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Concerted actions

Cleaner and safer technology promotion for reducing/eliminating risks associated with POPs in the environment

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Abstract

Man-made chemicals (Xenobiotics) have become part of man's existence in this planet and these chemicals during production, consumption and disposal in various outlets end up in the environment. Most of them biodegrade. However some remain in the environment with a long or indefinite half-life and interfere with the very existence of the planet. Some of them deplete the ozone layer, some travel through soil, water and carried by air to far off places. They enter the food chain and bio-accumulate in the fat tissues of man, aquatic animals, birds of prey causing cancer, interfering with reproduction processes, immune suppression etc. This paper deals with the UNIDO's activities on a global basis in the promotion of cleaner and safer technology for reducing/eliminating risks associated with POPs in the environment. It describes UNIDO's work through the 1980s to 1990s and into the new Millennium in areas related to management of POPs and related chemical pollutants. In the 1980s UNIDO assisted Poland in cleaner technology in the production of MCPA and gave advisory assistance for rehabilitation of lindane plant in Albania and recommended to stop the production of lindane in the plant due to economic and safety reasons at that time. In 1987 UNIDO organised the First International Workshop on Hazardous Waste Management. The recommendations of the workshop are still part of UNIDO's activities. In the 1990s UNIDO jointly with UNEP established a number of cleaner production centres in developing countries and they cover among others, pesticides, fertiliser, textile, pulp and paper industries which are all potential generators of persistent toxic substances. UNIDO's long running network Regional Network on Pesticides for Asia and the Pacific (RENAP) containing 15 member countries, has been contributing among others, to phasing out of POP pesticides, and moving to safer alternatives to POP pesticides such as phasing out of BHC production in India, use of bio- and botanical pesticides for agricultural and public health outlets and capacity building in ecotoxicology and environmental monitoring. Following the Inter Governmental Forum on POPs in Manila and Ottawa, UNIDO as a member of the Intergovernmental Organisation for Sound Management of Chemicals (IOMC) is pursuing promotion of environmentally safe non-combustion technology for disposal of hazardous chemicals including POPs. The paper also covers UNIDO's project on alternate technology and barrier removal for artisanal gold mining in Latin America, Africa and Asia to reduce/monitor/eliminate mercury pollution. Finally the paper gives an overview of UNIDO's policies and procedure to get funds for its technical cooperation projects in cleaner production and management/elimination of POPs in developing countries.

Introduction

UNIDO is one of the Specialised Agencies of the UN located in Vienna. During the last five years it has undergone various reorganisations and to day has a mandate for Environmentally Sustainable Industrial Development (ESID). This takes into account Economic, Environment and Social aspects of industrial development in developing countries. After a major reorganisation in 1997, it is now following an Integrated Programme approach in its technical cooperation logically linking different interrelated topics. On account of its mandate dealing with industries and related environmental issues, it is involved in technical cooperation in developing countries and countries with economics in transition, at the industry policy level, investment promotion and at the grass root level in promoting and transferring cleaner and safer technology. UNIDO is actively involved in the major environment related conventions and protocols. With a long standing experience in chemical and allied industries UNIDO has been asked to take an active role along with other agencies on the issues of POPs and other chemical pollutants of concern.

Issue of POPs

The evolution of DDT to POPs is very interesting.

Table 1. Evolution of DDT to POPs

- 1873 Invention of DDT by Zeidler
- 1940 Discovery of insecticidal activity by Müller
- 1942 introduction of DDT as pesticide
- 1945-53 invention of chlordane, heptachlor, drins
- 1960s Vietnam war and the use of agent Orange
- Ralph Nader's review on effects of DDT on birds of prey
- 1962 Rachel Carson's book on Silent Springs
- The Love Canal Incident and Seveso Accident
- 1992 World Summit in RIO
- Series of Meetings in Stockholm, Washington, Manila, Ottawa, Yokohama, Rotterdam, Bonn, Johannesburg
- Formation of IOMC
- PIC list, PRTR
- POPs
- 1997 UNEP Decision 18/32 on POPs
- 1997 Book @Our Stolen Future by Theo Coleburn and others
- 1999 GEF's decision to develop a funding mechanism for POP elimination
- Forthcoming meeting in Stockholm in May 2001

It is now well acknowledged that among the POPs identified there are nine agrochemicals, one is a group of industrial chemicals and two which are not manufactured but occur as by-products in certain chemical and allied industries and during incineration. In the late 1970s the waste load of PCBs discharged to waterways and sewers in the USA was in the region of 5kg/day mainly from the capacitor industries. Much greater quantities were discharged to land or for incineration at the rate of about 2,000 kg/day [Robin Chalmers, Chem. and Ind. 271 (1981)]. In the UK in the late 1970s even after the ban of organo-chlorines certain sewage sludge contained the following POPs (Table 2).

Table 2. POP residues in sewage sludge in the UK during late 1970s

Compound	Range of levels observed (mg/kg dry matter)
Aldrin	0-16.2
Dieldrin	0.03-2.2
PCBs	0-352
Chlordane	3-32
Total DDT isomers	0.1-1.1

Source: Derek Jamieson, Chem. & Ind. 67(1981)

With all the POPs used over the years in agriculture and public health outlets it is a fact that this planet is contaminated with both agrochemical and industrial POPs and we have to live with them for a long time to come because there is no way we can get rid of them due to their wide distribution, persistence and movement in the biosphere. UNEP GC decision 18/32 calls for, among other things,

- Develop legally binding instrument for the reduction and/or elimination of emissions, discharges and where appropriate the elimination of the manufacture and use of POPs.
- To use cleaner production processes including best available techniques to reduce and/or eliminate hazardous by-products associated with production, incineration and combustion.
- National capacity and capability to ensure the effective management of toxic substances to the development, implementation, monitoring and evaluation of an effective global action plan for POPs.

UNIDO's activities

Before 1997 most of UNIDO's activities in hazardous waste and toxic chemicals were covered by the Chemical Industries Branch and in 1997 after reorganisation, these activities were moved to Cleaner Production and Environmental Management Branch. UNIDO's technical cooperation programmes that are directly and indirectly linked to POPs could be divided into three phases. They cover programmes on national, regional and global basis.

- **1980s:** Work in chemical and allied industries that addressed to technology modification mainly based on economic, environmental and safety factors but not directly linked to reduction or elimination of POPs.
- **1990s:** Taking active role in UNCED and working with other UN agencies in areas such as cleaner production, elimination of ODS, safer alternatives to toxic and persistent pesticides and their formulations, dealing with mercury pollution in artisanal gold mining, GEF projects related to marine ecosystems.
- **New Millennium:** Continuing work started in the 1990s and pursuing work that started based on responsibilities given to UNIDO in major conventions and protocols.

Poland

In the 1980s, I want to particularly mention four projects, one here in Poland where UNIDO was asked to look at the cleaning of the production of MCPA, which is a major selective Herbicide manufactured at Organika enterprise located in Sarzyna. The total production was 2,000 tonnes/annum while the demand was 3,000 tonnes/annum. The original method was inefficient, produced unacceptable quantities of chloro-phenolic effluents and carbon tetrachloride which needed expensive end of pipe treatment. UNIDO used Danish technology to clean-up the process by using better quality raw materials, o-cresol, chloroacetic acid and modifying chlorination process at lower temperature using a catalyst. Enormous improvement was made in the process. Raw material consumption was less; the product was purer with much less effluents as shown in Table 3.

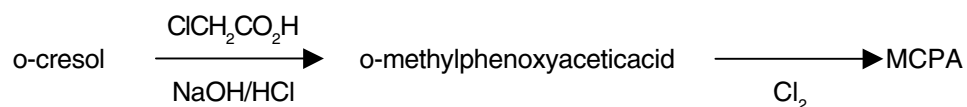


Table 3. Raw materials for 1,000 tonnes of MCPA

Raw material (tonnes)	Old method (tonnes)	Modified method (tonnes)	Savings (tonnes)
o-cresol	718	570	148
Chloroacetic acid	881	700	181
Chlorine	577	410	167
NaOH (28%w/w)	3,461	1,750	1,711
HCl (30%w/w)	957	1,400	(443)
H ₂ SO ₄ (96%w/w)	72		72
NaOH (50%w/w)		950	(950)
Na ₂ CO ₃	108		108
CCl ₄	144		144
Catalyst		(10)	(10)

The cleaner process gave almost complete chlorination; no handling of cresols thereby avoiding smell, and the wastewater did not contain any phenols and no chlorinated organic solvents and finally reduced the consumption of raw materials. Elimination of CCl₄ is a major achievement since this is now implicated in Montreal Protocol under group II, for elimination by 2010 in article 5 countries.

Albania

Another project was to look at a plant located at Durres in Albania producing 100 tonnes/annum of pure lindane. It is a very valuable compound for seed dressing, for wood treatment and fumigation of structures. For every gram of lindane produced, 5 to 6 grams of more toxic isomers of BHC are produced and in most cases either they are stored or dehydrochlorinated for producing other chemicals for use as intermediates. UNIDO did a complete survey of the plant and taking into consideration the badly corroded status of the plant and the large amount of toxic materials getting accumulated at the site, and doubts about long term future of lindane, UNIDO strongly recommended closing down the plant. Of course we do not know the present situation of the plant with all the accumulated stock. Fortunately the plant never operated to full capacity.

In both cases in Poland and Albania, UNIDO took action at that time mainly based on economic, environmental and human safety conditions not directly linked to POPs in those days.

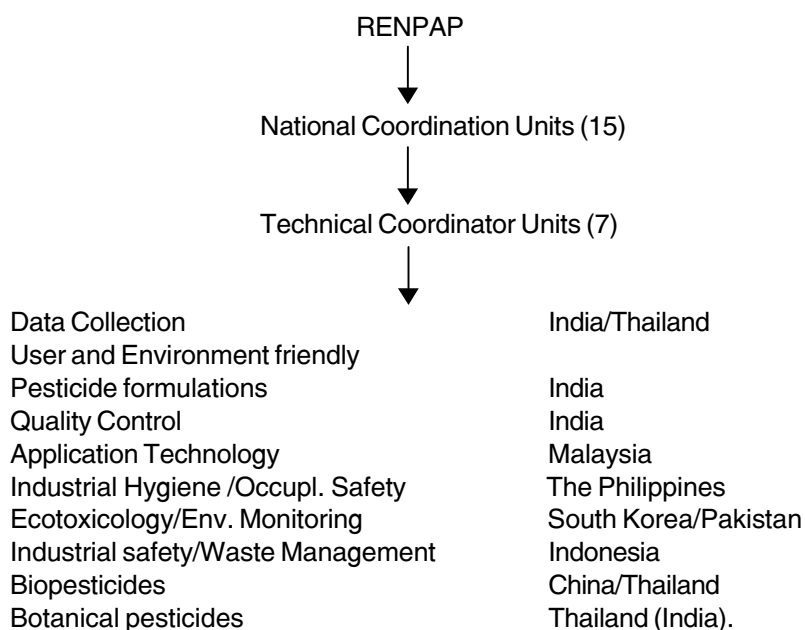
International Conference

In 1987, UNIDO organised a major international conference on hazardous waste management, and discussion took place on the dechlorination of PCBs, Dioxins and furans in organic liquids using catalyst at 250-300°C at a pressure of 50-60 bars through a process called KTI Chloro-off process. The dechlorination efficiency was 99.9%, which with today's standards may not be acceptable. A number of recommendations were made at that time on waste minimisation, source reduction/elimination of hazardous waste and those are still followed in UNIDO's projects.

Regional Networking

In the 1980s supported by UNDP and in collaboration with FAO, WHO and ESCAP, UNIDO established a network called Regional Network on Pesticides for Asia and the Pacific (RENAP). Initially there were only five member countries and the main idea was to exchange information on pesticide development and provide training in pesticide formulation, safety, quality control, and data required for registration, promote IPM and FAO code of conduct on pesticide use. The main aim was for capacity building by exchanging information and expertise within the region and also through international experts and training programmes.

In the 1990s RENAP grew from strength to strength from five to fifteen member countries and the project covered a broader area with the aim of moving away from toxic and persistent pesticides. Many countries in the network at that time were producing and /or using DDT, BHC, lindane and other POP agrochemicals. The network created awareness, capacity building and also data exchange on the pesticides produced, imported, exported and used in the region. India through UNIDO provided the overall regional coordination and countries, which were advanced in the region, took up technical coordinator role and conducted workshops for the region in selected fields. The overall coordination of RENAP is shown below.



The major contribution of the RENPAP project to POP reduction was that it was able to convince India to phase out the production of BHC. India is one of the major producers of BHC (~ 13%BHC dust) of around 300,000 tonnes /annum. The whole networking gave the member countries awareness to the changing scenario in pesticides over two decades, promoting harmonisation of data required for registration, promote IPM, integrated safety etc. Very importantly RENPAP catalysed to generate new programmes for the member countries such as:

- Ecotoxicology Centre for Pakistan (supported by Denmark)
- Safer and Environment Friendly Pesticide Formulation Development Centre in China (Supported by UNDP)
- Development of Integrated Safety Guidelines in Pesticide Formulation in Developing Countries (Supported by Finland)
- Major programme started in India for development of botanical pesticides based on Neem (*Azadirachta indica*) to replace some of the organochlorines. (Supported by UNDP)

At the request of the member countries, recently UNDP as an exception approved the RENPAP project for a fourth time for a period of four years in the New Millennium. The project will cover many areas related to POPs, bio-, and botanical pesticides and also in adopting cleaner technology for disposal of obsolete stocks of pesticides and collecting data/monitoring of contaminated land.

RENPAP is a clear example of regional networking as a powerful tool for implementing global conventions and leading to individual national projects based on the experience gained in the network activities. So projects such as RENPAP could play a very critical role in POPs and also introducing safer alternatives for toxic and persistent pesticides and their formulations.

Cleaner production centres

Major part of UNIDO's work during the 1990s is the establishment of national cleaner production centres (NPCs) world-wide along with UNEP. To date it has established 13 centres and eight more centres are likely to be started. These are:

The first 8 NPCs	Second Generation
Czech Republic (1994)	Tunisia (1996)
Brazil (1995)	Hungary (1997)
China (1995)	Nicaragua (1997)
India (1995)	Vietnam
Mexico (1995)	Costa Rica (1998)
Slovakia (1995)	El Salvador (1998)
Tanzania (1995)	Guatemala (1999)
Zimbabwe (1995)	Morocco (2000)
	Ethiopia (2000)
	Mozambique (2000)
	Kenya (2000)

The NPCs covered practically all industries. The main aim is to promote source reduction rather than end of pipe treatment, good house keeping, and continuous upgrading of the operation and management of the plant. These centres are key platforms to promote environmentally sustainable technologies in small and medium scale enterprises. Their main functions are capacity building, creating awareness to cleaner production and environmentally sustainable technologies. Till the end of 1999 they have made more than 500 in plant assessments, trained more than 25,000 trainees and have published a methodical tool "The Audit and Reduction manual for industrial Emissions and Wastes". The National Cleaner Production Centres are meant to be the tools rather than end of goal itself. These centres are ideal institutions to get involved in PRTR (Pollutant release Transfer Release) and for technology awareness for POPs disposal and alternatives.

China: Pulp and paper industries

At the request of the government of China, UNIDO looked at the alternate technology for chlorine bleaching in pulp and paper industries. Worldwide, pulp and paper industries are potential generators of small amounts of dioxin in their effluents due to chlorine used in the bleaching process. So elimination of this process in developing countries would be a valuable for control of POPs in the water effluents.

Demonstration Plant for Oxygen Pulping and Bleaching of Wheat and Rice Straw has the following elements.

Phase I: To establish the basic process parameters/equipment for the utilisation of oxygen/ozone/peroxide bleaching technologies in small mills using wheat and rice straw in order to reduce the generation and discharge of toxic organochlorine compounds;

Phase II: To demonstrate and disseminate chlorine free/chlorine reduced bleaching technologies for small pulp mills;

Activities:

1. Laboratory research work and training in Germany and USA one study tour in USA and Europe;
2. Literature survey on non-conventional pulping and bleaching of wheat straw;
3. Plant and process design of a demonstration plant for ECF/TCF bleaching to be installed in a 50 tpd straw pulp and paper mill in China;
4. Procurement and purchase of equipment (imported and locally manufactured) erection of the demonstration plant;
5. Commissioning and operation;
6. Techno-economic evaluation; organisation of an international seminar to disseminate the results;

Future:

UNIDO, along with the owners of the plant, is now looking for funding for technology transfer in their main plant.

Mercury pollution abatement

Another major activity was introduction of cleaner technology to control/eliminate the use of mercury in small-scale gold mining industries in Asia and South America. Even though heavy metals and organometallic pollutants are not per se included in the first set of POPs, they are of major concern coming from fertiliser use, mining, incineration or landfilling of hazardous waste. Mercury is one example where vapours coming out of incineration or mercury in the environment getting bioalkylated would pose a grave danger to human and animals living in the vicinity. Artisanal gold mining (small scale) in Asia, Africa and Latin America where mercury is used for extracting gold, is a highly hazardous process for the workers and also to the environment. UNIDO has been dealing with this in the Philippines and carried out full assessment of the contamination, identified hot spots, carried out health check of families involved in gold mining. Based on this a cleaner production technique has been introduced, which reduces the use of mercury, and it is recovered in a closed process and awareness and capacity building among the worker have been built. Based on the success of the project GEF has approved a Global preparatory phase to apply the Philippines example. Brazil, Sudan, Tanzania, Zimbabwe, Laos, Indonesia will be the participating countries. Non-hazardous mercury extraction methods such a gravity separation suitable for small-scale application is being looked at.

Non-incineration technologies for POP disposal

In the POP meeting in Manila and Ottawa, UNIDO was given the responsibility of promoting non-incineration technologies for disposal of POPs and other hazardous waste. In this connection UNIDO completed a project in Hungary on phytoremediation (using plants to clean-up soils contaminated with heavy metals and other pollutants) to clean up a site of Nitrokemia Ltd near lake Balaton. This is the biggest fresh water lake in Central Europe. The site was contaminated with heavy metals (Cd, Cr, Cu, Hg, Pb, Zn) and pesticides (acetochlor, phthalic acid, phenoxy acetic acid triazine etc.) and the company was willing to participate in the project. The project was carried out in two phases.

Phase 1: Research phase: The plants were chosen based on their ability to detoxify herbicides and heavy metals by interaction between the herbicide and glutathione catalysed by an enzyme called glutathione S-transferase and in chelating heavy metals. The poplar hybrid called (*Populus tremula* and *P. alb*) showed high degree of tolerance to herbicides and heavy metal salts. Initially glasshouse tests were carried out on leaves of selected poplar trees. The leaves contained high levels of glutathione S-transferase. Small-scale studies showed that the hybrid poplar trees have very high capability for bioaccumulation of Cd in their leaves.

Phase 2: Application phase: Based on the laboratory and glass house studies, 1,600 trees were planted in the 40 hectares site of Nitrokemia Co.. The trees are growing and the leachates from the sites are analysed on a regular bases for heavy metals and herbicides and compared with control plots. UNIDO is planning to start similar R&D projects in Russia and Ukraine.

UNIDO is now looking into non-combustible technologies for disposal of POPs stockpiles in the Philippines and Slovakia. This will be based on Australian experience on reductive decomposition to almost 100% efficient destruction of POPs. In the near future UNIDO will try to demonstrate pilot scale demonstration experiments to assess the suitability of the technology for developing countries.

Funds

UNIDO is not a funding agency but has access to many donor agencies. There should be a request from the Government to UNIDO through UNIDO field offices on directly in areas related to its mandate. UNIDO has access to donor agencies and to mention some of them:

IDF:	Industrial Development Fund given by certain member countries of UNIDO
Trust Fund:	Set up by interested parties
Montreal Protocol	
Funding Mechanism:	Mainly for elimination of ODS
GEF:	Global Fund for International Waters and Environment related matters, Energy etc.
Commodity Funds:	Funds related to agricultural production.
UNDP:	From Country Core funds.
UNIDO:	Seed Money for initiating Programmes especially Integrated Programmes

Depending on the type of request UNIDO will prepare the necessary project documents and approach the appropriate donors according to their priorities.

Finally we want to finish the paper with a quotation from the ex. Vice president of the USA, Al Gore.

"It is now clear that we waited too long to ask the right questions about CFC and we are going too slow in addressing the threat of climate change. We certainly waited too long to ask right questions about PCBs, DDT and other chemicals, now banned, that presented serious human health risks"

*Vice President Al Gore
writing Foreword to the Book Our Stolen Future*

Acknowledgement

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