

UNEP/GEF PROJECT REGIONAL BASED ASSESSMENT OF PERSISTENT TOXIC SUBSTANCES - EUROPEAN REGIONAL REPORT

Ivan Holoubek¹, Ruth Alcock², E. Brorstrom-Lunden³, Valeryj Petrosjan⁴, Ott Roots⁵, Victor Shatalov⁶, Anton Kocan⁷, Pavel Cupr¹, Irena Holoubkova¹

¹ RECETOX - TOCOEN & Associates, Kamenice 126/3, 625 00 Brno, Czech Republic

² c/o ENVIRONMENTAL RESEARCH SOLUTIONS, Ghyll Cottage, Mill Side, Witherslack, Nr Grange-over-Sands, Cumbria LA11 6SG, UK

³ IVL Swedish Environmental Research Institute, PO Box 47086, S-402 58 Göteborg, Sweden

⁴ Department of Chemistry, M.V. Lomonosov University Moscow 119899, Russia

⁵ Estonian Environment Research Centre, Marja 4D, 10 617 Tallin, Estonia

⁶ Meteorological Synthesizing Centra - East of EMEP, Architektor Vlasov Str. 51, 117 393 Moscow, Russia

⁷ Institute of Preventive and Clinical Medicině, Limbova 14, 833 01 Bratislava, Slovakia

Introduction

Based on the Stockholm Convention which was signed in 2001, scientifically-based assessment of the nature and scale of the threats to the environment and its resources posed by persistent toxic substances were performed. The assessment was led to the identification of priorities for intervention, and through application of a root cause analysis was attempted to identify appropriate measures to control, reduce or eliminate releases of PTS, at national, regional or global levels. Based on this approach, the GEF and UNEP Chemicals prepared project "Regionally Based Assessment of Persistent Toxic Substances"

The basic project topics were focused on identification of major sources of PTS at the regional level; impact of PTS on the environment and human health; assessment of trans-boundary transport of PTS; assessment of the root causes of PTS related problems, and regional capacity to manage these problems; identification of regional priority PTS related environmental issues; and identification of PTS related priority environmental issues at the global level.

To achieve these results, the globe is divided into 12 regions. The twelve regions were selected based on obtaining geographical consistency while trying to reside within financial constraints. Region III – Europe was consisted by 29 countries of Western, Northern, Central and Eastern Europe, the member countries of EU and many countries with economy in transition. Region III has a lot of information concerning to the sources and environmental levels of PTS, but geographic distribution of the available data is not equal for all parts of Region, better situation is in some countries of EU and Central Europe.

Sources of PTS in the Region III

Persistent Toxic Substances (PTS) can be introduced into the environment via numerous sources and activities. During the last decade a large amount of progress has been made in the production of atmospheric emission inventories of several PTS compounds within Europe. However there is still a lack of comparability in inventories produced by various organisations for the same compound group and this reduces transparency when comparing or compiling inventories. Improved emission inventories for PTS have become increasingly important as emission or source driven fate models for regional and global scales are developed.

Conclusions

- Within the Region as a whole there is a large amount of data relating to industrial point source emissions to the atmosphere. Sources to air of well studied compounds such as PAHs, PCBs, and PCDDs/Fs are generally well characterised and inventories have been calculated and updated regularly via EMEP. Due to restrictions on the manufacturing and more stringent control of releases, emissions from primary sources have been declining during the last 20 years. Understanding of secondary source inputs and the potential for environmental recycling of individual compounds continues to be limited and few measurements are available.
- Obsolete stocks of pesticides represent a potential source of PTS material particularly within the Central European Countries and Newly Independent States. Exact quantities and components of the stockpiled wastes are unknown at present but quantities are thought to be in excess of 80 000 t.
- For the compounds of emerging concern (e.g. PBDEs, chlorinated paraffins) emission sources to all environmental compartments are very poorly characterised, few formal inventories have been established and there is limited understanding of the principal contemporary source categories.
- Unlike sources to air, sources to land and water are very poorly quantified for all the PTS compounds.
- Prioritization of sources inputs within the Region as a whole highlight that the following compounds represent ongoing releases in the Region which are of most concern with respect the environment and health: hexachlorobenzene, PCBs, PCDD/Fs, PCP, PBDEs, chlorinated paraffins.

Levels and trends

- Region III has a lot of information concerning to environmental levels of PTS, but geographic distribution of the available data is not equal for all parts of Region, better situation is in some countries of EU and Central Europe.
- Very good and traditional monitoring system concerning also PTS exists (EN ECE EMEP, OSPAR, HELCOM) which are oriented to air and deposition (EMEP), seas (OSPAR, HELCOM); some new are ongoing (Caspic Sea, Black Sea). As far as rivers, the monitoring is realised mainly based on the national level, but a lot of multinational or regional activities already exist (Rhine, Danube).
- The measurements of PTS levels in some other compartments such as lakes, soils or vegetation is partly performed based on the international programmes (IM EMEP), national monitoring programmes (soils) or pilot or research projects (biota, lakes). Human exposure is measured and studied on the European levels (activities WHO Europe) and very frequently on the national levels.
- Although monitoring indicates that the loads of some hazardous substances have been reduced considerably over the past ten years especially in the Baltic Sea region, problems still persist. Comprehensive knowledge about the impact of most available chemicals, and their combinations, on human health and the environment is still lacking.
- The increasing number of these man-made substances is a matter of concern and calls for the application of the precautionary principle. On the other hand other seas, such as Black or Caspic still have a lot of heavily contaminated sites, where petroleum hydrocarbons and phtalates are the dominant organic contaminants of the Caspian Sea, but also the level of contamination of this sea decreased significantly during the last 10 years.
- The loads of many substances have been reduced by at least 50 % since the late 1980s - mainly due to the effective implementation of environmental legislation, the substitution of hazardous substances with harmless or less hazardous substances, and technological improvements.
- In former communistic countries reductions have been mainly due to fundamental socio-economic changes.

- The OCPs are no longer in use, have never been used, or have even been banned within the Region III. But one serious problem that remains is that in some countries various obsolete pesticides still remain in temporary storage awaiting suitable disposal.
- Polychlorinated biphenyls (PCBs) are no longer produced or used in new ways. Inventories are still being carried out in CEECs. Following an analysis of the legislative situation throughout the CEE part of Region, and the current uses, stockpiles and releases of PCBs measures have been proposed to ensure their safe handling and to reduce releases of PCBs from existing equipment.
- As a results of former production, long time and widespread use and also long-range transport from other part of Globe, OCPs, PCBs, PCDDs/Fs and PAHs and also some newer PTS are found in all environmental compartments including remote high mountain European sites, but principally the decreasing trends are observed.
- In this context, it is important to remember that a lot of countries of Region, such as the UK, Germany and others have a long industrial history, involving combustion activity in the form of wood and coal burning.
- Several studies reported that air PCDDs/Fs levels are declining in urban/industrialized centres. These trends are observed in Western Europe and are believed to be largely due to emission abatement actions taken in the early nineties. The decline of PCDDs/Fs levels in the atmosphere resulted in a decrease of these compounds in “atmospherically impacted” media such as vegetation, cow’s milk and meat products. Moreover, the human dietary intake of dioxins and furans dropped by almost a factor of 2 within the past 7 years.
- Analyses showed a decrease in the concentrations of the PAH compounds in the particle-phase in the ambient air during the second part of 80’s. This is a result of that the cars equipped with catalyst engines became a mandatory 1991.
- Relatively worse situation can be observed in the towns in the former communistic countries, where the number of cars dramatically increased after the political changes.

Ecotoxicology of PTS of regional concern

- Analysis of the observed ecotoxicological effects of PTS on birds, mammals and fish in Europe has shown, that although a wide number of laboratory and manipulated in situ studies with various organisms and effects were conducted and are documented in the literature, one has to carefully and critically evaluate these data.
- On one hand, the controlled laboratory toxicological studies with individual compounds or carefully prepared mixtures usually allow clear dose-response causality between chemical exposure and observed effects to be defined.
- On the other hand, laboratory tests alone seldom adequately describe what is likely to occur in the environment. The often complex and subtle effects of chronic, low-level environmental exposure to PTS are less well understood.
- In the environment, the universal exposure of organisms to low levels of a wide range of chemical contaminants makes it extremely difficult to ascribe an observed effect to any particular one of them. There is also the possibility that, in the environment, toxic substances in combination may act additively, antagonistically or synergistically.
- PTS can act via different mechanisms and cause various adverse effects in wildlife.

Human effects of PTS of regional concern

Many environmental epidemiological studies indicate that correlations do exist between chemical contamination and observed human health effects. To evaluate critically the adverse effects of individual PTS, it is necessary to compare data derived from experiments with the laboratory animals, the results of epidemiological studies due to accidental or occupational exposure, as well as the effects observed for „average“ population.

Conclusions

- Analysis of the results of environmental epidemiological studies shows, that correlations do exist between the chemical contamination of air, water and soil and human health. To elucidate the particular effects of individual toxicants (genotoxicity, estrogenic effects, carcinogenicity, neurotoxicity, immunotoxicity, etc.) it is important to compare the above mentioned results with the data, obtained from experiments with the laboratory animals.

Human exposure to PTS compounds in Region III – Europe

Over the last 10-15 years as interest in exposure to these compounds has increased there have been numerous surveys of both typical ‘background’ levels in the population and also small surveys of occupationally exposed individuals whose body lipids contain elevated concentrations. Compounds are most often monitored in human milk, serum and adipose although milk monitoring is far more widely practiced due to the relative ease of sample collection. Evidence from market basket surveys of principal foods and food groups suggest that exposure to many of the classical PTS compounds via food is very similar throughout the Region. European exposure to dioxins via food has declined considerably during the last decades. This is due to successful efforts that have led to the reduction of many known dioxin sources. Today the estimated intake by the European population of PCDDs/Fs and non-ortho PCBs, expressed as WHO-TEQs, is 1.2-3.0 pg.kg⁻¹ bw.day⁻¹.

Conclusions

- In summary, human exposure to PTS compounds is dominated by intake via terrestrial and aquatic food products which have high lipid content and have been subject to bioaccumulation within agricultural foodchains e.g. milk, meat, eggs and fish, (particularly oily and/or long-lived species). Exposure is generally well characterized and quantified for PCBs and PCDD/Fs and a range of OCPs.
- Human lipid concentrations of well characterized compounds such as PCBs and PCDD/Fs have been declining significantly in recent years throughout the Region at a rate of approximately 5% per year since the early 1990s. For some PTS compounds of emerging concern such as PBDEs, there is some evidence of increasing trends in human breast milk during the last 20 years.
- Breast-fed infants represent a distinct sub-group of the population whose exposure to PCDD/Fs and Dioxin-like PCBs will exceed current guideline values based on bodyweight for the first few months of life. In view of the significant declining trends in TEQ concentrations in breast milk over the last 20 years, WHO strongly recommend that breast feeding is encouraged and promoted for the child benefit.

Assessment of major pathways of contaminants transport

- Transboundary transport is important for the occurrence of PTS in the European region. Atmospheric transport processes are important pathways for PTS to both aquatic and terrestrial ecosystems.
- The evidence of LTR in the region has been investigated both with measurements and modelling.
- An integrated monitoring/modelling approach is applied for assessment of PTS contamination in the European region. This approach includes arrangement of superstation network, model assessment of contamination levels and national measurement campaigns. In modelling activities accumulation in the compartments other than atmosphere is important.