1956 - 1979

Somewhere between 1955 and 1965, the barges which ferried the solid municipal waste to the Volgermeer also started to collect waste in various industrial zones of Amsterdam. Among others, this industrial hazardous waste originated from several chemical industries and the producer of organic pesticides. In particular, the disposal of residues from the organic pesticides production (among which Agent Orange), can be considered as a game changer. Hazardous waste was mixed with large volumes of solid municipal waste. From time to time, local pop-ulation complained about uncontrolled fires at the dumpsite.

Volgermeer 1980 - 1981

In the late 1970s, environmental awareness of the Dutch population increased significantly. The local population started to complain more and more about the uncontrolled fires at the Volgermeer dumpsite. In 1980, a local shovel operator working at the Volgermeer polder discovered drums with the skull warning sign. Just at that time, soil pollution in 'Lekkerkerk' made headlines in the Dutch news. The discovery of the drums was a confir-mation that a new 'Lekkerkerk' was potentially born at the Volgermeer. The news of the drums rapidly spread in the local community and increased the existing agitation about the uncontrolled fires. Local leaders of the nearby village of Broek in Waterland established a committee that was able to mobilize the local population and attract a lot of attention in the national news. As local authorities initially denied the presence of hazardous waste and environmental and human risks, the local population decided to barricade the entrance to the Volgermeer. With-in three months' time, the City of Amsterdam was forced to cease further disposal of waste at the Volgermeer.

In the early 1980s, the Volgermeer continued to attract a lot of attention in the Netherlands, and the local com-mittee maintained its pressure on the local and national authorities. Local and national authorities realized that emergency measures had to be implemented. Drums at the surface of the dumpsite were collected and stored on-site. An attempt was made to isolate the surface water within the Volgermeer from the surrounding surface waters. The site was fenced and warning signs were posted.

Volgermeer 1982 - 1998

After the implementation of the emergency measures, preliminary studies were conducted. Given the scale of the dumpsite (six million cubic meters of hazardous waste with significant concentrations of organic pesticide resi-dues and dioxins) and the available techniques at that time, it was concluded that remediation was almost impos-sible and too expensive. Attention shifted towards the question on liabilities. Communication between authori-ties and the local committee almost ceased and was best characterized by distrust.

Given the isolated position of the Volgermeer and the discovery of another, large-scale soil pollution nearer to the population centre of Amsterdam, the authorities lost their focus on the Volgermeer. It was also hard for the local committee to attract further attention of the broader public. The general idea was that with the implemen-tation of the emergency measures, the situation at the Volgermeer was safeguarded.

Volgermeer 1999 - 2000

In the late 1990s, local and national authorities put the remediation of the Volgermeer back on the agenda, due to the involvement of two political leaders who sincerely wanted to fulfil an old promise to the local committee and resumed responsibility of the former disposal activities. At that time, the regulations on soil remediation had also changed in the Netherlands, which made it possible to use new concepts such as monitored natural attenua-tion and risk based land management as viable remediation options. Finally, in 2000, a remediation plan was drafted, approved by the authorities and accepted by the local committee.

The objective of this final plan was to remove direct contact possibilities with the polluted material through the installation of a top cover and monitoring of the pollution pathways. Field investigations and model calculation had shown that off-site spreading of the pollution was not possible. The earlier emergency measures were rein-stalled, and previously collected drums were removed from the site.

Volgermeer 2000 – 2013

From 2001 to 2010 the actual design and implementation of the remediation works took place. During this peri-od, an extensive monitoring program was set up (involving over 350 observation wells around the Volgermeer and just less than 300 within). On the basis of the monitoring results, it was shown that over large areas of the Volgermeer, high concentrations of degradation products of organic pollutants and pesticides residues were pre-sent in the pore water of the landfill body. More surprisingly, the groundwater in most of the observation wells just outside the landfill did not contain any pollution during this period. Also, the original surface waters within the landfill showed practically no pollution.

Further in-depth assessment revealed that the existing peat soil surrounding the Volgermeer landfill and the or-ganic rich sediments effectively contained the contamination inside the landfill body itself. Given the importance of the peat layers, a surprisingly simple and effective concept, i.e. the ‘natural cap’, was developed.

The original aim was to cap the waste by multiple layers, i.e. vegetation, topsoil, drainage, geo-membrane (HDPE) and gas ventilation and to maintain this top layer for eternity. In the natural-cap concept, a peat layer is to be developed on top of the remediated landfill. Meanwhile, this peat layer will act as a natural barrier, reducing the eternal aftercare and maintenance program which was deemed necessary for the original multi-layer-top solu-tion.

Peat will prevent off-site migration of

pollutants. This approach was founded on the assumption that engineering solutions should not inhibit natural processes of risk mitigation. Rather, engineering should enhance and support natural biological processes. Conservation of existing peat layers around the Volgermeer and development of new peat layers on top of the Volgermeer are important corner stones of this approach. Development and con-servation of peat bogs, on the mid-term, can also earn the area a special protected status of a valuable wetland area.

During the implementation of the remediation project, the local committee and other stakeholders were actively involved in the rehabilitation and transformation of the landfill site and monitoring results were transparently shared and discussed with them. Since 2011, local citizens are actively involved in the transformation of the area into a natural peat bog. Distrust truly changed to common trust. Together with several universities, a research program was set up to assess and validate the concept of the natural cap and the potential for peat development. Local and national authorities made long-term commitments for funding of aftercare and monitoring. Fall-back scenarios are available to man age unexpected risks, and remediation techniques, which can be utilized to inter-cept polluted groundwater (if needed), have been identified.

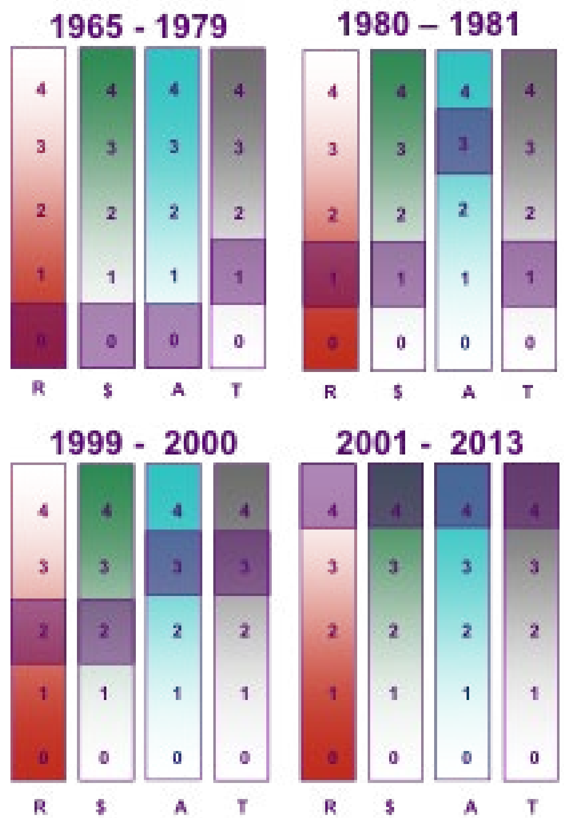

Figure 3-1: Classification Volgermeer in the Netherlands

3.2 Volgermeer Classification

Although, before 1955, large volumes of solid municipal waste had already been disposed at the Volgermeer, it cannot be considered as a hazardous waste dumpsite for that period of time because no hazardous waste was stored. After 1955, hazardous waste, mixed with large volumes of solid municipal waste, turned the Volgermeer into a hazardous waste dumpsite. Based on the above description of the Volgermeer, figure 3-1 visualizes the classification of the dumpsite from 1955 to date.

Volgermeer 1965 – 1979

The disposal of hazardous waste transformed the Volgermeer into an uncontrolled dumpsite. The large volumes of waste consisted of hazardous waste mixed with solid municipal waste. Although the local population was from time to time complaining about uncontrolled fires at the dumpsite, nobody was aware that a game change of hazardous waste disposal had taken place. Let alone anybody realized the increased risk profile of the Vol-germeer or the necessity to control risks.

Volgermeer 1980 - 1981
In 1980, the receptors were the first to become aware of the risks of the Volgermeer. By pressure of the local population further disposal of waste to the Volgermeer ceased. Shortly after, local and national authorities real-ized that emergency measures had to be implemented. Drums at the surface of the dumpsite were collected and stored on-site and the site was fenced and warning signs were installed. In this period, the Volgermeer can be considered a minimum controlled dumpsite.

Volgermeer 1982 – 1998
In this period, the authorities lost their focus on the Volgermeer. The installed emergency measures were not well maintained. The status of the dumpsite in this period is classified between a minimum and uncontrolled dumpsite.

Volgermeer 1999 - 2000
Due to the efforts of two political leaders, the awareness increased, and it was realized that new soil remediation concepts were available. On the basis of investigation results and model calculation, the state of the art remedia-tion concepts were applied as a design basis. Direct risks were controlled, funds were made available and respon-sibilities were allocated. In this period, the site can be classified as a semi-controlled dumpsite. Furthermore, the approved remediation plan for the Volgermeer ensured that potential risks would be controlled in a few years' time.

Volgermeer 2001 - 2013
From 2001 to 2010, remediation measures to control direct, potential and latent risks were designed and imple-mented. The waste was capped by multiple layers and, on top a peat layer is currently developing. Meanwhile, this peat layer will act as a natural barrier, reducing the aftercare program. Local and national authorities made long-term commitments for funding of aftercare and monitoring. In the year 2013 the Volgermeer was classified as a completely controlled dumpsite.

Future of the Volgermeer
The classification of a completely controlled dumpsite in 2013 cannot be taken as a guarantee for a bright future. Peat layers in Holland are under severe pressure due to dewatering, oxidation and excessive levels of nutrients in the environment (eutrophication). Nation-wide studies show evidence that peat layers might completely disap-pear within the next centuries. Since the current remediation concept is heavily dependent on the containment capacities of the peat layers, it may be clear that such a future disappearance can change the status of the Vol-germeer back to a less controlled dumpsite. Also a fainting focus at national, local or community level can threat-en the current status of a completely controlled dumpsite. Allocated budgets also need to be permanently secured, especially in times of severe budget constraints. In other words, the currently reached status of completely controlled sink is not automatically guaranteed for the future. To guarantee the status the Volgermeer, a dedicat-ed community of involved partners is required in the long-term.

3.3 Description dumpsite Vakhsh

The Vakhsh dumpsite history is divided into three distinctive periods: 1973 -1991, 1992 - 2008 and 2009 - 2013.

The conditions of the dumpsite will be described during each period. Based on these descriptions a classification for the Vakhsh dumpsite in these periods is presented and discussed. Specific attention is given to the effects of the disintegration of the Soviet Union.

Vakhsh 1973 - 1991
Huge amounts of pesticides, including POPs pesticides, were distributed across the Soviet Union almost free of charge to raise agricultural production back in the

1950s and 1960s. POPs pesticides were banned in the Soviet Union in the beginning of the 1970s. Polygons consisting of concrete sarcophagi were constructed to perma-nently store the banned POPs pesticides all over the Soviet Union. The banned solid pesticides and sometimes fluids were placed in the sarcophagi. Often fluids were burned to reduce the volume. The Vakhsh polygon, with around 30 sarcophagi, was constructed in a cattle-raising area a few kilometers upstream of an agricultural area with irrigation channels draining to the Vakhsh river system. The dumping started in 1973 and continued to 1990 when disposal was definitely stopped.

The site is situated approximately five kilometers east of the city of Vakhsh. The city of Vakhsh is one of the major cities in the Khatlon region in the southwestern part of Tajikistan. The city is situated about 40 kilometers north of the border with Afghanistan. Geographically the area is located in the valley of the Vakhsh River, one of the major boundary rivers of Tajikistan. The first aquifer is deeper than 50 meter below the surface of the poly-gon. The polygon was fenced and permanently guarded. To control erosion upslope areas were terraced and trees were planted. An irrigation system was installed to water the trees in the dry season. With the collapse of the Soviet Union, the agricultural system fell apart at the end of 1991. This left the Vakhsh polygon and others pesticide stocks unmanaged and many of these without designated owners.

Vakhsh 1992 – 2008

After the collapse of the Soviet Union, efforts to secure the site ended, the fences were stolen and local people (and their herds) could easily enter the polygon.
The erosion-control terraces on the slopes above the burial site were still present. The trees were gone and erosion of the terraces had started. All efforts and inputs to start afforestation on these slopes ceased to exist.

The neglect of environmental concern, combined with poor environmental awareness and planning, created a major environmental hotspot at the polygon, making it a legacy of the past. This legacy could hardly be dealt with in the post-civil war devastation and economic hardships.

The originally well designed Vakhsh polygon was also targeted by ‘illegal waste miners’. Especially DDT was taken out to be sold at local markets. The degradation of the polygon and the illegal waste mining resulted in exposure and spreading of pesticides. Exposed POPs pesticides contaminated the topsoil, migrated off-site by surface run-off and wind erosion. Trespassers and herders, especially children and cattle were exposed to the toxic waste.

Vakhsh 2009 - 2013

The World Bank received financing from the Canada Persistent Organic Pollutants Fund, through the Canadian International Development Agency on behalf of the Government of Canada for the inventory of the POPs pes-ticides and risk assessment. The World Bank applied a portion of these funds for ‘The Obsolete pesticides tech-nical study in the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan’.

The Vakhsh polygon was one of the top priority sites. Given the absence of monitoring and site management, a considerable potential was assumed to exist for contaminant spreading away from the designated area to the direct surroundings and inhabited areas. One of the objectives of the obsolete pesticides technical study was to assist Tajikistan in protecting the environment and human health by safely managing the Vakhsh polygon. To meet the objective a CSM was designed, and the environmental risks were assessed followed by a feasibility study for in-situ site remediation and or containment alternatives for the highly contaminated site.

The total estimated volume of POPs pesticides exposed was estimated to be around 1,500 tons. In addition, the quantity of POPs pesticides still buried in sarcophagi was estimated at 2,500 tons. Over the years, approximately 333,000 m2 of soil has been contaminated by POPs pesticides. The estimated volume of heavily contaminated soil is around 22,000 m3 (39,600 tons). The proposed and pre-design short-term measures to mitigate the direct environmental risks comprise gathering and containing the 1,500 tons of exposed POPs pesticides in the sar-cophagi, together with the still buried 2,500 tons, followed by final disposal as soon as possible.

In addition to the containment of the POPs pesticides and heavily contaminated soil awaiting final disposal, it is seen as crucial to install proper site management and install guards to prevent waste mining and to ensure proper containment of the remaining contaminated soil as long as needed. To keep trespassers and cattle safely away from the site and to reduce further risks, it will be necessary to fence the whole site. Very important additional short-term measures consist of reinstalling the old surface drainage and implementing erosion control measures. Last but not least, the awareness of all the stakeholders needs to be raised.

3.4 Vakhsh Classification

Based on the above description of the dumpsite, figure 3-2 visualizes the site classes for the four categories per period. The figure illustrates the stages of the Vakhsh dumpsite and can support the decision making process for the next steps necessary for proper site management.

Vakhsh 1973 - 1991

In the perspective of the site risk profile, the Vashkh dumpsite history has three distinct periods. The first period is from 1973 to 1991 when the site risks were limited to direct exposure of the site workers and the emissions (dioxin) from burning liquid pesticides. When dumping ceased, the environmental risks were contained by prop-er site management. Proper site management, guarding, monitoring and maintenance were guaranteed because funds were allocated by the Soviets. The site was a completely controlled dumpsite for nearly all categories. The fact that it was allowed to burn liquid pesticide demonstrates that the authorities were not fully aware of the en-vironmental risks.

Vakhsh 1992 – 2008

In the next period of 1992 - 2008, political instability, cut of funds and poverty led to further site destruction enlarging the environmental risks substantially. There was a decline in the awareness of the people using the site and its surroundings. The

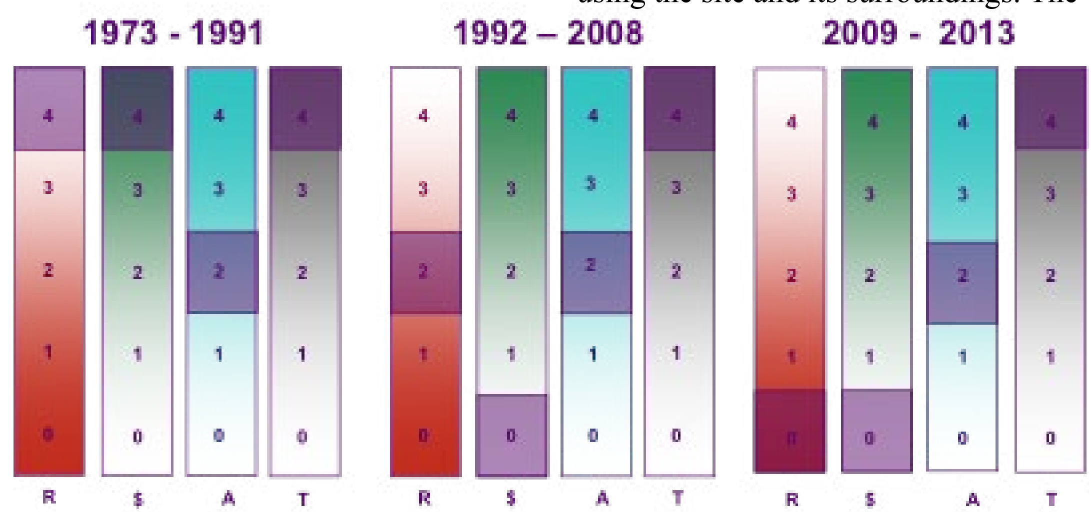

Figure 3-2: Classification Vakhsh in Tajikistan

status of the site fell back to an uncontrolled dumpsite. The remediation techniques to control all environmental risks were readily available and feasible in that period.

Vakhsh 2009 - 2013
The awareness of national stakeholders increased again through the results of the World Bank project after Ca-nadian funds became available in 2009. Until 2013, there was no follow up of this technical study because the Tajik national authorities had other priorities. The local authority's awareness was raised by training and partici-pation in the World Bank project, but they lack the means to implement proper site management. Waste miners, mostly young boys, are still active and will be active as long as there are POPs pesticides in the sarcophagi and there is market for these cheap alternatives for the expensive modern pesticides. The Vakhsh polygon can only become a completely controlled dumpsite again if the national stakeholders are aware that for implementing risk reducing measures, only limited investments are needed. Besides, the awareness of the waste miners should be raised. They should be told that their activities not only affect their own health, but also have a huge impact on the environment. The techniques to mitigate the direct risks on the short-term, to contain the potential risk and monitor the latent risks are available.

3.5 Description of Suzak B dumpsite

The Suzak B dumpsite history can be divided into three distinctive periods: 1973 -1991, 1992 – 2005 and 2005 – 2013. The boundary between the second and third period is not exactly known and was set to 2005. The next sections describe the dumpsite during each period and discuss its classification.

Suzak 1973 - 1991
The Suzak B dumpsite is located Kyrgyzstan. Kyrgyzstan is a former Soviet Union member and was therefore also subjected to the agricultural policy of the 1950s and 1960s. The Suzak B polygon was constructed and filled somewhere between 1970 and 1990. The Polygon consisted of around 5 - 10 sarcophagi filled with pesticides. The polygon was constructed in the vicinity of a settlement on the summit of a hill. The area was also a cattle-raising area. The first aquifer is deeper than 50 meter below the surface of the polygon. The polygon was fenced and permanently guarded. A site drainage system was installed to control erosion. The Suzak B polygon was left unmanaged and without designated owner after the collapse of the Soviet Union.

Suzak 1992 - 2005
After the collapse of the Soviet Union, the same happened at Suzak B as at Vakhsh in Tajikistan. The neglect of environmental concern, combined with poor environmental awareness and planning, created an environmental hotspot at the polygon, making it a legacy of the past. The originally well designed polygon was not so much targeted by 'illegal waste miners' compare to Vakhsh because the site was within the vicinity of the growing set-tlement. The degradation of the polygon and the illegal waste mining resulted in exposure and off-site migration of pesticides and also created nuisance to the people living nearby.

Suzak 2005 - 2013
The land pressure around the Suzak B dumpsite increased, and people were directly confronted with the negative environmental impact of the substandard condition of the polygon. To be able to use the surrounding land for horticulture and to eliminate the nuisances, the people living nearby the polygon organized and implemented risk reduction measures themselves. In the beginning of this century, they managed to fence the site and closed the waste miner's pits. In 2010, the site fence was still intact; a healthy look-

ing grass and shrub cover was present preventing wind erosion. Warning signs were installed making people well aware of the dangers involved in case their attention would weaken.

3.6 Suzak B Classification

Figure 3-3 visualizes the categories, which are further described in the next sections.

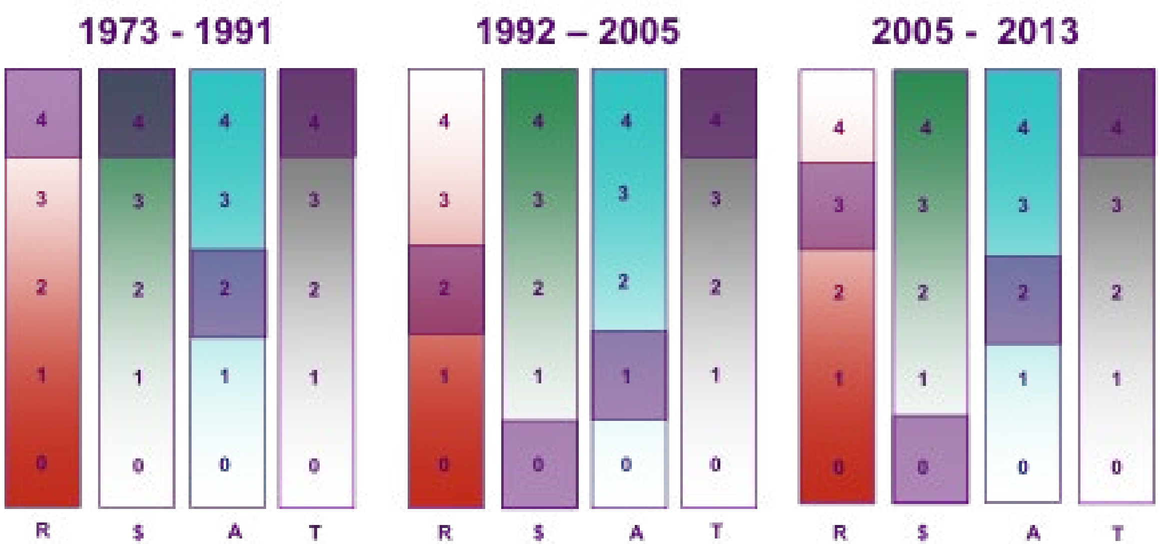

Figure 3-3: Classification Suzak B in Kyrgyzstan

Suzak 1973 - 1991

In the perspective of the site risk profile, the Suzak B dumpsite history has three distinct periods. In the first period, which lasted from 1973 to 1991, the site risks were limited to direct exposure of the site workers. When dumping ceased, the environmental risks were contained by proper site management. The site was a completely controlled dumpsite for nearly all categories. For the same reason as Vakhsh, the awareness category is not com-pletely controlled.

Suzak 1992 – 2005

In the next period, the cut of funds for proper site management and poverty led to the first steps in the direction of an uncontrolled dumpsite. This period was short because the people living close to the site experienced a negative impact. This led to an increase in awareness, and the status of the site fell back to a semi controlled dumpsite for the risk category only for a short period.

Suzak 2005 - 2013

Due to the collective initiatives, the direct risks were mitigated and the potential risks were contained. The dumpsite is now classified as controlled dumpsite for risk category. It is not a completely controlled dumpsite because the latent risks are not being monitored. The current status has been reached although there are hardly any funds available.

3.7 Discussion

In developing economies, we often see that the infinite assessment circle of Harmsen et al. (2009) is valid. The infinite circle (see figure 3-4) commences with site assessment. When the assessment reveals that the environ-mental problem is too big, the assessment report is often shelved and nothing is done. But the environmental risks remain. After some time, new initiatives are taken because of the remaining sense of urgency. Scarce funds are spent again on updating the earlier site assessment. Again the new site assessment reveals that the problem is too big and has often grown even bigger. The site assessment report is shelved again because the means are in-adequate to implement miti-gation measures. The environmental prob-lem is still too big. The proposed classifi-ca-tion introduced in this paper can help to achieve a breakthrough of this infinite assessment circle by:

- Assessing the dumpsite.
- Making a CSM.
- Assessing the environmental risks.
- Classifying the dumpsite.
- Identifying the hurdles for sustainable site management.
- Focussing only on removing these hurdles.

The success of the remediation of the Vol-germeer provides important lessons for remediation of uncontrolled dumpsites elsewhere in the world. The Volgermeer problem seemed also too big and from 1980 to 1999 nothing was done, except for some emergency measures. But this changed at end of the 1990s and classifica-tion of the Volgermeer in different periods demonstrates the causes of these changes. The Volgermeer has taught the fol-lowing lessons:

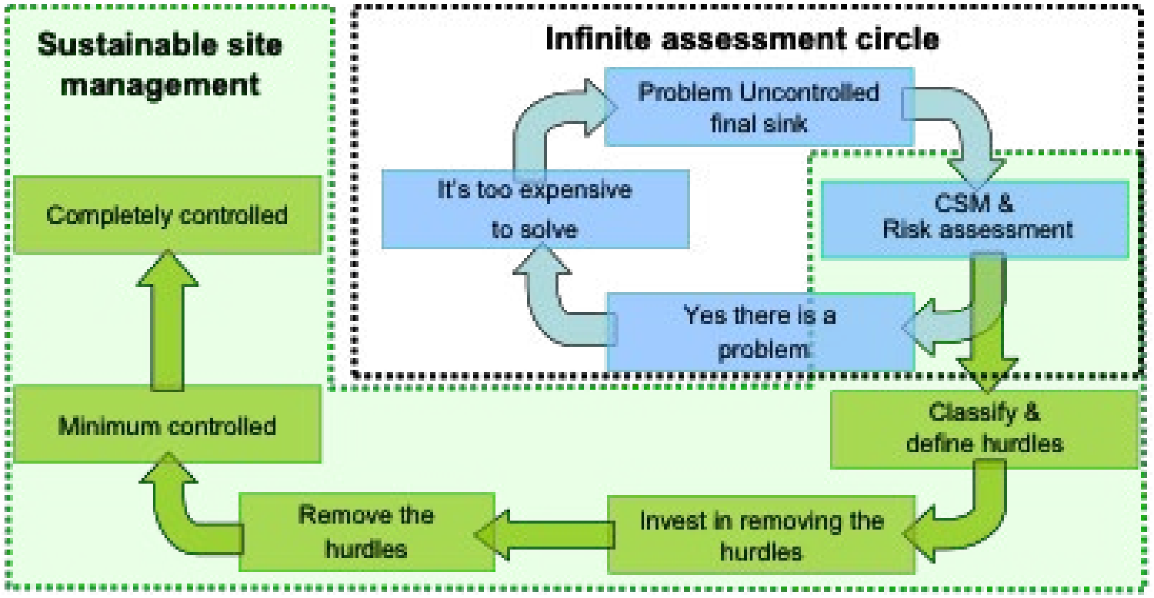

Figure 3-4: Breaking the infinite assessment circle (modified from Harmsen et al, 2009)

- It is crucial that the rehabilitation of the dumpsite is fostered by a person or a group with the power and willingness to do so (Kips et al, 2011).
- Make sure there is a socio-economic incentive. Let improvement of the so-cio-economic situation be a pow-erful driving force, for any chosen solution.
- Apply simple and effective solutions us-ing natural processes and locally available resources that add value to the future sur rounding land use. The concept preferably builds with nature instead of being against nature.
- Balance civil engineering and green re-habilitation. Recognise that it is essential to exchange knowledge (bio-geo-chem-ical-civil engineering) within the project setting and also at a broader scale.

When classifying Vakhsh, it becomes clear that the hurdle for implementing sustain-able site management is the awareness of the local and national decision makers.

They should be convinced that implementing mitigation measures to reduce the direct risks on the short-term can be simple and not costly by using locally available re-sources.

The classification of the current situation at Suzak B illustrates that an important driving force is the awareness of the local stakeholders. The people living nearby the polygon Suzak B are aware of the environmental risks and therefore implemented simple, but effective, risk reduction measures themselves.

The classifications of Vakhsh and Suzak B clearly demonstrate that even when the status of a controlled dumpsite was reached, relapse of the status may occur due to unforeseen circumstances. Although a dumpsite may be completely controlled, proper site management, monitoring and aftercare should be secured perpetually.

Using the classification tool provides a holistic view of the main features of the dumpsite that influence the pro-cess to go from an uncontrolled to a more controlled and finally to a sustainably managed dumpsite. The classifi-cations show at a single glance which initiatives should be deployed to implement sustainable site management. The classification also supports the decision making process for rehabilitation of the dumpsite with sustainable mitigation measures, turning the dumpsite into a completely controlled dumpsite.

4 Conclusions

Classifying dumpsites:

1. Helps to achieve a breakthrough of the infinite assessment circle.

2. Reveals the hurdles for implementing sustainable dumpsite management.

Using the proposed classification tool:

1. Provides a holistic view of the main features of the dumpsite that influence the process to go from an un-controlled to a more controlled and finally to a sustainably managed dumpsite.

2. Supports the decision making process for implementation of sustainable dumpsite management.

Classification of the Volgermeer, Vakhsh and Suzak B dumpsites shows that successful implementation of sus-tainable dumpsite management needs to:

1. Be fostered by a person or group with the power and willingness to do so.

2. Create socio-economic incentive with the future site.

3. Make as much as possible use of natural processes and locally available resources.

4. Secure proper site management, monitoring and aftercare perpetually.

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CLASSIFICATION OF POP PESTICIDE DUMPSITES

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This session was used to present and demonstrate the use of a simple classification tool. This tool is developed to present a holistic view on the status of a POP pesticides dumpsite, to explain the current status of a site and facilitate the identification of the gap(s) to break the infinite site assessment circle (Joop Harmsen et al., 2009) and to sustainably manage the dumpsite.

The introduction of this session was given by Boudewijn Fokke (Tauw, the Netherlands). The fact that the status of a dumpsite can vary from uncontrolled to controlled and the dumpsite characteristics describing the status were discussed. The chosen dumpsite characteristics are environmental risks, awareness of stakeholders, the availability of funds for sustainable site management, and availability of site remediation techniques.

The next part of the session was used to demonstrate the application of the tool. The first case was presented by Ingrid Rijk (Witteveen+Bos, the Netherlands). She used the tool to demonstrate the development of the 100 hectare hazardous waste dumpsite of Volgermeer the Netherlands from an uncontrolled to a completely controlled site over the last 60 years.

Tomasz Stobiecki (Institute of Plant Protection, National Research Institute Sosnicowice Branch, Poland) gave a presentation on the status of the Rudna Góra, a POPs pesticide dumpsite near Jarworzno in Poland, over the last 100 years. Matthijs Bouwknegt and Boudewijn Fokke (Tauw), the Netherlands) characterized respectively the POPs pesticide dumpsite Suzak A in Kyrgyzstan and the Nubarashen dumpsite in Armenia. The last presentation of the session was by Joop Harmsen (Alterra Wageningen, the Netherlands) on his experiences in the 'Risk Reduction of Soil Contaminated by Obsolete Pesticides in Africa' project.

After the presentations of the cases, the usefulness of the tool was discussed with the audience. It was concluded that POPs pesticide dumpsite classification demonstrates which initiatives should be taken to arrive at a sustainable dumpsite management. It was also concluded that the tool should be improved by including the legal status of the site and the willingness to allocate funds for sustainable site management.

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