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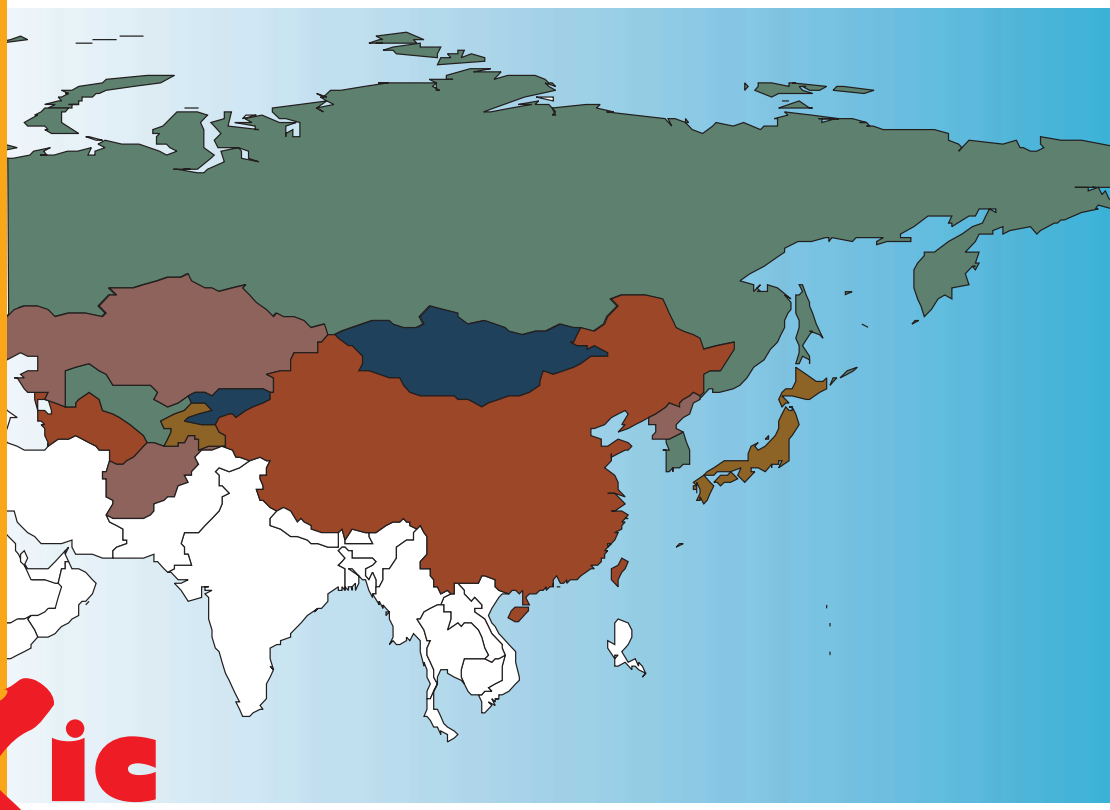
Central and North East Asia
REGIONAL REPORT



Regionally Based Assessment of Persistent Toxic Substances

December 2002

Global Environment Facility

UNITED NATIONS
ENVIRONMENT
PROGRAMME

UNEP

CHEMICALS

Regionally Based Assessment of Persistent Toxic Substances

Afghanistan, China, Democratic People's Republic of Korea, South Korea, Japan, Kazakhstan, Kyrgyzstan, Mongolia, Russian Federation, Tajikistan, Turkmenistan, Uzbekistan

CENTRAL AND NORTH EAST ASIA REGIONAL REPORT

DECEMBER 2002

GLOBAL ENVIRONMENT FACILITY

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The Inter-Organization Programme for the Sound Management of Chemicals (IOMC), was established in 1995 by UNEP, ILO, FAO, WHO, UNIDO and OECD (Participating Organizations), following recommendations made by the 1992 UN Conference on Environment and Development to strengthen cooperation and increase coordination in the field of chemical safety. In January 1998, UNITAR formally joined the IOMC as a Participating Organization. The purpose of the IOMC is to promote coordination of the policies and activities pursued by the Participating Organizations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

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EXECUTIVE SUMMARY

1. As part of the global project supported by UNEP/GEF, this report presents findings of an assessment of sources, fates and effects related to the 12 Stockholm Convention chemicals which include pesticides (aldrin, endrin, dieldrin, chlordane, DDT, toxapnene, mirex, heptacholor, hexachlorobenzene), industrial chemicals (PCBs and also hexachlorobenzene) and unintentional by-products (PCDD/PCDF), as well as six additional chemicals (PAHs, organic mercury compounds, organic tin compounds, HCH, brominated flame retardant [PBDE]), and pentachlorophenol (PCP) at the Central and North-East Asia (Region VII) which includes 11 countries: China, Japan, Republic of Korea, Democratic People's Republic of Korea, Russian Federation, Mongolia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

2. This report is based on data gathering and interpretation of existing information, and through questionnaires related to information on sources, environmental concentrations and impacts of PTS, and also by participating in two technical workshops, using a Regional expert network comprising scientists, researchers, and representatives from government, industry and NGOs in different countries within this Region.

3. There is wide variation between the 11 countries of this Region in terms of geography, industrialization, economic development and environmental monitoring and remediation. These variations are reflected in the amount of information available on PTS and their management. In general, data on PTS within the Region is still rather sparse especially in countries with their economies in transition.

4. The results of the scoring exercise derived from the 1st Technical Workshop indicated that PCDD/PCDF, PCBs, PAHs, DDT and HCH are chemicals of Regional concern meaning that there is either a) a major production of the chemical for local and export use, b) evidence of the chemical as a contaminant in large scale production of other chemicals, c) known emissions of the chemical from large scale incinerators or chlorine bleaching of pulp or other related combustion facilities, d) evidence of leakage from major stockpiles of the chemical, e) large-scale use of the chemical throughout the Region, and/or f) spatial and/or temporal trends increasing Regionally from levels above threshold. With regard to data gaps, there is insufficient and/or unreliable data on 8 of the 18 chemicals. These are mainly industrial chemicals (PCBs, PBDE, HCB) and unintentional by-products (PCDD/PCDF, PAHs). There is also insufficient information available for PCP and organic mercury compounds.

5. The environmental levels, toxicological and ecotoxicological effects of PTS within the Region have been assessed by means of data collection and literature review. The results of the scoring exercise derived from the 2nd Technical Workshop revealed that PCDD/PCDF, PCBs, DDT and PAHs are chemicals of Regional concern in terms of environmental levels and ecotoxicological effects, and these five plus HCH are Regional concern for human health. With regards to data gaps, there are insufficient reliable data on 7 of the 18 chemicals. These chemicals are mainly industrial chemicals (PCBs, HCH, and PBDE) and unintentional by-products (PCDD/PCDF, PAHs). There is also insufficient data related to DDT and toxaphene. More information is needed concerning the temporal and spatial distributions of PTS in different ecological compartments, especially in developing countries and countries with their economies in transition. It is difficult to compare data generated by different countries using different sampling, sample preparation and analytical methods.

6. Due to the wide range of meteorological and geographical parameters of Region VI, there is insufficient information on the pathways of contaminant transport. Some countries have experience of transport assessment by modelling: such as hemispheric MSCE-POP by EMEP, multimedia modelling by Korea (POPsME and EDCSeoul) and Grid-Catchments integrated MMM by Japan. In general, the transboundary transport of PTS within the Region is not yet well described neither by modelling or monitoring approaches. Source inventory data, monitoring data, modelling data, and source pattern/fingerprints are urgently needed for the assessment of PTS in the Region.

7. The Regional capacity and need to manage PTS of the 11 countries within the Region were assessed through collection of information by country representatives. Japan and Republic of Korea, especially the former, have comparatively well-established PTS management systems within the Region. China has monitored the import and export of toxic chemicals since 1994, and is in the process of establishing an inventory of POPs, pesticides and PDF-B with a national implementation plan (NIP) as required by the Sockholm Convention. The Russian Federation started an environmental administration of chemicals and relevant research some time ago whilst the management of PTS in other countries was initiated more

recently. The difficulties involved in the management of PTS for most countries within the Region include a) lack of funds, b) lack of information, c) lack of advanced or best available technology, d) insufficient knowledge and training of special personnel, e) low public awareness, and f) lack of coordination of government departments dealing with PTS.

8. It can be concluded that the major barriers of PTS management of developing countries and countries with economies in transition in the Region is the lack of fund for technology transfer. Safe disposal of obsolete pesticides such as DDT and their substitutes should receive high priority. Capacity building for technical and management personnel to deal with PTS, and raising the awareness of the general public are urgently need in these countries. A Regional organization is recommended to be established for setting up a monitoring network using standardized methodologies. The more reliable data generated could be used to more accurately assess the fates and effects, including the transboudnary movement of PTS in the Region.

1 INTRODUCTION

1.1 OVERVIEW OF THE RBA PTS PROJECT

Following the recommendations of the Intergovernmental Forum on Chemical Safety, the UNEP Governing Council decided in February 1997 (Decision 19/13 C) that immediate international action should be initiated to protect human health and the environment through measures which will reduce and/or eliminate the emissions and discharges of an initial set of twelve persistent organic pollutants (POPs). Accordingly an Intergovernmental Negotiating Committee (INC) was established with a mandate to prepare an international legally binding instrument for implementing international action on certain persistent organic pollutants. These series of negotiations have resulted in the adoption of the Stockholm Convention in 2001. The initial 12 substances fitting these categories that have been selected under the Stockholm Convention include: aldrin, endrin, dieldrin, chlordane, DDT, toxaphene, mirex, heptachlor, hexachlorobenzene, PCBs, dioxins and furans. Beside these 12, there are many other substances that satisfy the criteria listed above for which their sources, environmental concentrations and effects are to be assessed.

Persistent toxic substances can be manufactured substances for use in various sectors of industry, pesticides, or by-products of industrial processes and combustion. To date, their scientific assessment has largely concentrated on specific local and/or Regional environmental and health effects, in particular “hot spots” such as the Great Lakes Region of North America or the Baltic Sea.

The substances of greatest concern are anthropogenic organic compounds with certain distinctive characteristics:

- PERSISTENCE IN THE ENVIRONMENT
- RESISTANCE TO DEGRADATION
- ACUTE AND CHRONIC TOXICITY
- BIO-ACCUMULATION
- LONG RANGE TRANSPORT BY AIR, WATER OR MIGRATORY SPECIES ACROSS STATE BOUNDARIES

1.1.1 Objectives

There is a need for a scientifically-based assessment of the nature and scale of the threats to the environment and its resources posed by persistent toxic substances that will provide guidance to the international community concerning the priorities for future remedial and preventive action. The assessment will lead to the identification of priorities for intervention, and through application of a root cause analysis will attempt to identify appropriate measures to control, reduce or eliminate releases of PTS, at national, Regional or global levels.

The objective of the project is to deliver a measure of the nature and comparative severity of damage and threats posed at national, Regional and ultimately at global levels by PTS. This will provide the GEF with a science-based rationale for assigning priorities for action among and between chemical related environmental issues, and to determine the extent to which differences in priority exist among Regions.

1.1.2 Results

The project relies upon the collection and interpretation of existing data and information as the basis for the assessment. No research will be undertaken to generate primary data, but projections will be made to fill data/information gaps, and to predict threats to the environment. The proposed activities are designed to obtain the following expected results:

- Identification of major sources of PTS at the Regional level;
- Impact of PTS on the environment and human health;
- Assessment of transboundary 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.

The outcome of this project will be a scientific assessment of the threats posed by persistent toxic substances to the environment and human health. The activities to be undertaken in this project comprise an evaluation of the sources of persistent toxic substances, their levels in the environment and consequent impact on biota and humans, their modes of transport over a range of distances, the existing alternatives to their use and remediation options, as well as the barriers that prevent their good management.

1.2 METHODOLOGY

1.2.1 Regional Divisions

To achieve these results, the globe is divided into 12 Regions namely: Arctic, North America, Europe, Mediterranean, Sub-Saharan Africa, Indian Ocean, Central and North East Asia (Western North Pacific), South East Asia and South Pacific, Pacific Islands, Central America and the Caribbean, Eastern and Western South America, Antarctica. The twelve Regions were selected based on obtaining geographical consistency while trying to reside within financial constraints.

1.2.2 Management Structure

The project is directed by the project manager who is located at UNEP Chemicals in Geneva, Switzerland. A Steering Group comprising of representatives of other relevant intergovernmental organisations along with participation from industry and the non-governmental community is established to monitor the progress of the project and provide direction for the project manager. Each Region is controlled by a Regional coordinator assisted by a team of approximately 4 persons. The co-ordinator and the Regional team are responsible for promoting the project, the collection of data at the national level and to carry out a series of technical and priority setting workshops for analysing the data on PTS on a Regional basis. Besides the 12 POPs from the Stockholm Convention, the Regional team selects the chemicals to be assessed for its Region with selection open for review during the various workshops undertaken throughout the assessment process. Each team writes the Regional report for the respective Region.

1.2.3 Data Processing

Data is collected on sources, environmental concentrations, human and ecological effects through questionnaires that are filled in at the national level. The results from this data collection along with presentations from Regional experts at the technical workshops, are used to develop Regional reports on the PTS selected for analysis. A priority setting workshop with participation of representatives from each country results in priorities being established regarding the threats and damages of these substances to each Region. The information and conclusions derived from the 12 Regional reports will be used to develop a global report on the state of these PTS in the environment.

The project is not intended to generate new information but to rely on existing data and its assessment to arrive at priorities for these substances. The establishment of a broad and wide- ranging network of participants involving all sectors of society was used for data collection and subsequent evaluation. Close cooperation with other intergovernmental organizations such as UNECE, WHO, FAO, UNPD, World Bank and others was obtained. Most have representatives on the Steering Group Committee that monitors the progress of the project and critically reviews its implementation. Contributions were garnered from UNEP focal points, UNEP POPs focal points, national focal points selected by the Regional teams, industry, government agencies, research scientists and NGOs.

1.2.4 Project Funding

The project costs approximately US$4.2 million funded mainly by the Global Environment Facility (GEF) with sponsorship from countries including Australia, France, Germany, Sweden, Switzerland and the USA. The project runs between September, 2000 to April, 2003 with the intention that the reports be presented to the first meeting of the Conference of the Parties of the Stockholm Convention projected for 2003/4.

1.3 SCOPE OF THE CENTRAL AND NORTH EAST ASIA REGIONAL ASSESSMENT

As defined in the UNEP/GEF's *Guidance Document for the Collection, Assembly and Evaluation of Data on Sources, Environmental Levels and Impacts of Persistent Toxic Substances*, persistent toxic substances share the following characteristics (UNEP, 2000):

- organic (including organometallic) substances;
- slowly degraded in the environment;
- accumulating in biota and;
- toxic

Many PTS have the ability to be transported over long distances across international boundaries through atmospheric, aquatic or biological media. They are detectable even in areas where the chemicals have never been used. Due to their affinity to lipids, PTS are absorbed by the fatty tissue of people and animals. They are bioaccumulated and biomagnified through the food chain. PTS pose adverse health effects, such as reproductive disorders, developmental deformities and cancer in both humans and wildlife. As a consequence to their significant threat to both our environment and to our health, PTS are a major concern at the local, national, Regional and global level. A subset of the PTS are Persistent Organic Pollutants (POPs) which are organochlorine compounds that persist in the environment, resist degradation, and produce acute and chronic toxicity.

The United Nations Environment Programme (UNEP) has identified twelve POPs to be the initial chemicals targeted for global elimination or restriction of production and use. Under the Stockholm Convention, an international legally binding treaty formally adopted on 22 May 2001, global awareness on the adverse effects of POPs has been heightened. The treaty requires governments from over 122 countries to take action on the POPs through minimizing and eliminating the production, import, export, disposal, and use. The twelve POPs, also known as the dirty dozen, consists of the pesticides **aldrin, chlordane, DDT, dieldrin, endrin, hexachlorobenzene, heptachlor, mirex,** and **toxaphene**; the industrial chemicals **polychlorinated biphenyls (PCBs)** and **hexachlorobenzene** (which is also a pesticide mentioned above); and the unintentional by-products **polychlorinated dibenzoparadioxins (PCDD**) and **polychlorinated dibenzofurans (PCDF)**. The treaty comes into force when it has been ratified by 50 countries. It is a sound and effective treaty that can be updated and expanded over the decades to proactively manage POPs. The Stockholm Convention has provisions for adding a chemical to the list of POPs if the chemical meets the criteria for persistence in the environment, bioaccumulation, and transportability. This provision helps to ensure that the treaty remains dynamic and responsive.

Most of the 12 POPs are subject to an immediate ban, however, DDT has been granted a health-related exemption because it is needed in many countries to control malarial mosquitoes. These countries are permitted to use DDT until a suitable alternative is found.

The objectives of the Regionally Based Assessment of Persistent Toxic Substances project are complementary to the Stockholm Convention. The project a) identifies sources of PTS; b) assesses the impact of PTS on human health and the environment; c) assesses transboundary pathways of PTS, d) assesses root causes of PTS problems and capacity to manage Regionally; and e) identifies Regional and global priority PTS environmental issues.

For this project, the globe has been divided into 12 Regions -Arctic, North America, Europe, Mediterranean, Sub-Saharan Africa, Indian Ocean, Central and North East Asia, South East Asia and South Pacific, Pacific islands, Central America and the Caribbean, Eastern and Western South America, and Antarctica. In each Region, the collection of PTS data is to be managed by a Regional Co-ordinator who is assisted by a team of approximately 4 persons. Each Region is to collect information on the twelve Stockholm POPs in addition to other PTS which are of potential concern for the Region. The following is a list of chemicals provided by UNEP Chemicals for possible consideration by each Region.

Table 1.1: **List of PTS for Regional Consideration**

Stockholm Convention POPs	Other PTS
Aldrin	Chlordecone
Chlordane	Hexabromobiphenyl
DDT	HCH
Dieldrin	PAHs
Endrin	Polybrominated Diphenyl Ether (PBDE)
Heptachlor	Chlorinated Paraffins
Hexachlorobenzene (HCB)	Endosulphan
Mirex	Atrazine
Toxaphene	Pentachlorophenol (PCP)
PCBs	Organic Mercury Compounds
Dioxins	Organic Tin Compounds
Furans	Organic Lead Compounds
	Phthalates
	Octylphenols
	Nonylphenols

Upon consultations with experts within the Region, the Regional team of the Central and North East Asia selected the following PTS in addition to the 12 POPs to be considered of potential concern for the Region:

- HCH
- PAHs
- PBDE
- Pentachlorophenol (PCP)
- Organic Mercury Compounds
- Organic Tin Compounds

The Stockholm Convention allows participating parties to register specific exemptions for the 12 POPs. The following is a list, received as of 22 May 2001, for specific exemptions for the countries of Region VII (UNEP, 2001a) (Table 1.2). It should be noted that the list is not a preliminary draft of the register of specific exemptions to be established under article 4 of the Convention.

Table 1.2 Extract from Revised List of Requests for Specific Exemptions in Annex A and Annex B and acceptable purposes in Annex B to the Stockholm Convention (UNEP, 2001a)

Country	Specific exemption or acceptable purpose
China	Production and use of chlordane as a termiticide in buildings and dams Production and use of hexachlorobenzene as an intermediate Production and use of mirex as a termiticide Production and use of DDT as an intermediate Production and use of DDT for disease vector use in accordance with Part II of Annex B of the Stockholm Convention on Persistent Organic Pollutants
Japan	Wooden articles in use treated with chlordane as a termiticide in the structures of houses Wooden articles in use treated with heptachlor as a termiticide in the structures of houses
Republic of Korea	Use of chlordane as an additive in plywood adhesives Use of heptachlor in articles in use in general Use of PCBs in articles in use in accordance with Part II of Annex A of the Stockholm Convention on Persistent Organic Pollutants
Russian Federation	Use of PCBs in dielectric solvents for industrial electric equipment Production and use of hexachlorobenzene as an intermediate Production and use of DDT for disease vector use in accordance with Part II of Annex B of the Stockholm Convention on Persistent Organic Pollutants

1.3.1 Existing Assessments

Assessment of PTS in some of the countries of the Region, especially in the more developed countries, has been conducted. The Ministry of the Environment of Japan has been systematically conducting surveys for nearly three decades to monitor environmental levels of some of the POPs, such as DDT and HCB (Japan started monitoring in 1974). In 2002, the Ministry of the Environment reorganised the environmental monitoring and started POPs monitoring. In the Republic of Korea, research projects on POPs/PTS include the 10-year National Research Plan (1999-2008) and projects to investigate endocrine disrupting chemicals. Chemical information exchange systems such as Chem-Net Korea and ESCAP Clearinghouse system have been implemented for public dissemination of PTS information. In China, preliminary surveys on PCBs were carried out in the middle of the 1990's. A two-year project to provide an inventory of POP pesticides has recently began. Furthermore, laboratories for the monitoring of PCDD/PCDF are also being established in China. In Hong Kong SAR, a 3-year project "A Study of Toxic Substances Pollution in Hong Kong", commissioned by the Environmental Protection Department, is currently being finalised. Its primary focus is on identifying and quantifying pollutants, including PTS, released into local waters to establish a Priority Toxic Substances List. The Russian Federation has concentrated on assessment of the PCB inventory and sources and environmental levels of PCDD/PCDF. In some of the Commonwealth of Independent States (CIS) countries, compilation of inventories of sources has only recently began. For example, Tajikistan started an inventory of PTS sources in 1998. In Mongolia, source inventory of PTS has not started yet due to lack of professional capacity.

1.3.2 Intra-Regional Links and Collaboration

Within Region VII, only Japan and Republic of Korea have collaboration projects on PTS. The Ministry of Environment, National Institute of Environmental Research (NIER), of the Republic of Korea has been working closely with the Ministry of the Environment, National Institute for Environmental Studies (NIES) of Japan on a project to investigate endocrine disrupting chemicals (EDC), such as PCDD/PCDF and PCBs.

1.3.3 Omissions and Weaknesses

Information for this report is based mainly on literature review and information submitted by country experts and relevant government departments. Information collected via questionnaires prepared by UNEP-Chemicals on sources, concentrations, and impacts has not been comprehensive due to lack of human resources and lack of available data from some of the countries. Of the completed questionnaires received, the majority of the information has been on environmental concentrations with little information provided in relation to sources of PTS. In addition to poor documentation of source inventories of pesticides, information with regards to the fate of the pesticides has not been well documented (i.e. whether the pesticides have been exported, stockpiled, etc.). Previously, there have not been any formal established communication channels on PTS between the countries of the Region (perhaps except Japan and Republic of Korea), therefore dialogue concerning PTS issues has been weak and should be developed.

1.4 METHODOLOGY

The development of this report was carried out through the gathering and interpretation of existing information, including literature review (journals, reports, databases), and through the contribution of a Regional expert network. Prior to this project, there had been no Regionally-coordinated network on PTS, aside from a collaborative project between two countries (Japan and Republic of Korea). To establish the Regional expert network, country experts on PTS, scientists, researchers, government, industry and NGOs were informed of the UNEP/GEF project and invited to participate. The expert network contributed to the project by filling questionnaires relating to information on sources, environmental concentrations and impacts of PTS, and by participating in two technical workshops. The questionnaires, thirteen in total, were developed by UNEP-Chemicals specifically for this project and can be found in the project website: www.chem.unep.ch/pts. All completed questionnaires were stored in the project website database. During the two technical workshops- 1st Technical Workshop (Sources and Concentration of PTS in the Environment, 18-20 March 2002, Tokyo, Japan) and the 2nd Technical Workshop ((Eco)toxicological Impact and Transboundary Transport of Persistent Toxic Substances, 14-16 May 2002, Hong Kong, PR China), background discussion papers were presented by the Regional team, and invited participants presented technical papers on the situation of PTS in their countries. Information contained within technical papers was incorporated into the background discussion papers for the development of this draft Regional report. During the technical workshops, the participants were divided into

working groups to discuss prioritisation of sources, environmental levels, (eco)toxicological effects, transboundary transport of chemicals, and data gaps of each of the 18 chemicals with the aid of a scoring system developed by UNEP-Chemicals. In final plenary sessions, participants from the respective workshops, upon collective agreement, assigned overall scores to each chemical. The scoring mechanism was a tool used to prioritise the chemicals. The scoring results were a collective effort of all the participants of the workshops. The scoring sheet (Annex 1) together with the final scores are listed in Chapter 2 and Chapter 3.

1.5 GENERAL DEFINITIONS OF CHEMICALS

The following are the general definitions of the 18 persistent toxic substances presented as the 12 Stockholm Convention POPs followed by the 6 Regional specific chemicals:

Stockholm Convention POPs

1.5.1 Persistent Toxic Substances - Pesticides

1.5.1.1 Aldrin

Chemical Name: 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo,exo-5,8-dimethanonaphthalene ($C_{12}H_8Cl_6$).

CAS Number: 309-00-2

Properties: Solubility in water: 27 µg/L at 25°C; vapour pressure: 2.3 x 10^{-5} mm Hg at 20°C; log K_{OW}: 5.17-7.4.

Discovery/Uses: It has been manufactured commercially since 1950, and used throughout the world up to the early 1970's to control soil pests such as corn rootworm, wireworms, rice water weevil, and grasshoppers. It has also been used to protect wooden structures from termites.

Persistence/Fate: Readily metabolised to dieldrin by both plants and animals. Biodegradation is expected to be slow and it binds strongly to soil particles, and is resistant to leaching into groundwater. Aldrin was classified as moderately persistent with half-life in soil and surface waters ranging from 20 days to 1.6 years.

Toxicity: Aldrin is toxic to humans; the lethal dose for an adult has been estimated to be about 80 mg/kg body weight. The acute oral LD_{50} in laboratory animals is in the range of 33 mg/kg body weight for guinea pigs to 320 mg/kg body weight for hamsters. The toxicity of aldrin to aquatic organisms is quite variable, with aquatic insects being the most sensitive group of invertebrates. The 96-h LC_{50} values range from 1-200 µg/L for insects, and from 2.2-53 µg/L for fish. The maximum residue limits in food recommended by FAO/WHO varies from 0.006 mg/kg milk fat to 0.2 mg/kg meat fat. Water quality criteria between 0.1 to 180 µg/L have been published.

1.5.1.2 Chlordane

Chemical Name: 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene ($C_{10}H_6Cl_8$).

CAS Number: 57-74-9

Properties: Solubility in water: 56 µg/L at 25°C; vapour pressure: 0.98 x 10^{-5} mm Hg at 25 °C; log K_{OW}: 4.58-5.57.

Discovery/Uses: Chlordane appeared in 1945 and was used primarily as an insecticide for control of cockroaches, ants, termites, and other household pests. Technical chlordane is a mixture of at least 120 compounds. Of these, 60-75% are chlordane isomers, the remainder being related to endo-compounds including heptachlor, nonachlor, diels-alder adduct of cyclopentadiene and penta/hexa/octachlorocyclopentadienes.

Persistence/Fate: Chlordane is highly persistent in soils with a half-life of about 4 years. Its persistence and high partition coefficient promotes binding to aquatic sediments and bioconcentration in organisms.

Toxicity: LC_{50} from 0.4 mg/L (pink shrimp) to 90 mg/L (rainbow trout) have been reported for aquatic organisms. The acute toxicity for mammals is moderate with an LD_{50} in rat of 200-590 mg/kg body weight (19.1 mg/kg body weight for oxychlordane). The maximum residue limits for chlordane in food are, according to FAO/WHO between 0.002 mg/kg milk fat and 0.5 mg/kg poultry fat. Water quality criteria of 1.5 to 6 µg/L have been published. Chlordane has been classified as a substance for which there is evidence of endocrine disruption in an intact organism and possible carcinogenicity to humans.

1.5.1.3 Dichlorodiphenyltrichloroethane (DDT)

Chemical Name: 1,1,1-Trichloro-2,2-bis-(4-chlorophenyl)-ethane ($C_{14}H_9Cl_5$).

CAS Number: 50-29-3.

Properties: Solubility in water: 1.2-5.5 µg/L at 25°C; vapour pressure: 0.2 x 10^{-6} mm Hg at 20°C; log K_{OW}: 6.19 for *pp*'-DDT, 5.5 for *pp'*-DDD and 5.7 for *pp'*-DDE.

Discovery/Use: DDT appeared for use during World War II to control insects that spread diseases like malaria, dengue fever and typhus. Following this, it was widely used on a variety of agricultural crops. The technical product is a mixture of about 85% *pp'*-DDT and 15% *op'*-DDT isomers.

Persistence/Fate: DDT is highly persistent in soils with a half-life of up to 15 years and of 7 days in air. It also exhibits high bioconcentration factors (in the order of 50000 for fish and 500000 for bivalves). In the environment, the product is metabolised mainly to DDD and DDE.

Toxicity: The lowest dietary concentration of DDT reported to cause egg shell thinning was 0.6 mg/kg for the black duck. LC_{50} of 1.5 mg/L for largemouth bass and 56 mg/L for guppy have been reported. The acute toxicity of DDT for mammals is moderate with an LD_{50} in rat of 113-118 mg/kg body weight. DDT has been shown to have an estrogen-like activity, and possible carcinogenic activity in humans. The maximum residue level in food recommended by WHO/FAO range from 0.02 mg/kg milk fat to 5 mg/kg meat fat. Maximum permissible DDT residue levels in drinking water (WHO) is 1.0 µg/L.

DDT for control of disease vectors is exempt from ban under Annex B of the Stockholm Convention.

There is no continuous record of world production of DDT, and estimates of its usage vary. UNEP suggested that annual world consumption from 1971 to 1981 was 68,800 t (UNEP, 1990). Currently, most uses of DDT is for public health vector control. In 1990, the production of DDT was estimated at 2800 t (UNEP/FAO/PIC/INC.1/inf.1, 1996).

1.5.1.4 Dieldrin

Chemical Name: 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydroexo-1,4-endo-5,8-dimethanonaphthalene ($C_{12}H_8Cl_6O$).

CAS Number: 60-57-1

Properties: Solubility in water: 140 µg/L at 20°C; vapour pressure: 1.78 x 10^{-7} mm Hg at 20°C; log K_{OW}: 3.69-6.2.**Discovery/Uses:** It appeared in 1948 after World War II and used mainly for the control of soil insects such as corn rootworms, wireworms and catworms.

Persistence/Fate: It is highly persistent in soils, with a half-life of 3-4 years in temperate climates, and bioconcentrates in organisms. The persistence in air has been estimated in 4-40 h.

Toxicity: The acute toxicity for fish is high (LC_{50} between 1.1 and 41 mg/L) and moderate for mammals (LD_{50} in mouse and rat ranging from 40 to 70 mg/kg body weight). However, a daily administration of 0.6 mg/kg to rabbits adversely affected the survival rate. Aldrin and dieldrin mainly affect the central nervous system but there is no direct evidence that they cause cancer in humans. The maximum residue limits in food recommended by FAO/WHO varies from 0.006 mg/kg milk fat and 0.2 mg/kg poultry fat. Water quality criteria between 0.1 to 18 µg/L have been published.

1.5.1.5 Endrin

Chemical Name: 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene ($C_{12}H_8Cl_6O$).

CAS Number: 72-20-8

Properties: Solubility in water: 220-260 µg/L at 25 °C; vapour pressure: 2.7 x 10^{-7}mm Hg at 25°C; log K_{OW}: 3.21-5.34.

Discovery/Uses: It has been used since the 50s against a wide range of agricultural pests, mostly on cotton but also on rice, sugar cane, maize and other crops. It has also been used as a rodenticide.

Persistence/Fate: Is highly persistent in soils (half-lives of up to 12 years have been reported in some cases). Bioconcentration factors of 14 to 18,000 have been recorded in fish, after continuous exposure.

Toxicity: Endrin is very toxic to fish, aquatic invertebrates and phytoplankton; the LC_{50} values are mostly less than 1 µg/L. The acute toxicity is high in laboratory animals, with LD_{50} values of 3-43 mg/kg, and a dermal LD_{50} of 5-20 mg/kg in rats. Long term toxicity in the rat has been studied over two years and a NOEL of 0.05 mg/kg bw/day was found.

1.5.1.6 Heptachlor

Chemical Name: 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene ($C_{10}H_5Cl_7$).

CAS Number: 76-44-8

Properties: Solubility in water: 180 µg/L at 25°C; vapour pressure: 0.3 x 10^{-5} mm Hg at 20°C; log K_{OW}: 4.4-5.5.

Production/Uses: Heptachlor is used primarily against soil insects and termites, but also against cotton insects, grasshoppers, and malaria mosquitoes. Heptachlor epoxide is a more stable breakdown product of heptachlor.

Persistence/Fate: Heptachlor is metabolised in soils, plants and animals to heptachlor epoxide, which is more stable in biological systems and is carcinogenic. The half-life of heptachlor in soil is in temperate Regions 0.75 – 2 years. Its high partition coefficient provides the necessary conditions for bioconcentrating in organisms.

Toxicity: The acute toxicity of heptachlor to mammals is moderate (LD_{50} values between 40 and 119 mg/kg have been published). The toxicity to aquatic organisms is higher and LC_{50} values down to 0.11 µg/L have been found for pink shrimp. Limited information is available on the effects in humans and studies are inconclusive regarding heptachlor and cancer. The maximum residue levels recommended by FAO/WHO are between 0.006 mg/kg milk fat and 0.2 mg/kg meat or poultry fat.

1.5.1.7 Hexachlorobenzene (HCB)

Chemical Name: Hexachlorobenzene (C_6Cl_6)

CAS Number: 118-74-1

Properties: Solubility in water: 50 µg/L at 20°C; vapour pressure: 1.09 x 10^{-5} mm Hg at 20°C; log K_{OW}: 3.93-6.42.

Discovery/Uses: It was first introduced in 1945 as fungicide for seed treatments of grain crops, and used to make fireworks, ammunition, and synthetic rubber. Today it is mainly a by-product in the production of a large number of chlorinated compounds, particularly lower chlorinated benzenes, solvents and several pesticides. HCB is emitted to the atmosphere in flue gases generated by waste incineration facilities and metallurgical industries.

Persistence/Fate: HCB has an estimated half-life in soils of 2.7-5.7 years and of 0.5-4.2 years in air. HCB has a relatively high bioaccumulation potential and long half-life in biota.

Toxicity: LC_{50} for fish varies between 50 and 200 µg/L. The acute toxicity of HCB is low with LD_{50} values of 3.5 mg/g for rats. Mild effects of the [rat] liver have been observed at a daily dose of 0.25 mg HCB/kg bw. HCB is known to cause liver disease in humans (porphyria cutanea tarda) and has been classified as a possible carcinogen to humans by IARC.

1.5.1.8 Mirex

Chemical Name: 1,1a,2,2a,3,3a,4,5,5a,5b,6-Dodecachloroacta-hydro-1,3,4-metheno-1H-cyclobuta[cd]pentalene ($C_{10}Cl_{12}$).

CAS Number: 2385-85-5

Properties: Solubility in water: 0.07 µg/L at 25°C; vapour pressure: 3 x 10^{-7} mm Hg at 25°C; log K_{OW}: 5.28.

Discovery/Uses: The use in pesticide formulations started in the mid 1950's largely focused on the control of ants. It is also a fire retardant for plastics, rubber, paint, paper and electrical goods. Technical grade preparations of mirex contain 95.19% mirex and 2.58% chlordecone, the rest being unspecified.
Persistence/Fate: Mirex is considered to be one of the most stable and persistent pesticides, with a half-life is soils of up to 10 years. Bioconcentration factors of 2600 and 51400 have been observed in pink shrimp and fathead minnows, respectively. It is capable of undergoing long-range transport due to its relative volatility (VPL = 4.76 Pa; H = 52 Pa m^3/mol).

Toxicity: The acute toxicity of Mirex for mammals is moderate with an LD_{50} in rat of 235 mg/kg and dermal toxicity in rabbits of 80 mg/kg. Mirex is also toxic to fish and can affect their behaviour (LC_{50} (96 h) from 0.2 to 30 mg/L for rainbow trout and bluegill, respectively). Delayed mortality of crustaceans occurred at 1 µg/L exposure levels. There is evidence of its potential for endocrine disruption and possibly carcinogenic risk to humans.

1.5.1.9 Toxaphene

Chemical Name: Polychlorinated bornanes and camphenes ($C_{10}H_{10}Cl_8$).

CAS Number: 8001-35-2

Properties: Solubility in water: 550 µg/L at 20°C; vapour pressure: 3.3 x 10^{-5} mm Hg at 25°C; log K_{OW} : 3.23-5.50.

Discovery/Uses: Toxaphene has been in use since 1949 as a nonsystemic insecticide with some acaricidal activity, primarily on cotton, cereal grains fruits, nuts and vegetables. It was also used to control livestock ectoparasites such as lice, flies, ticks, mange, and scab mites. The technical product is a complex mixture of over 300 congeners, containing 67-69% chlorine by weight.

Persistence/Fate: Toxaphene has a half life in soil from 100 days up to 12 years. It has been shown to bioconcentrate in aquatic organisms (BCF of 4247 in mosquito fish and 76000 in brook trout).

Toxicity: Toxaphene is highly toxic in fish, with 96-hour LC_{50} values in the range of 1.8 µg/L in rainbow trout to 22 µg/L in bluegill. Long term exposure to 0.5 µg/L reduced egg viability to zero. The acute oral toxicity is in the range of 49 mg/kg body weight in dogs to 365 mg/kg in guinea pigs. In long term studies NOEL in rats was 0.35 mg/kg bw/day, LD_{50} ranging from 60 to 293 mg/kg bw. For toxaphene exists a strong evidence of the potential for endocrine disruption. Toxaphene is carcinogenic in mice and rats and is of carcinogenic risk to humans, with a cancer potency factor of 1.1 mg/kg/day for oral exposure.

1.5.2 Persistent Toxic Substances – Industrial Compounds

1.5.2.1 Polychlorinated biphenyls (PCBs)

Chemical Name: Polychlorinated biphenyls ($C_{12}H_{(10-n)}Cl_n$, where n is within the range of 1-10).

CAS Number: Various (e.g. for Aroclor 1242, CAS No.: 53469-21-9; for Aroclor 1254, CAS No.: 11097-69-1);

Properties: Water solubility decreases with increasing chlorination: 0.01 to 0.0001 µg/L at 25°C; vapour pressure: 1.6-0.003 x 10^{-6} mm Hg at 20°C; log K_{OW}: 4.3-8.26.

Discovery/Uses: PCBs were introduced in 1929 and were manufactured in different countries under various trade names (e.g., Aroclor, Clophen, Phenoclor). They are chemically stable and heat resistant, and were used worldwide as transformer and capacitor oils, hydraulic and heat exchange fluids, and lubricating and cutting oils. Theoretically, a total of 209 possible chlorinated biphenyl congeners exist, but only about 130 of these are likely to occur in commercial products.

Persistence/Fate: Most PCB congeners, particularly those lacking adjacent unsubstituted positions on the biphenyl rings (e.g., 2,4,5-, 2,3,5- or 2,3,6-substituted on both rings) are extremely persistent in the environment. They are estimated to have half-lives ranging from three weeks to two years in air and, with the exception of mono- and di-chlorobiphenyls, more than six years in aerobic soils and sediments. PCBs also have extremely long half-lives in adult fish, for example, an eight-year study of eels found that the half-life of CB153 was more than ten years.

Toxicity: LC_{50} for the larval stages of rainbow trout is 0.32 µg/L with a NOEL of 0.01 µg/L. The acute toxicity of PCB in mammals is generally low and LD_{50} values in rat of 1 g/kg bw. IARC has concluded that PCB are carcinogenic to laboratory animals and probably also for humans. They have also been classified as substances for which there is evidence of endocrine disruption in an intact organism.

1.5.3 Persistent Toxic Substances – Unintentional By-Products

1.5.3.1 Polychlorinated dibenzo-p-dioxins (PCDD) and Polychlorinated dibenzofurans (PCDF)

Chemical Name: PCDD ($C_{12}H_{(8-n)}Cl_nO_2$) and PCDF ($C_{12}H_{(8-n)}Cl_nO$) may contain between 1 and 8 chlorine atoms. Dioxins and furans have 75 and 135 possible positional isomers, respectively.

CAS Number: Various (2,3,7,8-TetraCDD: 1746-01-6; 2,3,7,8-TetraCDF: 51207-31-9).

Properties: Solubility in water: in the range 0.43 – 0.0002 ng/L at 25°C; vapour pressure: $2 – 0.007 \times 10^{-6}$ mm Hg at 20°C; log K_{OW}: in the range 6.60 – 8.20 for tetra- to octa-substituted congeners.

Discovery/Uses: They are by-products resulting from the production of other chemicals and from the low-temperature combustion and incineration processes. They have no known use.

Persistence/Fate: PCDD/PCDF are characterised by their lipophilicity, semi-volatility and resistance to degradation (half life of TCDD in soil of 10-12 years) and to long-range transport. They are also known for their ability to bio-concentrate and biomagnify under typical environmental conditions.

Toxicity: The toxicological effects reported refers to the 2,3,7,8-substituted compounds (17 congeners) that are agonist for the AhR. All the 2,3,7,8-substituted PCDDs and PCDFs plus coplanar PCBs (with no chlorine substitution at the ortho positions) show the same type of biological and toxic response. Possible effects include dermal toxicity, immunotoxicity, reproductive effects and teratogenicity, endocrine disruption and carcinogenicity. At the present time, the only persistent effect associated with dioxin exposure in humans is chloracne. The most sensitive groups are fetus and neonatal infants.

Effects on the immune systems in the mouse have been found at doses of 10 ng/kg bw/day, while reproductive effects were seen in rhesus monkeys at 1-2 ng/kg bw/day. Biochemical effects have been seen in rats down to 0.1 ng/kg bw/day. In a re-evaluation of the TDI for dioxins, furans (and planar PCB), the WHO decided to recommend a range of 1-4 TEQ pg/kg bw, although more recently the acceptable intake value has been set monthly at 1-70 TEQ pg/kg bw.

1.5.4 Regional Specific Chemicals

1.5.4.1 Hexachlorocyclohexanes (HCH)

Chemical Name: 1,2,3,4,5,6-Hexachlorocyclohexane (mixed isomers) ($C_6H_6Cl_6$).

CAS Number: 608-73-1 (γ-HCH, lindane: 58-89-9).

Properties: γ-HCH: solubility in water: 7 mg/L at 20°C; vapour pressure: 3.3×10^{-5} mm Hg at 20°C; log K_{OW}: 3.8.

Discovery/Uses: There are two principle formulations: "technical HCH", which is a mixture of various isomers, including α-HCH (55-80%), β-HCH (5-14%) and γ-HCH (8-15%), and "lindane", which is essentially pure γ-HCH. Historically, lindane was one of the most widely used insecticides in the world. Its insecticidal properties were discovered in the early 1940s. It controls a wide range of sucking and chewing insects and has been used for seed treatment and soil application, in household biocidal products, and as textile and wood preservatives.

Persistence/Fate: Lindane and other HCH isomers are relatively persistent in soils and water, with half lives generally greater than 1 and 2 years, respectively. HCH are much less bioaccumulative than other organochlorines because of their relatively low lipophilicity. On the contrary, their relatively high vapour pressures, particularly of the α-HCH isomer, determine their long-range transport in the atmosphere. BCF for lindane is 1400.

Toxicity: Lindane is moderately toxic for invertebrates and fish, with LC_{50} values of 20-90 µg/L. The acute toxicity for mice and rats is moderate with LD_{50} values in the range of 60-250 mg/kg. Lindane was found to have no mutagenic potential in a number of studies but endocrine disrupting activity.

1.5.4.2 Polycyclic Aromatic Hydrocarbons (PAHs)

Chemical Name: PAHs are a group of compounds consisting of two or more fused aromatic rings.

CAS Number: Various

Properties: Solubility in water: 0.00014 -2.1 mg/L at 25ºC; vapour pressure: from 0.0015×10^{-9} to 0.0051

mmHg at 25°C; log K_{OW}: 4.79-8.20

Discovery/Use: Most of these are formed during incomplete combustion of organic material and the composition of PAHs mixture vary with the source(s) and also due to selective weathering effects in the environment.

Persistence/Fate: Persistence of the PAHs varies with their molecular weight. The low molecular weight PAHs are the most easily degraded. The reported half-lives of naphthalene, anthracene and benzo(e)pyrene in sediment are 9, 43 and 83 hours, respectively, whereas for higher molecular weight PAHs, their half-lives are up to several years in soils/sediments. The BCFs in aquatic organisms frequently range between 100-2000 and it increases with increasing molecular size. Due to their wide distribution, the environmental pollution by PAHs has aroused global concern.

Toxicity: The acute toxicity of low PAHs is moderate with an LD_{50} of naphthalene and anthracene in rat of 490 and 18000 mg/kg body weight respectively, whereas the higher PAHs exhibit higher toxicity and LD_{50} of benzo(a)anthracene in mice is 10mg/kg body weight. In *Daphnia pulex*, LC_{50} for naphthalene is 1.0 mg/L, for phenanthrene 0.1 mg/L and for benzo(a)pyrene is 0.005 mg/L. The critical effect of many PAHs in mammals is their carcinogenic potential. The metabolic action of these substances produce intermediates that bind covalently with cellular DNA. IARC has classified benz[a]anthracene, benzo[a]pyrene, and dibenzo[a,h]anthracene as probable carcinogenic to humans. Benzo[b]fluoranthene and indeno[1,2,3-c,d]pyrene were classified as possible carcinogens to humans.

1.5.4.3 Polybrominated Diphenyl Ethers (PBDE)

Chemical Name: Polybrominated diphenyl ethers ($C_{12}H_{(10-n)}Br_nO$, where n = 1-10). As in the case of PCBs the total number of congeners is 209, with a predominance in commercial mixtures of the tetra-, penta- and octa-substituted isomers.

CAS Number: Various (PeBDE: 32534-81-9; OBDE: 32536-52-0; DeBDE: 1163-19-5)

Properties: Solubility in water: 0.9 ng/L at 25°C (PeBDE); vapour pressure: 3.85×10^{-3} to $<10^{-7}$ mmHg at 20-25 °C; log K_{OW}: 4.28 - 9.9.

Discovery/Uses: Since the 1960's, three commercial PBDE formulations have been in production. The pentabrominated product is used principally to flame retard polyurethane foams in furniture, carpet underlay and bedding. Commercial octa is a mixture of hexa- (10-12%), hepta- (44-46%), octa- (33-35%) and nonabromodiphenyl (10-11%) ethers. It is used to treat a wide variety of thermoplastics and is recommended for injection moulding applications such as high impact polystyrene (HIPS). The deca product (a single congener) is used predominantly for textiles and denser plastics such as housings for a variety of electrical products in particular TVs and computers.

Persistence/Fate: Data on environmental fate, although limited, suggest that biodegradation is not an important degradation pathway, but that photodegradation may play a significant role. They have already been found in high concentrations in marine birds and mammals from remote areas. The half-lives of PBDE components in rat adipose tissue varies between 19 and 119 days, the higher values being for the higher brominated congeners.

Toxicity: The available data suggest that the lower (tetra- to hexa-) PBDE congeners are likely to be carcinogens, endocrine disruptors, and/or neurodevelopmental toxicants. Studies in rats with commercial PeBDE indicate a low acute toxicity via oral and dermal routes of exposure, with LD_{50} values > 2000 mg/kg bw. In a 30-day study with rats, effects on the liver could be seen at a dose of 2 mg/kg bw/day, with a NOEL at 1mg/kg bw/day. The toxicity to *Daphnia magna* has also been investigated with a reported LC_{50} of 14 μg/L and a NOEC of 4.9 μg/L. Although data on toxicology is limited, they have potential endocrine disrupting properties, and there are concerns over the health effects of exposure.

1.5.4.4 Pentachlorophenol (PCP)

Chemical Name: Pentachlorophenol (C_6Cl_5OH).

CAS Number: 87-86-5.

Properties: Solubility in water: 14 mg/L at 20°C; vapour pressure: 16×10^{-5} mm Hg at 20°C; log K_{OW}: 3.32 – 5.86.

Discovery/Uses: It is used as insecticide (termiticide), fungicide, non-selective contact herbicide (defoliant) and, particularly as wood preservative. It is also used in anti-fouling paints and other materials (e.g. textiles,

inks, paints, disinfectants and cleaners) as inhibitor of fermentation. Technical PCP contains trace amounts of PCDD and PCDF

Persistence/Fate: The rate of photodecomposition increases with pH ($t_{1/2}$ 100 h at pH 3.3 and 3.5 h at pH 7.3). Complete decomposition in soil suspensions takes >72 days, other authors reports half-life in soils of 23-178 days. Although enriched through the food chain, it is rapidly eliminated after discontinuing the exposure ($t_{1/2}$ = 10-24 h for fish). Highest measured BCF was 771.

Toxicity: It has been proven to be acutely toxic to aquatic organisms and have certain effects on human health at very low concentrations. The 24-h LC_{50} values for trout were reported as 0.2 mg/L, and chronic toxicity effects were observed at concentrations down to 3.2 µg/L. Mammalian acute toxicity of PCP is moderate-high. LD_{50} oral in rat ranging from 50 to 210 mg/kg bw have been reported. LC_{50} ranged from 0.093 mg/L in rainbow trout (48 h) to 0.77-0.97 mg/L for guppy (96 h) and 0.47 mg/L for fathead minnow (48 h).

1.5.4.5 Organic Mercury Compounds

Chemical Name: The main compound of concern is methyl mercury ($HgCH_3$).

CAS Number: 22967-92-6

Properties: Solubility in water: 0.1 g/L at 21°C ($HgCH_3Cl$) and 1.0 g/L at 25ºC ($Hg(CH_3)_2$); vapour pressure: 8.5 x 10^{-3} mm Hg at 25°C ($HgCH_3Cl$); log K_{OW}: 1.6 ($HgCH_3Cl$) and 2.28 ($Hg(CH_3)_2$).

Production/Uses: There are many sources of mercury release to the environment, both natural (volcanoes, mercury deposits, and volatilisation from the ocean) and human-related (coal combustion, chlorine alkali processing, waste incineration, and metal processing). It is also used in thermometers, batteries, lamps, industrial processes, refining, lubrication oils, and dental amalgams. Methyl mercury has no industrial uses; it is formed in the environment by methylation of the inorganic mercurial ion mainly by microorganisms in the water and soil.

Persistence/Fate: Mercury released into the environment can either stay close to its source for long periods, or be widely dispersed on a Regional or even world-wide basis. Not only are methylated mercury compounds toxic, but highly bioaccumulative as well. The increase in concentration of mercury as it transfers through the aquatic food chain results in relatively high levels of mercury in fish consumed by humans. Ingested elemental mercury is only 0.01% absorbed, but methyl mercury is nearly 100% absorbed from the gastrointestinal tract. The biological half-life of mercury is 60 days.

Toxicity: Long-term exposure to organic mercury can permanently damage the brain, kidneys, and developing fetus. The most sensitive target of low level exposure to metallic and organic mercury following short or long term exposures appears to be the nervous system.

1.5.4.6 Organic Tin Compounds

Chemical Name: Organotin compounds comprise mono-, di-, tri- and tetrabutyl and triphenyl tin compounds. They conform to the following general formula $(n\text{-}C_4H_9)_nSn\text{-}X$ and $(C_6H_5)_3Sn\text{-}X$, where X is an anion or a group linked covalently through a hetero-atom.

CAS Number: 56-35-9 (TBTO); 76-87-9 (TPTOH)

Properties: Solubility in water: 4 mg/L (TBTO) and 1 mg/L (TPTOH) at 25°C and pH 7; vapour pressure: 7.5 x 10^{-7} mm Hg at 20°C (TBTO) 3.5 x 10^{-8} mmHg at 50ºC (TPTOH); log K_{OW}: 3.19 - 3.84. In sea water and under normal conditions, TBT exists as three species in seawater (hydroxide, chloride, and carbonate).

Discovery/Uses: They are mainly used as antifouling paints (tributyl and triphenyl tin) for underwater structures and ships. Minor identified applications are as antiseptic or disinfecting agents in textiles and industrial water systems, such as cooling tower and refrigeration water systems, wood pulp and paper mill systems, and breweries. They are also used as stabilizers in plastics and as catalytic agents in soft foam production. It is also used to control the shistosomiasis in various parts of the world.

Persistence/Fate: Under aerobic conditions, TBT takes 1 to 3 months to degrade, but in anaerobic soils may persist for more than 2 years. Because of the low water solubility it binds strongly to suspended material and sediments. TBT is lipophilic and tends to accumulate in aquatic organisms. Oysters exposed to very low concentrations exhibit BCF values from 1000 to 6000.

Toxicity: TBT is moderately toxic and all breakdown products are even less toxic. Its impact on the environment was discovered in the early 1980's in France with harmful effects in aquatic organisms, such as

shell malformations of oysters, imposex in marine snails and reduced resistance to infection (e.g. in flounder). Molluscs react adversely to very low levels of TBT (0.06-2.3 μg/L). Lobster larvae show a nearly complete cessation of growth at just 1.0 μg /L TBT. In laboratory tests, reproduction was inhibited when female snails exposed to 0.05-0.003 μg /L of TBT developed male characteristics. Large doses of TBT have been shown to damage the reproductive and central nervous systems, bone structure, and the liver bile duct of mammals.

1.6 DEFINITION OF THE CENTRAL AND NORTH EAST ASIA REGION

The Central and North East Asia Region consists of the 11 countries: China, Japan, Republic of Korea, Democratic People's of Korea, Mongolia, Russian Federation and the five Commonwealth of Independent States (CIS)- Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. China and the Russian Federation are two of the world's largest countries. The total population in the Region is estimated to be about 1.6 billion, a quarter of the world population. Agricultural activity is extensive in the Region and is an important factor which may cause pesticide over usage, water pollution and water management problems.

China China is the third largest country in the world with a land area of 9.6 million km^2. The land border is 22800 km long, and the coastline is 18000 km long. It is located approximately between latitudes 4ºN - 53ºN and longitudes 73ºE – 135ºE. It has the largest population in the world estimated to be 1.3 billion in July 2001 (excluding Taiwan province and Jinmen, Mazu Island of Fujian province which has a population of 22.3 million).

Since the start of the policy of economic reform and opening to the outside world in 1978, China's economy has grown remarkably by positively affecting the agricultural and industrial sectors. Agricultural output doubled in the 1980's, and industry expanded. The gross domestic product (GDP) was approximately 9600 billion in 2001. The major industries include metallurgy (iron, steel), coal, crude oil, machinery, textiles, cement, chemicals, and electronics.

Hong Kong Special Administrative Region (SAR) and Macau SAR both have the power of self-governing directly under the central government of China, according to the policy of "one country, two systems".

Japan Japan is a technologically advanced country consisting of a chain of islands located on the western edge of the North Pacific Ocean east of the Korean Peninsula. The islands occupy a total area of approximately 380000 km^2 consisting of approximately 374744 km^2 land and 3091 km^2 water. It is located approximately between latitudes 27ºN - 42ºN and longitudes 130ºE – 148ºE. Its population is 126.8 million (July 2001 estimate).

Japan lacks natural resources and imports most of its raw materials. It is strong in manufacturing and its major industries include automobile production, chemical industry, cement, electrical and electronic equipment, fertilisers, fisheries, food processing, forestry, iron and steel, non-ferrous metals, oil refining, petrochemicals, ship building and textiles. Japan is limited in arable land area and imports a high percentage of its food from abroad.

Republic of Korea Republic of Korea is located at the southern half of the Korean Peninsula. It shares a 238 km border with the Democratic People's Republic of Korea. Its total area is 98480 km^2 comprising of 98190 km^2 land and 290 km^2 water. It is located approximately between latitudes 33ºN - 38ºN and longitudes 126ºE - 129ºE. The population is 47.9 million (July 2001). Natural resources in Republic of Korea include coal, tungsten, graphite, molybdenum, lead and hydropower potential. Its major industries include shipbuilding, automobile production, machinery, electronics, chemicals, steel, textiles, and food processing.

Democratic People's Republic of Korea The Democratic People's Republic of Korea (DPRK) is located at the northern half of the Korean Peninsula between China and Republic of Korea. Its total area is 120540 km^2 comprising of 120410 km^2 land and 130 km^2 water. It is located approximately between latitudes 35ºN - 41ºN and longitudes 124ºE – 130ºE. The population is 21.97 million (July 2001). DPRK is a highly-centralised Communist country that faces desperate economic conditions. In recent years, DPRK has experienced lower crop production and other economic difficulties resulting in serious shortages of food, electrical power, clean water and medicine. The population remains vulnerable to prolonged malnutrition and deteriorating living conditions. Industry includes military products, machine building, electric power, and chemicals.

Russian Federation The Russian Federation is the largest country in the world. It borders the Arctic Ocean and is located between Europe and the North Pacific Ocean. The area of the entire country is 17,075,200 km^2 comprising of 16,995,800 km^2 land and 79400 km^2 water, however, the entire country is not included in Region

VII. The physical area of the Russian Federation that is included in Region VII is located approximately between latitudes 43ºN and 66ºN (the southern limit of the Arctic Circle) and longitudes 46ºE – 166ºE and occupies approximately 9,767,000 km^2. The northern part and the western part of the Russian Federation are included in the Regional assessments of Region I (Arctic) and Region III (Europe), respectively. The population of the whole Russian Federation is approximately 145 million (July 2001 estimate).

The section of Russian Federation can be divided into three broad geographic Regions: namely the *European part* which includes the territory lying west of the Ural Mountains (the *European part* accounts for a small section in Region VII; *Siberia*, stretching east from the Urals; and the *Far Eastern part* which includes the extreme southeast and the Pacific coast. The Asian Region of Russia refers to Siberia and the Far East.

Its natural resource base includes major deposits of oil, natural gas, coal, many strategic minerals, and timber. Russian Federation is a leading exporter of gas and oil. Major industries include all forms of machine building from rolling mills to high-performance aircraft and space vehicles; shipbuilding; road and rail transportation equipment; communications equipment; agricultural machinery, tractors, and construction equipment; electric power generating and transmitting equipment.

Mongolia Mongolia is the seventh largest country in Asia and the 18th largest in the world. It is a land-locked country bordered by Russian Federation to the north and China to the east, south, and west. Mongolia covers an area of 1,566,500 km^2 and is located approximately between latitudes 40ºN - 53ºN and longitudes 88ºE – 119 ºE. The population is 2,654,600 (2000). The Mongolian economy is relatively diversified. Agriculture accounts for close to 25.7 % of gross domestic product (GDP), industry and construction for 25.5 % (2001). The country has one of the world's highest ratios of livestock to people. In 1998, for example, the ratio of sheep to people was 5 to 1. Mining, mainly copper, provides an estimated 44.2 % of the economy's export earnings (2001). Leading industries include copper, processing of animal products, building materials, food and beverages, and coal mining. There are sizeable reserves of copper, gold, coal and other minerals. Prospects for petroleum in commercial quantities are encouraging.

Kazakhstan The Republic of Kazakhstan is the second largest of the Commonwealth of Independent States (and the 9th largest country in the world) which gained independence from the former Soviet Union on 16 December 1991. It is a land-locked State with an area of 2,756,000 km^2 (land: 2,669,800 km^2; water bodies: 47, 500 km^2). The Russian Federation borders Kazakhstan on the west and north, China lies to the east, Kyrgyzstan, Uzbekistan, and Turkmenistan lie to the south, and the Caspian Sea joins Russia on the west. It is located approximately between latitudes 40ºN - 55ºN and longitudes 45ºE – 87ºE. The country is divided into 14 oblasts, 160 districts and 2276 village okrugs. It has a population of 14.8 million (2000). Kazakhstan borders the Aral Sea, split into two bodies of water, and the Caspian Sea on the western boundary. Kazakhstan is a large agricultural producer (livestock and grain). Agricultural areas comprise of 2.2 million km^2 . Leading industries consists of extractive industries (oil, coal, iron ore, manganese, chromite, lead, zinc, copper, titanium, bauxite, gold, silver, phosphates, sulphur), iron and steel, nonferrous metal, tractors and other agricultural machinery, electric motors, and construction materials. Kazakhstan faces potentially severe health and environmental problems from the legacy of the Cold War. High levels of radiation have resulted from the dismantling of nuclear weapons factories, and from years of nuclear testing. Industrial pollution is heavy in many cities. The fisheries of the Aral Sea have been seriously affected by irrigation projects, which have also increased soil erosion and salinisation.

Kyrgyzstan Kyrgyzstan is a land-locked country whose neighbours are Kazakhstan to the north, China to the east, China and Tajikistan to the south and Uzbekistan to the west. It occupies a total area of 198500 km^2 comprising of 191300 km^2 land and 72400 km^2 water. It is located approximately between latitudes 39ºN - 43ºN and longitudes 69ºE – 91ºE. It has a population of 4.75 million (July 2001). Kyrgyzstan is a small, mountainous country whose economy is undergoing transition. Its economy relies mainly on agriculture. There are about 101,000 km^2 of arable land used as pastures and growing of crops (including cotton, sugar beet, vegetables, tobacco, grain). Agriculture contributes to almost 50% of the Gross Domestic Product (Pak et al., 2002). Cotton, potatoes, wool, and meat are the main agricultural products and exports. Industries include small machinery, textiles, food processing, cement, refrigerators, furniture, electric motors, gold, and rare earth metals.

Tajikistan Tajikistan is a land-locked country located in Central Asia, west of China. It is the southern most republic of the former Soviet Union. Its bordering countries are Afghanistan, China, Kyrgyzstan, and Uzbekistan. It occupies a total area of 143100 km^2 comprising of 142700 km^2 land and 400 km^2 water. It is located approximately between latitudes 35ºN - 39ºN and longitudes 68ºE – 75ºE. It has a population of 6.13

million (July 2001 estimate). Tajikistan has the lowest per capita GDP among the 15 former Soviet republics. Cotton is the most important crop. Before independence from the Soviet Union, the area relied on the textile industry and concentrated on cotton production. Now, industry consists only of aluminum plants, hydropower and mining facilities, and small obsolete factories mostly in light industry and food processing (CIA, 2001).

Turkmenistan Turkmenistan, with a population of 4.6 million (July 2001), is located in the west of Central Asia, bordering the Caspian Sea, Afghanistan, Iran, Kazakhstan and Uzbekistan. It occupies a total area of 488100 km^2 (CIA, 2001). It is located approximately between latitudes 32˚N - 41˚N and longitudes 51˚E - 68˚E. Turkmenistan is largely desert country whereby approximately 350000 km^2 is occupied by the waterless Karakum Desert (rainfall occurs once every several years). However, intensive agriculture occurs in irrigated oases. Only 2.5% of Turkmenistan is arable with the only significant agriculture along the banks of the Amudarya River, which runs along the eastern edge of the Karaku. Water is carried along the 1100 km long Lenin Canal from the Amu river to the capital, Ashkhabad. One-half of its irrigated land is planted with cotton, making it the world's tenth largest producer. Turkmenistan is the fifth largest in gas reserves in the world and also has large oil resources (CIA, 2001). The seabed of the Caspian Sea is believed to be the world's largest oil deposits. A Caspian summit to be held in Turkmenistan is planned for 2002 to discuss how the resources of the Caspian Sea is to be used among the five littoral countries (Anon, 2002). Industry comprises of cotton mills, sulphur, super-phosphate and other chemical processing plants.

Uzbekistan Uzbekistan is a land-locked country located in Central Asia bordered by Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan. It occupies a total area of 447400 km^2 comprising of 425400 km^2 land and 22000 km^2 water. It is located approximately between latitudes 35ºN - 43ºN and longitudes 57ºE – 74ºE. Uzbekistan includes the southern portion of the Aral Sea with a 420 km shoreline. The independent state has a population of 25.2 million (July 2001). Ten percent of Uzbekistan consists of intensely cultivated, irrigated river valleys. Uzbekistan is now the world's third largest cotton exporter, a large producer of gold and oil, and a Regionally significant producer of chemicals and machinery. Previously, during the Soviet era, intensive production of "white gold" (cotton) and grain led to overuse of agrochemicals and the depletion of water supplies. Independent since 1991, the country seeks to gradually lessen its dependence on agriculture while developing its mineral and petroleum reserves (CIA, 2001).

1.7 PHYSICAL SETTING

Region VII includes continental landmass, several major islands and various bodies of water. The continental landmass is characterised by a hilly, often mountainous landscape, rolling plains, and deserts.

The proportions of the varied topography of China are: mountainous regions (33%), plateaus (26%), basins (19%), plains (12%), and hills (10%) (China Today, February 1996). There are several major mountain systems within the Region. In China, the Qinghai-Tibet Plateau averages more than 4000 m above sea level with Mt. Qomolangma, the world's highest peak (8848 m) and the main peak of the Himalayas. In the Republic of Korea, two major mountain ranges run as a spine down the peninsula close to the eastern coastline.

In the Democratic People's Republic of Korea, about 80% of land area is moderately high mountains separated by deep, narrow valleys and small, cultivated plains. The remainder is lowland plains covering small, scattered areas. South-east of the West Siberian Plain of the Russian Federation, a series of mountains and plateau make up a high mountains system – Altai (maximum elevation of 4506 m – Mount Belukha) and Sayan Mountains (maximum elevation of 3491 m – near Hoevsgoel-Nuur Lake). The Altai Mountains fringe the east border of Kazakhstan.

Two great Central Asian mountain systems—the Tian Shan and the Pamirs that generally run east to west also dominate the landscape. Kyrgyzstan is almost completely mountainous and is subject to major earthquakes. The country lies at the juncture of the Tian Shan (northeast) and the Pamirs (Pamiro-Alai mountains at southwest). The highest elevation in Kyrgyzstan reaches 7439 m – Pik Pobedy. More than half of the republic's territory lies at an elevation higher than about 2500 m. More than 90 % of Tajikistan is occupied by mountains, and almost half of the Republic lies at an elevation of 3000 m or higher.

Eastern Tajikistan includes the mountainous Pamirs Region. Ismail Samani Peak (7495 m), the highest mountain in the former USSR, towers over northeast Tajikistan. In Turkmenistan, foothills and mountains, some of which exceed 3100 m, rise along the country's southern (mainly Kopetdag Gershi and Paropamisus Range) and easternmost borders.

In Uzbekistan, branches of the Tian Shan and Pamirs (Gissar-Altai) mountains rise in the southeast and

northeast, with the highest elevation in Uzbekistan reaching 4643 m. East of 43ºE, are the relatively low Ural Mountains of the Russian Federation. The highest elevation is in the north at Mount Narodnaya (People's Mountain), at 1894 m.

There is also volcanic activity within the Region. On the Kamchatka Peninsula located on the far east of the Russian Federation, 23 of the 120 volcanoes are currently active. The highest cone, Mount Klyuchevskaya, reaches an elevation of 4750 m. This volcanic mountain chain continues southward in the Kuril Islands in the North Pacific Ocean.

On the east coast of China running from north to south are the Northeast Plain, the North China Plain and the Middle-Lower Reaches of the Yangtze River Plain. Rolling plains with an average elevation of 180 m can be found in the European section of the Russian Federation. The southern border of the European section includes the Caspian Lowland with an average depression of -20 metres.

East of the Ural Mountains, the plain Region continues, entering Siberia in the West Siberian Plain, an expansive and poorly drained flat area that is generally marshy or swampy. East of the Yenisey River is the rolling upland of the Central Siberian Plateau. Elevations here average about 500 to 700 m, and reaches a maximum in the south at Yeniseysky Kryazh at 1104 m. Rivers in this Region have dissected or eroded the surface and in some places have formed deep canyons. South-east of the Lena River, a series of mountains, basins and plateau make up the South Siberian Uplands. The main highlands are Aldanskoye Nagorye (maximum elevation of 2264 m), Stanovoye Nagorye (maximum elevation of 3073 m).

The Region's higher ranges, such as the Stanovoy Khrebet (maximum elevation of 2412 m) and Yablonevyy Range, generally reach maximum elevations of about 2000 to 3000 m. Kazakhstan is a vast, generally low-lying plain (mainly – part of Caspian and Turan Depressions in the west, Kirgiz Steppe in center and south border of Western Siberian Lowland in the north). The Vpadina Karagiye (Karagiye Depression) is 132 m below sea level. Most of Turkmenistan is made up of plains, nearly all of which are occupied by the *Garagum Desert* and its oases. Four-fifths of the country lies at an elevation of about 500 meters or less. The Vpadina Akdzhakaya, located in the north central part of the country, is the lowest point in the republic at about 81 meters below sea level. Sandy desert plains make up most of Uzbekistan. The north central part of the republic is occupied by the Qyzylqum Desert (in borders of Turan Depression), one of the largest deserts in the world and the second largest of the former USSR. The Gobi, a huge desert Region, covers a wide arid tract in central and southeast Mongolia.

Japan consists of four main islands – Honshu, Hokkaido, Shikoku, and Kyushu – and several smaller islands. It is a highly mountainous Region, with 75 to 80% being covered by mountains. Since the country rests on the boundaries of the Philippine, Pacific and Eurasian plates, it is prone to earthquakes. It has 188 volcanoes, 40 of which are active.

Bodies of water within the Region include the Pacific Ocean, various seas, rivers, and lakes. Three of the longest rivers are the Yangtze River (6300 km) and Yellow River (5464 km) in China, and the Ob River in the Russian Federation. The largest lakes are the Aral Sea (33800 km) in Kazakhstan and Uzbekistan, Lake Baikal (31500 km^2) in Russian Federation, and Lake Balkhask (18428 km^2) in Kazakhstan. The Caspian Sea (394299 km^2) lies outside the Region and borders Russian Federation, Kazakhstan, and Turkmenistan.

Region VII lies between 4ºN and 66ºN. In general, the southern most countries experience a temperate climate. Monsoon and humid climates dominate the eastern part of China, however, the northwestern part is arid due to wind erosion and drought, and the Qinghai-Tibet Highland region can be found blanketed by frost. The Russian Federation encompasses several distinct climate zones.

In general, the climate is temperate and can be divided into four broad climatic zones. The first – zone of ***temperate-continental climate (TCC)*** averages -17°C in January and +18°C in July (extends from west border of the country to the West-Siberian Plain, including Ural Mountains) – Region of taiga with high humidity in the north and a Region of mixed forests and forest-steppes with average humidity. The second – zone of ***continental climate (CC)***(-20°C in January and +18°C in July), covers the West-Siberian Plain – Region of taiga and forest-steppes with average humidification. The third – zone of ***extreme continental climate (ECC),*** covers the Central Siberian Plateau, Altai, Sayan Mountains, Buryatiya, Chita Region and Lena – Aldan rivers basins

The coldest winter temperatures occur in eastern Siberia. During January, temperatures average -32°C which can plummet to -64°C (Yakutsk, and -54°C in Chita). During July, temperatures average +24°C (maximum +39°C). The far eastern part experiences ***maritime and monsoon climates of mixed forest (MMC)*** averages -

12°C in January and +15°C in July (including Kamchatka Peninsula, Sakhalin and Kuril Islands) zones. Close to the Arctic Circle border, the climate is subarctic climate zone.

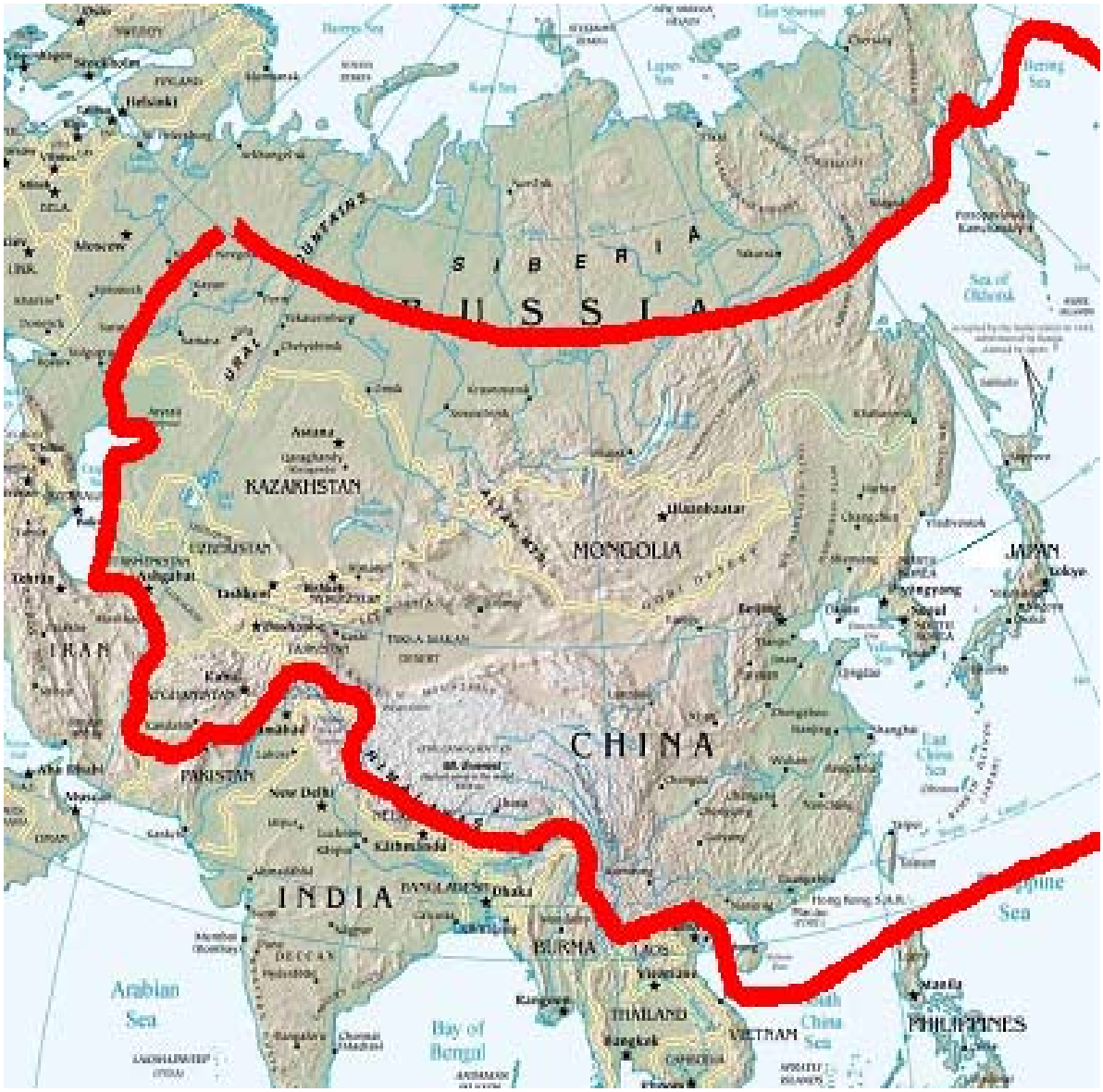
The CIS countries experience a continental climate whereby there are noticeable temperature differences during the winter and summer months. In January, the average daily temperature is usually below -1°C dropping to -27°C at higher elevations (such as in Kyrgyzstan), while the average daily temperature in July is approximately 26°C. Precipitation is a few hundred millimeters per year. Due to the high elevation of some of the countries, glaciers and permanent snowfields can be found. In Kyrgyzstan, they cover more than 3 % of the total land area.

1.8 PATTERNS OF DEVELOPMENT/SETTLEMENT

The majority of the population is concentrated in the eastern half of the Region particularly along the east coast. The population density is greatest in the coastal region of China. In the Republic of Korea, since 70 % of the land is mountainous, the population is concentrated in the lowlands in the northern part of the country and in the southern end. The lower latitudes of Japan are more densely populated than the upper latitudes.

The average population density of the Russian Federation in Region VII is approximately 6.8 persons/km^2 , however, as 57% of the population lives on only 13% of the land, the average density is 30.5 persons/km^2. The country of Kazakhstan is sparsely populated with a density of 5.5 persons/km^2. The maximum density of 17 persons/km^2 can be found in the irrigated agricultural southern districts of the country in Almaty and South Kazakhstan oblasts. A map of Region VII is shown below in Figure 1.1:

Figure 1.1: **Map of Region VII**



Region VII

2 SOURCE CHARACTERISATION

2.1 BACKGROUND INFORMATION TO PTS SOURCES

Persistent toxic substances (PTS) have received worldwide attention. They are organochlorine compounds (chlorinated hydrocarbons) that are characterised by low water solubility, high lipophilicity, and are both toxic and persistent in the environment. The PTS that are considered for Region VII are comprised of pesticides, industrial compounds and unintentional by-products. The production and usage of these pesticides and industrial compounds and the production and emissions of unintentional by-products have resulted in the ubiquitous distribution of these toxic substances throughout the earth's ecosphere, consequently causing adverse impact on the environment and to living organisms.

The use of synthetic organic pesticides has been, and still is in many parts of the world, a necessity for the control of pests and also for disease control. This is true for Region VII. These chemicals are effective as pesticides, but they also have inherent properties which cause health and environmental impacts. Pesticides are toxicants which are capable of affecting many types of biota, including nontarget organisms. Many pesticides need to be resistant to environmental degradation such that they can persist in treated areas and thus enhance their effectiveness, however, this also promotes long-term effects in natural ecosystems (Connell and Miller, 1984). In Region VII, most PTS pesticides are derived from agricultural practices.

The industrial compounds have introduced technological innovation and benefits to industries and thus have been significantly produced in some countries of the Region. Unintentional by-products result from anthropogenic sources, such as during the manufacture of pesticides and industrial compounds, and incineration processes.

PTS affect the environment and human health in several ways. Since many PTS have a high affinity for soil and are hence retained in this environmental medium, the PTS may be taken up by crops and by grazing animals and finally reach the human food chain. The contaminants may also be transported during run-off from land into watercourses. In areas that are characterised by heavy rainfall, soil erosion can be severe and eroded soils may therefore cause significant pollution of waterways. Weak and ineffective control of emissions by industries and lack of stringent control by governments have also contributed to the global pollution of the environment by PTS.

In order to assess the extent of the impact that persistent toxic substances has on the Central and North East Asia Region, it is necessary to trace the life cycle of the chemicals from its initial introduction into the environment to their transport fate within the Region. For pesticides and industrial chemicals, the source into the environment could be from its production, its use, or import into the Region. Thus, it may be important to determine the location of the production facilities and the quantity of chemicals being produced, as well as where and how they are used or stored. For unintentional by-products, the source will be due to the process responsible for its unintentional production and emission. Therefore, it is important to identify how they are produced and how much are produced and emitted.

2.1.1 Scoring of PTS

As mentioned in the methodology section of Chapter 1, a scoring mechanism was utilised as a tool to prioritise the 18 selected persistent toxic substances of Region VII according to sources and source data gaps. Detailed instructions for scoring can be found in the Annex 1. The scoring results based on a collective effort of all the participants of the 1st Technical Workshop held in Tokyo, Japan, have been prioritised according to level of concern and data gaps and are listed in Table 2.1.

In interpreting the scores, it is important to note that different scores for chemicals indicate that the chemicals are of different levels of concern. For example, a chemical having a source score of '2' is a chemical of Regional concern compared to a chemical having a source score of '1' indicating a chemical of local concern. The scoring system does not provide any information on the ranking or prioritisation of chemicals having the same source scores. In the following table (Table 2.1), the chemicals have been grouped according to score, but they are not ranked within each group.

Table 2.1 Scoring for Prioritising PTS for Sources and Data Gaps

Chemicals	Sources	Data Gaps
PCDD	2	2
PCDF	2	2
PCBs	2	2
PAHs	2	2
DDT	2	1
HCH	2	1
PCP	1	2
Org Hg Cmpds	1	2
PBDE	1	2
HCB	1	2
Org Tin Cmpds	1	1
Toxaphene	0	1
Heptachlor	0	1
Aldrin	0	1
Chlordane*	1	1
Dieldrin	0	1
Endrin	0	1
Mirex	0	1

Score=0 –chemical is of no concern/supportive data is collected
Score=1 –chemical has local concern/supportive data is limited
Score=2 –chemical has Regional concern/supportive data is lacking

*During the 1st Technical Workshop, chlordane was given a score of '0', however upon the collection of further information on chlordane and discussions during the Regional Priority Setting Meeting, the score was later revised to '1'.

The results of the scoring exercise indicate that PCDD, PCDF, PCBs, PAHs, DDT and HCH are chemicals of Regional concern. This means that there is either a) a major production of the chemical for local and export use, b) evidence of the chemical as a contaminant in large scale production of other chemicals, c) known emissions of the chemical from large scale incinerators or chlorine bleaching of pulp or other related combustion facilities, d) evidence of leakage from major stockpiles of the chemical, e) large-scale use of the chemical throughout the Region, and/or f) spatial and /or temporal trends increasing Regionally from levels above threshold.

With regards to data gaps, there is insufficient and/or unreliable data on 8 of the 18 chemicals. These chemicals are mainly industrial chemicals (PCBs, PBDE, HCB) and unintentional by-products (PCDD/PCDF, PAHs). There is also insufficient information available for PCP and organomercury compounds.

The sources including production, use and emissions of the 18 persistent toxic substances and the availability of supportive data are described in the following section.

2.2 PRODUCTION, USE AND EMISSION

2.2.1 Persistent Toxic Substances - Pesticides

Pesticides are still being manufactured and applied within the Region. In the Commonwealth of Independent States (CIS) countries, the application of pesticides and agricultural chemicals has been a serious issue. For example, in Tajikistan, economic recession had previously resulted in the scarcity of seeds for the growing of crops thus leading to the import of seeds from abroad. However, as significant amounts of seeds were not adaptable to the local environment, they became vulnerable to diseases and agricultural pests. Consequently, more pesticides than usual have been applied to protect the crops. Pesticide load in some areas of Tajikistan ranged from 120 – 2680 kg/km^2 and even reached 4800 kg/km^2 for cotton fields (Ministry for Nature Protection Republic of Tajikistan, 2000). In addition, before independence from the Soviet Union, Tajikistan concentrated on cotton production to support its textile industry. DDT and various pesticides were heavily used to protect the crops.

In the CIS countries and in the Russian Federation, obsolete pesticides are a significant problem. Often cataloguing and documentation procedures of pesticides are inadequate or non-existent, as is the case for pesticides located at the Sakhalin Oblast and the Primorski Krai of the Russian Federation. Monitoring of obsolete pesticides are also lacking, therefore the locations of inconsistent burial of obsolete pesticides and their quantities are not always known. The burial of obsolete pesticides, such as in Kyrgyzstan, has also led to leakage and exposure of pesticides to the atmosphere. Some measures are known to have been taken in the past to maintain banned pesticides in underground facilities which consisted of trenches and ferro-concrete bunkers.. In 1973 and 1980, 764 t and 255 t, respectively, of DDT, aldrin, and HCH were stored in such facilities in the Kurg-Ukok and Tash-baka Kungey Regions of Kyrgyzstan (Pak et al., 2002). In other areas of Kyrgyzstan, there is about 227 t of prohibited and deteriorated pesticides (Shakirov et al., 2002a). Due to poor control over chemical imports into some of the countries of Region VII, large volumes of banned chemicals with expired validity dates have been imported into the Region.

Currently, in Uzbekistan, banned and obsolete pesticides kept in storehouses amount to approximately 1433 t. Of these, 118 t are organochlorine pesticides. Out-of-date pesticides are non-uniformly distributed across the territory whereby greatest stocks (1022 t) are found in the Surkhandarya and Kashcadarya areas in southern Uzbekistan. More than 15,000 t of banned and obsolete pesticides have been kept in special underground facilities (made of ferro-concrete) since 1972. There are 14 such facilities in Uzbekistan occupying more than 0.6 km^2. Environmental monitoring is conducted to control them. Open, unsealed facilities also exist in the country posing a negative impact on the surrounding environment. During the 1980s when cotton monoculture was dominant in Uzbekistan, aerial spraying was widely used to protect cotton and defoliation. Presently, there are 461 former agriculture aerodromes on the territory of Uzbekistan, which occupy 45 km^2. Soil pollution levels at these aerodromes exceed the norm by more than 100 times (State Committee for Nature Protection of the Republic of Uzbekistan, 2002).

In some of the countries of the Region, certain persistent toxic pesticides have never been used. For example, in Mongolia, there is no information confirming that aldrin, dieldrin, chlordane, endrin, mirex, heptachlor and toxaphene had been previously used or is presently used. However, from 1950–1970, DDT had been supplied from the former Soviet Union in small quantities and used for the purpose of protecting plants and disinfecting livestock. According to unreliable sources of information, small volumes of DDT are still kept in some rural areas. In the Russian Federation, aldrin, dieldrin, endrin, chlordane, mirex, toxaphene and heptachlor have not been used.

The following tables are a summary of the estimated amount of pesticides in some of the countries within the Region:

Table 2.2 Obsolete and Banned Pesticides Located in Asian Part of Russian Federation (Yufit & Grosheva, 2002)

Location	Total amount available with suppliers and economic sites	Obsolete and banned pesticides
Kurgan Oblast		929 t (2000) 1000 t (1999) 700 t prohibited and waste pesticides produced in 1972–1975 (1997)
Tyumen Oblast		218 t - Out of 200 storage sites, 135 have licenses, 25 were shutdown (1998). Approximately 130 t (1996)
Chelyabinsk Oblast		170 t (1998)
Tyva Republic	202 t (fertilizers and pesticides)	16 t of pesticides prohibited for use. In 1992 there were 20 storage sites for mineral fertilizers and pesticides in Tyva. By 2000, there were none (2000). Over 100 t waste, prohibited and depreciated pesticides and their package were found in destroyed warehouses of abandoned farms (Kolkhozes and Sovkhozes) (1999).
Altai Krai		More than 1500 t of unspent pesticides, including hexachlorocyclohexane - 116 t, DDT - 14 t, Trichlorfon – 18.3 t, have accumulated in the Region. There is an urgent problem of their neutralization.
Krasnoyarsk Krai	126 t	66 t
Kamchatka Oblast		Pesticide landfill built in 1979-1982 at foot of Kozelsky volcano 102 t of various pesticides
Kemerovo Oblast		185 t (1998)
Primorski Krai		579 t pesticides (2000) 500 t pesticides (1997)
Amur Oblast		Over 590 t pesticides, including highly toxic mercury-containing Granosan - 20 t (1999).
Magadan oblast		19 t of various pesticides, 600 kg of which is DDT that has not been used since 1989 (1999)
Sakhalin oblast		352 t, out of which 149 t are stored on industrial land, and 203 t are landfilled (2000). 375 t of obsolete waste and prohibited pesticides were accumulated, out of which 69 t were stored directly on-site (1999)
Yakutia (Sakha)		Approximately 127 t of various pesticides (e.g. Granosan ~24 t) are stockpiled on 9 storage areas

Table 2.3 Transport of Pesticides in Krasnoyarsk Territory, Russian Federation 1999, (t) (Shekhovtsov, 2002)

Pesticide	Amount Present on 1 January 1999	Received in 1999	Total in 1999	Used in 1999	In Storage 1 January 2000
Insecticides	28	10	38	11	27
Fungicides	28	6	34	10	24
Herbicides	92	36	128	76	53
Seed Dressing	29	38	67	45	22
Total	177	90	267	142	126

Table 2.4 Results of the Preliminary PTS Inventory in Kazakhstan (Ishankulov, 2002a)

PTS	Toxaphene	HCH	DDT
Location	Northern Kazakhstan oblast, Akkainsky Region	Atyrau oblast, Atyrau anti plague station	East Kazakhstan, Zharminsky Region, Zhangiztobe village
Quantity	15 t	24 t	0.5 t
Formulation	Emulsible concentrate	Wettable powder	Wettable powder
Type of container	---	Paper sacks	Plastic bag
State of container	---	Normal	Normal
Year of Import	---	1985	1965-1970
Origin (country, company)	---	---	USSR

In addition to the infromation listed in Table 2.4, it has also been reported that there are 500 t of non-identified pesticides kept in storehouses in Kazakhstan. The presence of PTS among these pesticides are assumed to be high.

Table 2.5 Pesticides Stored in Underground Facilities in Kyrgyzstan (Pak et al., 2002)

Name of Pesticide	Location	
	Kurg-Ukok (t)	Tash-Baka Kungey (t)
1973		
MME 20% DDT	22.7	37.3
30% DDT s.p.	5.5	2.0
72% DDT techn.	5.5	-
5.5% DDT dust	5.4	518.4
50% DDT paste	0.1	97.5
Aldrin	-	69.5
Subtotal	*39.2*	*724.7*
1980		
5.5% DDT dust	250.7	-
12% HCH dust	4.5	-
Subtotal	*255.2*	
Total	**294.4**	**724.7**

Certain pesticides have never been used in the Region, and many have already been banned, as shown in Table 2.6.

Table 2.6 Data on Usage and Ban of Pesticides

	Aldrin	Chlordane	DDT	Dieldrin	Endrin	Heptachlor	HCB	Mirex	Toxaphene	HCH	PCP
China	Not used	(1)	1983 (1)	Not used	Not used	NR			1987 (2)	1983 (2)	
-*Hong Kong SAR*	1988 (2)	1991 (2)	1988 (2)	1988 (2)	NR	NR	NR	1997 (2)	1984 (2)	1991 (2) 1991 (2) -lindane	1994 (2)
-*Taiwan Province*	1975 (1) 1989 (2)	1988 (2)	1973 (1) 1989 (2)	1975 (1) 1989 (2)	1971 (1) 1989 (2)	1975 (1) 1989 (2)	1989 (2)	NR	1983 (1) 1989 (2)	Banned Banned - lindane	
Japan	1975 (1) 1981 (2)	1968 (1) 1986 (2)	1971 (1) 1981 (2)	1981 (2)	1975 (1) 1981 (2)	1975 (1) 1986 (2)	NR as pesticide	2002 (2)	2002 (2)	1971 (1) Banned -lindane	1990 (1)
Republic of Korea	1969 (1) 1986 (2)	1969 (1)	1969 (1) 1986 (2)	1970 (1)	1969 (1) 1999 (2)	1979 (1) 1999 (2)	NR		1982 (1)	1991 (1) 1986 (2) -lindane	
Mongolia	1997 (2) NR	1997 (2) Not used	1997 (2)	1997 (2)	1997 (2)	1997 (2)	NR	NR	1997 (2)	1990 NR- lindane	
Russian Federation	1980 (2) Not used	NR Not used	1970 (1)	NR	NR	1982 (2)	1986 (1)	Banned Not used	NR	1987 (2) 1987 (2)-lindane	
Kazakhstan	1986 (1)	1986	1986 (1)	1986	1986	1986		1986	1986 (2)	1986	
Kyrgyzstan	1973	1973	1973	1973	1973	1973		1973	1973	1973	
Tajikistan	1973	1990	(1)	1990	1990		1990	NR	1986	Banned	1973
Uzbekistan	1990's	1990's	2000	2001	NR	1980 (2)	NR	NR	NR	2000	NR

Note:
1. Banned from agriculture
2. Banned from all purposes

NR: Not registered

The following is the status of persistent toxic pesticides in the Central and North East Asia Region:

Aldrin Aldrin has not been used in China, Mongolia or the Russian Federation and is currently banned from all countries in the Region. During the 1960's and 1970's, aldrin had already been banned from agricultural use by four countries, namely the Republic of Korea, Japan, Kyrgyzstan, and Tajikistan.

It has been reported in a UNEP survey that formulations of aldrin, dieldrin, endrin, and DDT were buried in the ground in concrete boxes in Japan from 1971 to 1972. The total quantity buried was approximately 4000 t, however the percentage of each pesticide is not known. The report states that monitoring verified no leakage to the surrounding soil and underground water (UNEP, 1997). Further investigations may be necessary to validate the existence of the buried pesticides In Kyrgyzstan, although aldrin was banned in 1973, 8.6 t of the pesticide was found within the Republic in 1989 (Pak et al., 2002).

Within the Region, aldrin is a chemical of low priority of concern as it has been banned in all of the countries and was not historically widely used in the Region.

Chlordane Chlordane has not been used in Monglia, or the Russian Federation. Chlordane had been used in China as a pesticide in agriculture, but now that usage is no longer permitted. However, it is still being produced and being used locally as a termiticide in structures such as buildings and dams. In Japan, chlordane had never been produced, but has been imported for usage. From 1958 to 1970, 262 t (technical grade) were imported as a raw material for agricultural pesticides until it was banned as an agricultural pesticide in 1968. After this time, the use of chlordane as a termite control agent increased (Ministry of the Environment, Government of Japan, 2002). From 1979-1986, 12900 t were imported. Both China and Japan have registered the exemption of chlordane from the Stockholm Convention. For China, the exemption is for production and use of chlordane as a termiticide in buildings and dams, and for Japan, the exemption is for the continuous use of wooden articles (which had previously been treated with chlordane and/or heptachlor) as a termiticide in structure of houses. Of the Commonwealth of Independent States (CIS), limited quantities have been found, e.g. in irrigated farmlands of Tajikistan although chlordane was banned in 1990. Obsolete stocks were also reported to be located at some agricultural enterprises in Uzbekistan several years after the ban on production and usage in the 1990's.

Except for China and Japan which have requested exemption from the Stockholm Convention for chlordane as a termiticide, chlordane is banned from all other countries of the Region. Chlordane is a local concern for the region.

DDT Of all the pesticides, DDT is more widely known due to its usage by many countries in the world and the abundant studies that have been conducted on its adverse effects. In this Region, DDT is a significant concern as it has been extensively applied. China had been a significant producer and user of DDT since the 1950's until its ban on production and agricultural use were enforced in 1983. During its 30 years of production, 0.4 million t were produced. Hence, approximately 10000 t of DDT had been produced annually in China (Hua and Shan, 1996). There may be stockpiling of DDT in China.

Besides its use as a pesticide, DDT has played an important role in disease vector control. For the prevention of the spreading of malaria in China, the country has a small amount of DDT stored and readily available. At the same time, if other countries need to prevent the occurrence of the disease or upon emergency situations, China can export DDT to these other countries, based on Prior Informed Consent (PIC) procedures.

China, Republic of Korea, and Russian Federation have requested exemptions from the Stockholm Convention for DDT; China, for the production and use of DDT as an intermediate and for vector control; Republic of Korea for use as a de minimis contaminant in dicofol (maximum concentration 0.1%), and Russian Federation for production and use for vector control. Dicofol is an organochlorine miticide used on fruit, vegetable and field crops.

In Hong Kong SAR, DDT was banned from use on 31 December 1987, and currently can be traded only under permit. From 1979 to 1982, 5023 to 5996 kg of DDT was imported into Hong Kong annually (Morton, 1990). In Japan, DDT has been reported to be buried in concrete boxes along with other pesticides (see *aldrin*) (UNEP, 1997), however, this needs to be confirmed. In Mongolia, DDT was supplied from the former Soviet Union during period 1950-1970. Small quantities of DDT are being kept in some rural areas in Mongolia.

Before its ban in 1972 from agricultural use, DDT was extensively applied in the Russian Federation. There are also reports that DDT has been buried or is being stockpiled within the Russian Federation. The Oblast Environment and Nature Use Committee (14 September 2001) reported that in 1953-57, DDT was applied to

2509 km^2 of Tomsk oblast and that unspent DDT was disposed of in pits, however, the locations of the disposal sites were not documented. The uncontained buried DDT had contaminated bottom sediments of the Chulym River. It has also been reported that the total amount of DDT in registered tombs and stores which are kept in poor conditions (with possible leakage) exceeds 600 t. In the Magadan oblast, about 0.6 t of DDT has remained unused since 1989 and is being stockpiled (Deputy Governor of Magadan oblast, 2001) (refer to Table 2.2). Also, in the village of Teguldet in Tomsk oblast, 184.7 t of DDT dust have been buried.

In the CIS countries, although DDT has been banned as a pesticide, the toxic chemical is still present within the territory. For example, stocks of DDT (0.5 t) have been found in East Kazakhstan in the Zhangiztobe village of the Zharminsky Region (refer to Table 2.4). It is estimated that 995 t of DDT are buried in Kyrgyzstan, a country in which DDT have been substituted by pyrethroids. Approximately 33 t of pyrethroids have been used to date (Shakirov, 2002a).

In Tajikistan, it has been reported that a large volume of prohibited chemicals (approximately 200-500 t) including DDT are still being imported (Ministry for Nature Protection Republic of Tajikistan, 2000). In Turkmenistan, DDT has been found in all agricultural regions of the country, and residual quantities of 109 t have been found at four toxic waste burial grounds of the Akhal Region (Enev), Mary Region (Karabota), Lebap Region (Zergher), and Dashoguz Region (Takhta) (Glazovsky, 2002).

Overall, DDT has been banned as a pesticide from all countries of the Region and has been specified for exemption for vector control in China and in the Russian Federation in accordance to Part II of Annex B of the Stockholm Convention on Persistent Organic Pollutants. As a result of stockpiling and burial, DDT is a chemical of high priority of concern for this Region.

Dieldrin Dieldrin has not been used in Mongolia, the Russian Federation or in Uzbekistan. For five of the countries in Region VII, the pesticide had been banned in the 1960's and 1970's. Dieldrin is currently banned from all of the countries of the Region and thus is a PTS of low priority of concern.

Endrin Endrin has not been used in China (excluding Taiwan Province, which banned endrin in 1989), Mongolia, the Russian Federation, Kazakhstan, and in Kyrgyzstan. During the 1960's and 1970's, endrin was banned from the Republic of Korea, Japan, and Kyrgyzstan. The pesticide is currently banned from all countries of the Region and is a PTS of low priority of concern.

Heptachlor Heptachlor has not been registered for use in China (excluding Taiwan Province, which banned heptachlor in 1989), Mongolia, and Russian Federation. It is currently banned in most countries and was banned from Republic of Korea, Japan, and Kyrgzystan in the 1970's. Some stockpiling exists in Uzbekistan at agricultural sites, however, the amount is unknown.

Heptachlor is a local concern for some of the CIS countries due to limited releases or stockpiling.

Hexachlorobenzene In the past, hexachlorobenzene (HCB) has been used as both a pesticide (fungicide) and as an industrial chemical for carbon anode treatments, synthetic rubber additives, and wood preservatives. Today, HCB is mostly formed as an intermediate in a number of organic synthetic processes. In addition to these, major sources into the environment are pesticides contaminated with HCB and the incineration of various wastes. Due to the various possible sources of HCB it will be discussed in this report under the sections of Pesticides, Industrial Chemicals, and will also be reviewed under Unintentional By-Products.

In the Region, HCB has not been used as a pesticide in Japan, Republic of Korea, Mongolia and Uzbekistan. In most of the CIS countries, there is no data on the usage and production of HCB.

China has been listed as an exemption from the Stockholm Convention for production and use as an intermediate. HCB is a pesticide of serious concern in the Russian Federation as it had been extensively applied. Approximately 610 t were used in the former USSR. HCB was banned in 1986 for agricultural purposes and the toxicant is now used in industry and for military purposes (Shekhovtsov, 2002). From 1990, HCB had not been used in Tajikistan, and governmental monitoring data has indicated that HCB is present in limited quantities in irrigated farmland in the country. HCB, as a pesticide, is a local concern for the Region.

Mirex Mirex has not been produced or used in the Republic of Korea, Japan, Russian Federation, Mongolia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan.

China has applied for an exemption from the Stockholm Convention for the production and use of mirex as a termiticide. There is limited production and some local use as a termiticide.

Mirex was the last of the Stockholm Convention pesticides used in Hong Kong SAR to be banned. From 1992

until its deregistration on 31 December 1996, 141.5 kg of the pesticide was imported and 24.3 kg was exported from Hong Kong SAR. During this time, Hong Kong SAR had a net gain of 117.2 kg of mirex (AFCD, 2001).

Mirex has not been used in many countries of the Region and has been banned from most of the countries. Therefore, mirex is a chemical of relatively low priority of concern.

Toxaphene Toxaphene has not been used in Japan, the Russian Federation, or in Uzbekistan and has been banned from agricultural use by most of the countries during the 1980's.

In the past, 24000 t of toxaphene were produced from 1964 to 1980 in China (Xu, 2002), and 99 t of the pesticide were produced for agricultural pest control in Taeku City of Republic of Korea (UNEP, 1997). There is no usage and stockpiling of the pesticide in these countries. There is stockpiling of toxaphene in the Russian Federation (approximately 50 t) and in the Northern Kazakhstan oblast, Akkainsky Region (approximately 15 t) (refer to Table 2.4).

Toxaphene is of some concern in the Russian Federation, Mongolia and some of the CIS countries (Kazakhstan, Kyrgyzstan).

HCH HCH is banned in China, Republic of Korea, Japan, Kazakhstan, Kyrgyzstan and Uzbekistan, and restricted in the Democratic People's Republic of Korea, Russian Federation, and Mongolia.

HCH was widely produced and used in China from the 1950's until its ban in 1983. During the 30 years, 4.9 million t of HCH were produced in China (Hua and Shan, 1996). The production of lindane (γ-HCH) is only permitted to control specific pests, or it can be exported to other countries on request of their respective governments. In Hong Kong SAR, lindane was banned on 15 March 1991 (AFCD, 2001). Prior to the ban, import and export data for Hong Kong between November 1986 and end of January 1988 showed that Hong Kong had a net gain of 11t of lindane during this period (Ip, 1990).

In Japan, 389000 t of HCH were produced from 1948 until its ban in 1971. It is used for insecticide, termite control, and wood preservative.

HCH was extensively used in the Russian Federation, and production of HCH was banned in 1987. It is estimated that there is a stockpile of approximately 1000 t of HCH whereby the Altai Region accounts for 116 t. In Kazakhstan, 24 t of HCH are located at the Atyrau oblast (refer to Table 2.4).

HCHs including lindane is an important concern for the Region as significant stockpiles exist and lindane is still being produced.

PCP In Region VII, PCP has been used as a fungicide, herbicide, termiticide, wood preservative, industrial fungicide and as a mold preventive. As a herbicide, it has been used in paddy fields and farmlands.

In China, PCP is still being produced and used as a pesticide and as a wood preservation. About 5000 t of PCP were produced annually in the 1990's. Sodium pentachlorophenate has been sprayed since the 1960's in China for controlling the spreading of snail schistosomiasis.

In Japan, PCP was registered as a fungicide in 1955 and as a herbicide in 1957, however in 1990, the chemical was banned from production and use. The cumulative production in Japan amounts to 175700 t, 97% of which was used prior to 1974.

PCP is restricted in the Democratic People's Republic of Korea and banned in Japan and Tajikistan. It has been deregistered in Hong Kong SAR since 1993, but can be traded under permit. It is assumed to not have been either produced or used in Uzbekistan. In the other countries, PCP is still being used in China, Mongolia, and the Russian Federation, particularly in the wood-forest industry and railway industry. Residual amounts may be found in storage in Tajikistan, but this has not been confirmed. Limited data is available about the usage in Republic of Korea, Democratic People's Republic of Korea, Kazakhstan, Kyrgyzstan and Turkmenistan. In general, there is insufficient information about PCP in the Region.

2.2.2 Persistent Toxic Substances – Industrial Compounds

Polychlorinated biphenyls (PCBs) PCB sources are thought to be classified into two groups divided by the formation process: one group are PCBs contained within PCB products manufactured in past industrial activities, which are intentional products; and the other group are PCBs formed as a byproduct in the process of combustion, such as municipal solid waste (MSW) incineration. In addition, a minute amount of PCBs are reportedly contained in agricultural chemicals and various chemical products as impurities. The following is a

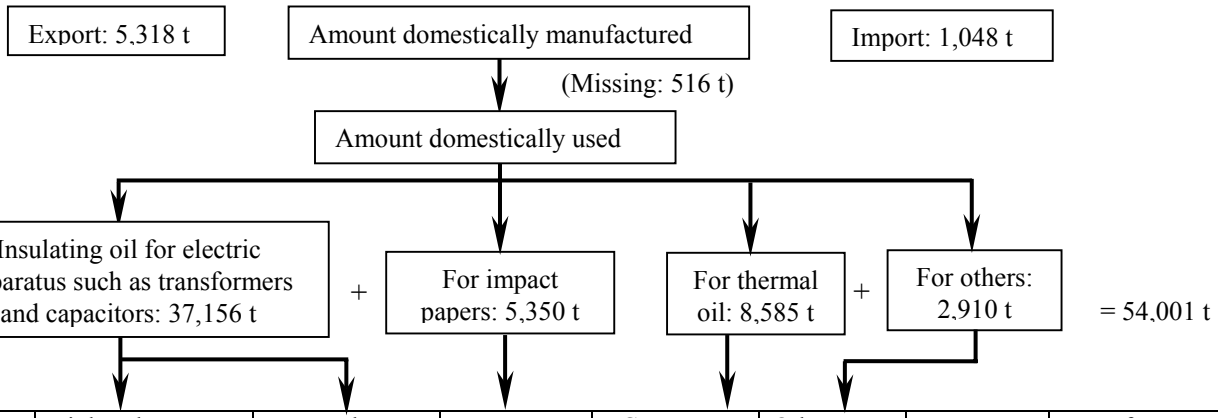
description of industrial PCBs:

In the past, the largest sources of PCBs were manufacturing and application of PCB products. PCB products in Europe, USA and Japan have the following commercial names:

France:	Aceclor, Phenoclor and Pyralene
France/UK:	Santothern and Therminol
UK:	Ducanol, Plastivar and Pyroclor
UK/USA:	Askarel and Aroclor
USA:	Asbestol, Bakola 131, Chlorextol, Diaclor and Dykanol
West Germany:	Clophen
Italy:	Apirorlio, DK and Fenchlor
Japan:	Kanechlor
Russian Federation:	Sovol and Sovtol

The total amount manufactured in the world is assumed to be over 1 M t. In some countries, especially developing countries, PCB-containing products cannot be disposed of, but must be stored as these countries lack the appropriate technology for effective and safe disposal. However, during PCB storage, some may become lost due to inadequate documentation of inventory or some may leak into the environment. Although there is no accurate data with regards to leakage, it has been estimated that 0.05% of the amount of PCBs contained in stored PCB products are leaking per year in the US (Harrad et al., 1994). In addition, vaporisation of PCB from PCB-containing products and their release during accidents such as fires could be significant.

In Japan, 58787 t of PCBs were manufactured from 1954 until the production ban in 1972. It is estimated that 54000 t has been used domestically and that amongst this, 37156 t were used as insulating oil for transformers, capacitors and other electric devices, 8585 t for heating media, 5350 t for pressure sensitive papers and 2910 t for other open type uses including plastic materials and paints (Hiraoka, 2001). The amount of PCB imported, exported and used is shown in Figure 2.1 (Hiraoka, 2001). Although a part of these products and waste PCBs have been stored, some products containing PCB are still used in a closed system even as recently as 1998.



Product	High voltage transformers and capacitors	Low-voltage transformers and capacitors	Impact papers	PCB	Others	Waste cloth and sludge	Transformers for poles
Purpose	Power plants, substation and power receiving facilities	Electric apparatus parts	Office supplies (copy papers)	Thermal oil	Plasticizers and paints	Cleaning	Power distribution
Major business	Constructors, Electric power companies and JR	Consumer electronics makers	Public offices and private sector	Manufacturers		Factories and Japan Railway	6 power companies in main land
Form	High level PCB, metal containers and coils	Insulting papers containing PCB, metal and plastic containers and coils	PCB applied papers	Liquid PCB		PCB-wiped cloth and sludge	Low level PCB, insulating oil, metal containers and coils
PCB level	High voltage transformers: 1/3 of average weight is insulating oil (PCB level: 60 ~ 70%).	PCB content/each: few ~ dozens g	PCB: 3 ~5 % of the weight of pressure sensitive papers	Variety from undiluted solution to ppm order			PCB level in insulating oil: few ~ dozens ppm*.

For transformers for poles, PCB has not been used intentionally since the beginning. It is supposed that PCB came to be mixed in the recycling process of insulating oil.

Fig. 2.1 PCB amount used and quantity consumed by application in Japan

China issued a "Relevant Regulations for Stopping the Production of PCBs" in 1974 and issued a "Circular on Preventing the Pollution of Hazardous Substances of PCBs" in 1979. Approximately 10000 t of PCBs were manufactured and of these, 9000 t were trichlorobiphenyl applied for transformers and capacitors. The remaining 1000 t were pentachlorobiphenyl mainly applied for paints, inks and lubricants as an additive. The first set of facilities for PCB incineration, located in Shenyang, began operation in 1995. The capacity of the facility is about 400 t waste annually (Li, 2002).

PCBs are a serious concern for the Russian Federation. PCBs were produced at plants located in the European part of Russian Federation from 1960-1990. During this period, the total amount was estimated to be 300000-500000 t – consisting of Sovol (PCBs) and Sovtol (mixture of PCBs and trichlorobenzene) as capacitor dielectric fluid. Capacitors were produced at a plant in Serpukhov (European part of Russian Federation). Location of operating capacitors in the Asian part of Russian Federation are unknown. The salvaging of oils used in condensers and transformers is also a major problem. Main sources of PCB pollution in the Asian part of Russian Federation are due to the numerous hydroelectric power stations, railroads, and industrial plants, which have condensers and transformers. PCBs are also formed from chemical plants as by-products (Shekhovtsov, 2002). PCBs are still being extensively applied in electrical equipment within the country. According to the PCB inventory under the Arctic Monitoring and Assessment Program (AMAP) and based on official data supplied by industry, the amount of PCBs in Russian Federation today is still tens of thousands of

tonnes. However, no accurate data is available concerning PCB amounts in the Asian part of Russian Federation (Yufit and Grosheva, 2002). At the beginning of 2002, 224.8 t of PCB-containing waste were found on 11 industrial sites of Sverdlovsk oblast. Another 190.3 t were generated in the course of the year and 1.5 t were exported from the oblast. Therefore, a total of 413.6 t were located at the oblast. According to the Stockholm Convention on POPs, Russian Federation has been given a 25-year deferment for the full destruction of PCBs. The total amount of PCBs (active substance) produced in the former USSR is approximately 180000 t.

The Ministry of Energy and Mineral Resources of the Republic of Kazakhstan estimate volumes of PCB (trichlorodiphenyl), which is used in electrical equipment by industry as dielectric fluid, amount to 1060 t. PCBs are mostly present in capacitators which were produced prior to 1994 at the Ust-Kamenogorsk Capacitor Plant.

Small amounts of PCBs are being added to the transformer oil of some power stations operating in Mongolia, notably in Ulaanbaatar city (Namkhai, 2002).

Hexachlorobenzene (HCB) HCB has been used as an industrial chemical. In Japan, during the period from 1952-1972, 70000 t of HCB was produced as a raw material for PCP. In the Russian Federation, HCB is banned for agricultural usage, but it can be found in pyrotechnical compounds. Past emissions of HCB from Russian Federation is documented in Table 2.7.

Table 2.7 Historic HCB emissions (kg/y) in Russian Federation (Münch and Axenfeld, 1999)

Year	Emission
1970	36092
1975	36369
1980	24501
1985	24376
1990	12120
1993-95	10980

Polybrominated diphenyl ethers (PBDEs) PBDEs have been widely used as brominated flame retardants which enhances the flame retardation quality of consumer products through the addition to or reaction with plastics and synthetic fibres. Their effects on the environment and human health have been a cause of concern. Furthermore, it has been reported that PBDD/PCDF form via thermolysis of brominated flame retardants. Worldwide demand of PBDEs reached approximately 70000 t (Table 2.7) in the 1999 (Rahman et al., 2001). Production in Japan (Table 2.8) was about 10000t/y at its peak, but in recent years it has been approximately 5000t/y (Nishizawa, 1997, 1999, 2000).

Table 2.8 Worldwide Demand of PBDEs (1999, t/y) (Rahman et al., 2001)

	US	Europe	Asia	Total
deca-BDE	24,300	7,500	23,000	54,800
octa-BDE	1,375	450	2,000	3,825
penta-BDE	8,290	210	0	8,500

Table 2.9 Production of PBDEs in Japan (t/y) (Nishizawa, 1997, 1999, 2000)

	1991	1993	1995	1997	1999
deca-BDE	9,800	5,800	4,900	4,700	4,450
octa-BDE	1,500	900	300	250	250

Although there is not much data on the demand in brominated flame retardants, 75% of production has been reportedly used in electric and electronic products in the US (Raether, 1998). It seems to be similar for PBDEs. In the UK, 1500 t/y of PBDEs were used in upholstered furniture in 1999 and 85t/y were used in electric products. The main purpose of using PBDEs in Japan are said to be in household electric appliances and Office Automation apparatus. PBDEs contained in electric and electronic products are possibly thought to enter the environment by volatilising and leaching during their use and waste processes. On the other hand, there can also be emissions from manufacturing plants of flame retardants.

In other countries of the Region, there is limited information on PBDE. In Mongolia, Russian Federation, and most of the CIS countries, there is no data on usage.

2.2.3 Persistent Toxic Substances – Unintentional by-Products

2.2.3.1 Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF) – Industrial Sources

PCDD/PCDF have various sources and are produced as unintentional by-products of many manufacturing and combustion processes involving the use, production or disposal of chlorine or chlorine-derived chemicals, notably, polyvinyl chloride (PVC) polymers. Sources of significant environmental concern for PCDD/PCDF include waste incineration, combustion in landfill fires, open burning, and many organochlorine production processes. PCDD/PCDF emissions from the steel industry, ceramic industry, power generation, and vehicles fuelled with leaded petrol are other sources of PCDD/Fs in the environment (Alcock and Jones, 1996; UNEP, 2001). In addition, PCDD/PCDF are emitted from paper making processes from pulp mills and can be found in wastewater from the bleaching process. PCDD/PCDF are also found in the technical product of 2,4-D.

Sources of PCDD/PCDF and their emission factors are specified for 15 countries (Austria, Australia, Belgium, Switzerland, Canada, Germany, Denmark, France, Hungary, Sweden, Japan, New Zealand, Slovakia, UK and USA) (UNEP, 2001).

In Hong Kong SAR, soil on the property of a previously privately-owned shipyard had recently been found to be contaminated with PCDD/PCDF among other contaminants. The estimated volume of the soil is 30000 m^3 (CED, 2002). The source of the PCDD/PCDF may be from open burning on the site. Two incinerators which will undergo decommissioning work will also contribute to sources of PCDD/PCDF, however the volume needs to be confirmed.

In the Russian Federation, environmental pollution by PCDD/PCDF is not a major concern, however the combustion of hazardous waste (approximately 42 million t in 1998) is a potential source of these substances (6-7 kg TEQ/year; including European and Arctic Russia). Table 2.10 lists the potential sources of dioxin pollution from the Russian Federation:

Table 2.10 Industrial Plants As Potential Sources of Pollution by PTS (Especially Dioxins andDioxin-Like Compounds (Russian Dioxin Program, 1997)

Region	City	Industrial Plant
Kurgan Oblast	Kurgan	Kurgan plant of medicine "Syntez"
Sverdlovsk Oblast	Ekaterinburg	"Uraltyazhmash"
		Plant of transformer
		Ural Indusrtial Union "Stroiplastpolimer"
	Kamyshlov	Kamyshlov plant "Uralizolyator"
		Kamyshlov leather plant
	Kirovograd	Kirovograd copper-melting plant
	Nizhni Tagil	Nizhni Tagil Plastics Plant
	Nizhnya Tura	Nizhneturinski plant of electric apparatus
	Novoutkinsk	Novoutkinsk plant "Iskra"
	Pervoural'sk	Share Society "Khrompic"
	Rezh	Rezh's Chemical plant
	Sysert	Sysert's electro-technical plant
	Tavda	Tavda's Wood Plant
Chelyabinsk Oblast	Chelyabinsk	Chelyabinsk varnish factory
Altai Krai	Yarovoye	OAO AltaiKhimProm
Krasnoyarsk Krai	Igarka	Igarskiy Sawmill
	Lesosibirsk	Novoeniseyisky Sawmill
		Tunguska Sawmill
Irkutsk Oblast	Angarsk	Angarsk electromechanical factory
	Bratsk	BratskKompleksKholding
	Ust-Ilimsk	Ust-Ilimsk Lumbermill Factory
	Baikalsk	Baikalsk Pulp and Papet Mill
	Bratsk	Bratsk Chlorine Factory
	Irkutsk	East-Siberian Branch of GosNIIKhlorProekt
	Usolye-Sibirskoye	"Sibsol" Combine
		AO "Sibirsky Silikon"
		AO "UsolyeKhimProm"
	Sayansk	AO " SayanskKhimProm "
Kemerovo Oblast	Kemerovo	OAO "Azot"
		PO "Karbolit"
		AO "KhimProm"
	Novokuzhnetsk	"SibEnergoTcherMet"
	Myski	Experimentalno-Mekhanitcheskiy Zavod
Novosibirsk Oblast	Novosibirsk	Zavod ElectroMontazhnykh Izdeliy
		Novosibirsk Chemical Factory
		OAO "Novosibirsk ChimConcentrats Factory"
Tomsk Oblast	Tomsk	Tomsk Lumbermill Combine
Far East	Ussuriysk	Ussuriysk Tannery
	Vladivostok	Incinerator Factory

Region	City	Industrial Plant
Khabarovsk Krai	Amursk	Amursk Pulp and Paper Mill AO "AmurskBumProm"
Birobijan City	Birobijan	Biribijan Transformer Factory

More than 20 cities of the Asian Region of Russian Federation (Angarsk, Amursk, Baikalsk, Bratsk, Selenguinsk, Norilsk, Shelekhov, Achinsk, Belovo, Barnaul) have industries that may be sources of PCDD/PCDF emission in the environment (Revich, 2002). No analyses of PCDD/PCDF have been carried out in Kazakhstan. It is speculated that PCDD/PCDF may be emitted from ferrous and non-ferrous, metallurgy, energy and chemical industries.

No analyses of dioxins and furans have been carried out in Kazakhstan. It is speculated that dioxins and furans may be emitted from ferrous and non-ferrous, metallurgy, energy and chemical industries.

Due to an unstable economy of Tajikistan, several industries that can contribute to emissions of PCDD/PCDF have closed. These included a cement plant, transformer plant in Kurgan-Tubpe, Vachsh chemical plant and the Yavan electrochemical plant. Therefore, for the last 10 years, emissions of PCDD/PCDF are likely to be minimal, however, since 1997 following political stabilisation, plants have started operating. One of the main PTS sources is a large aluminium plant. Although the plant operates at 60% capacity, 200 t of resin (tar) substances are formed as a result of thermal treatment. PCDD/PCDF sources in Tajikistan are generated from chemical and metal works, cement production and burning of municipal solid waste (Djuraev, 2002).

2.2.3.1.1 PCDDs/PCDF in Incineration Processes

Municipal waste incineration is the greatest contributor to releases of PCDD/PCDF, however, as a result of better control of PCDD/PCDF emissions in some of the countries in recent years, the amounts of PCDD/PCDF now released are significantly lower than the values reported in the past. In Japan, the emission amount in 1999 was reduced to 1/3 of that in 1997 (Table 2.11).

Table 2.11 PCDDs/PCDFs and Co-PCBs Inventory in Japan (Ministry of the Environment Japan, http://www.env.go.jp)

Source	1997	1998	1999	2000
MSW incinerator	5,000	1,550	1,350	1,019
	Water: 0.044*	Water: 0.044*	Water: 0.035*	Water: 0.035*
Industrial waste incinerator	1,500	1,100	690	555
	Water: 5.27*	Water: 5.27*	Water: 5.29*	Water: 2.47*
Small-sized waste incinerator	368 ~619	368 ~ 619	307 ~ 509	353~370
Crematorium	2.1 ~ 4.6	2.2 ~ 4.8	2.2 ~ 4.8	2.2~4.9
Industry related source				
Electric furnace	228.5	139.9	141.5	131.1
Steel manufacturing sintering process	135	113.8	101.3	69.8
Zinc recycling	47.4	25.4	21.8	26.5
Aluminum alloy manufacture	25.066	23.166	17.366	16.566
Other businesses	26.3	25.7	17.6	14.6977
Cigarette smoke	0.1~0.2	0.1~0.2	0.1~0.2	0.1~0.2
Automobile emission gas	1.12	1.12	1.12	1.61
Final disposal site	0.093*	0.093*	0.093*	0.093
Others	7.30*	6.83*	6.93*	5.95*
	7.30*			
Total	7,343 ~ 7,597	3,358 ~ 3,612	2,659 ~ 2,864	2,198~2,218

Unit: g-WHO-TEQ/y (TEF: WHO1998)
*Amount released to water system

Kim et al. (2001) measured the PCDD/PCDF concentrations in emission gases from 9 commercial sized MSW incineration facilities in the Republic of Korea. The results were 1.18 ~ 29.61 ng-TEQ/Nm^3 (average: 5.75, median: 2.77) at the exits of waste heat boilers and 0.026 ~ 4.548 ng-TEQ/Nm^3 (average: 0.92, median: 0.07) in gases released from stacks in 1998. In the Republic of Korea, PCDD/PCDF emission control has been promoted and its regulation has been established (UNEP, 1999). For new MSW incineration facilities, the regulation states that the maximum allowable level after 19 July 1997 is 0.1 ng-TEQ/Nm^3 and for existing facilities, the maximum allowable level between 1 July 1997 and 30 June 2003 is 0.5 ng-TEQ/Nm^3, and 0.1 ng-TEQ/Nm^3 after 1 July 1 2003. As a result, the PCDD/PCDF concentrations in the gases from MSW facilities were remarkably reduced: 5.87 ng-TEQ/Nm^3 in 1997 → 0.92 ng-TEQ/Nm^3 in 1998 → 0.051 ng-TEQ/Nm^3 in 1999. For incineration facilities with the exception of MSW incinerators, Oh et al. (1999) reported the results shown in Table 2.11. Since the data is insufficient, it is difficult to estimate the average concentration. However, the emission factors were calculated. The total capacity of industrial waste incinerators in Republic of Korea is 10260 t/day.

Table 2.12 Dioxins Concentrations In Emission Gases and Emission Factors in Republic of Korea (Oh et al., 1999)

	n	Waste to be incinerated	PCDDs/PCDFs Concentration (ng-TEQ/Nm^3)			Emission Factor (ng-TEQ/kg)		
			Range	Average	Median	Range	Average	Median
MSW incinerator	11	*1	0.13~22.3	1.75	0.81	0.4~112	20.3	9.0
Small-sized incinerator	1	*2	5.86			123		
	1	*3	0.25			2.7		
Incinerator in hospital	1	*4	43.3			496		
	1	*5	2.68			37.3		
Industrial incinerator	1	*6	0.03			0.5		

Composition of waste to be incinerated (%):

	Perishables	Papers	Plastics	Fabric	Wood	Waste oil
*1	46.6	23.1	17.1	5.5		
*2		51.2	26.0	13.9		
*3		51.2	7.5	10.3	27.4	
*4		32.3	29.8	24.2	7.9	
*5		8.4	50.2	41.5		
*6						100

By the end of the 1980's, several large waste incineration plants and many small waste incineration facilities were built and operated in certain areas of the Pearl River Delta, such as Shenzhen, Zhuhai, and Huizhou. It is estimated that 70% of the light industrial waste (such as PVC plastics, rubber, leather and cloth, etc.) were mixed with the municipal waste in some Regions where the waste production was up to 215 t per day. In the Pearl River Delta Region, the main sources of PCDD/PCDF were likely from waste incineration, PVC industries and emissions from leaded petrol fuelling vehicles (Fu, 2002).

No analyses have been conducted to investigate for presence of PCDD/PCDF in Mongolia at rubbish dumps of cities where wastes are burned.

PCDD/PCDF in Turkmenistan are mainly generated as a result of waste incineration, however there is no regular monitoring except for chlorine-organic pesticides (such as DDT and its metabolite).

2.2.3.1.2 PCDD/PCDF in Agricultural Chemicals

In the past, products which contained PCDD/PCDF, such as agricultural chemicals, were used and the PCDD/PCDF released from these products were significant. It has been noted that the PCDD/PCDF

concentrations in waste agricultural chemicals in Japan varied with production year (Masunaga, 2000, Table 2.13). Using these concentrations and the precise analysis of PCDD/PCDF in sediment samples in Shinji Lake and Tokyo Bay, nationwide amounts released in the environment during the past 40 years were estimated. In costal waters, 50% of the pollutants in Tokyo Bay were originated from past usage of PCP. Less than 10% was caused by fallout from air (combustion-derived). In comparison, in Shinji Lake, pollution from PCP, CNP and combustion were estimated to be approximately 60%, 10% and 30%, respectively.

Table 2.13 Estimation of environmental load of PCDD/PCDF derived from PCP and CNP in Japan (Masunaga, 2000)

Agricultural Chemicals	Utility Period	Amount Shipped (t)	Actual/TEQ	Average Dioxin Concentration	Estimated PCDD/PCDF Released
PCP	1955-(1974)	164000	PCDD/PCDFs I-TEQ WHO-TEQ	1,100 (n=33)[1] (μg/g) 3.77 (n=9)[1] (μg-TEQ/g) 1.25 (n=8)[1] (μg-TEQ/g)	180,000 (kg) 600 (kg-TEQ) 200 (kg-TEQ)
CNP	1965-(1994)	82000	PCDD/PCDFs I-TEQ WHO-TEQ	3,500 (1970), 280(1985)[2] (μg/g) 4.1(1970), 0.002(1985)[2] (μg-TEQ/g) 10 (1970), 0.003(1985)[2] (μg-TEQ/g)	190,000 (kg) 180 (kg-TEQ) 440 (kg-TEQ)

1) Average of reported values in the world including 4 types in Japan
2) The concentrations are assumed lower than those in year of manufacture based on report

Several recent studies have shown that PCDD/PCDF pollution in some areas of China was partly attributed to the production and use of pesticide sodium-pentachlochlorophenol (Na-PCP) (Bao et al., 1995). Residues of PCDD/PCDF have been found to be higher in concentration in environment media (such as soils, sediments and food web) in areas that had been sprayed with Na-PCP.

2.2.3.1.3 PCDD/PCDF in PCBs

PCBs also contain PCDD/PCDF and the concentrations are listed in Table 2.14 as follows (UNEP, 2001). Research carried out in Russian Federation has shown a correlation between an increase of PCDD/PCDF levels in human breast milk with environmental pollution due to the use of PCBs.

Table 2.14 Dioxins in Technical PCBs (UNEP, 2001)

PCBs	Dioxins concentrations (μg-TEQ/t)
Low level chlorine compounds (Clophen A30 and Aroclor 1242)	15,000
Middle level chlorine compounds (Clophen A40 and Aroclor 1248)	70,000
Middle level chlorine compounds (Clophen A50 and Aroclor 1254)	300,000
High level chlorine compounds (Clophen A60 and Aroclor 1260)	1,500,000

2.2.3.1.4 PCDD/PCDF in Other Chemicals

The process of manufacturing chlorophenol by chlorination of phenol or hydrolysis of chlorobenzene can produce PCDD/PCDF. Of the chlorophenols, pentachlorophenol produces the most significant amount of PCDD/PCDF, for example, 3660 ppm of octa-PCDD and 0.8-400 ppm of hepta-PCDF, respectively (US EPA, 1988). PCDD/PCDF are also secondly produced in the process of manufacturing chlorophenol-based pesticides, herbicides and bactericides. Of these, 2,4,5-T and CNP are well known. 2,4-PA and chlometoxynyl contains PCDD/PCDF and reportedly 23 ppm and 24 ppm of PCDD/PCDF are contained in chlometoxynyl and 2,4-PA, respectively. Taking trichlorobenzene as an example, 759 ppb of PCDD and 1145 ppb of PCDF are contained (US PA, 1988). There is a report that 7170 ppb of PCDD and 3285 ppb of PCDF are contained in

hexachlorobenzene and 809 (mg/kg dry wt) of PCDD and 933 (mg/kg dry wt) of PCDF are contained in sludge in the process of manufacturing trichlorobenzene-based PCP (Na salt).

Industries producing chloro-alkali are a source of PCDD/PCDF. In China, there are about 200 chloro-alkali factories. In 1998, the amount of alkali produced in China was over 5 million tonnes (Li, 2002).

2.2.3.1.5 Emission Factors of PCDD/PCDF as By-Product

Table 2.15 shows the compiled emission factors of PCDD/F based on UNEP's classification (UNEP, 2001). Facilities preventing the release of PCDD/PCDF are grouped into 5 levels that are classified in detail according to PCDD/PCDF emission factors estimated by UNEP. According to the UNEP calculation by level of emission gas treatment system and combustion control system, the total amounts in emission gases were between 0.5 and 3500 µg-TEQ/t-waste. Excluding the facilities without control system, the amounts were between 0.5 and 350 µg-TEQ/t.

Table 2.15 Emission Factors of PCDDs/PCDFs (UNEP, 2001)

Category	Source	Occurrence Factor (µg TEQ/t)
Waste incineration	Municipal solid waste incineration	30–350
	Toxic waste incineration	10–350
	Medical waste incineration	525–3000
	Incineration of light components in shredder	1–1000
	Sewage sludge incineration	0.4–50
	Incineration of waste wood and biomass	1–100
	Animal burning	5–500
Metal industries	Steel sintering	0.3–20
	Coke production	0.3–3
	Factories for steel industry and steel casting	0.1–3
	Foundries	1–4.3
	Copper production	0.03–50
	Aluminum production (all sections)	10–35
	Lead production	0.5–80
	Zinc production	5–100
	Brass production	0.1–1
	Magnesium production	50–250
	Other non-ferrous metal	2–100
	Metal shredding	0.2
	Recycling of electric wire	3.3–5000
Electricity	Fossil-fuel-fired utility	2.5–10
	Biomass fuelled power plant	5–500
	Landfill and biogas incineration	8
	House heating and cooking—biomass	100–1500
	House heating—fossil fuels	1.5–70
Ceramic industries	Cement kiln	0.15–5
	Lime	0.07–10
	Brick	0.02–0.2
	Glass	0.015–0.2
	Ceramics	0.02–0.2
	Mixing asphalt	0.0007–0.07

Exhaust gases from transportation systems	4-stroke engine	0.00–2.2
	2-stroke engine	2.5–3.5
	Diesel engine	0.1
	Crude petroleum engine	4
Uncontrolled burning	Fire/incineration—biomass	5–30
	Fire, waste fire, landfill fire, industrial fire, accidental fire	94–400
Other	Biomass drying	0.007–10
	Crematoria	0.4–90
	Smoked room	0.6–50
	Residue from dry cleaning	NA
	Cigarette smoke	0.1–0.3

(1) Waste Incineration Facilities

As for MSW incineration facilities which are the biggest sources of PCDD/PCDF, Table 2.12 indicates that the average amount released is about 20 µg-TEQ/t in Korea. In Japan, it is approx. 30-120 µg-TEQ/t, dividing the total amount of PCDD/PCDF by the total quantity of MSW of about 41.1 M t. These values are based on the release through emission gases.

In 1999-2000, an inventory of PCDD/PCDF emitting sources was undertaken with US EPA financial support. It gave a figure of at least 10 kg for total PCDD/PCDF air emission in the Russian Federation. In Russian Federation, PCDD/PCDF is mainly generated from the incineration of hazardous waste (42.2 million t/y) producing 10835 g I-TEQ/year of PCDD/PCDF air emission. PCDD/PCDF monitoring has only been undertaken in the Krasnoyarsk and Irkutsk oblast. Research is recommended in other areas such as in European Russian Federation and especially in Siberia and the Far East.

(2) Metal Industry

Sintering plants are very important sources of PCDD/PCDF when compared with MSW incineration facilities. The levels of PCDD/PCDF in emission gases from sintering plants were between 0.6 and 3.4 ng-TEQ/m^3 in the UK (Eduljee & Dyke, 1996), which are not remarkably high. However, the amount released becomes high due to the large amount of emission gas. When the amount of PCDD/PCDF released from 1 t sintered metals are calculated using the data, the released levels are between 1.2 and 9.0 µg-TEQ/t.

2.2.3.2 PCBs

2.2.3.2.1 PCBs - Combustion By-Products of Iincineration Processes

PCBs were formed and released from MSW incineration (Sakai et. al., 1993, 1999). The following are the unit releases per one-tonne waste of PCB in the existing incinerator: Emission gas: 240 µg, Fly ash: 790 µg, Bottom ash: 18 µg and Total: approximately 1000 µg (Table 2.16). In this measurement PCB in emission gas was 48 ng/Nm^3. Of which, the release of coplanar PCBs (Co-PCBs) was about 140 µg/t-waste and the toxicity equivalent amount was 2.8 µg/t-waste. These values are measurements in existing incinerators and the PCB amount released from a new incinerator is thought to be drastically lower. Kaba et al. (1993) measured PCB concentrations in gas released from 10 existing old-type incinerators in Kyoto. The concentrations in emission gases vary greatly from 61.6 ng/Nm^3 to 155 µg/Nm^3. There is a positive correlation between CO and PCB concentration in emission gas at 0.1% significant level. Therefore, it is thought to be caused by the difference in combustion conditions. The average PCB concentration in gases from 10 incinerators is 17700 ng/Nm^3 (median: approx. 1800 ng/Nm^3).

Chang et al. (1999) measured PCBs in flue gases released from local MSW incinerators in Korea and reported that PCB concentrations in gases released from 9 furnaces were between 0.005 and 12 ng-TEQ/Nm^3 (average: 1.72 ng-TEQ/Nm^3) and the total amount released was 24.9 g-TEQ/y. For the calculation of the amount released, it was assumed that the furnaces were operated for 300 days/y and the amount of emission gases were 5000 Nm^3 per one-tonne waste. From these assumptions, the PCB amount released from the combustion of one tonne waste is 8.6 µg-TEQ/t-waste.

Table 2.16 PCB Output/Input in MSW Incineration Facilities (Sakai et al., 1999 a and b)

		Concentration	Unit Generation	Amount Released	Total Amount Output	Amount Input
PCBs (Total)	Emission gas	48 (ng/Nm^3)	5000 (Nm^3/t waste)	240 (μg/t waste)	1000 (μg/t waste)	13,000~33,000 (μg/t waste)
	Fly ash	26 (ng/g)	30 (kg/t waste)	790 (μg/t waste)		
	Bottom ash	0.12 (ng/g)	150 (kg/t waste)	18 (μg/t waste)		
Co-PCBs (Total)	Emission gas	11 (ng/Nm^3)	5000 (Nm^3/t waste)	55 (μg/t waste)	140 (μg/t waste)	450 ~ 550 (μg/t waste)
	Fly ash	2.7 (ng/g)	30 (kg/t waste)	81 (μg/t waste)		
	Bottom ash	0.012 (ng/g)	150 (kg/t waste)	1.9 (μg/t waste)		
Co-PCBs (TEQ)	Emission gas	0.23 (ngTEQ/Nm^3)	5000 (Nm^3/t waste)	1.2 (μgTEQ/t waste)	2.8 (μgTEQ/t waste)	0.31 ~ 0.29 (μgTEQ/t waste)
	Fly ash	0.053 (ngTEQ/g)	30 (kg/t waste)	1.6 (μgTEQ/t waste)		
	Bottom ash	0.00023 (ngTEQ/g)	150 (kg/t waste)	0.035 (μgTEQ/t waste)		
PCDDs/DFs + Co-PCBs (TEQ)	Emission gas	1.8 ~ 14 (ngTEQ/Nm^3)	5000 (Nm^3/t waste)	9 ~ 70 (μgTEQ/t waste)	160 ~ 220 (μgTEQ/t wastee)	1.5 (μgTEQ/t waste)
	Fly ash	5.0 (ngTEQ/g)	30 (kg/t waste)	150 (μgTEQ/t waste)		
	Bottom ash	0.021 (ngTEQ/g)	150 (kg/t waste)	3.2 (μgTEQ/t waste)		

The PCB concentrations in gases released from 12 MSW incinerators in the US were between non detectable (ND) and 7000 ng/Nm^3 (average: 1800 ng/Nm^3, median: 275 ng/Nm^3). Those in 10 hazardous waste incineration facilities were between 21 and 14700 ng/Nm^3 (average: 2430 ng/Nm^3, median: 755 ng/Nm^3) (Lemieux et al., 1999). As mentioned above, the measurements of the PCB amounts released from incineration facilities is variable, which is thought to be caused by the difference in incineration conditions.

2.2.3.2.2 PCBs in ChemicalBy-Products

HCB and PCP contain high levels of PCBs among agricultural chemicals. It has been observed that PCBs in sediments and soils in the area of Ya-Er Lake were about 8200 ng-PCB/(g dry wt) in soils, which is supposed to be caused by a chemical plant around the lake area. This chemical plant has not manufactured PCBs, but HCB and PCP. It is assumed that PCBs generated as a by-product from the manufacturing process of these chemicals was released through drainage. PCB concentrations in inks and pigments are reported. The PCB concentrations in 7 samples of printing inks used in Denmark were between 1~184 ppb (average: 52 ppb, median: 16 ppb) (Rastogi et. al, 1992).

2.2.3.2.3 PCBs in Secondary Sources

Sewage sludge is sometimes applied for agricultural use. In the UK, 43% of the sewage sludge of 1.22 x 10^6 t (dry wt.) is used for agriculture, and the amount of PCBs in sewage sludge volatilising into the atmosphere was about 85 kg/y (Harrad et al. 1994). Concentration range of 0.084~19 μg/g of PCBs were detected in 12 samples of composts containing MSW and sewage sludge in the USA (average: approx. 4.2 μg/g, median: approx. 1.4 μg/g) (Malloy et al., 1993).

2.2.3.3 HCB

2.2.3.3.1 HCB in Pesticides

HCB is a byproduct formed during the production of some pesticides and remains as an impurity in these products. It is used as a raw material for PCP, PCNB (pentachloronitrobenzene), TCTP (dimethyl 2,3,5,6-terephthalate), chlorothalonil (TPN), and picloram. Some reports on HCB concentrations in these pesticides are

presented in Table 2.17. By multiplying the HCB concentrations by the usage of each pesticide, it is estimated that in the 1990's, 580 kg/y of HCB entered the environment in the UK (UK National Env. Tech. Centre, 2000), 1270 kg/y in the US, and 6463 kg/y worldwide (Bailey, 2001). HCB has been detected in bottom sediments in China, which presume the source to be impurities in PCP. Other reports suggest that the sources could also be PCP or HCH. However, none of the reports mention the quantity of HCB that has entered the environment.

Table 2.17 HCB Content Rates In Pesticides

Pentachloro phenol (PCP)	Pentachloro nitrobenzene (PCNB)	Dimethyl-2,3,5,6-tetrachloro terephthalate (TCTP)	Chlorothalonil (TPN)	Picloram	Reference
ND	0.5–2.0% (Average 1.0%)	0.1–11% (Average 7.7%)	ND	—	Saito et al., 1976
—	0.1%	—	—	—	Nishimura et al., 1980
0.4%	0.7%	—	—	—	Ando et al., 1984
—	—	10%–14%	—	—	Wapensy, 1969
0.04%	—	—	—	—	Schewetz et al., 1978
—	—	9% (1973) 8% (1974)	—	—	Burns et al., 1974
—	—	0.3% (1972)	—	—	Mumma et al, 1975
—	1.8%–11%	—	—	—	Sittig, 1980
—	0.5% (1983) 0.1% (1988)	—	—	—	US-EPA, 1982**
Average 0.01%	< 0.05%	< 0.3%	< 0.05%	< 0.02%	Tobin, 1986**
—	0.05%	0.07%–0.3%	0.0018%–0.0026%	—	Benazon, 1999
0.005%–0.01%	0.05%	0.1%	0.004%	0.005%	Bailey, 2001

* Per ingredient, or it was not confirmed whether per ingredient or per product

** Self-standards set by pesticide manufacturers in the US

2.2.3.3.2 HCB in Chemicals

HCB is formed as a byproduct during the manufacture of chlorinated organic solvents such as tetrachloroethylene (PCE), trichloroethylene (TCE), and carbon tetrachloride. Although HCB is separated by distillation of the solvents, traces may remain. Separated HCB may be found in the distillation bottom fractions. It has been estimated that, from 1980 to 1983 in the US, 3178 t/y of HCB was produced as a byproduct from the manufacture of PCE, TCE, and carbon tetrachloride whereas the amount of HCB produced as a byproduct from the manufacture of chlorobenzene was about 0.0065 t/y (Jacoff et al., 1986). Thus, we can infer that the three chlorinated solvents are the major sources of HCB. Calculating from the amounts of HCB by-products and the production of chlorinated solvents gives a result of 1–24 kg-HCB/t-PCE.

However, not all of these HCB byproducts in solvent residues are released into the environment; most are incinerated and disposed of in landfill sites. The rate of HCB decomposed by thermal incineration is reported to be more than 99.97%–99.99% in the US (Jacoff et al., 1986, Quinlivan et al., 1975). It has been estimated that 1–24 g of HCB was emitted for each tonne of chlorinated solvents produced, which results in a value 3 orders of magnitude lower than the above-mentioned 1–24 kg-HCB/t-PCE and was equivalent to a 99.9% decomposition rate during incineration.

In China, the Ya-Er Lake located in the eastern part of Wuhan city, Hubei Province along the lower reaches of the Yangtze River had been polluted with HCB from 1962-1987 by direct discharge of effluent from a large chemical factory located on the bank of the lake. The effluent discharge resulted in serious pollution of the

surrounding soils and lake (Liu et al., 1985; Zhang et al., 1980).

2.2.3.3.3 HCB from Waste Incineration

HCB emissions from incineration facilities are quite different, depending on the type of furnace, collection method, and incineration temperature; the measured values of HCB concentrations in flue gas range widely from 0.13 μg/m^3 to a few hundred μg/m^3. Komatsu et al. (1992) and Kaba et al. (1992) carried out research into HCB emission routes; their findings are shown in Table 2.18. The most important emission route was thought to be in the form of flue gas, accounting for 62%–97.9%, followed by 1.9%–38% (42.4–2020 ng/g dry wt) in flyash, 0%–0.2% ND–28.7 ng/g dry wt) in incinerator ash, with negligible amounts found in the cooling water for the flue gas. With regard to the HCB emissions originating from municipal solid waste incineration, values of 560–56000 kg/y were measured in the 1990's worldwide (Bailey, 2001). Although the range of estimated HCB emission factors was wide, most were within 1–100 mg/t-waste. Multiplying these emission factors by 40 million t/y, which was the annual amount of municipal waste incinerated in the 1990's in Japan, the total HCB emissions were estimated to be 40–4000 kg-HCB/y.

Table 2.18 HCB Emission Factors Derived from Municipal Solid Waste Incineration in Japan

HCB Concentration in Flue Gas (μg/Nm^3)			**HCB Emission Factor (mg/t-waste)**		
Minimum	Maximum	Average	Minimum	Maximum	Average
0.03	3.2	1.3	1.0	51	19
0.16	12	2.9	0.80	90	24
0.36	14	7.9	3.6	200	76
0.05	0.09	0.063	0.32	0.61	0.44
0.04	3.5	1.6	0.29	25	12
0.82	110	38	5.7	770	270
6	110	59	90	1700	880
–	–	11	–	–	77
–	–	0.11	–	–	0.77

Another controlled combustion process is cement production. Using data from a survey conducted by the Canadian Portland Cement Association, the HCB emission factor in cement production to be 0.17 mg-HCB/t-cement (Bailey, 2001). The production of cement in Japan has been 70 000 000–90 000 000 t/y from the late 1970's to the present; thus, HCB emissions are presumed to be approximately 10 kg-HCB/y. Even though uncontrolled combustion processes, such as fires and open burning, can be considered to increase the amount of HCB released to the environment owing to incomplete combustion, there are not many available data. With a simulation of open burning in steel drums, Lemieux (1999) estimated HCB emissions to be 22–48 mg-HCB/t-waste, 2 orders of magnitude higher than the emission factor estimated above for recent municipal waste incineration.

2.2.3.4 PCP

In the manufacturing of PCP, other PTS chemicals can be produced as intermediates. The manufacture of PCP is a four step process whereby HCH is thermolysed in the presence of iron to yield chlorobenzenes which are further chlorinated to produce HCB. HCB is then hydrolysed in alkaline conditions to produce PCP. During its manufacturing, a certain amount of solid waste can be produced which may contain about 10% PCDD/PCDF (Bao et al., 1989). Further information on the production of these PTS as intermediates or as by-products is provided in a later section. Technical grade PCP, which is approximately 86% pure has historically contained PCDD/PCDF (e.g. tetra-, hexa- and octochlorodibenzo-p-dioxins) and HCB as manufacturing by-products (Extoxnet, 1996) .

In addition to the presence of PCP in the environment due to its uses as stated above, PCP can also be unintentionally produced. PCP can be emitted from various sources, such as from the timber industry (through leakage and volatilisation), textile industry, mushroom cultivation, combustion processes (coal, cokes, fluid fuels/gas, treated wood, gasoline), and sewage sludge. (Wild et. al., 1992). While the emission from wood treatment shows high values, cultivation of mushrooms was only indicated as an agricultural purpose. The emission from the combustion process was estimated on the basis of PCP concentration in fly ash, not taking

into consideration PCP in flue gas.

Wikstroem et al. (1999) reported that PCP concentration in the flue gas ranged from 0.13 to 2.24 μg/Nm3 (n=11, the average 0.73 and the medium 0.45μg/Nm^3) based on the results of combustion experiments of artificial municipal solid wastes by means of laboratory-scale fluid bed furnace. If the flue gas emission per waste-tonne is assumed to be 5000 Nm^3, the emission factor will be 0.65-11.2 mg/t waste.

2.2.3.5 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are ubiquitous and are formed during incomplete combustion of fossil fuels and other organic compounds. It may also arise from petrochemical industrial practices. Among the many hydrocarbons, benzo[a]pyrene poses the most concern since it is the most carcinogenic.

The main sources of PAHs in the Region are generated from power plants, automobile exhaust, coal industry and metal production (aluminium, iron and steel industry).

In the Asian Region of Russian Federation, the major sources of PAHs are from the aluminium and coal industry. There are large aluminium plants located in Krasnoyarsk and coal burning is predominant in the cities of Irkutsk Region (e.g. Bratsk, Shelehovo, Sayansk). The highest concentrations are registered in cities with cold climatic conditions where coal is used and aluminium plants are located – Chita, Shelehovo, Novokuznetsk, Bratsk, Zima, Kansk, Irkutsk, Yujno-Sahalinsk, and Ulan-Ude (Revich, 2002). In the Russian Federation, automobiles are also major PAHs contributors to air pollution. For example, PAHs generated from leaded gasoline vehicles and vehicles that have not been fitted with exhaust gas catalytic afterburners. PAHs are also prevalent in the Asian Region of Russian Federation which is dominated by the coal and petroleum industry.

In China, many studies have been carried out on PAH sources in the Pearl River Delta. The sources of PAH emissions in the Pearl River Delta are mainly non-point sources which are difficult to control. These include wet and dry atmospheric deposition and river runoff. Major sources of PAHs are industrial sewages (both petroleum-and combustion derived), vehicle emissions and power plant emissions. Mobile combustion emissions are thought to be primary contributors to PAH contamination in the atmospheric environment of several urban cities including Guangzhou, Hong Kong SAR and Macau SAR (Fu et al., 1997; Qi et al., 2001).

It has been reported that PAHs found in mangrove sediments of Hong Kong SAR originated from petrogenic (oil spill and leakage from boats and ships) and pyrolytic inputs, discharge from municipal and industrial wastewater and runoff (Tam et al., 2001). Stormwater runoff is likely to contain trace amounts of PAHs originating from roadways and motor vehicle discharges. PAHs found in marine sediments are likely to have originated from domestic sewage, stormwater runoff and industrial discharges. Overall, the occurrence of PAHs is mainly combustion-derived opposed to petroleum-derived since there is no raw petroleum industry in Hong Kong (Hong et al., 1995). Emissions from vehicles is a major PAH contributor in Hong Kong SAR. Local deposition of PAH in Hong Kong SAR may be a more important source than long-range atmospheric transportation (Lam, 2002).

2.2.4 Organic Metals

2.2.4.1 Organic Tin Compounds

Butyltins have been considered as the most widely distributed marine toxic contaminants, especially in coastal waters with frequent shipping activities (Page et al., 1996; Ruiz et al., 1996). Sources of TBT in coastal environments are primarily attributed to leaching from ship paint. Owing to its extreme toxicity to aquatic life even at low concentrations and its hormone disrupting effects on marine invertebrates (Thain and Waldock, 1986; Valkirs et al., 1987), tributyltin and other forms of organotin, such as phenyltin, have been legislatively banned for use in anti-fouling paints since the late 1980's in most European and North American countries. Unfortunately, only a few countries or Regions in Asia have such regulations.

In the Region, organic tins have not been produced or used in Mongolia, Kazakhstan, Kyrgyzstan, and Uzbekistan. In Tajikistan, small quantities of organic tins are used, however further clarification is required. Use has been restricted in Republic of Korea since 2000.

Studies have shown that butyltin compounds were widespread in the aquatic environment in China (Jiang et al., 2001). In the Pearl River Delta of China, there are several large harbours; Huangpu Harbor and Victoria Harbour are the most important for shipping activities. Both domestic and international vessels with TBT-containing anti-fouling paint that sail and dock in the area are the main causes for the tributyltin contamination

in the coastal waters of the area (Fu, 2002). Relatively high concentrations of TBT have been found in sediments from the Pearl River where more than 30 shipyards are located. Shipping and activities, especially at shipyards are mainly responsible for the TBT contamination in the Region.

In Hong Kong SAR, regulations were introduced in 1992 to control the sale and usage of TBT paint. TBT is not a registered pesticide in Hong Kong SAR, but is still widely used as anti-fouling paints under a special permit system. Under the permit system, application of TBT paint is not allowed on vessels below 25 m in length with the exemption of aluminum hull, and TBT paints can only be sold to permit holders in containers of 20 litres or more. Its use is monitored via permit records. The consumption of TBT from 1996 to 2000 is shown below (AFCD, 2001):

Table 2.18 Consumption of TBT in Hong Kong SAR(quantity in kg active ingredient) (1996-2000) (AFCD, 2001)

Organic Tin Compounds	**1996**	**1997**	**1998**	**1999**	**2000**	**Sub-total**
Tributyltin fluoride (TBTF)	471	285	172	179	135	1,242
Tributyltin methacrylate (TBTM) copolymer	87,806	90,686	69,861	69,723	50,346	368,422
Tributyltin oxide (TBTO)	3,792	2,521	1,753	2,681	1,172	11,919
Total	92,069	93,492	71,786	72,583	51,653	381,583

In Japan, TBT was banned from production for pesticide use in 1977 and banned from household use in 1979. Approximately 11840 t were used for antifouling paints. Production and use of tributyltin oxide (TBTO) discontinued in 1989. The production of TPhT, which was banned in 1989, had an accumulated production of 346 t. TBT was banned from all new vessels in 1990 and banned from all vessels in 1992. Due to bans on organotin compounds in Japan, a decrease of 82% concentration in Japanese waters between 1989 and 1996 have been reported (ORTEP, 2001).

2.2.4.2 Organic Mercury Compounds

Representative organic mercury compounds include alkyl mercury (e.g. methylmercury) and allylmercury (e.g. phenylmercury acetate) which were used as pesticides and medicines. Methylmercury and ethyl mercury chloride have been utilized for the sterilisation of seeds as a pesticide. Other sources of mercury include gold mining activities and sites of demolished chemical factories. The most well known source of organic mercury to the environment, usually released with wastewater, is the byproduct formation of methylmercury from inorganic mercury used as catalyst in the production process of acetaldehyde from acetylene. Methylmercury was the cause of Minamata disease in Japan. Approximately 1 kg catalysts were consumed per 1 t acetaldehyde. The production of acetaldehyde in Japan in 1960 was 50,000 t, and the consumption of mercury was 50 t annually.

In China, mercury is mainly used for the battery, lamp, gold extraction, chloro-alkali industry and medicine. The total amount of mercury emission from coal combustion was estimated at about 296-302.9 t annually in the mid-1990's with 213.8 t discharged into the atmosphere and the other 89.1 t remaining in ash and cinder. The data collected from 15 provinces, autonomous Regions and cities showed that the average content of organic mercury in coal was 0.037 mg/kg, accounting for 18.8% of total mercury in coal, and the average content of organic mercury remaining in ash was 0.045 mg/kg, accounting for 28.1% of total mercury in ash. From 1978 through 1995, mercury emission had increased at an average of 4.8% per year.

In Mongolia, mercury was restricted in 1997, however, mercury contamination is a serious concern since a large volume of mercury compounds have been used over the past 30 years for the purpose of gold extraction. Presently, a large technogenic mercury placer exists in the Boroo riverbed of the Selenge Aimage which is located 120 km from Ulaanbaatar in northern Mongolia (Tumenbayer et al., 2000). In 2000, the Ministry of Nature and Environment of Mongolia implemented a project to remove mercury accumulated in the river sediment. Due to efforts of the project, 25 kg of mercury was removed from 400 m^3 river sediment over a 0.4 km^2 area (Namkhai, 2002).

In the Russian Federation, a large number of toxic substances, including mercury lamps, are disposed of in MSW landfills. Approximately 22.5 t of Granosan (ethyl mercury chloride), a mercury-containing chemical

used as a fungicide for grains, are stockpiled on nine storage areas of Yakutia (Sakha) in the Asian part of Russian Federation. Stockpiles of Granosan in the Amursk Region and the Krasnoyarsk Region, have also been found to be 20 t and 3 t, respectively. Granosan was banned in 1994. In both the Chita Region and the Altai Region, organomercury has been used for gold mining. In addition, plants in Usolie-Sibirskoe and Sayansk (Irkutsk Region) among others utilised mercury electrolysis in the production of chlorine. Mercury from these plants has polluted the sediments, water and fishes of the Bratsk reservoir (Revich, 2002).

In Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, mercury producing plants are still in operation, however very little information is available.

2.3 DATA GAPS

As mentioned earlier in Section 2.1, the 18 persistent toxic substances reviewed for Region VII were scored according to the degree of data gaps experienced for PTS sources, by participants of the 3-day 1st Technical Workshop. None of the chemicals had a score of '0' representing the establishment of full data sets, complete evidence and/or ongoing monitoring data available. Ten of the toxic substances, consisting mostly of pesticides were assigned a score of '1' indicating limited available data, conflicting data, and /or further monitoring data are required on a wider scale. A score of '2' was assigned to 8 of the chemicals which consisted of mainly industrial chemicals (PCBs, PBDE, HCB) and unintentional by-products (PCDD/PCDF, PAHs). PCP and organic mercury were also scored '2'. For these 8 chemicals, there is very little or unreliable source data available.

In general, inventories of PTS sources are not well documented in the Region, in particular for developing countries and countries with economies in transition. There is basically little information available on PTS in DPRK, and inventories of PTS sources in the Russian Federation have mainly been devoted to the industrially developed European part of Russia where the population is greatest. There is a scarcity of reliable data on the sources of PTS in the Asian territory of Russia (Siberia and Far East). Little information is available on the quantity and location of obsolete pesticides in the CIS countries. In some cases, obsolete pesticides have not been properly labelled, therefore the identities of pesticides are often unknown. Furthermore, environmental management and health controls in developing countries have not been adequately implemented to support their rapid industrialisation, thus resulting in stockpiling of obsolete pesticides and releases of toxic emissions to the environment.

For some countries, although some PTS sources have been or are being monitored, the list of PTS monitored is often shorter than the Stockholm Convention's list of 12 POPs, resulting in data gaps. For example, in Russia, there is almost a complete lack of data on HCB stocks and occurrence. In Kazakhstan, there are no source inventories particularly focused on PTS. In Tajikistan, there is little or no monitoring of PCDD/PCDF and PAHs, and monitoring systems for obsolete pesticide stocks in Uzbekistan have not been established. PCDD/PCDF sources have also been poorly investigated in the developing countries. Calls for sound efforts aimed at emission inventory compilation are necessary.

In the Region, open burning and forest fires could be a fairly significant contributor of PCDD/PCDF and PAHs emissions to the atmosphere, however, almost little or no information is available. In Russian Federation, forest fires annually destroy huge taiga massifs, some of which had been treated with pesticides.

2.4 SUMMARY OF HOT SPOTS AND MOST SIGNIFICANT REGIONAL SOURCES

Hot spots are specific locations that have been significantly affected by PTS sources resulting from non-anthropogenic or anthropogenic activities. The hot spots pose significant adverse impacts to the environment and require urgent remedial actions.

In the Central and North East Asia Region, the former Soviet Union has major hot spots for obsolete pesticides. A meeting held in Moscow on 7-8 February, 2001 by the Arctic Council for the "The ecological reasonable mangement in field of stores of out-of-date pesticides" project have identified priority Regions whereby the inventory of out-of-date pesticides should be documented. These Regions are the Kamchatka Peninsula, Krasnoyarsk Krai, Magadan Oblast, Sakha Republic (Yakutia) and Tyumen Oblast of the Russian Federation. Furthermore, inventory for out-of-date pesticides in three sub-boreal Regions have been identified: Altai Krai, Kurgan and Omsk Oblast (Shekhovtsov, 2002). Members of the Commonwealth of Independent States have a large quantity of PTS which are obsolete and redundant. A conservative estimate suggests there is greater than 150000 t of obsolete pesticides. Much is in poor condition and not properly managed (PAN UK, 2000). In

Kyrgyzstan, obsolete pesiticides such as aldrin and DDT are buried, however information about quantity and location are not available. For some countries, such as Kazakhstan, the identification of hot spots is premature due to the lack of detailed PTS inventories which are necessary to identify hot spots. Tajikistan was one of the Regions leading users of pesticides (for cotton growing). Approximately 60% of all the pesticides used within the country, were used for cotton crops. The amount of pesticide varied from 1.29 to 2220 kg/km^2, sometimes reaching 5000 kg/ km^2 in the past, but this has decreased substantially (i.e. 0.03 kg/ha) due to the price of pesticides and a decrease in imports. There is also a problem with lack of control of import of obsolete pesticides and burial of prohibited PTS. In Turkmenistan, almost all pesticides are buried due to the lack of management and insufficient expertise for management. In Uzbekistan, greatest stocks of out-dated pesticides are located in the Surkhan-Darya area (southern Uzbekistan).

In the Pearl River Delta, it is estimated that 76,000 – 100,000 t of organochlorine pesticides were used annually from 1972 to 1982 (Hua and Shan, 1996). Approximately 1.8 to 2.7 kg per metric acre of these pesticides were applied to the agricultural zones around the delta region (GAEMS, 1996). Although production and usage of DDT and HCHs have been officially banned in China since 1983, organochlorine pollutants found in the environment around the delta region are most likely derived from organochlorine pesticide residues in agricultural soils. The pesticides ultimately enter into the Pearl River through evaporation (including wind-driven transport of suspended particulates) and surface runoff. The Pearl River carries a considerable load of up to 863 t per annum (Zhou et al., 1997) of chlorinated pesticides. There is evidence from the distribution profiles of DDT and its degradation products that current input of fresh DDT as an impurity of other pesticides may still continue in some areas of the Pearl River Delta.

The Russian Federation is notably contaminated with PCBs especially in the Asian part due to the presence of numerous large hydroelectric power stations and thermal power stations, railroads, and also industrial plants.

Uncontrolled burning of municipal waste is a noticeable contributor to PCDD/PCDF in addition to industries producing chloro-alkali as PCDD/PCDF is released as a by-product during the manufacture of certain chemicals, such as chlorophenols.

2.5 CONCLUSIONS

In general, for all of the countries of the Region, information on source inventories of PTS are not as readily available as information on levels of PTS in environmental compartments. In particular, many of the developing countries or countries with economies in transition have not established source inventories for PTS. Of the countries, Japan has taken the lead in the characterisation of PTS as it has been building a relatively broad database on PTS over the past three decades. The Republic of Korea is also relatively advanced in her development of PTS source inventories. Through the collection of PTS information from the various countries of the Region, it is noted that although some of the countries lack sufficient monitoring of PTS, programs on emission control, and adequate quality control, the awareness of PTS issues is growing.

In the Central and North East Asia Region, the group of chemicals that are of high priority are PCDD/PCDF, PCBs, PAHs, DDT and HCH as there is either a) still major production of the chemical for local and export use, b) evidence of the chemical as a contaminant in large scale production of other chemicals, c) known emissions of the chemical from large scale incinerators or chlorine bleaching of pulp or other related combustion facilities, d) evidence of leakage from major stockpiles of the chemical, e) large-scale use of the chemical throughout the Region, and/or f) spatial and/or temporal trends increasing Regionally from levels above threshold. For these chemicals except for DDT and HCH, information on sources is also noticeably insufficient or unreliable.

3 ENVIRONMENTAL LEVELS, TOXICOLOGICAL AND ECOTOXICOLOGICAL PATTERNS

3.1 INTRODUCTION

This chapter deals with the environmental levels and trends, and toxicological and ecotoxicological effects of PTS in the Region. The relative spatial and temporal variations in environmental concentrations of PTS are described. The following section addresses hot spots whereby relatively high concentrations of PTS have been reported in a variety of sources.

In Region VII, the awareness of significant environmental and human health effects of PTS have only relatively recently been growing. Thus, the data reported herein are insufficient to make a full review of the spatial and temporal variations as well as toxicological and ecotoxicological effects in this Region. For example, the standard methods for sampling and analytical measurements of PTS have not been established among most countries. Thus, data gaps are briefly explained, followed by the conclusion section.

3.1.1 Scoring of PTS

As mentioned in the methodology section of Chapter 1, a scoring mechanism was utilised as a tool to prioritise the 18 selected PTS of Region VII. Detailed instructions for scoring can be found in Annex 1. The scoring results based on a collective effort of all the participants of the 1st and 2nd Technical Workshops have been prioritised according to level of concern and data gaps (Table 3.1).

Table 3.1 Scoring for Prioritizing PTS for Environmental Levels, Toxicology and Ecotoxicology and Data Gaps

Chemicals	Environ. Levels	Data Gaps	Toxicol. Effects	Data Gaps	Ecotoxicol. Effects	Data Gaps
PCDD	2	2	2	2	2	2
PCDF	2	2	2	2	2	2
PCBs	2	2	2	2	2	2
DDT	2	2	2	2	2	2
PAHs	2	2	2	2	2	2
Toxaphene	1	2	0	1	0	1
HCH	1	2	2	2	1	2
PCP	1	1	1	1	1	1
Org Hg Cmpds	1	1	1	1	1	1
Org Tin Cmpds	1	1	1	1	1	1
PBDE	1	1	1	2	1	2
Chlordane	1	0	0	0	0	0
HCB	1	0	1	1	1	1
Heptachlor	0	1	0	1	0	1
Aldrin	0	0	0	1	0	1
Dieldrin	0	0	0	0	0	0
Endrin	0	0	0	0	0	0
Mirex	0	0	0	0	0	0

Score=0-chemical is of no concern/supportive data is collected

Score=1-chemical has local concern/supportive data is limited
Score=2-chemical has Regional concern/supportive data is lacking

In interpreting the scores, it is important to note that different scores for chemicals indicate that the chemicals are of different levels of concern. For example, a chemical having a score of '2' is a chemical of Regional concern compared to a chemical having a score of '1' indicating a chemical of local concern. The scoring system does not provide any information on the ranking or prioritisation of chemicals having the same level scores i.e. in the table above, the chemicals have been grouped according to score, but they are not ranked within each group.

The results of the scoring exercise indicate that PCDD/PCDF, PCBs, DDT and PAHs are chemicals of Regional concern for environmental levels and ecotoxicological effects, and these five PTS in addition to HCH are of Regional concern for human effects.

With regards to data gaps, there are insufficient reliable data on 8 of the 18 chemicals. These chemicals are mainly industrial chemicals (PCBs, HCH and PBDE) and unintentional by-products (PCDD/PCDF, PAHs). There is also insufficient information available for DDT and toxaphene.

3.2 LEVELS AND TRENDS

A few reports from government and academia have been published with regards to PTS levels and trends in the Region. Some data without references came from the data in questionnaires submitted to the UNEP/GEF PTS program. In the following tables, a value of 0 means less than detection limit of an analytical method used for the analysis.

3.2.1 Air/Deposition

Table 3.2 presents the range of concentration of 8 PTS in air sample conducted in four countries.

Table 3.2 Concentrations of PTS in air samples from Region VII (ng/m^3)

Country / Chemicals	China	Japan	Russian Federation	Republic of Korea
DDTs	*0.004 ~ 0.116*	—	—	—
PCDD/PCDF *	—	0.0073 ~ 1.0*1	—	*0.015 ~ 1.496*5*
Endrin	*0.022*	—	—	—
HCB	—	0.18 ~ 0.4 0.013 ~ 1.1*2	0.070 ~ 0.170	*0.020 ~ 0.387*5*
Heptachlor	*0.001 ~ 0.002*	—	—	—
PAHs	—	0.012 ~ 48 0.042 ~ 2.7*3	~ 124*6	*0.001 ~ 1.663*5*
PCBs	0.297 ~ 0.537 **	0.13 ~ 1.4 0.091 ~ 2.3*4	0.009 ~ 0.023	—
Toxaphene	—	—	0.011 ~ 0.021	—

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
* : The unit of dioxins is pg-TEQ/m^3
**: PCBs concentrations in gas phase; 0.048 – 0.157 ng/m^3 in particulate phase
*1: Dioxins Surveillance Data (2000) from Ministry of the Environment, Japan
*2: Chemicals in the Environment, Ministry of the Environment, Japan (2000)
*3: Chemicals in the Environment, Ministry of the Environment, Japan (2001)
*4: Chemicals in the Environment, Ministry of the Environment, Japan (2001)
*5: Annual Report of EDCs Research Project, NIER (2000)
*6: Reported in Bratsk city, Irkutsk oblast (Revich, 2002)

In a study on wet and dry deposition of organochlorine pesticides in the Pearl River Delta, China, the wet and dry deposition samples collected from 14 stations from April to June 2001 were analysed to assess their deposition fluxes in order to gain an insight into their possible migration processes in air. The deposition fluxes of HCHs and DDTs were within the range of 0.6-9.4 ng/m^2/day and 0.4-15.0 ng/m^2/day, respectively. Organochlorines such as DDTs, HCHs, heptachlor, and dieldrin were detected in aerosol samples collected from Guangzhou, Shenzhen, Zhuhai, and Hong Kong SAR cities in the Pearl River Delta (Cheng et al., 2000). Concentrations of DDTs in aerosols were higher in Guangzhou and Zhuhai than those in other cities in this region.

PCB levels were measured in gas and particulate phase of air sampled from three cities (Guangzhou, Shenzhen and Zhaoqing) in the Pearl River Delta (Li et al., 2001). The study reported PCB concentrations of 0.297 to 0.537 ng/m^3 in gas phase, and 0.048-0.157 ng/m^3 in particulate phase.

In the 2000 National Dioxin (PCDD+PCDF+co-PCB) Survey of Japan, the average atmospheric levels (gas+particulates), of 920 sites were reported to be 0.15 pg-TEQ/m^3 with a range of 0.073 to 1.0 pg-TEQ/m^3 (National Dioxin Survey, Ministry of the Environment, Japan, 2000). The levels in 10 sites (1.1 % of total) exceeded the Air Environment Standard (0.6 pg-TEQ/m^3) of Japan.

In 2000, PCBs were detected in all the air samples in 15 cities all over Japan, with a range between 0.13 and 1.4 ng/m^3 (Ministry of the Environment, Japan, Chemicals in the Environment, 2000). HCB was detected in all the sampling sites (which were grouped into three categories: (a) near the sources, (b) residential areas and (c) suburbs) at with a range of 0.18 to 0.4 ng/m^3, and average of 0.27 ng/m^3. No clear difference could be observed among the three categories (Ministry of the Environment, Japan, Endocrine Disruptive Chemicals Survey, 2000).

In the early 1990s, atmospheric concentrations of several organochlorine compounds at Lake Baikal in the Russian Federation were reported. Levels of HCB and PCBs were reported to be 70-170 and 8.7-23 pg/m^3, respectively (Iwata et al., 1995), while toxaphene levels were 11 to 21 pg/m^3 (McConnell et al., 1993). The chromatographic pattern of toxaphene was extremely "weathered" compared with the standard, and the congener pattern of air samples was similar to lake water, indicating the importance of atmospheric deposition processes.

In 2000, organochlorines in air samples of Republic of Korea were reported, and the levels of HCB, PAHs and PCDD/PCDF were 0.02-0.387 ng/m^3, 0.001-1.663 ng/m^3, and 0.015-1.496 pg-TEQ/m^3, respectively (NIER, Annual Report of EDCs Research Project, 2000). In addition, PCDD/PCDF levels in Republic of Korea were reported to be 0.593, 0.244 and 0.122 pg-TEQ/m^3 for large, medium and small cities, respectively (NIER, Annual Report of EDCs Research Project, 2000).

In the Asian part of the Russian Federation (Siberia and Far East), the total air emissions of benzo(a)pyrene have been monitored in major provinces and cities and are shown in Table 3.3. The major contribution of PAHs is from vehicular emissions.

Table 3.3 Emission of PAH (Benzo(a)pyrene) in the Asian Regions of Russian Federation, 1999 (Shekhovtsov, 2002)

Region	Total Air Emission, t
Sverdlovsk oblast	3.52
Chelyabinsk oblast	0.43
Novosibirsk oblast	0.12
Omsk oblast	1.45
Tomsk oblast	0.01
Krasnoyarski krai	2.93
Altaiski krai	0.70
Kemerov oblast	1.08
Chitinskaya oblast	0.01
Magadanskaya oblast	1.80

Yakutiya (Sakha)	0.09
Primorski krai	0.80
Sakhalinskaya oblast	0.001
Chukotka aut.okrug	0.02

3.2.2 Surface Waters (Water and Sediment)

3.2.2.1 Seas/Oceans

3.2.2.1.1 Water

A few reports have been published for the PTS concentrations of water samples in this Region. The concentrations published were very high for some countries, as shown in Table 3.4.

Table 3.4 Concentrations of PTS in Sea Water Samples from Region VII (ng/m^3)

Country / Chemicals	Kazakhstan	Japan
PCDD/PCDF*	—	0.012 ~ 2.2[*1]
HCH	*0 ~ 40*	—
PCBs	—	0 ~ 150 0.11 ~ 2.8[*2]

※Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is pg-TEQ/L
*1: Dioxin Surveillance Data, Ministry of the Environment, Japan (2000)
*2: Chemicals in the Environment, Ministry of the Environment, Japan (2001)

In water environment (both river water and coastal sea water) in 1997 of Japan, the sum of PCDD/PCDF reported by the Ministry of the Environment gave the average concentration of 0.37 pg-TEQ/m^3 at 12 sites with variations between 0.005 and 3.9 pg-TEQ/m^3, and the data from the local governments at 21 sites ranged from ND (not detected) to 0.4 pg-TEQ/m^3 with an average concentration of 0.061 pg-TEQ/m^3. It should be mentioned here that they did not classify whether the water system was a sea or inland.

In the Japan National Dioxin (PCDD+PCDF+co-planar PCB) Survey in 2000, the average level in water (rivers, lakes and coastal sea water) in a total of 2,116 sites was reported to be 0.31 pg-TEQ/L with a range of 0.012 to 48 pg-TEQ/L (Ministry of the Environment, Japan, National Dioxin Survey, 2000). The levels in 83 sites (3.9 % or total) exceeded Water Environment Standard (1pg-TEQ/L) of Japan. In general, PCDD/PCDF levels in coastal water were an order of magnitude lower than those in rivers. The average level in ground water (total 1,479 sites) was 0.097 pg-TEQ/L, ranging from 0.00081 to 0.89 pg-TEQ/L. Total PCB analyzed in 1999 ranged from ND (less than 0.01ng/L for each isomer) to 150 with a detection frequency of 131 among 171 samples (Ministry of the Environment, Japan, Endocrine Disruptive Chemicals Survey, 2000).

3.2.2.1.2 Sediment

In sediment samples of China and the Republic of Korea, organochlorines such as DDT, dieldrin, HCH, PAHs and PCBs were detected. They are shown in Table 3.5.

Table 3.5 Concentrations of PTS in Marine Sediment Samples in Region VII (μg/kg)

Country / Chemicals	China	Japan	Kazakhstan	Republic of Korea
Aldrin	—	—	—	*0*[*3]

Chlordane	—	0 ~ 12.9 ND ~ 11.1[*1]	—	*0 ~ 0.21*[*3]*
DDTs	*1.56 ~ 1,629*	0 ~ 31.9 ND ~ 17.2[*1]	6 ~ 4,600	*0 ~ 1.26*[*3]*
Dieldrin	*2.4 ~ 11*	ND ~ 0.02[*1]	—	*0 ~ 0.10*[*3]*
Dioxins *	—	0.018 ~ 470[*2]	—	—
Endrin	—	—	—	*0 ~ 0.25*[*3]*
HCB	—	ND ~ 4.9[*1]	—	*0 ~ 0.21*[*3]*
HCH	*0.43 ~ 17*	ND ~ 2.8[*1]	—	*0 ~ 2.07*[*3]*
Heptachlor	—	—	—	*0 ~0.01*[*3]*
Mirex	—	—	—	*0*[*3]*
PAHs	*39 ~ 68,560*	98.8 ~ 2,300 [**,*1]	—	*1.19 ~ 1,093*[*3]*
PCBs	*5 ~ 750*	0 ~ 770 0.54 ~ 750[*1]	—	*0 ~ 1.62*[*3]*
TBT	—	0 ~ 450	—	—
TPT	—	0 ~ 62	—	—

※Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
* : The unit of dioxins is pg-TEQ/g
**: Concentration of only benzo(a)pyrene of PAHs
*1: Chemicals in the Environment, Ministry of the Environment (2001)
*2: Dioxin Surveillance Data, Ministry of the Environment (2000)
*3: "Monitoring of POPs in the coastal environment, KORDI (2001)

In the National Dioxin (PCDD/F+co-PCB) Survey in Japan in 2000, the average level in sediments (total 1836 sites) was 9.6 pg-TEQ/g, ranging from 0.0011 to 1400 pg-TEQ/g (Ministry of the Environment, Japan, National Dioxin Survey, 2000). In the results of PCB analysis in 1999, 47 out of 48 samples showed detectable levels of PCB ranging between ND (<0.01) to 770 ng/g wet wt (Ministry of the Environment, Japan, Endocrine Disruptive Chemicals Survey, 1999). HCB was detected in some sediments (4 out of 17 sites) in 2000 with a range of 0.18 to 4.9 ng/g dry wt (Ministry of the Environment, Japan, Chemicals in the Environment). B(a)P was detected in 12 out of 17 sediment samples with a range of 2.4 to 2300 ng/g dry wt (Ministry of the Environment, Japan, Chemicals in the Environment). Other polycyclic aromatic hydrocarbons, including benzo(a)anthracene, benzo(e)pyrene, pyrene, anthracene, benzo(ghi)perylene, phenanthrene etc., were also detected in almost all samples with levels up to several hundreds ng/g dry. TBT and TPT were detected in high frequencies, i.e., 85 out of 103 and 45 out of 99 sites, respectively, with levels up to 450 and 62 ng/g dry wt., respectively (Ministry of the Environment, Japan, Chemicals in the Environment).

3.2.2.2 Inland Waters

3.2.2.2.1 Water

Chlordane, HCB, PCBs, toxaphene, DDTs, PCDD/PCDF and HCH were found in water samples of Japan, Kazakhstan, Russian Federation and Republic of Korea as indicated in Table 3.6. PCDD/PCDF concentrations of Republic of Korea were 0.001-1.061 pg TEQ/L (NIER, Annual Report of EDCs Research Project, 2000), while HCH was reported at 1-322,000 ng/L in Kazakhstan (State Enterprise "Kazhydromet").

Table 3.6 Concentrations of PTS in Inland Water Samples from Region VII (ng/L)

Country / Chemicals	Japan	Kazakhstan	Russia	Republic of Korea

Chlordane	—	—	0.034	—
DDTs	—	*0.405 ~ 1,200*	0.053 ~ 5,900	—
PCDD/PCDF*	0.014 ~ 48[*1]	—	—	*0.001 ~ 1.061*[*3]
HCB	—	—	0.007 ~ 0.028	—
HCH	330 ~ 55,000	*1 ~ 322,000*	2 ~ 2,200	—
PCBs	0.095 ~ 8.4[*2]	—	0.018 ~ 0.590	—
Toxaphene	—	—	0.064	—

※ Italic data come from Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is pg-TEQ/L
*1: Dioxin Surveillance data, Ministry of the Environment (2000)
*2: Chemicals in the Environment, Ministry of the Environment, Japan (2001)
*3: Annual Report of EDCs Research Project, NIER (2000)

γ-HCH concentration of Tya River in Buryatian Republic, Russian Federation was reported at 3 ng/L, while the concentrations of α-HCH and γ-HCH of Bargousin River were 1-2 ng/L and 2-4 ng/L, respectively. The total concentration of α-HCH and γ-HCH in the Selenga River was 2 ng/L (Regional Administration, and Committee of Natural Resources, Russian Federation, 2001).

HCH concentration in water samples from the Lena River in Yakutya (Saha) region was 330-5500 ng/L. Total concentrations of HCH and DDT compounds in water samples of the Ural River in Chelyabinsk region were 400-1,700 ng/L and 400-5,900 ng/L respectively, while those in Miass River were 60-2,200 ng/L and 280-4,200 ng/L respectively**.** In Krasnoyarsk region, concentrations of α-HCH, and γ-HCH in river water samples were 22-98 and 16-96 ng/L respectively, while those in water samples from reservoirs were 0.098-0.099 and 0.090 ng/L, respectively. DDT was not detected in this region (Region Administration, and Committee of Natural Resources, Russian Federation, 2001).

Organochlorine levels in Lake Baikal in the Russia Federation were analyzed in the early 1990s. Levels of HCB and PCBs were reported to be 0.007-0.028 and 0.18-0.590 ng/L, respectively (Iwata et al., 1995). In another report, total HCH, total chlordane, total DDT, and toxaphene in (dissolved+particulate) phases of water in Lake Baikal were reported to be (1.340+ND), (0.028+0.006), (0.047+0.006), and (0.064+NA) ng/L, respectively (Kucklick et al., 1993) (NA = not analyzed). HCHs and DDTs were analyzed in rivers of Russian Federation (Kucklick et al., 1993). Ural, Volga and Ob River Basins were among the most polluted. In East Russian Federation, Amur River sometimes showed relatively high levels of α-HCH (<5-1840 ng/L), γ-HCH (<5-620 ng/L) and DDT (<50-450 ng/L).

3.2.2.2.2 Sediment

DDTs, HCB, HCH, organic tins, PCBs, PAHs and PCDD/PCDF were detected in sediment samples of China, Japan, Russian Federation, Kazakhstan and the Republic of Korea as shown in Table 3.7.

Table 3.7 Concentrations of PTS in Sediment Samples from Inland Waters in Region VII (μg/kg)

Country / Chemicals	China	Japan	Kazakhstan	Russian Federation	Republic of Korea (dry)
DDTs	*0 ~ 38*	ND ~ 11.7[*3]	*0 ~ 53*	0.02 ~ 64.5	—
PCDD/PCDF*	—	0.002 ~ 20 *[1] 16.1 ~ 50.7 *[2]	—	0.03 ~ 7.7	*0 ~ 0.244*[*5]
HCB	—	ND ~ 0.35[*3]	—	0.005 ~ 0.160	—
HCH	*0.05 ~ 2.07*	ND~ 2.9[*3]	*47*	0.015 ~ 69	—

Organic Tin compounds	1.7 ~ 379.7 **	ND ~ 220[*3]	—	—	*0 ~ 3.82*[*5]
PAHs	*170 ~ 2,145*	ND~ 76[*3,*4]	—	—	*0 ~ 3*[*5]
PCBs	*43 ~ 461*	0.042 ~ 160[*3]	*188*	0.08 ~ 6.1	—

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is pg-TEQ/g
**: Concentration of only TBT as organic tin compounds
*1: Sample from river sediments
*2: Samples from lake sediments
*3: Chemicals in the Environment, Ministry of the Environment (2001)
*4: Only benzo(a)pyrene was analyzed
*5: Annual Report of EDCs Research Project, NIER (2000)

The levels of organic tins (TBTs) in surface sediments from the Pearl River Delta were reported in the range from 1.7 to 379.7 ng/g (Zhang et al., 2002). Compared to that in sediments from other parts of the world, the TBT concentration in the Pearl River Delta sediments is relatively low. High TBT concentrations (328.7-377.7 ng/g) were found in sediments from the Front Channel of the Pearl River (Zhujiang) where more than 30 shipyards and ship-repairers were located. It was therefore suggested that shipping activities, especially at shipyards, were mostly responsible for the TBT contamination in the Region.

In Japan, HCB was detected in some sediments 4 out of 17 sites in 2000 with a range of 0.18 to 4.9 ng/g dry wt. In sediments of Japan, the sum of PCDD/PCDF reported by the Ministry of the Environment in 1997 ranged from 0.002 to 20.0 pg-TEQ/g dry wt with an average of 3.68 pg-TEQ/g dry wt in river sediments, from 16.1 to 50.7 pg-TEQ/g dry wt with an average of 33.1 pg-TEQ/g dry wt in lake sediments, and from 0.012 to 49.3 pg-TEQ/g dry wt with an average of 17.1 pg-TEQ/g dry wt in coastal sediments, respectively.

Sediment concentrations of PCDD/PCDF in Lake Baikal and Selenga River in Irkutsk Region of the Russian Federation were reported to be 0.03 and 0.05 pg TEQ/g respectively, while that of the sediments near a discharging point from a pulp and paper mill plant was 7.7 pg TEQ/g.

Total concentrations of HCH compounds and DDT compounds in bottom sediments in Ural River in Chelyabinsk Region were 0.015-30 and 0.02-64.5 μg/kg respectively, while those in Miass River were 0.04-69 and 0.29-64.5 μg/kg respectively (Regional Administration, and Committee of Natural Resources, Russian Federation, 2001).

In Lake Baikal sediments, levels of HCB, α-HCH, β-HCH, γ-HCH, p,p'-DDT, p,p'-DDE, p,p'-DDD, t-chlordane, c-chlordane and PCB were reported to be 0.005-0.16, 0.006-0.054, 0.01-0.056, 0.003-0.009, 0.007-0.83, 0.007-1.3, 0.009-0.6, <0.001, <0.001-0.002 and 0.08-6.1 ng/g dry wt., respectively (Iwata et al., 1995).

3.2.3 Groundwater

Few data have been reported on the PTS concentrations in groundwater.

In ground water samples from Japan, PCDD/F concentrations ranged from 0.00081 to 0.89 pg-TEQ/L at 1479 sites with no samples exceeding the Japanese Environmental Standards for Ground Water (1pg TEQ/L) (Ministry of Environment, Japan, 2001).

3.2.4 Soils

Few data were reported for the detection and concentration of PCBs, PCDD/PCDF, PAHs, HCH in agricultural soil samples. Concentrations of PCBs, PCDD/PCDF, and PAHs in agricultural soil samples of the Republic of Korea were 0-1.215, 0-46.5, and 0-9 μg/kg, respectively. (NIER, Annual Report of EDCs Research Project, 2000).

3.2.4.1 Agricultural Soils

A survey has been carried out on the levels of DDTs and HCHs in soils from the Pearl River Delta, China in 2000 (Zhang, et. al., 2001). Sixty-three soil samples were analyzed and the results showed DDTs (averaged 68.5 ng/g in all samples) ranged from 15-125 ng/g in 70% of the samples and HCHs (averaged 16.2 ng/g in all samples) ranged from 2-30 ng/g in 80% of the samples were detected in agriculture soils as shown in Table 3.8. Results of analyses of soil samples taken near one of the pits whereby DDT was disposed of in the Tomsk

oblast of the Russian Federation gave DDT concentrations ranging from 160-38500 μg/kg.

Table 3.8 Concentrations of Some PTS in Agricultural Soil Samples From Region VII (μg/kg)

Country / Chemicals	China	Kazakhstan	Russian Federation	Republic of Korea
DDTs	*0.015 ~ 0.125*	0.003 ~ 0.093	160-38,500*[2]	—
Dioxins *	—	—		*0 ~ 46.5*[1]
HCH	*0.002 ~ 0.030*	*0.022*	10-110*[2]	—
PAHs	—	—		*0 ~ 9*[1]
PCBs	—	—		*0 ~ 1.215*[1]

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is ng-TEQ/kg
*1: Annual Report of EDCs Research Project, NIER (2000)
*2: Yufit and Grosheva, 2002

3.2.4.2 Unmanaged Soils

Tble 3.9 Concentrations of PTS in Unmanaged Soil Samples from Region VII (μg/kg)

Country / Chemicals	China	Japan	Kazakhstan	Russia
DDTs	6.7	—	—	6.7
PCDD/PCDF *	0.11 ~ 0.15	0 ~1,200	0.12 ~ 370	0.22 ~ 0.75
HCB	—	—	—	0.05 ~ 1.6
HCH	0.18 ~ 8.2	10	*0 ~ 10*	1~ 110
PAHs	—	—	—	0.92
PCBs	7.1 ~ 8.2	—	—	1.4 ~ 92

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is ng-TEQ/kg

According to Table 3.9, in the National Dioxin Survey (PCDD+PCDF+co-planar PCB) in Japan in 2000, the average level in soil (total 3,031 sites) was 6.9 pg-TEQ/g, ranging from 0 to 1,200 pg-TEQ/g (National Dioxin Survey, Ministry of the Environment, Japan, 2000). One location near the source exceeded the Soil Environment Standard (1,000 pg-TEQ/g) of Japan. PCP and γ-HCH were detected in 1 out of 94 soil samples with 12 and 10 ng/g dry wt, respectively (Ministry of the Environment, Japan, Endocrine Disruptive Chemicals Survey). The other HCHs were not detected at all.

In soils around Lake Baikal, levels of HCB, and PCBs were reported to be 0.05-1.6 and 1.4-92 ng/g dry wt, respectively (Iwata et al., 1995).

A survey had been carried out on the levels of DDTs and HCHs in soils from the Pearl River Delta, China in 2000 (Zhang, et. al., 2001). The concentrations of DDTs (averaged 6.7 ng/g) and HCHs (average 8.2 ng/g) in the non-cultivated soils were lower than those in the cultivated soils.

HCH levels in soils of Tibet were reported to be 0.18-5.38 ng/g (Fu et al., 2001).

Soils from an industrial area near Angara of Irkutsk Region showed 312 pg TEQ/g of dioxin concentrations in soils while the background concentration was 0.22-0.75 pg TEQ/g. In Tomsk Region, forest had been treated with DDT and HCH from 1953 to 1957. A variety of pesticides were detected from the soil samples whereby DDT: 0.16-38.5 mg/kg, DDD ND-1.6 mg/kg, DDE ND-0.99 mg/kg, and HCH 0.01-0.11 mg/kg. PAH

concentration in Sibkabel was reported to be 920 μg/g. HCH concentration of soil near Lena River in Yakutya (Saha) Region was 0.001-0.017 mg/kg (Regional Administration, and Committee of Natural Resources of Dioxins, Russian Federation, 2001).

HCH level in Kazakhstan was reported to be very high, 1000-1967 μg/kg. The sum of dioxins in soils varied considerably, and ranged from 0.12 to 370 pg-TEQ/g, and 0.001 to 550 pg-TEQ/g near the incinerators (Regional Administration, and Committee of Natural Resources, Kazakhstan, 2001).

3.2.5 Aquatic Biota

The ranges of DDTs, HCHs, and PCBs in tilapia (fish) collected from inland river systems of Hong Kong SAR were 28.2-40.1 ng/g (dry wt), 2.04-3.76 ng/g (dry wt) and 267-310 ng/g (dry wt), respectively (Zhou et al., 1999a). It was revealed that the homologue pattern of PCBs varied between fish species. Feeding habits of fish intervened in the PCBs accumulation process. Higher contents of PCBs and chlorine numbers were found in black bass (*Micropterus salmoides*) located in the highest trophic level (Zhou et al., 1999b).

In Japan in 1999, 40 samples among 70 showed PCB data greater than the quantification limit in fish samples (edible parts). These data ranged from ND (quantification limit in biological samples was 10 ng/g wet wt tissue) to 780 ng/g wet wt tissue. In mussels (whole homogenates), 13 samples out of 30 were above the quantification limit, ranging from ND to 52 ng/g wet wt, and in birds (pectoral muscle) the frequency of quantification was 7 out of 10, ranging from ND to 20 ng/g wet wt. Occasionally, high concentration of PCBs have been reported in wildlife, especially those in top predators in the marine environment. In a recent report from Prof. Tanabe and Prof. Iwata, Ehime University, the average concentration of PCBs in the adipose tissue of black-footed albatross in Western Pacific Ocean was reported to be 90000 ng/g.

PCDD/PCDF levels in aquatic organisms in rivers, lakes and coastal environment of Japan were found to range from ND to 1.33, with an average of 0.46 pg-TEQ/g wet wt, from 0.34 to 0.44 with an average of 0.38 pg-TEQ/g wet wt, and from ND to 2.90 with the average of 0.83 pg-TEQ/g wet wt, respectively.

HCB analysis in Japan was also conducted on biological samples. HCB was detected in fishes, mussels and birds with frequencies of 10 % (7 out of 69), 0 % (0 out of 30) and 50 % (5 out of 10), respectively (the quantification limit was 1 ng/g wet wt). The levels, however, were very low with maximum values of 2 ng/g wet wt in fishes and birds.

3.2.5.1 Marine Organisms

Bivalves are commonly used to assess PTS in the marine environment as shown, for example, in Table 3.10. Several studies have been conducted on the levels of organochlorines and other contaminants in green mussel (*Perna viridis*) from the Pearl River Estuary (Fang et al., 2001) and Hong Kong SAR waters (Phillips et al., 1985, Tanabe et al., 1987).

The levels of organotins in several marine organisms (fish, mussel and shrimp) from the Pearl River Estuary (Zhang et al., 2002, in manuscript) were reported. Results for measurements of butyltin compounds in fish muscle samples from three sampling sites, mussel samples from one sampling site and shrimp samples from one sampling site in the Pearl River Estuary were reported. The TBT concentrations in the fish tissue samples vary from 4.8 to 18.8 ng/g wet wt. The TBT concentration in the mussel sample (13.2 ng/g) was comparable to that of the fish samples (18.8 ng/g), but higher than that of the shrimp sample (3.6 ng/g).

In Japan, TBT and TPT were detected in some marine fishes (10 and 13 out of 70 samples, respectively) with levels up to 160 and 100 ng/g wet wt, respectively (Ministry of the Environment, Japan, Chemicals in the Environment). Dieldrin was detected in 10 out of 70 fishes and in 5 out of 30 mussels with levels up to 4 and 160 ng/g wet wt, respectively.

Bivalves are commonly used to assess PTS in the marine environment as shown in Table 3.10.

Table 3.10 Concentrations of PTS in Bivalve Samples From Seawaters in Region VII (μg/kg)

Country / Chemicals	Japan	Republic of Korea
Aldrin	—	*0 ~ 2.55*[*3]
Chlordane	<1 ~ 37[*1]	*1.34 ~7.12*[*3]
Coplanar PCBs *	—	—
DDTs	<1 ~ 5[*1]	*6.60 ~ 59.46*[*3]
Dieldrin	<1 ~ 160[*1]	*0 ~ 5.60*[*3]
Dioxins *	0.32 ~ 0.82[*,*2]	—
Endrin	—	*0 ~ 1.37*[*3]
Furans *	—	—
HCH	<1[*1]	*2.02 ~ 22.63*[*3]
Heptachlor	—	*0 ~ 0.23*[*3]
Hexachlorobenzene	<1[*1]	*0.08 ~ 1.06*[*3]
Mirex	—	*0 ~ 0.40*[*3]
PAHs	—	*149 ~ 1,141*[*3]
PCBs	3.2 ~ 9.9[*1] 6.9[*1]	*3.34 ~64.10*[*3]
TBT	<0.05[*1]	—
TPT	<0.02 ~ 0.02[*1]	—

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins, furans, and coplanar PCBs is ng/kg
*1: Chemicals in the Environment, Ministry of the Environment, Japan (2001)
*2: Dioxins Surveillance Data, Ministry of the Environment, Japan (2001)
It includes PCDD, PCDF and Coplanar PCBs and its unit is ng-TEQ/kg
*3: Monitoring of POPs in the Coastal Environment, KORDI (2001)

Concentrations of PTS in crustacean samples in Japanese seawater were reported as: chlordane 31μg/kg, DDTs 180 μg/kg, HCH < 2 μg/kg HCB 8.5 μg/kg, PCBs 270 μg/kg. In fish samples concentrations were reported as: chlordane 6.6-510 μg/kg, DDTs 20-12000 μg/kg, dieldrin 0-4 μg/kg, HCH 2.1-3100 μg/kg, HCB 1.3- 120 μg/kg and PCBs 0-1100 μg/kg.

The TBT concentration of marine fish samples from China was reported as 4.8-18.8 μg/kg, while the PCDD/PCDF concentration of those in the Russian Federation was 35 ng/kg.

Table 3.11 Concentrations of PTS in Marine Fish Samples in Region VII (μg/kg)

Country / Chemicals	China	Japan	Russian Federation
Chlordane	—	*6.6 ~ 510* <1 ~ 34[*1]	—
DDTs	—	*20 ~ 1,200* <1 ~ 66[*1]	—

Dieldrin	—	<1 ~ 4[*1]	—
Dioxins *	—	0.15 ~ 1.2 (shark)[*2] 0.10 ~ 0.95 (cod) [*2]	35
HCH	—	*2.1 ~ 3,100* <1 ~ 1[*1]	—
Hexachlorobenzene	—	*1.3 ~ 120* <1	—
PCBs	—	*0 ~ 1,100* <10 ~ 950[*1] 3.8 ~ 350[*1]	—
TBT	4.8 ~ 18.8	<50 ~ 160	—
TPT	—	<10 ~ 100	—

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is ng TEQ/kg
*1: Chemicals in the Environment, Ministry of the Environment, Japan (2001)
*2: Marine Environmental Monitoring, Ministry of the Environment (2000)

Several studies related to PTS concentrations in marine mammal, prawn or starfish samples were reported from China, Japan and the Russian Federation (Table 3.12 - 3.13). In Japan, organic tins and PCBs in mammalian samples were 50-18,000 and 320 µg/kg, respectively, while 40-41 µg/kg chlordane, 46-50 µg/kg DDTs, 13 µg/kg HCH, 5.9-7.8 µg/kg HCB, 460-470 µg/kg PCBs and 3.6 µg/kg of TBT in prawn samples were reported. In starfish samples, 16-160 µg/kg chlordane, 49-170 µg/kg DDTs, 8.9-44 µg/kg HCH, 30 µg/kg HCB and 45 µg/kg PCBs were detected.

Table 3.12 Concentrations of PTS in Mammalian Samples from Seawaters in Region VII (µg/kg)

Country / Chemicals	China (dolphin, porpoise)	Japan (sea lion, seal, whale)	Russian Federation (seal)
Chlordane	*14 ~ 840*	—	1,500 ~ 1,700
DDTs	*2,600 ~ 160,000*	12,000 ~ 30,000	54,000 ~ 62,000
HCH	*5.4 ~ 2,200*	—	200 ~ 220
Hexachlorobenzene	*5.6 ~ 240*	—	—
Organo Tin Compounds	*13,000 ~ 21,000*	*50 ~ 18,000*	—
PCBs	*800 ~ 48,000*	*320*	24,000 ~ 28,000
PCDD/PCDF	—	0.71 ~ 13* 17 ~ 360**	—
Toxaphene	—	—	930 ~ 1,300

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: Muscle levels in the two whale species (pg TEQ/g wet)
**: Fat levels in the two whale species (pg TEQ/g fat)

Table 3.13 Concentrations of PTS in Crustacean, Prawn and Starfish Samples From Seawaters in Japan (μg/kg)

Species / Chemicals	Crustacean	Prawn	Starfish
Chlordane	*31*	*40 ~ 41*	*16 ~ 160*
DDTs	*180*	*46 ~ 50*	*49 ~ 170*
HCH	*<2*	*13*	*8.9 ~ 44*
Hexachlorobenzene	*8.5*	*5.9 ~ 7.8*	*30*
PCBs	*270*	*460 ~ 470*	*45*
TBT	—	*3.6*	—

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/

3.2.5.2 Freshwater

Table 3.14 shows some of the PTS concentrations in amphibian, bivalve and fish samples in Republic of Korea were reported as 0.17 μ/g DDT, 0.636 pg-TEQ/g dioxins, 0.91 μg/kg HCB, 5.16 μg/kg organic tin compounds, and 0.3 μg/kg PCB for amphibia samples, while 0.35 μg/kg chlordane, 4.2 μg/kg DDT, 4.053 pg-TEQ/kg dioxins, 1.3 μg/kg HCB, 124.32 μg/kg organic tin compounds, and 57.4 μg/kg PCBs for fish samples.

In China, DDTs and PCBs were reported at 1-54 μg/kg and 1-17 μg/kg, respectively for bivalve samples, 5-40.1 μg/kg DDT, 2-240 μg/kg HCH, and 267 μg/kg PCBs for fish samples, and 8-26 μg/kg DDT, 5.5 μg/kg PCBs for prawn samples. The concentration of PTS in fish samples were reported from the Russian Federation as 90-141 μg/kg chlordane, 280-30 μg/kg DDTs, 20-21 μg/kg HCB, 730-1,600 μg/kg PCBs and 930-1,300 μg/kg toxaphene, respectively.

Table 3.14 Concentrations of PTS in Amphibian Samples From Freshwaters in Region VII (μg/kg)

Country / Chemicals	Republic of Korea
DDTs	*0 ~ 0.17*
PCDD/PCDF*	*ND ~ 0.636*
Hexachlorobenzene	*0 ~ 0.91*
Organic Tin Compounds	*0 ~ 5.16*
PCBs	*0 ~ 0.3*

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is pg-TEQ/g

Table 3.15 Concentrations of PTS in Fish Samples From Freshwaters in Region VII (μg/kg)

Country / Chemicals	China	Kazakhstan	Japan	Russian Federation	Republic of Korea
Chlordane	—	-	13 ~ 22[*1]	90 ~ 141	*0 ~ 0.35*
DDTs	*5 ~ 40.1*	*0 ~ 11*	7 ~ 18[*1]	280 ~ 300	*0 ~ 4.2*
Dieldrin	—	—	<1[*1]	-	-

PCDD/PCDF*	—	—	—	0.2 ~ 1.2**	*ND ~ 4.053*
HCH	*2 ~ 240*	—	2 ~ 3[*1]	20 ~ 21	—
Hexachlorobenzene	—	—	<1[*1]	—	*0 ~ 1.3*[*2]
Organic Tin Compounds	—	—	—	—	*0 ~ 124.32*[*2]
PCBs	*2 ~ 267*	—	<30 ~ 50[*1]	730 ~ 1,600	*0.41 ~ 57.4*[*2]
Toxaphene	—	—	—	30 ~ 1,300	—

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/
*: The unit of dioxins is pg-TEQ/g
**: PCDDs + PCDFs in Omul in Lake Baikal (pg TEQ/g wet wt) (Mamontov, A.A., 1998)
*2: Annual Report of EDCs Research Project, NIER (2000)

Levels of total HCH, total chlordane, total DDT, PCB and toxaphene in organisms of Lake Baikal were reported to be 0.02-0.021, 0.09-0.141, 0.28-0.3, 0.73-1.6 and 0.93-1.3 mg/kg lipid basis for omul (fish), and 0.2-0.22, 1.5-1.7, 54-62, 24-28 and 2.2-2.3 mg/kg lipid basis for Baikal Seal, respectively (Kucklick,. et al., 1993).

3.2.6 Terrestrial Biota

Table 3.16 shows PTS concentrations in humans reported in China (breast milk) and Japan (adipose, liver, bile). China reported 6031 μg/kg DDTs, 40-800 μg/kg dieldrin, 2960-30090 μg/kg HCH, 1781 μg/kg HCB and 250-1,430 μg/kg PCBs, while the data of Japan were 42-3,800 μg/kg chlordane, 40-8100 μg/kg DDTs, 47-3200 μg/kg HCH, 17-240 μg/kg HCB and 230-6600 μg/kg PCBs, respectively.

Table 3.16 Concentrations of PTS in Humans From Region VII (μg/kg)

Country / Chemicals	China (breast milk)	Japan (adipose, liver, bile)
Chlordane	—	42 ~ 3,800
DDTs	6,031	140 ~ 8,100
Dieldrin	40 ~ 800	—
HCH	2,960 ~ 30,090	47 ~ 3,200
Hexachlorobenzene	1,781	17 ~ 240
PCBs	250 ~ 1,430	230 ~ 6,600

※ Italic data reported in questionnaires completed and submitted to the project website http://www.chem.unep.ch/pts/

Results from a survey conducted in China on human breast milk, sampled during the lactation period (3-5 weeks), showed mean levels of *p,p'*-DDT (Hong Kong SAR: 0.39; Guangzhou: 0.7 μg/g of lipid), *p,p'*-DDE (2.28; 2.85), and β -HCH (0.95; 1.11). These values were 2-15 folds higher when compared to studies conducted elsewhere, such as United Kingdom, Germany, Sweden, Spain and Canada), however, PCB concentrations (0.035; 0.031) of the samples were found to be 10 times lower. Both DDT and PCB showed good correlations with consumption of seafood (Wong et al., 2002).

Figures 3.1 and 3.2 below show relatively low concentration of PCDD/PCDF in the blood of Siberian inhabitants, even those situated at industrial centers, such as Shelekhov (aluminium plant), Sayansk (PVC plant), and Angarsk (oil-chemistry industry) in the Russian Federation.

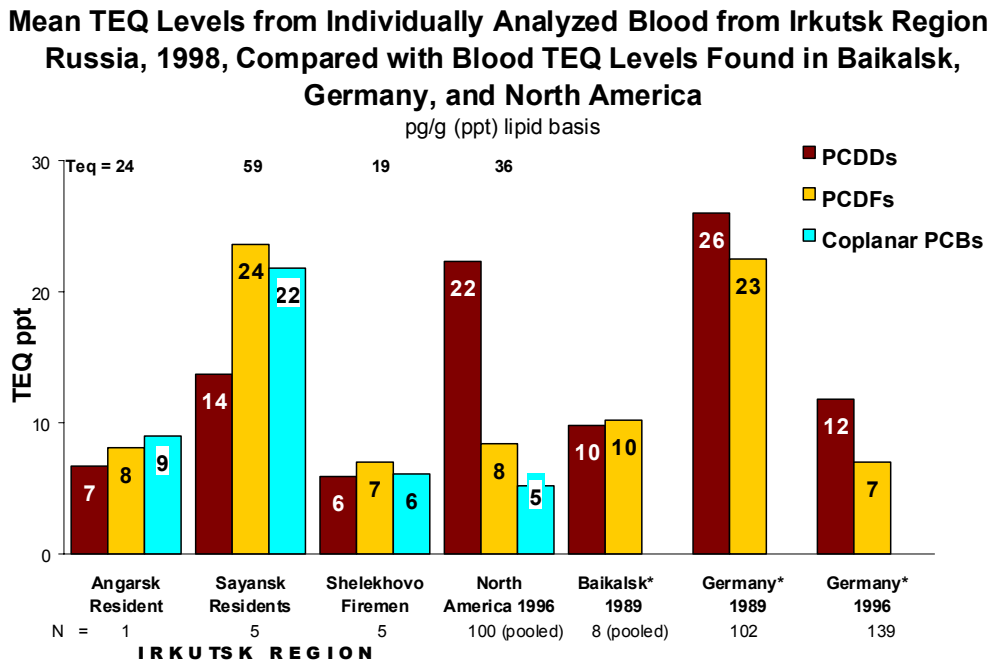


Figure 3.1

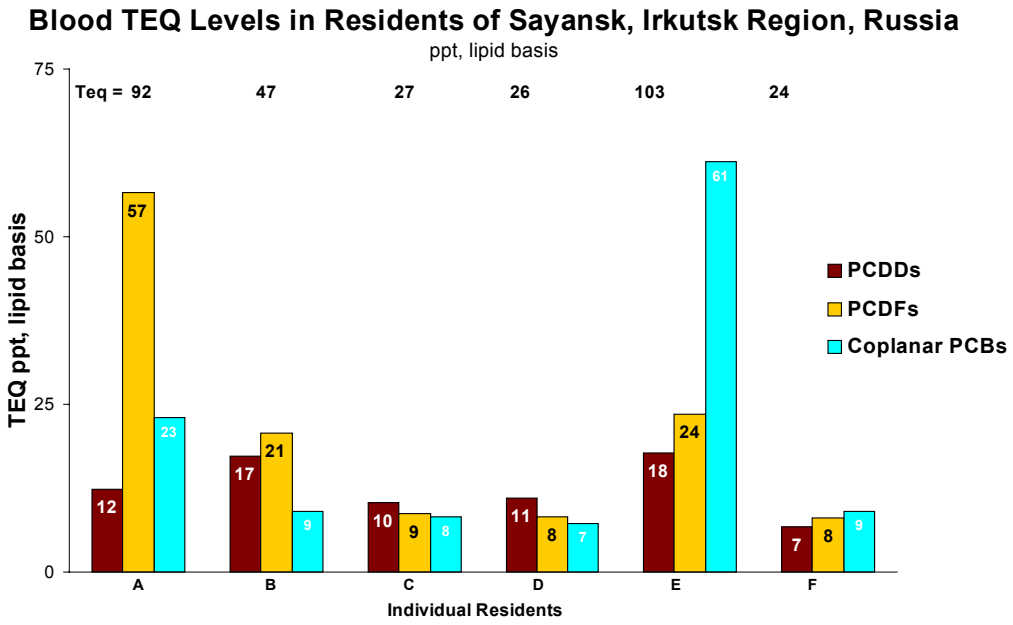


Figure 3.2

3.2.7 Time Trends of PTS in the Region

The Ministry of the Environment, Japan, has been conducting environmental monitoring of major organochlorines for nearly three decades, and of organic tins for more than a decade (Ministry of the Environment, Japan Chemicals in the Environment). Frequencies of detection (ratios between the number of detected samples and the total samples) have been decreasing for many of the compounds, including PCBs in fish (25/30 in 1978 to 36/70 in 2000) and bivalves (15/15 in 1978 to 10/30 in 2000), HCB in fish (30/30 in 1978 to 7/69 in 2000), dieldrin in fish (22/30 in 1978 to 10/70 in 2000) and bivalves (10/15 in 1978 to 5/30 in 2000), p,p'-DDT in fish (25/30 in 1978 to 16/69 in 2000) and bivalves (15/15 in 1978 to 4/30 in 2000), and γ-HCH in fish (30/30 in 1978 to 1/69 in 2000) and bivalves (15/15 in 1978 to 0/30 in 2000), suggesting that levels in Japan have generally been decreasing in recent decades. Due to the increase of proportion of ND data,

however, in recent years, it is difficult to calculate the average level of each compound in order to obtain quantitative aspect on the time trends.

A similar trend is observed in organic tin analysis; frequencies of detection of TBT has decreased from 23/60 in 1985 to 10/70 in 2000 in fish, and from 15/20 in 1985 to 0/30 in 2000 in bivalves, respectively. Frequencies of detection of TPT also decreased from 40/65 in 1989 to 13/70 in 2000 in fish, and 17/25 in 1989 to 1/30 in 2000 in bivalves. Furthermore, frequencies of detection in water (coasts and estuary) decreased from 62/79 in 1990 to 9/102 in 2000 in TBT, and 16/75 in 1990 to 0/102 in 2000 in TPT. However, the detection frequencies in sediments have not changed significantly during the period; i.e., 79/90 in 1990 to 81/99 in 2000 for TBT, and 52/81 in 1990 to 52/96 in 2000 for TPT, respectively. The average levels of TBT and TPT in marine sediments (calculated as ND which equals to half of the detection limit) have been stable in recent several years.

Among the above samples, sea bass collected in Tokyo and Osaka Bays, the most populated areas in Japan, almost always showed the highest detection frequencies for all the chemicals and may deserve further discussion. In both cases, the average levels of PCBs seemed to decrease in late 1970s, but no clear decreasing trends were observed in the recent two decades. DDTs seemed to decrease in late 1970s ~ early 1980s, and then became almost stable until now. Chlordanes, on the other hand, have been decreasing slowly in both places in the two decades. TBT and TPT levels, on the other hand, showed considerable fluctuation, without a clear decreasing trend, until early 1990s, and then started to decrease. The decrease of TPT seemed to proceed a little earlier than TBT. The change in TBT and TPT levels in sea bass generally coincide with the start of their regulation by the Japanese government.

Many of the PTS chemicals have been monitored in human breast milk obtained from Osaka Prefecture, Japan, for 27 years (Konishi et al., 2001). Total PCBs levels showed decreasing trends with a couple of small peaks in late 1970s and early 1980s during the period. γ-HCH, DDT and DDE also showed clear decreasing trends during the period. Dieldrin also showed a decreasing trend, too, in the first decade, while HCB levels showed a slight increase at the beginning of 1980s and then decreased. Chlordane levels, on the other hand, varied considerably, but did not show a clear decreasing trend in the last decade. Compared with the levels in middle 1970s, γ-HCH decreased to 3.1%, total DDT (DDT+DDE) to 7.1 %, and PCB to 13.2 %, respectively. PCDD/PCDF levels were also analysed in the archived samples, which were preserved as extracted lipids (Ministry of Health and Welfare, 2000). The total level (including co-PCBs) was approximately 65 pg-TEQ/g lipid basis during the mid 1970s, but decreased to 24 pg-TEQ/g lipid basis in 1999. The decrease of co-PCBs was most significant followed by PCDF. PCDD levels, on the other hand, remained nearly unchanged from early 1970s until late 1980s, and then started to decrease slowly.

In another program, PCDD/PCDF levels were analysed in archived diet samples obtained in Kansai Region (Ministry of Health and Welfare, 1999) and in Kobe and Nagano cities (Sakurai, et al., 2001), Japan, respectively. PCDD and co-PCB levels were higher in mid-1970s, and showed considerable decrease until late 1990s. On the other hand, PCDF levels seemed to be rather constant from mid-1970s to mid-1980s, and then decreased. On a TEQ basis, co-PCB contributes more significantly followed by PCDD and PCDF. In the analysis of archived human adipose tissues, (PCDD+PCDF) and co-PCBs were reported to be 31.6 and 35.4 pg-TEQ/g lipid basis in 1970-71, and 11.9 and 15.3 pg-TEQ/g wet wt in 2000 (Choi et al., 2002a). For brominated compounds, both 2,3,7,8-TeBDD and 2,3,7,8-TeBDF decreased slightly in the period (median decreased from 1.7 to 0.51 pg/g lipid basis, and 3.3 to 2.8 pg/g lipid basis, respectively) whilst a 44-fold increase was observed in PBDE (median; 29.2 to 1288 pg/g lipid basis) (Choi et al., 2002a). Detailed analysis of the archived fish samples, on the other hand, showed that PBDE levels (sum of tri- to hexa-) peaked in late 1980s and started to decrease steeply during 1990s until 2000, concomitant with the production of PBDE which had peaked in 1990 and gradually declined due to its replacement by Tetrabromobisphenol A (TBBPA) (Ohta et al., 2002).

There are several reports analysing sediment core samples in order to reveal time trend of PCBs, PCDD/PCDF and other pollutants in Japan (Araki, et al., 2000; Okuda et al., 2000; Masunaga et al., 2001; Choi et al., 2002b; Sakai et al., 2002). Many showed that PCB concentrations were highest in the 1960s followed by a decrease, the rate of which has declined recently. PCDD/PCDF pollution showed a steep increase from the 1940s to the 1960s, with a peak in late 1960s to early 1970s, which started to decrease after that, but again the rate slowed down and the level became almost flat in recent decades. In the retrospective analysis of archived paddy field samples (Seike, et al., 2002), OCDD showed a peak in mid 1960s while 1,3,6,8-TCDD increased in late 1960s and decreased in 1970s. In TEQ, PCDDs, especially 5-7 chlorinated congeners, have been dominant contributors although the contribution from PCDFs has been increasing gradually in recent years. In Japan the agrochemical PCP became popular in the 1960s. However, the usage stopped in the early ‘70s while CNP

registered in 1965, widely used through the 1970s but gradually decreased through 1980s and its usage stopped in the mid 1990s. OCDD and 1,3,6,8-TCDD are the characteristic isomers of PCP and CNP, respectively. The above data seem to support the view that in Japan PCDD/PCDF were emitted into the environment in the 1960s to early 1970s as impurities of agrochemicals, especially PCP and then CNP, while incineration processes remained as a dominant source until recently.

Distribution in sediment cores obtained from Macau estuary in China showed that DDT had a peak at 79 ng/g in 1993 while the level was lower, between ND and 28.9 ng/g, after 1960. Total HCH, on the other hand, again showed a peak of 82.3 ng/g in 1993 which decreased to less than detection limit afterwards (Zhang, et al., 1999). PAHs levels in a sediment core sample from Ya-Er Lake showed that B(a)P levels were 18.7-49.2 ng/g with an increasing trend after 1970 (Chen, et al., 1997). When comparing the PTS contents in human breast milk samples collected from Hong Kong in 1989 (Ip and Phillips, 1989) and 2002 (Wong et al., 2002), it was noted that all the concentrations were decreased (p,p'-DDT 2.17 to 0.39; p,p'-DDE 11.67 to 2.48; β-HCH 15.96 to 0.95. However, the concentrations were 2-15 folds higher when compared with studies conducted elsewhere (i.e. U.K., Germany, Sweden, Spain and Canada).

3.3 TOXICOLOGICAL AND ECOTOXICOLOGICAL EFFECTS OF PTS

3.3.1 Introduction

Some human populations and some wildlife species in northern and temperate Regions are known to suffer significant injury from certain PTS. There are fewer studies that document health effects in different Regions (background, south and north) caused by PTS in the environment. It stands to reason, however, that if PTS can cause adverse effects to human health and ecosystems thousands of kilometers from their sources, PTS can cause similar and greater injury in and near source areas. Documented injuries were especially prevalent in high predator species and included:

- reproductive failure and population decline;
- abnormally functioning thyroids and other hormone system disfunctions;
- feminisation of males and masculinisation of females;
- compromised immune systems;
- behavioral abnormalities;
- tumors and cancers;
- gross birth defects.

Alarmed by these data, scientists investigated similar injury to humans, who also can be considered high predators. In the years that followed, good evidence was gathered associating human exposure to specific PTS or classes of PTS with:

- cancers and tumors at multiple sites;
- neurobehavioral impairment including learning disorders, reduced performance on standard tests and changes in temperament;
- immune system changes;
- reproductive deficits and sex-linked disorders;
- a shortened period of lactation in nursing mothers;
- diseases such as endometriosis, increased incidence of diabetes, and others.

Of particular concern is evidence suggesting that women, infants, and children are especially vulnerable to certain effects of PTS.

In humans, as in wildlife, effects caused by exposure to PTS is often expressed, not in the exposed adult population, but in the offspring generation. Maternal body burdens of PTS are transferred through the placenta to the developing fetus and through breast milk to the nursing infant, and can cause effects at vulnerable stages of developing that may not be expressed until the infant reaches puberty or adulthood.

3.3.2 Toxicology of PTS of Regional Concern

Toxicological and eco-toxicological research is conducted all over the world, resulting in international databases on basic toxicants (IARC Monographs, 1977, 1987, 1997).

The estimation of summary toxicity of pollutants in the water and wastes use in different countries, including countries of Region VII, have been carried out for many years. Automatic systems, such as "Microtox", "Vitotox", among others are well known. Some years ago, the Russian Federation initiated and developed recommendations for the detection of toxicity of water samples, air samples, soils etc. by luminescent bacterial test.

Mutagenicity was investigated in scientific research laboratories of Japan, Republic of Korea, and the Russian Federation, including Ames test Salmonella/microsome and another short-term tests in different genetic samples. More commonly conducted are total mutagenicity and toxicity of environment pollution which have been carried out within the framework of ecological examination.

According to the data from the State Centre of Ecological Programs of the Russian Ministry of Natural Resources, sources of PTS (pesticides, PCBs, PAHs, PCDD/PCDF) exist in the Asian Part of the Russian Federation. Unfortunately, all the data concerning environmental levels of PTS and their influences on public health are very fragmentary and are only available for the European part of the Russian Federation. The main sources of PTS in Regions VII are metallurgic and chemical industries (PCDD/PCDF, PCBs, HCB). PAHs are a serious problem in the high-density industrial areas. Human health problems are related to pesticides manufacture and usage especially organochlorine pesticides with their application in agriculture and forestry for many years.

Due to lack of storage and the use of PTS, including DDT, PCBs, and HCB, in agricultural districts of the Kemerovo area of the Russian Federation have resulted in cytogenetic damages in children and adults; the level of chromosomal aberrations being two times greater than populations in ecologically clear areas, and corresponding to a level of genetic damage of the population located in Kemerovo' industrial areas. Kemerovo is characterized by strong pollution generated from chemical, coal industries and metallurgical enterprises.

Determination of the somatic mutant frequencies at the TCR locus was performed in 70 persons - inhabitants of Shelekhov city (Irkutsk Region, Russian Federation). The control group consisted of 13 healthy volunteers and 57 firemen who were involved with putting out the fire at the Cable factory in 1992. In addition, TCR mutant cell frequencies in these two groups were compared with results previously received for 75 healthy inhabitants (control group) of Obninsk (Kaluga Oblast) and 140 workers involved in the clean-up of the Chernobyl site contaminated with relatively low doses (up to 0.25 Gy) of ionizing irradiation of a well-known genotoxic agent. The observed data confirmed the effects of genotoxic agent(s) on both the firemen and the residents of Shelekhov city, where a large aluminum plant is located.

Depending on the genome features of various individuals can keep stability or find out the increased sensitivity to the injuring agents. When in an organism, the majority of xenobiotics do not render direct biological effect. In the initial stage, the xenobiotics are exposed to various transformations called biotransformation. The biotransformation xenobiotics, as a rule, undergo a multi-stage process, in which simultaneously or serially many participate in detoxification ferments. Quite often, intermediate products of biotransformation in the initial stages of this process can be more toxic, have more expressed mutagenic, teratogenic and even carcinogenic activities than initial connections, and therefore cause various pathological condition and illnesses.

It is clear that from even the brief list of the reasons of distinctions in individual sensitivity of man to toxic influences, this testifies to the extraordinary complexity of the decision of the problem for the estimation of the dangers of contact with chemicals, and human risk for health, including genetic risk. At the same time, the induction mutation in human somatic cells has been proven, and the account of risk is carried out on the probability of development of cancer diseases. Practically total monitoring cytogenetic markers (ChA, CHE, MN) in lymphocytes of blood of the inhabitants of a number of European countries convincingly has proved their connection with frequency oncopathology (Revazova, 2002).

PTS are accumulated in food which are the main sources of PTS intake in human organisms. The use of polluted soils for agricultural activities is a feature of many small Russian cities as they are located nearby large metallurgic and chemical enterprises. Practically, all the Asian countries of the former USSR had used huge amounts of PTS, especially DDT and HCH.

3.3.2.1 Pesticides

Environmental levels and human exposure of PTS (pesticides) in Region VII has decreased due to the prohibited use of these substances in most of the countries. Mass DDT use and storage for many years is the most dangerous problem for the Russian population (Revich, 2002). Territorial organisations of the Russian Ministry of Health has been carrying out a constant control of pesticides, including DDT, in foodstuffs, soils and water (Bragina, Garbuzova, 2001). Over a number of years DDT has been reported in the 18 – 33% of the samples, and HCH in 21 – 33%.

A potential area of concern for the Region VII is the possibility of pesticide contamination in Pacific seafood. The most polluted Region of the Japan Sea is the Golden Horn Bay. Average concentrations of organoclorine pesticides in sea water (including DDT and its metabolites, α- and γ-HCH) varied within the limits 0.8 – 1.9 ng/l. Pesticide pollution of the Bay's sediments suggests an anthropogenic influence over a long period of time. For example, the DDT content of Golden Horn Bay sediment is 200 times higher than in sediments from the Amurski gulf and 80 times higher than in sediments from the Ussuriisky Gulf (Revich, 2002).

Pesticide use over a long period and their high levels in foodstuffs has led to their intake in breast milk of women living in agricultural regions. Significant changes in reproductive health of women living at pesticides polluted territories have been recorded. These include late menarche, spontaneous abortions, and high frequency of gynecological diseases, obstetric and perinatal pathologies. This is especially evident in the Asian countries of the former USSR.

Investigation of the contamination of human body fluids (gastric juice, blood, breast milk) by DDT and HCH have been carried out in Kazakhstan and Kyrgyzstan. The results showed high contamination by pesticides (especially DDT, DDE, HCH) of blood serum of pregnant women (20–100 times higher than reported in Sweden). More than 50% of blood samples from pregnant women from the Aral Sea region were found to be contaminated by pesticides. Investigations also showed that the imbilical blood of 90% of newborns were contaminated with pesticides eventhough the blood serum of the pregnant women sometimes failed to indicate any presence of pesticides. Breast milk studies confirmed the possibility of the transfer of pesticides to newborns through breast milk (Samuratova, 2002).

In the Karapalkak Region of Uzbekistan, maternal blood samples were found to contain HCH, DDT, and HCB. The mother/infant ratio was calculated in a subset of 12 pairs for HCB, β-HCH, *pp*-DDE and *pp*-DDT. The median ratio was 2.1, 2.8, 3.0 and 3.3, respectively. Relatively high quantities of HCH (α- and β-) and *pp*-DDE were measured in all 41 samples. 68% and 43% of the subjects contained more than 1000 ng/g (lipid basis) of β-HCH and *pp*-DDE (Revich, 2002).

Chlordane and mirex are not used and produced as pesticides, but are used for public health in small amounts. In the prevention and control of termites (white ants), chlordane, heptachlor and DDT are used. DDT is used mainly for control of some vectors of diseases, such as malaria. Investigation indicated that since the prohibition of DDT, and other PTS pesticides, the residual DDT in tea leaves and breast milk had noticeably decreased. The investigation in Changsha, China showed that HCB contents in human breast milk had increased 60% within 10 years (Li, 2002).

3.3.2.2 PCBs and PAHs

The greatest volume of PCBs in Region VII is found in electrical equipment. After entering the environment, PCBs accumulate in various media at concentrations which are influenced by a variety of factors. In the Asian part of the Russian Federation, PCBs have been studied most extensively in hyperboreal organisms. This forms part of the Arctic Pollution Monitoring Program (AMAP). There is a concern that foodstuffs with a high fat content, such as marine mammals, deer and fish, form an important part of hyperboreal diets which may be a source of increased intake of PCBs. The impact of PCBs on health has been studied in Serpukhov city (European part of the Russian Federation), where past production of condensers filled with PCBs were produced. Results have shown that even 10 years after the use of PCBs at the plant had been banned, the levels of PCBs in soil and vegetables were still extremely high (Revich, 2002). However, the concentrations of PCBs in breast milk (Kazakhstan) were lower than those reported for European women.

There is no accurate information about the storage of PCBs which poses a potential pollution risk. There is shortage of systematic information about human exposure to PCBs and the effects of PCBs on human health.

Cities in the Asian Region of the Russian Federation, unlike the European Region, are dominated by the use of coal and petroleum for fuel. PAHs are the dominant PTS in terms of its adverse influence on human health.

There are many reasons for concern including: the presence of a large aluminium plant in Krasnoyarsk city and metallurgic plants in Norilsk city, in the Irkutsk Region, and the metallurgic plants of the Sverdlovsk, Chelyabinsk Region, and Kuzbass. Systematic control of PAH control in air is conducted in 30 cities of the Asian Region of the Russia Federation The highest concentrations have been measured in cities with negative microclimatic conditions where coal is used for a Thermal Power station and for metallurgic (especially aluminium) plants. These are located in: Cnita, Shelekhov, Novokuznetsk, Bratsk, Zima, Kansk, Irkutak, Yuzhno-Sakhalinsk. More than 10 million people are exposed to high concentrations of benzo[a]pyrene – generally greater than 1 ng/m3. In several cities the level of air pollution by PAHs is extremely high (124 ng/m3 in Bratsk city, Irkutsk Region). Results of epidemiological studies on the estimation of Benzo[a]pyrene as a risk factor of lung cancer showed a significant increase for people living in industrial cities with concentrations of PAH in air higher than 3 ng/m3. Even higher levels of PAHs in the air have been measured in Siberian Far East cities, which have a total population of approximately 9 million (Revich, 2002).

3.3.2.3 PCDD/Fs

The current estimate of background exposure levels to PCDD/PCDFs for adults in Korea is 0.43 pg TEQ/kg/day (Korea Food and Drug Administration, 2001). Additional exposure may be expected from other sources. The exposure contribution of food, air and soil was 85.3%, 14.7%, and 0.02%, respectively and that of meat and dairy products including milk was 12.3% and 3.4%, respectively. It was recognised that the human exposure patterns of PCDD/PCDF were very different from those of Europe and America. This feature of Korean background exposure levels of PCDD/PCDF may be caused by the high ingestion rate of cereal and vegetables than meat and dairy products (Lee et al., 2002).

Potential sources of PCDD/PCDF in the Asian part of the Russian Federation are the large metallurgic, chemical and pulp and paper industries. There is only one municipal waste incinerator in Vladivostok, but irregular burning of the toxic waste is the main source of air pollution in the Region. An investigation by Prof. Schecter in 1986–1998 showed the levels of PCDD/PCDF in foodstuffs and human body fluids (blood and breast milk) were lower in Siberian cities than in Europe and North America.

A large amount of the pesticide sodium pentachlorophenol (Na-PCP) salt have been sprayed over vast areas in central China to control schistosomiasis, a parasitic disease of epidemic proportions (Schecter, 1996). Approximately 5000 tons of Na-PCP are produced in China annually. PCDD/PCDF are found as impurities in commertial Na-PCP product. These contaminats are subsequently released into the environment and present a significant contribution to human exposure to PCDD/PCDF in China.

3.3.3 Ecotoxicology of PTS of Regional Concern

Several reports on the environmental efects of PTS were presented and discussed during the 2nd Technical Workshop.

In recent years, several species of marine mammals and birds have been affected by unusual diseases and mortalities. While several factors have been attributed to these events, a potential suspect is the exposure to PTS. Investigation of the toxic effects of PTS in higher tropic level wildlife showed that PTS, such as organochlorine pesticides, PCBs, organotins, *etc* , are found in tissues of a wide variety of wildlife. Extremely high concentrations have been found in animals inflicted with diseases and/or victims of mass mortalities. Elevated contamination by PTS has been found in open sea animals such as cetaceans and albatrosses, which seemed to be attributable to to their low capacity to metabolise toxic persistent contaminants. Significant correlations between biochemical parameters (serum hormone concentrations and cytochrome P450 enzyme activities) and residues of PTS have been found in some species of marine animals, which indicates that these chemicals may be causing toxic effects in animals even at the current levels of exposure (Chiba et al., 2002).

Lam's (2002) review indicated that elevated levels of PTS including PAHs, PCBs and certain organochlorine pesticides are a long-term significance to the health of Hong Kong SAR water's ecosystem. Specifically, it is apparent that PAHs and pesticides may pose a risk not only to the marine ecosystem, but also to primary and secondary consumers of marine organisms. Although there are now considerable data on the levels of PTS in the marine sediments and, to a lesser extent, other environmental compartments, such as biota, there is still a general paucity of information of the sources of PTS and their precise effects on biological systems in Hong Kong SAR's marine waters. Authors of this study suggest that while the concentration of some toxicants in a specific environmental compartment may be relatively easy to quantify, it is the potential biological/ecological effects on the population that are more difficult to measure or predict.

3.4 HOT SPOTS

In this Region, limited data have been published or reported and the sampling sites have been also localised. Also, these data were reported based on insufficient replicates of samples. In addition, the sampling and the analytical methods were not standardized. Although high levels of PTS in different ecological compartments have been detected in some areas, these data do not currently allow rigorous identification of hot spots.

Based on data available at this stage, the following hot spots have been identified in the Region: HCH concentrations of inland water in Kazakhstan, PAHs concentrations in sediment in the sea of China, Japan, and the Republic of Korea were higher than those detected in other areas in Region VII.

Agricultural areas with high use of pesticides showed remarkably high concentrations of organochlorines in soils and sediments, while urban areas showed high concentrations of PTS in air and soil, due mainly to automobile sources. In addition, industrialized areas with chemical use and metallurgical plants showed high concentration profiles of PTS. For example, high concentrations of organic mercury compounds in blood, urine and hair of inhabitants in Kyrgyzstan were reported (Kasymov et al., 2000). DDTs in marine mammals of Japan and the Russian Federation were high.

3.5 DATA GAPS

Limited data have been published or reported in certain Regions or countries within Region VII. In addition, the availability of information on contaminant levels of PTS is very recent except for Japan. It is therefore important to recognise that data on the spatial and temporal distributions reported here are insufficient to evaluate the effects of PTS on human health or on the environment. Also, there is as yet little conclusive scientific information directly linking harmful human effects to low levels of exposure to these contaminants.

Overall, the information on temporal trends in this Region is very limited. The results available reinforce the importance of precise sampling, analysis and archiving programs, which would allow continuous long-term monitoring of key populations and retrospective analysis for new contaminants.

Data reported herein are insufficient to make a full review of the spatial and temporal variations in this Region because many countries in this Region began the monitoring of PTS concentration only recently. Furthermore, locations for monitoring have been scattered, and not comprehensive or consistent in the viewpoint of long and global manner. Countries within Region VII should agree upon common standard methods for sampling, treatment and analysis of PTS.

3.6 CONCLUSION

Spatial and temporal data on PTS monitoring have been collected from some countries in this Region, while monitoring data concerning PTS were not found from some countries.

In this Region, the spectrum of national economic size is very wide. This may explain the variances in data collection whereby some countries have collected data relatively earlier and more intensively, while some countries have only recently or in the stages of developing their programs on PTS monitoring and inventories.

Based on the reported data, DDTs, HCH, dioxins, furans, PCBs and PAHs are the high priority chemicals among other PTS in this Region. Many monitoring data for these chemicals were reported at a variety of environmental media and biota, and very often the concentrations of one or some of those chemicals were found to be relatively high, compared with other chemicals at certain environmental sample.

In addition, the data analysis described in previous sections was inclusive at this point for the full understanding of the temporal and spatial trend.

More monitoring data from the countries in this Region should be collected for the full understanding and evaluation of the present environmental levels of PTS in this Region. International cooperation on this matter is required to obtain more precise and meaningful data in this Region.

It is widely accepted that PTS can concentrate in living organisms, including humans, to levels that can potentially cause injury to human health and/or the environment even in Regions far from where they were initially used or released. For Region VII, this phenomenon has been demonstrated in the Siberian territory which is characterized by a cold climate and in the high mountain territory where PTS can accumulate and persist for a long time.

4 MAJOR PATHWAYS OF CONTAMINANT TRANSPORT

The objective of this chapter is to provide basic information concerning contaminant transport within Region VII. Because the Region is spread over a wide-range of different meteorological conditions with insufficient information on the pathways of contaminant transport, the summary provided below will be considered as preliminary.

4.1 INTRODUCTION

4.1.1 General

Region VII covers a variety of countries with different climatic and geographic conditions. Temperature and rainfall vary greatly which may give rise to significant differences in fate processes of the contaminants. In addition, the large area of open ocean may have a significant contribution to contaminant transport. The characteristics of the Region may cause substantial differences in pollutant fate and transport when compared to other Regions e.g., the Arctic Region. The limited available information in this Region has also made it difficult to determing long-range transport of pollutants within the Region. Major data gaps should be investigated in this Region especially for long-range transport information.

4.1.2 Regionally Specific Features

The organochlorine pesticides have similar properties, such as low water solubility, high lipophilicity, and are persistent in the environment. Their half-lives in soil range from 2 years to 12 years (Connell and Miller, 1984). Worldwide use of pesticides has resulted in the distribution of these persistent pesticides throughout the earth's ecosphere whereby the atmosphere has been the one of the most major routes for the widespread distribution.

Pesticides applied to soils and crops may enter the atmosphere in several ways. For example, significant proportions of aerially applied pesticides never reach the target and drift away from the treated area. Pesticides may also volatilise from treated soils and crops and contaminate the atmosphere.

The major routes of pesticide translocation into the hydrosphere are generally governed by surface runoff and aerial transport and deposition. Kerr and Vass (1973) concluded that aerial transport and deposition exceeded surface runoff as the principal source of input for pesticides in the oceans. Significant amounts of pesticides to the environment may originate from many industrial, agricultural and domestic sources.

The most widely used persistent organochlorines, ranked in order of global usage between 1950 and 1992 were HCHs (6.3 Mt), DDT (2.6 Mt), toxaphene (1.33 Mt) and PCBs (1.2 Mt). HCHs are the most abundant OC in arctic air and water (Jensen et al., 1997). Besides India, HCH has mostly been used in China and the former Soviet Union. In 1983, China and India switched to using only the pesticide-active isomer of HCH (γ-HCH or lindane).

Stockpiling of several chemicals with limited amounts has been reported from Japan, Russian Federation, and Kazakhstan. However, there is very limited information for most of countries in the Region, and further studies are needed to clarify the possible sources and/or stockpiling of contaminants in the Region.

It should be noted that the majority of PTS are a mixture of known and/or unknown complex isomer/congeners that may have different transport/fate characteristics in the environment. Furthermore, concentrations of pesticides may be reported on a different basis, e.g. on pure chemical basis or total formulation basis. Clear emission and isomer/congener information is required which may also affect accurate assessment of chemical transport.

4.2 MEASUREMENTS/MODELLING APPROACH FOR TRANSPORT ASSESSMENT

An integrated measurement/modelling approach is highly recommended. The limited coverage of the Region by a monitoring network does not allow one to make the assessment of PTS contamination in the Region based only on monitoring data. On the other hand, modelling methods need monitoring data for model evaluation and formulation. Hence, for assessment of PTS contamination in the Region, an integrated measurement/modelling approach is highly recommended.

4.3 OVERVIEW OF EXISTING MODELLING PROGRAMS AND PROJECTS

There are a limited number of existing modelling programs and projects in the Region on the long-range transport of PTS. Long-range transport of other contaminants, such as sulphur oxide, nitrogen oxide, VOC and particles like yellow-sand have been studied for the East Asia Region, but not for semivolatile substances including PTS. As modelling with multimedia consideration may be more suitable for semivolatile compounds, limited examples of multimedia modelling programs within the Region are described below.

4.3.1 Japan

A multimedia environmental fate model integrating river catchments and gridded air compartments has been developed using geographical information systems (GIS) (Suzuki et al., 2001). This model will be used to assess multimedia chemical fate on real geographic information. The model formulation is based on the fugacity approach. The geographical resolution for the air-grid is 5 km and that for river catchement and river stretches are on similar scales. Necessary geographical and meteorological databases including wind data, hydrological data and emission data have been developed. Several models with and without various multimedia considerations have developed, and the different models share the same geographical/hydrological datasets for calculation as a common basis. A case study on the Shinano river basin has been performed. The basin area was roughly 15000 km^2 with a maximum river path length of 380 km, containing about 600 air-grid and 1500 catchments and river segments. Simulation based on the real PCDD/PCDF emissions from municipal solid waste incinerators showed general agreement with monitoring data for air and river water. Simulated soil concentrations were significantly lower than monitoring data, probably because of the lack of emission data from the past agrochemical impurities. Comparison of fate characteristics among several chemicals including PCDD/PCDF, dichlorobenzene and trichloroethylene indicated different media/geographical distribution for different chemicals.

The model can predict the environmental fate of contaminants in the multimedia environment. Environmental fate for PTS including PCDD/PCDF can be simulated well by the models. Geographical and hydrological databases will be developed for the whole Japanese environment, which enables the fate analysis with real environmental conditions incorporating real river stream fluxes and geographical catchments.

4.3.2 Republic of Korea

4.3.2.1 POPsME

In Republic of Korea, a three-year research project has just been completed to develop a dynamic multimedia mass balance fate and transport model (named POPsME (persistent organic pollutants in multimedia environment) (Lee et al.,2002). The main purpose of the model is to describe the long-term average behaviour of target substances, beginning with polycyclic aromatic hydrocarbons (PAHs), in multimedia environments relevant to Republic of Korea. This work has been conducted as part of an integrated effort to establish a risk assessment methodology that takes into account multimedia, multi-route exposure pathways. The model domain includes the Seoul metropolitan and neighbouring areas (about 150km x 150km) of diverse land including the most densely populated cities in the country, agricultural areas, and forests, and even a small coastal area. The domain will be expanded to cover the whole of Republic of Korea in a year.

POPsME is an unsteady (Level IV) mass balance model where each medium is represented by a homogeneous compartment. The environmental media included in the model are air (gas and particles), water, suspended solids, bottom sediment, bare soil, coniferous plants and the soil, deciduous plants and the soil, and farm land.

The model has been designed to have variable spatial resolutions. The smallest “grid size” is currently limited to 10km x 10km mainly due to computer based limitations in data handling capacity. Monte-Carlo simulation capability has been included to estimate uncertainties of the model outcomes. The model is written in Fortran and runs on a PC. The model is currently being evaluated by comparing the measured and predicted PAH concentrations in multimedia.

4.3.2.2 ECO2 Project

A three-year project has been launched to set priorities for the management of environmental quality of industrial complexes and large cities. Human health risk and ecotoxicological effects are the criteria to be used to set the priorities. A dynamic multimedia mass balance model (tentatively named as ECO2) is being developed for the prediction of environmental levels of PAHs, VOCs, and POPs in a selected industrial complex and neighbouring residential areas (30 km x 30 km). The model is similar to POPsME in principle and

structure except that it deals with VOCs as well as SOCs. Measurements of multimedia concentrations of contaminants of concern are being conducted to evaluate the model. The model, after calibration and evaluation, will be applied for the prediction of environmental fate of the substances to major industrial areas and cities in Republic of Korea.

4.3.2.3 EDC Seoul

To understand the environmental fate of endocrine disrupting chemicals (EDCs), a single cell multimedia fate model has been constructed and evaluated. The EDCs of concern were PAHs, OCls, PCBs, Alkyl phenols, and phthalates. The model (EDC Seoul) will be refined in an ongoing research and used to support decision-making concerning the management of EDCs (NIER, 2002).

4.3.3 Russian Federation

In the Russian Federation, the EMEP/MSCE-POP model has been utilised to predict transboundary transport of pollutants. This model is a multicompartment one describing processes in and exchange between basic environmental compartments (atmosphere, soil, seawater, vegetation). A Regional (European Region, resolution 50×50 km^2 and 150×150 km^2) and hemispheric (Northern Hemisphere, resolution 2.5º×2.5º) are under development in MSC-E. Detailed model structure is described in Malanichev et al. (2002).

In particular, apart from atmospheric transport, the model takes into account the transport of pollutants by sea currents. This is essential for pollutants which tend to accumulate in the marine environment (e.g. HCB and γ-HCH). Vegetation should beconsidered when describing POP transport from atmosphere to soil. Forest litter is introduced as an intermediate media between vegetation and soil. Model parameterisation has been carried out for PAHs (B(a)P), HCHs (γ-HCH), PCBs, HCB, and PCDD/PCDF.

In the model, media such as atmosphere, soil, and sea are separated vertically into a number of layers to describe the vertical transport of a pollutant in question. To describe variability of soil and vegetation properties in the horizontal direction the corresponding land-use and leaf area index information is taken into account.

Time scale. Due to large accumulation capacities of soil and sea compartments and long periods required for establishing an equilibrium, for correct evaluation of POP environmental pollution levels long-term calculations are to be performed. This can be illustrated by plots of long-term dynamics of PCB accumulation in various media (Shatalov, 2001) calculated for the period from 1970 to 2010 under the assumption that emissions from 1995 are constant.

Model reliability. At present the discrepancies between measured and calculated data for all the pollutants considered are within the order of magnitude. However, for particular pollutants the agreement is better. About 75% of comparisons between measured and calculated B(a)P, PCBs and PCDD/PCDF air concentrations are within a factor of 3, and about 70% of comparisons between measured and calculated PCDD/PCDF concentrations in soil are within a factor of 4, etc. More detailed information on comparison of calculated data against measurements can be found in Shatalov et al. (2000; 2001;2002).

Detailed description of the hemispheric MSCE-POP model is published in EMEP/MSC-E Report 8/2002 (Malanichev et al. 2002, in preparation) and in MSC-E web site: www.msceast.org.

4.3.4 Other Modelling Programs

Long-range transport of aerosol particles, sulphur oxides, nitrogen oxides or other compounds has been studied by several research groups, including those based in Japan and China (Hong Kong SAR). The Chemical Weather Forecast System (CFORS) for these compounds is already being run for the East Asia Region (Uno, et al., 2000) for those compounds. Although these efforts suggest possible long-range transport of PTS, the different nature of target chemicals may give ride to substantial changes of transport phenomena. Model application and improvement targetting semivolatile substances including PTS are therefore necessary for the transport assessment of PTS.

4.4 EXISTING MONITORING PROGRAMMES CONCERNING PTS TRANSPORT

From the assessment of transport of PTS a special need for multi-media monitoring should be recognised. However, there are limited monitoring programs in this Region especially from the point of multimedia monitoring. The importance of soil data is noted as it is likely to be an important repository.Monitoring-based studies have supported evidence for long-range transport of PTS in the Region. As shown in Chapter 3, various

monitoring efforts have been carried out by several countries within the Region.

Organochlorine pesticides such as HCHs and DDTs were found in different environmental samples collected from Asian countries (Iwata et al., 1994). The Asia-Pacific Phase of the Mussel Watch Project revealed a widespread pollution problem caused by DDTs, PCBs and organic tin compounds (Hong et al., 2002; Sudaryanto et al., 2000 & 2002; Monirith et al., 2000; and Tanabe et al., 2000) although their distribution patterns are different. Concentrations of DDT, HCH and PCBs were reported for water, snow, soil, plant and animal samples taken at Tibet, China (Sun et al., 1986; and Fu et al., 2001).

Other monitoring data can be found in Chapter 3, which also generally provides evidence of long-range-transport of PTS in the Region.

Although the implications from monitoring studies have been carefully interpreted, a mechanistic understanding of the possible long-range transport of target compounds is necessary for confirmation. However, long-range/transboundary transport of PTS in the Region could be strongly implicated based on the monitoring studies already reported in the Region.

4.5 TRANSBOUNDARY MOVEMENT OF PTS

4.5.1 Atmospheric Transport

4.5.1.1 General Implication of the Atmospheric Transport Concerning the Region

Among the three environmental compartments, higher concentrations of PTS compounds can be found in the atmospheric compartment as a result of global redistribution by volatilisation and atmospheric transport. This is governed by the physico-chemical properties of the PTS compounds which include water solubility, vapour pressure, Henry's law constant (H), octanol water partition coefficient (K_{OW}), and the organic carbon water partition coefficient (K_{OC}). Because some of these physical properties are strongly dependent on environmental conditions, Region-specific consideration may be necessary for the assessment of transport in the Region. For example, water solubility and vapour pressure are strongly affected by temperature. The distribution of PTS may tend to be inversely related to vapour pressure, and thus to temperature. Lower temperatures favour greater partitioning of these compounds from the vapour phase to particles suspended in the atmosphere. This increases the likelihood of their removal and transport to the surface of the earth by rain and snow. For tropical countries that experience high temperatures, the practice of using some pesticides in tropical agriculture during the warmer, wetter growing season may facilitate the rapid dissipation of PTS through air and water (IPCS, 1995).

4.5.1.2 Meteorological Condition

The varying seasons affect the transport of PTS. During the winter (e.g. January), a high pressure system is located over most of the Central and North East Asia Region whereby a maximum pressure of approximately 1038 mb is located south of Lake Baikal. Comparatively, on the eastern areas of the Russian Federation at the Bering Sea, a low pressure system exists at approximately 1008 mb. During the winter, northeast monsoon winds sweep south from northern China, while westerly winds originate from northeast Region of the Russian Federation.

During the summer months (e.g. July), the Region is dominated by a relatively low pressure system accompanied by southeast monsoon winds from the South China Sea.

In general, the main air mass over the majority of the Russian Federation and parts of Mongolia and the CIS countries is maritime polar (cool and fairly moist) which moves southeast. China experiences a continental tropical (hot and dry) air mass.

4.5.1.3 Single and Multi-Hop Pathways

There are two types of atmospheric transport pathways:- the single-hop pathway and the multi-hop pathway. Single-hop pathway describe the movement of substances that are emitted to the atmosphere, transported and deposited to the surface never to return to the atmosphere. PTS that undergo single-hop transport pathways include involatile organochlorines (e.g. DDT), and PAHs (e.g. benzo(a)pyrene). In contrast, the multi-hop pathways describe the movement of substances that re-enter the atmosphere after initial deposition to the earth's surface. Processes by which this can occur include volatilisation from the earth's surface under warmer temperatures than those in which it was deposited, sudden exposure of ocean water to the atmosphere after being covered by ice or resuspension of soil dust by wind. The majority of organochlorine PTS and many

PAHs exhibit atmospheric transport by multi-hop pathways (Jensen et al.,1997).

To assess the pathways for PTS transport in the Region, hemispheric simulations of PTS transport from European sources can be used. The example calculations for γ-HCH, PCBs and HCB for 1990 are carried out with the use of expert emission estimates by Pacyna et al., (1999), that were recalculated to the grid of the hemispherical model MSCE-POP (2.5°x2.5°). Results obtained for HCH in the course of these simulations are shown in Figure 4.1 (Malanichev 2002).

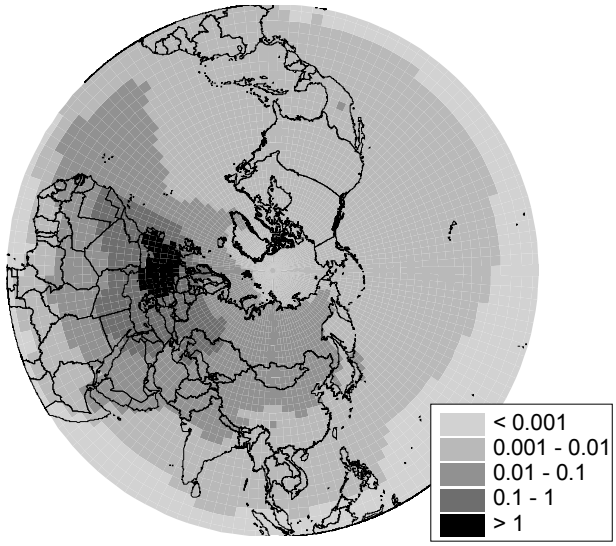


Figure 4.1 Spatial Distribution of Mean Annual γ-HCH Concentrations in the Surface Air Over the Northern Hemisphere for 1990, ng/m^3 (Malanichev, 2002)

The results suggest the possibility of long-range transport of PTS from the European Region to the Asian Region. However, simulation based on emission from the Asian Region is necessary to confirm the transboundary movement of PTS within and across the Region.

4.5.1.4 Transboundary Transport

Model estimates (Lee et al. 2001) show that PAHs, PCBs, and OCls can travel a few hundreds to thousands kilometers before their concentration levels in air reduces to a half initial values, which strongly indicates that transboundary movements of these substances would readily occur from Republic of Korea to other countries in this Region or vice versa.

Multimedia modelling (Suzuki et al., 2000) can be used to calculate a rough estimate of escaping amount of PCDD/PCDF from the Japanese environment. It depends on the scenario and the congener, but more than half of the PCDD/PCDF entering the atmospheric environment of Japan may escape from the Region.

Those data show the apparent possibility of transboundary transport of PTS from each country, however, more detailed study may be necessary to determine the transport within the Region.

4.5.1.5 Atmospheric-Surface Exchange

Deposition and re-emission processes are included in MSCE-POP model results, as shown in Figures 4.2 to 4.4. The importance of multi-hop pathways for γ-HCH is shown by the example of accumulation in seawater (see Figure 4.2).

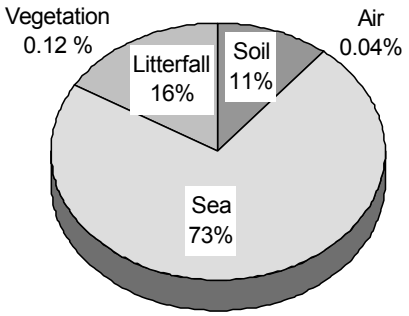


Figure 4.2 γ–HCH Redistribution Between Main Environmental Compartments (Malanichev, 2002)

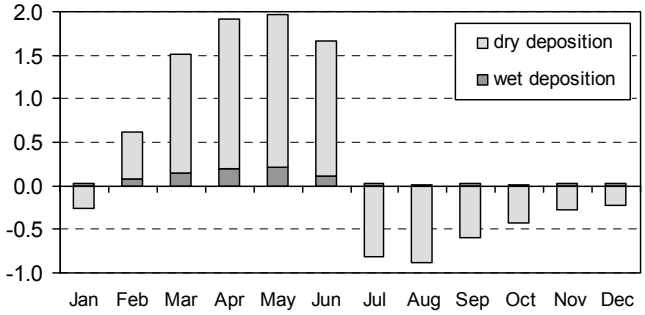


Figure 4.3 Seasonal Variations for Dry and Wet Deposition Fluxes of γ-HCH Over Sea, μg/m^2/month (Negative Values Mean Re-emission) (Malanichev, 2002)

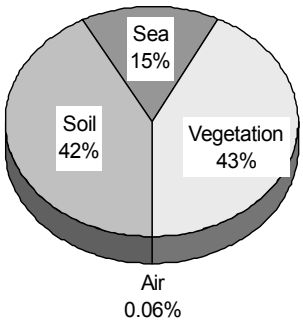


Figure 4.4 PCB Redistribution Between Main Environmental Compartments (Malanichev, 2002)

The role of re-emission process (and, hence, of the multi-hop pathway for HCB long-range transport) can be illustrated by long-term trends of gaseous flux over land and sea (Figure 4.5).

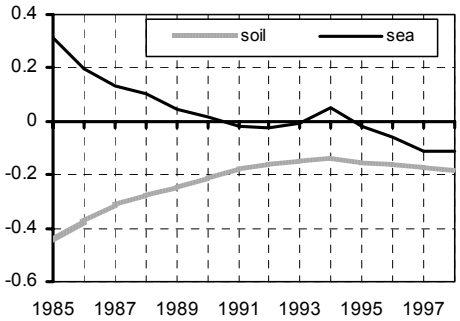


Figure 4.5 Dynamics of Flux of Gaseous Exchange of HCB Between the Atmosphere and the Underlying Surface During 1985-98, g/km^2/y

One can see that during the period from 1985 to 1993 re-emission flux from sea did not occur. This is controlled by the large capacity of the marine environment: during this period accumulation in sea takes place. However, towards the end of the simulation period due to reduction in atmospheric concentrations, gaseous fluxes both from soil and sea become essential and can lead to further long-range transport of the re-emitted pollutant. It is expected that with further reductions in air concentrations the re-emission flux from the sea will exceed that from soil.

4.5.1.6 Multimedia Distribution Data

PAHs, PCBs, OCls, PCDD/PCDF and other compounds have been measured in multimedia environments in the Republic of Korea. The media include atmospheric vapour phases, atmospheric aerosols, dissolved and sorbed to suspeneded sediments in water, sediment, tree leaves, and soils. Most of the data are available, however, whether the data are relevant to transboundary movement of PTS is unclear at the moment (NIER, 2002).

Multimedia monitoring data for PCDD/PCDF is available in Japan. The same sampling points have beena employed for simultaneous multimedia monitoring where possible, so the data can directly be used for the estimate of the multimedia distribution of PCDD/PCDF for air, water, soil and sediment. Some of these results are shown in Figure 4.6.

4.5.1.7 Travel Distance

Long-range transport potential (LRTP) can be evaluated in many ways (Mackay et al., 2001). One of them is by half-distance (HD), that is the distance which a parcel of a given PTS travels until its mass is reduced by half.

For evaluating of HD the results of long-term simulations for the above mentioned PTS (from 1970 to 1998) in the European Region are used. The necessity of long-term simulations for this purpose is required owing to the fact that the distribution of the considered pollutant between various environmental compartments will strongly affect HD. This is affected by a possibility of re-volatilisation of earlier accumulated PTS to the atmosphere with subsequent atmospheric transport (multi-hop pathway). As a result, the distribution between different environmental compartments can be established only within a sufficiently long period (several decades).

Environmental half-lives of PTS in the atmosphere from degradation and deposition processes can be used to calculate HD on this basis as a product of the calculated half-life with average wind speed. The latter is evaluated at 4 m/s according to (Beyer and Matthies, 2001). Annual emissions of some PTS transported outside the European region have been estimated (Table 4.1).

Table 4.1 Comparison of LRTP Calculated By Different Models (Malanichev, 2002)

Congeners	Atmospheric Half-Lives, (days) MSCE-POP Model	Half-Distance, km	
		MSCE-POP Model	Beyer and Matthies (2001)
2,3,7,8-TCDF	7.9	2740	3806
2,3,4,7,8-PeCDF	7.0	2400	2530
1,2,3,4,7,8-HxCDF	6.9	2390	2905
1,2,3,6,7,8-HxCDF	6.5	2240	1797
2,3,7,8-TCDD	5.3	1820	2348
1,2,3,7,8-PeCDD	5.0	1730	687
1,2,3,7,8,9-HxCDD	4.9	1690	-
1,2,3,6,7,8-HxCDD	4.8	1650	-

Figures 4.6 and 4.7 show the geographical distribution of atmospheric and soil concentrations of PCDD/PCDF and the geographical distribution of PCDD/PCDF into air in the Japanese environment (see Chapter 3). The data in Figures 4.6 and 4.7 do not directly show the quantitative travel distance, however, atmospheric levels are changing roughly one order of magnitude between higher and lower concentration areas, which are a few hundred kilometers apart from each other.

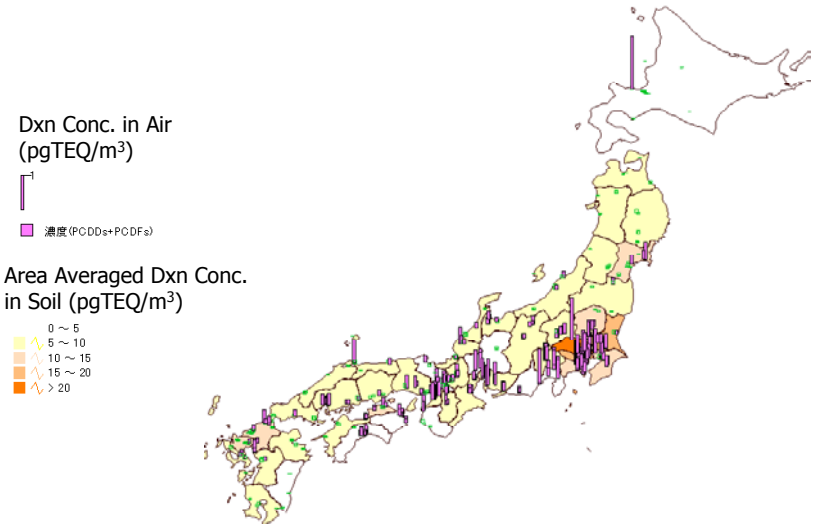


Figure 4.6 Geographical Distribution of Atmospheric and Soil Concentration of PCDD/PCDF (Suzuki et al., 2001)

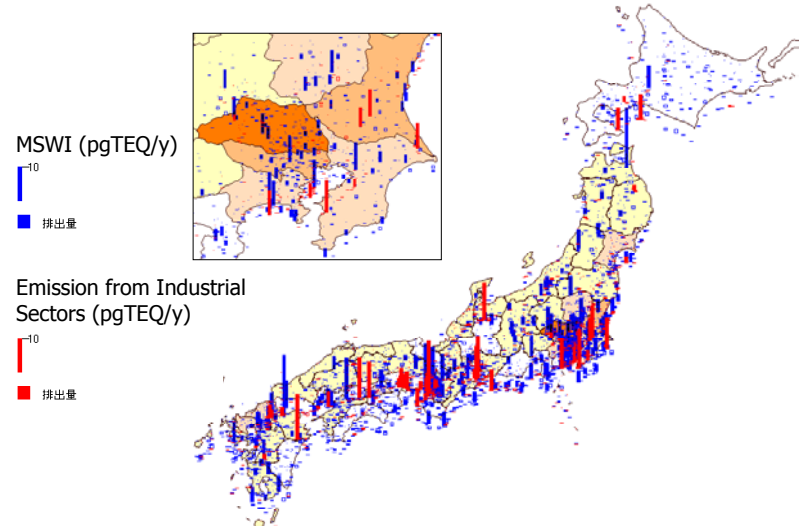


Figure 4.7 Geographical Distribusion of PCDD/PCDF Emission Into Air (Suzuki et al., 2001)

4.5.1.8 Surface Exchange on Vegetation

Contaminant levels of PTS in tree leaves have been measured in the Republic of Korea, which show possible surface exchange with vegetation (NIER, 2002).

4.5.1.9 Atmospheric Deposition

A year-round monitoring program of atmospheric deposition of PAHs, DDT and HCH was conducted in 2001-2002 in the Pearl River Delta, South China. Table 4.2 (Qi et al., in manuscript) below shows the atmospheric deposition fluxes of PAHs in a sampling season. More data will become available for seasonal variations and for DDT and HCH.

Table 4.2 Atmospheric Deposition Fluxes of Priority PAHs in Spring 2001, the Pearl River Delta, South China (µg/m^2·day) (Qi et al., in manuscript)

Compound\Sampling Station	Hong Kong SAR	Guangzhou	Qingyuan	Zhuhai	Zhongshan	Zhaoqing
Naphthalene	ND	0.002	ND	0.000	0.002	0.004
Acenaphthylene	ND	0.009	0.004	ND	0.002	0.002
Acenaphthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	0.018	0.009	ND	0.007	0.004
phenanthrene	0.031	0.109	0.086	0.023	0.052	0.046
Anthracene	0.002	0.009	0.007	ND	0.002	0.002
Fluoranthene	0.018	0.084	0.060	0.009	0.029	0.028
Pyrene	0.015	0.061	0.044	0.007	0.023	0.022
Benz(a)anthracene	0.002	0.023	0.013	ND	0.002	0.004
Chrysene	0.018	0.122	0.100	0.009	0.032	0.042
Benzo(b)fluoranthene	0.007	0.059	0.058	ND	0.011	0.020
Benzo(k)fluoranthene	0.004	0.038	0.035	0.002	0.007	0.011
Benzo(a)pyrene	0.002	0.014	0.018	ND	0.002	0.004
INDeno(1,2,3-cd)pyrene	0.002	0.043	0.038	ND	0.007	0.011
Dibenz(a,h)anthracene	ND	0.020	0.020	ND	ND	ND
Benzo(g,h,I)perylene	0.004	0.036	0.035	ND	0.007	0.011

ND = Not Detected

In another study on the wet and dry deposition of organochlorine pesticides in the Pearl River Delta, samples collected from 14 stations from April to June 2001 were analysed to assess deposition fluxes in order to gain an insight into possible migration processes in air. The deposition fluxes of HCHs and DDTs are within the range of 0.6-9.4 ng/m^2/day and 0.4-15.0ng/m^2/day, respectively.

Nationwide monitoring of PCDD/PCDF deposition was carried out in 1999 in Japan. Wet and dry deposition was separately collected by automatic sampling instruments. Results of this survey are summarized in Table 4.3 (Takei et al., 2000).

Table 4.3 Atmospheric Deposition of PCDD/PCDFs and Co-PCBs in Japan (Takei et al., 2000)

	Mean	Median	Range	Unit	N
PCDD/Fs	21	17	0.20-170	pgTEQ/m^2/day	205
PCDD/Fs+Co-PCBs	21	18	0.34-66	pgTEQ/m^2/day	103

Table 4.4 shows the selected measured data for dry particulate deposition flux of PAHs from air to land in Republic of Korea. More data will become available for PCBs, organochlorines, and phthalates (Lee, 2002).

Table 4.4 Atmospheric Deposition of Selected PAHs in Republic of Korea (ng/m^2/day) (Lee, 2002)

	sample site + year	Acenaph-Thylene	Acenaph-thene	Fluorene	Phenanthrene	Anthracene
summer	seoul '99	ND	ND	ND	ND	2638.49
	inch '99	ND	ND	ND	ND	2394.99
	yangs'99	ND	ND	ND	ND	2573.18

	yangp '99	ND	ND	ND	ND	2394.99
	hwac '99	ND	ND	ND	ND	4683.19
	choongj '99	ND	ND	ND	ND	896.80
	island '99	ND	ND	ND	ND	2204.44
autumn	seoul '99	ND	ND	ND	631.51	440.17
	inch '99	ND	ND	ND	2269.48	682.08
	yangs '99	ND	ND	ND	150.59	803.05
winter	seoul 2000	738.91	1077.25	3834.20	4872.10	147.64
	inch 2000	964.71	1612.79	5885.71	12398.02	398.65
	yangs 2000	556.10	1087.40	3890.53	2994.93	ND
	yangp 2000	344.47	663.27	2519.25	6155.48	169.97
spring	seoul 2000	226.17	504.08	1008.06	3217.57	ND
	inch 2000	211.59	587.65	1174.62	4705.38	674.14
	yangs 2000	140.36	397.54	832.29	2218.27	59.32
	yangp 2000	557.84	1322.28	3040.81	7905.18	ND

ND = Not Detected

Atmospheric deposition resulting from European sources are simulated by MSCE-POP model. Selected results are shown in Table 4.5 (Shatalov V. et al, 2000)

Table 4.5 Deposition Fluxes Over Sea Caused By European Emission Sources (Malanichev , 2002)

Chemical	Deposition Flux, μg/m^2/y	
	Near European Borders	Near Asian Borders
γ-HCH	1 – 50	0 – 10
PCBs	0.1 – 1	0 – 0.1
HCH	0.03 – 0.2	0.01 – 0.1

4.5.2 Terrestrial Hydrology Related to PTS Transport

4.5.2.1 General Geographical Characteristics of the Region

The land mass of Region VII including freshwater lakes and river systems, etc. is 32.8 million km^2. The terrestrial/freshwater compartment supports terrestrial and freshwater ecosystems and its surface area serves as a receptor for atmospherically transported contaminants. Persistent toxic substances can enter into the terrestrial/freshwater compartment by the atmosphere and from direct discharges to the land and water. Rivers may be key pathways for long-range transport as they can collect water and particulate matter from catchment areas and transport them over significant distances. The catchment areas of large rivers can include a variety of sources of contaminants such as agricultural runoff (contaminated with pesticides). Discharges of municipal and industrial sewage from heavily populated and industrialised areas also contribute to the contaminant load (AMAP, 1998). Table 4.6 shows the geographical characteristics of selected rivers and Table 4.7 shows the chracteristics of selected lakes within the Region.

Table 4.6 Geographical Characteristics of Selected Rivers Within Region VII

http://www.infoplease.com/ipa/A0001779.html

River	Source	Outflow	Approximate Length (km)
Chang Jiang (Yangtze)	Tibetan Plateau, China	China Sea	6,300
Huang Ho (Yellow)	Eastern part of Kunlan Mts., West China	Gulf of Chihli	5,464
Ob	Altai Mts., Russian Federation	Gulf of Ob	5,567
Yenisei	Tannu-Ola Mts., western Tuva, Russian Federation	Arctic Ocean	4,506

Irtish	Altai Mts., Russian Federation	Ob River	4,438
Heilong (Amur)	Confluence of Shilka (Russian Federation) and Argun (Manchuria) rivers	Tatar Strait	3,420
Lena	Baikal Mts., Russian Federation	Arctic Ocean	4,268
Mekong	Tibetan highlands	South China Sea	4,023
Ural	Southern Ural Mts., Russian Federation	Caspian Sea	2,533
Amu Darya (Oxus)	Nicholas Range, Pamir Mts., Turkmenistan	Aral Sea	2,414
Salween	Tibet, south of Kunlun Mts.	Gulf of Martaban	2,414
Perl	Eastern Yunnan Province, China	China Sea	2,197
Songhua	China–North Korea boundary	Amur River	1,927

Table 4.7 Geographical characteristics of selected lakes within Region VII

http://www.infoplease.com/ipa/A0001777.html

Name and Location	Area (km^2)	Maximum Depth (m)
Caspian Sea, Azerbaijan-Russia-Kazakhstan-Turkmenistan-Iran[1]	394,299	946
Aral, Kazakhstan-Uzbekistan	33,800	68
Baikal, Russian Federation	31,500	1,741
Balkhash, Kazakhstan	18,428	27
Issyk-Kul, Kyrgyzstan	6,200	700
Poyang, China	3,583	—

4.5.2.2 Transport By Rivers

Monitoring data summarised in Chapter 3 may be used to estimate the possible transport of PTS in the Region. Contamination by PCBs in Chinese river, soils and mussels are reported (Chen et al.,1999; Chu et al., 1995). However, at this moment, there are no summarised estimates describing the transport of PTS by river discharge based on these monitoring data.

4.5.2.3 Local Wastewater Discharges

Local wastewater discharges can carry significant amounts of contaminants, such as those from untreated or partially treated municipal sewage, construction waste, disposal of industrial wastewaters (i.e.oil, mining, smelting) etc. Storm and melt-water from ice and snow, which are usually channeled directly to receiving water bodies without treatment, may be highly contaminated due to spills and localised atmospheric fallout.

4.5.2.4 Regional Wastewater Sources

Wastewaters within the Region may originate from the discharges of contaminants from heavily industrialised developments. For example, due to rapid industrialisation of the Pearl River Delta Region after China's open door policy, the delta has become significantly polluted and has adversely affected the quality of the environment.

Regional wastewater sources into the freshwater systems of theRegion need to be further investigated.

4.5.2.5 Snowpack and Snowmelt

There is a lack of knowledge and information concerning snowpack and icemelt. However in general, for most of the Region, they are not believed to be significant as most of the countries are in the temperate climatic zone. Transport through ice is not considered significant in the Region.

4.5.3 Oceans as Pathway

4.5.3.1 General Description of the Region

The ocean that have direct physical contact with the terrestrial compartment of Region VII is the Pacific Ocean. There are several other major water bodies. Figure 4.8 shows the HCB concentration distribution in the upper oceanic layer estimated by MSCE-POP model from European sources.

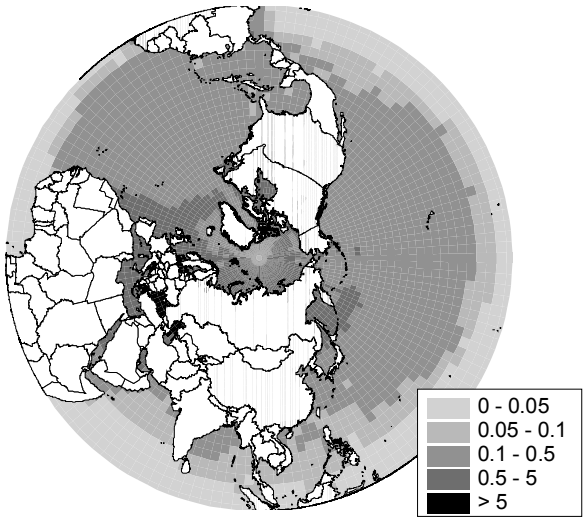


Figure 4.8 HCB Concentration Distribution in the Upper Ooceanic Layer from European Sources in 1990, pg/l
(Malanichev, 2002)

4.5.3.2 River Discharges to the Oceans

There are several large rivers that have discharges to the oceans in the Region. Information on the possible discharge of PTS compounds by the river is necessary for a detailed understanding of this pathway.

4.5.3.3 Atmospheric Deposition to the Oceans

Contaminants that have been emitted into the atmosphere will eventually return to the terrestrial and freshwater compartments along with the oceans. As previously mentioned, transport through the atmosphere is the fastest of the three components.

4.5.3.4 Ice

The Sea of Okhotsk and the Tatar Strait, located in the east of the Russian Federation, exhibit temporary ice pack cover. However, in general, ice is not significant for the Region VII.

4.5.3.5 Sea Currents as Possible Oceanic Transport Pathway

The major currents in the Region are the Oyashio, the Tsushima Current, and Kuroshio Current located around Japan.

Figure 4.9 shows that the PCDD/PCDF levels in squid obtained in northeastern part of Pacific Ocean decreases with distance from Japan coast. Monitoring data show relatively high concentrations in shore areas of Japan compared to the central ocean. Transport mechanisms for the phenomena are not well described yet although the monitored concentration gradient apparently shows transport from terrestrial Region to oceanic Region.

Sea currents are an important consideration for this Region. It should be noted that these currents may have transboundary transport implications for Region I (Arctic), Region VIII (South-east Asia and South Pacific), and Region IX (Pacific Islands).

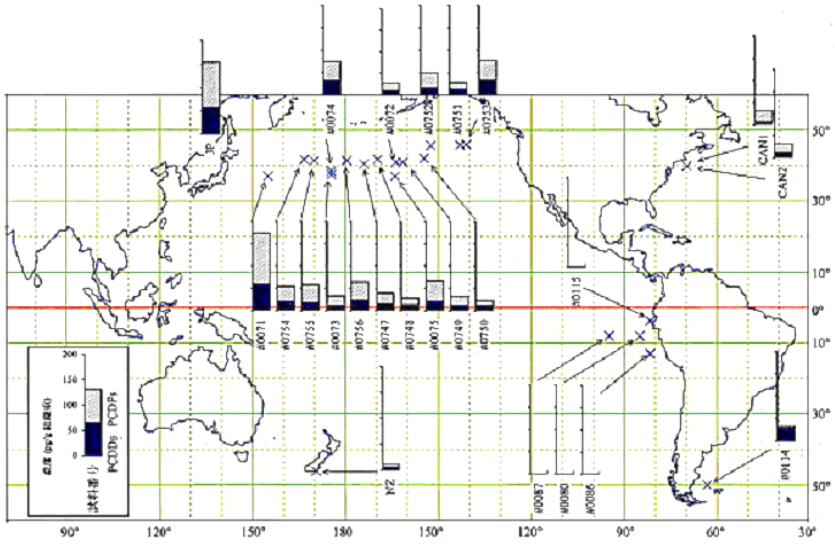


Figure 4.9 PCDD/PCDF concentration of squid in Pacific Ocean (pg/g) (Hashimoto et al., 2000)

4.6 DATA GAPS

Major data gaps exist in the Region. The following section outlines possible data gaps to attain improved assessment of contaminant transport in the Region.

4.6.1 What Information Needs To Be Collected?

4.6.1.1 Source Inventory Data

Establishment of consistent emission inventory across different regions is required. Expert estimate of emission may be used as the initial step of emission evaluation.

4.6.1.2 Monitoring Data Concerning Modelling Purpose

A monitoring strategy should be designed to get temporally and spatially representative information in different parts within the Region and across Regions. Monitoring data are necessary for model validation and evaluation of levels of pollution. Monitoring data for soil should receive priority.

4.6.1.3 Contamination Level in Biota

Ecological effect seems to be more important at this stage, however, monitoring data for biota are also important to quantify the chemical transport by biota migration. Data to fulfill the gaps should be developed in the Region.

4.6.1.4 Modelling Data

Physico-chemical properties are not available for some PTS. Possible factors that may affect Region specific conditions, e.g. temperature, degradation rate, sedimentation/resuspension of suspended solids may also be important. Information on the partition coefficients between gas and particles in air is extremely important, along with data on wet deposition. The role of vegetation in the exchange process between air and soil is likely to be important, so land cover information should be considered in more detail in the modelling work. Interactions between air and ocean including sea current should also be taken into consideration.

4.6.2 How Should It Be Collected?

4.6.2.1 Source Inventory Data

The general needs for possible harmonisation of source inventory system has been identified. It is recommended that a harmonised inventory system be developed..

4.6.2.2 Monitoring Data for Modelling Purpose

A data gap for Regional scale monitoring from the point of modelling has been identified. It is recommended that monitoring strategy with regionally harmonised methods and systems are to be developed to narrow the

data gap on this point.

4.6.2.3 Concentration Level in Biota

Monitoring strategies with regionally harmonised methods and systems are also important to fulfil the data gap for bio-transport of PTS.

4.6.2.4 Modelling Data

Chemical-specific modelling data is not a regionally specific data gap, however, many modelling data have a Region-specific nature, e.g., meteorological and/or geographical characteristics of the Region. Information on advective transport by sea currents and/or large rivers may have priorities in combination with appropriate monitoring dataset.

4.6.2.5 Source Pattern and Fingerprint

Characterisation and comparison of source patterns and fingerprints in different Regions may provide critical evidence for trans-boundary transport of PTS, as well as their possible decay in the process of atmospheric transport. These may include the use of molecular markers, pollutant patterns and compound-specific stable isotopic compositions or patterns of selected compounds.

4.7 CONCLUSIONS

Because of the meteorological and geographical nature of the Region VII, there may be special concerns for the development of transport models with a relatively large ocean area. Monitoring data do exist in several countries, showing the possibility of long-range transport of PTS compounds. Some countries have experience of transport assessment by modelling methodology, including; the hemispheric model at MSCE (EMEP), multimedia modelling by Republic of Korea (POPsME and EDCSeoul) and Japan (Grid-Catchments integrated MMM). However, the transboundary transport of PTS within the Region VII is not yet well described by either modelling or monitoring approaches.

Substantial effort will be necessary to fill the data and technical gaps and to assess the long-range transport of PTS in the Region.

Several data gaps are identified, and the importance of the gaps could tentatively prioritised as follows:

(1) Source inventory data: This is especially important, not only from the point of source identification, but also from the point of the extensive transport assessment.

(2) Monitoring data: Again this is especially important, not only from the point of monitoring itself, but also from the point of developing reliable transport assessments.

(3) Modelling data: There is always a general need for this topic, but continuing efforts in cooperation with global experts could be suggested as a possible way forward.

(5) Source patterns and fingerprints: This point is not directly a data gap, but it should be considered to be an important methodology to fulfill the gaps concerning PTS transport.

As a general comment for conclusion, transport assessment using an integrated approach may be important for future risk management of PTS in the Region.

5 PRELIMINARY ASSESSMENT OF THE REGIONAL CAPACITY AND NEED TO MANAGE PTS

5.1 INTRODUCTION

There are eleven countries with different economic development levels in the Region, which include developed countries such as Japan, developing countries such as China and Mongolia, and Russian Federation and Kazakhstan etc. whose economies are under transition. This chapter attempts to collate and integrate the capacities and needs of these countries based on their status.

To compose this chapter, a questionnaire, designed in October 2001, was circulated to Regional team members and representatives of the different countries within Region VII. Information was also collected from a wide range of sources during various environmental protection meetings held within the Region using presentations of representatives from different countries. This chapter is based on synthesising as much information as possible, and several revisions.

5.2 MONITORING CAPACITY

5.2.1 Environmental Monitoring

5.2.1.1 National Level

Only a few countries in the Region possess stable environmental monitoring personnel, for example, in Japan environmental monitoring is one of the major duties of its Ministry of Environment. The government of Japan has a number environmental monitoring personel who are assured of funding and advanced instrumentation, and are under strict administration. They provide abundant and comparable scientific data on the historical and present state of environmental pollution. Moreover, other concerned ministries, local governments, universities and some private research institutions also conduct some PTS monitoring.

In Republic of Korea, the Ministry of Environment has established mid- and long-term research plans concerning Endocrine Disrupting Chemiocals (EDCs) including PTS. According to this plan, National Environmental Monitoring is being conducted to measure the environmental levels of contamination by EDCs.

In China, environment monitoring is carried out under a unified plan, with organisation and coordination by environmental protection departments at different levels. Environment monitoring stations including those belonging to the agricultural sector have been set up at four levels (central, province, county, enterprise) to form a nationwide network of environmental protection, which carries out monitoring of certain pollutants and pollution indices according to unified standards with standardised processes and procedures. However, in addition to inefficient equipment and lack of funding, there are no stipulations with regard to the monitoring of PTS, thus regular monitoring of PTS has not yet been carried out. The scattered data collected are mainly generated from scientific research institutes and institutions of higher learning. Efforts have been made to set up major facilities for analysing PTS in several cities throughout China.

In China, under the organization of Ministry of Health (MOH), several PTS monitoring programs have been implemented. In 1980s, China joined the Global Environment Monitoring System (GEMS), and the Chinese Center for Disease Control and Prevention (CDC) passed the quality control evaluation of GEMS. In the middle of 1980s, a monitoring program on accumulation level of hazardous substances in human body, which was developed by MOH, was implemented in 31cities of 28 provinces. DDT in water as well as DDT and PCB in biological materials were monitored until 1990s. As there were not enough funds to support routine operation of environmental monitoring stations, such monitoring programs discontinued after 1990s. However, the CDCs in the national and provincial levels still have the ability to monitor the main PTS in water and biological materials. For the improvement of the quality and reliability of hazard monitoring data, the MOH has begun to certify laboratories for toxicity evaluation and to establish national GLP laboratory and networking for chemical safety testing since 2000.

In Hong Kong SAR, the Environmental Protection Department has commissioned environmental consultants to monitor PTS in the environment. Scientists from local universities have conducted studies related to PTS contamination in different ecological compartments.

In Russian Federation there are 4 laboratories accredited for PCDD/PCDF analysis (also on an international level).

No regular environment monitoring personnel have been appointed in some of the countries in the Region, where monitoring is carried out on an ad-hoc basis by research institutes. This prevents governments from obtaining comprehensive information about environmental pollution.

5.2.1.2 Regional level

So far there is no Regional network for the monitoring of chemicals in the environment.

5.2.1.3 Global level

The Global Environment Monitoring System (GEMS) was established as early as the early 80's, and many countries in this Region joined the system. However, this system does not have funding to support the routine operation of environment monitoring stations for all countries. Furthermore, PTS are not included in the items for monitoring according to the requirement of GEMS.

5.2.2 Methods of Monitoring

5.2.2.1 National Level

In order to ensure the comparability of data collected, many countries in the Region have set requirements for monitoring methods. All of these standardised methods are mostly focused on organiochlorine pesticides. When it comes to different environmental media, in most cases only PTS in water are monitored. A summary of the existing standardised methods of different countries are shown below in Table 5.1.

Table 5.1 Major Standardised Monitoring Methods*

PTS	Countries	Environmental Media	Analytical Methods	Detection Limit
Aldrin	Japan	Air/water/sediment/ organisms	POPs** GC/MS-SIM	No DL
	Republic of Korea	Water	Analytical Methods on EDCs ***	1 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.06 μg /kg dry
	Russian Federation	Foodstuff	Photocolorimetry, TLC, GC, GLC	0.01- 0.1 mg/kg
		Fruits and vegetable	Photocolorimetry	0.1 mg/kg
		Air	Photocolorimetry	0.1 μg Cl_2 in sample
		Meat, meat products and animal fat, water, soil, fish, milk, etc.	TLC	0.02-0.08 mg/kg
		Water		0.0025 mg/L
		Milk		0.01 mg/L
		Meat, fish, fat		0.02 mg/kg
		Butter		0.0025 mg/kg
			GLC	0.5 μg/ml extract, or 0.01 μg in sample
Chlordane	Japan	Air/water/sediment/organisms	POPs GC/MS-SIM	No DL
		Sediments	Black book** GC/MS-SIM	1 ng/g dry

		Organisms	Black book GC/ECD or GC/MS	1 ng/g wet
	Republic of Korea	Water	Analytical Methods on EDCs	1 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.07 µg/kg dry
DDT	China	Surface water/ground water/ some wastewater	GB7492-87**** GC/ECD	200 ng/L
		Soil	GB/T 14550-93 GC/ECD	>0.005 mg/kg
	Japan	Air/water/sediments/ organisms	POPs GC/MS-SIM	No DL
		Sediments	Black book GC/MS-SIM	1 ng/g dry
		Organisms	Black book GC/ECD or GC/MS	1 ng/g wet
	Kazakhstan	Water/soil	Vapour phase chromatographer	
	Republic of Korea	Water	Analytical Methods on EDCs	25 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	5 µg/kg dry
	Kyrgyzstan	Water		200 µg/L
	Russian Federation	Air/soil/water/foodstuff	TLC, GLC	0.01-0.05 mg/kg (L)
Dieldrin	Japan	Air/water/sediments/ organisms	POPs GC/MS-SIM	No DL
		Sediments	Black book GC/MS-SIM	1 ng/g dry
		Organisms	Black book GC/ECD or GC/MS	1 ng/g wet
	Russian Federation see aldrin	Air/soil/water	Photocalorimetric, TLC, GC	0.01-0.1mg/kg (L)
	Republic of Korea	Water	Analytical Methods on EDCs	6 ng/ L
Endrin	Japan	Air/ water/sediment/ organisms	POPs GC/MS-SIM	No DL
	Republic of Korea	Water	Analytical Methods on EDCs	3 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.13 µg/kg dry

Heptachlor	Japan	Air/water/sediment/organisms	POPs GC/MS-SIM	No DL
	Republic of Korea	Water	Analytical Methods on EDCs	1 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.04 μg/kg dry
	Russian Federation	Air/water/soil		0.01-0.1mg/kg (L)
HCB	Japan	Air/water/sediment/ organisms	POPs GC/MS-SIM	No DL
		Sediments	Black book GC/MS-SIM	1 ng/g dry
		Organisms	Black book GC/ECD or GC/MS	1 ng/g wet
	Republic of Korea	Air	Analytical Methods on EDCs	0.01 ng/ m^3
	Republic of Korea	Water	Analytical Methods on EDCs	0.5 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.02 μg/kg dry
	Russian Federation	Air	GLC	$5*10^{-5}$ μg/μL solvent
		Water/foodstuff	TLC	0.5 μg (90 %)
		Soil	GLC	0.005-0.007 mg/kg
Mirex	No information			
Toxaphene	Russian Federation	Air/soil/water/plants	GLC	0.1-0.2 ng
PCBs	China	Surface water	"Standard Guideline for the Water and Waste Water Monitoring " (ed. 15) GC/ECD	
	Japan	Air/water/sediment/ organisms	POPs GC/MS-SIM	No DL
		Water	Water Environment Quality Standard GLC	0.5 μg/L
		Organisms	Black book GC/ECD or GC/MS	10 ng/g wet
	Republic of Korea	Water	Analytical Methods on EDCs	100 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.5 μg/kg dry

	Russian Federation	Water, soil, air, live organism, foodstuff	GLC, CMS (as sum PCB, analog EPA-600) For environmental matrix RD 52.18578-97. Moscow 1999. For foodstuff MUK 4.1.1023-01. Min of Health RF, 2001.	DL-1 ng
PCDD	China	In gas/ liquid/solid status	HJ/T 77-2001	10-100 pg/L (Water) 1-10 ng/kg (Solid) 0.5-5.0 pg/µl (extractant)
	Japan	Air/water/sediment/soil/ organisms	For dioxins analysis, an analytical laboratory accredited system exists in Japan GC/MS-SIM	
	Republic of Korea	Air/water/sediment/soil	Analytical Methods on EDCs	
	Russian Federation	Air	GN 2.16.014-94	<0.01-< 0.05 pg/g in sample
		Drinking water, ground and fresh water, water inlet	Order of Ministry of Health USSR No.142-9/105. 05.05.1991	<0.01-<0.05 pg/g in sample
		Soil, bottom sediments	Order of Ministry of Health USSR No. 697. 08.09.68.	<0.01-<0.05 pg/g in sample
		Milk and dairy, fish and fish productions, meat and meat productions	Order of Ministry of Health USSR No.142-9/105. 05.05.1991	<0.01-<0.05 pg/g in sample
PCDF	see PCDD			
B(a)P	China	Surface water/industrial waste water	GB11895-89	
		Air	GB/T 15439-1995	6×10^{-5} ng/L (acetonitrile as mobil phase) 1.8×10^{-5} ng/L (methanol/water as mobil phase)
	Japan	Air/water/sediments/ organisms	GC/MS HPLC-FL	No DL
	Republic of Korea	Air	Analytical Methods on EDCs	0.03 ng/m^3
	Republic of Korea	Water	Analytical Methods on EDCs	10 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.1 µg/kg dry

HCH	China	Surface water/Ground water/ Some sewage	GB7492-87 GC/ECD	4 ng/L
		Soil	GB/T 14550-93	0.005 mg/kg
	Japan	Air/water/sediments/ organisms	POPs GC/MS-SIM	No DL
		Sediments	Black book GC/MS-SIM	1 ng/g dry
		Organisms	Black GC/ECD or GC/MS	
	Kazakhstan	Water/soil	Vapour phase chromatographer	
	Republic of Korea	Water	Analytical Methods on EDCs	1 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.02 μg/kg dry (β-HCH) 0.03 μg/kg dry (γ-HCH) 0.04 μg/kg dry (δ,α-HCH)
	Kyrgyzstan	Water		4 μg /L (γ -HCH)
	Russian Federation	Water, soil, live organism, foodstuff	GLC	4-10 μg/kg (γ -HCH)
			TLC	120 μg/kg (γ -HCH)
			Oscillopolarography	1 μg/kg (γ -HCH)
PCP	China	Surface water	GB 8972-88 GC/ECD	0.04 μg/L (50mL)
		Industrial water	GB 9803-88 Spectrophotometer	0.01 mg/L
	Republic of Korea	Water	Analytical Methods on EDCs	5 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.5 μg/kg dry
PCP-Na	China	Surface water	GB 8972-88 GC/ECD	0.04 μg/L (50mL)
PBDE	No information			
Organic Mercury Comp.	Japan	Water	GLC or TLC-AAS	0.0005mg/L

Methyl Mercury	China	Water	GB/T17132-1997 GC/ECD	0.01 ng/L
		Water (Methyl Hg, Ethyl Hg)	GB/T14204-93 GC/ECD	10 ng/L (Methyl Hg) 20 ng/L (Ethyl Hg)
		Sediment	GB/T17132-1997 GC/ECD	0.02 ng/kg
		Fish	GB/T17132-1997 GC/ECD	0.1 ng/kg
		Hair	GB/T17132-1997 GC/ECD	1 ng/kg
		Urine	GB/T17132-1997 GC/ECD	2 ng/L
Ethyl Hg (pesticides)	Russian Federation	Air in industrial area, water		
		Foodstuff	SanPiN 42-123-4540-87	
			GLC	0.005 mg/kg
			TLC	0.12-0.4 mg/kg
Org. Tin Compds.	Republic of Korea	Water	Analytical Methods on EDCs	1 ng/L
	Republic of Korea	Sediment/soil	Analytical Methods on EDCs	0.1 µg/kg dry

*AAS: Atomic Absorption Spectrometry; CMS: Chromato-Mass-Spectrometry; GC: Gas Chromatography; GLC: Gas-liquid Chromatography; HPLC-FL: High Performance Liquid Chromatography with Fluorimetric Detection; SIM: Selected (or Single) Ion Monitoring; TLC: Thin-layer Chromatography
** POPs: POPs monitoring method (2001~); Black book: Analytical methods used for monitoring in "Chemicals in the Environment". These methods have been, or will be used for long-term environmental monitoring in Japan.
***Analytical Methods on EDCs were published by NIER of Republic of Korea
****GB: National Standard of China

5.2.2.2 Regional Level

A UN sponsored university project has provided standards and methods for participants for at least some of the compounds of concern, however, it was found that different methods are used in different countries even for the monitoring of the same chemicals. There is so far no unified methods in the Region for PTS analysis. This hampers the comparability of the data collected by different countries.
http://landbase.hq.unu.edu/Monitoring/MonitoringtheEnvironment.htm

5.2.3 Items Actually Monitored

5.2.3.1 Regular Monitoring

The establishment of certain methods does not guarantee that actual monitoring will be carried out. In China, there are standardised methods to monitor PTS in certain goods or products as is required by foreign trade, but not all such products are monitored. The standard for PCDD/PCDF analysis in ash released from incinerators was set in 1999, but the laboratories are still being established and need to be certified, it is essential for China to build up her capacity in regular monitoring of PCDD/PCDF.

Japan has carried out regular monitoring for most PTS**.** The Ministry of Environment started environmental monitoring from 1974 and has been reporting monitoring data annually in *Chemicals in the Environment* (or KUROHON—"black book" in Japanese). The monitoring includes several categories, i.e., 1) a survey of prioritised chemicals (c.a. 20 compounds each year) in air and water, 2) yearly monitoring by GC/MS of Class I + frequently detected chemicals in water and sediments, 3) yearly GC/ECD and GC/FPD monitoring of Class I organochlorines and organotins, respectively in mussels and other organisms, 4) monitoring of residue levels of some of the designated/registered chemicals in ambient air, indoor air, foods, water and sediments, and 5) monitoring of unintentionally produced chemicals (until 1997; PCDD/PCDF and coplanar-PCBs, 1998~:

PBDDs and PBDFs).

An extensive nationwide survey for unintentionally produced chemicals has been conducted and the data reported. Legislation has been passed concerning special measures against PCDD/PCDF in 1999. Furthermore, another nationwide survey in Japan on endocrine disruptive chemicals started in 1998 (SPEED'98) (http://www.env.go.jp), and the analytical data on some PTS are also reported.

In Hong Kong SAR, the Environmental Protection Department has been monitoring PCBs and PAHs in marine sediment since 1987 and in 2000, a total of 60 stations (45 in open waters and 15 in typhoon shelters) were routinely monitored (EPD, 2001). Routine monitoring of PCDD/PCDF, PAHS and total PCBs in ambient air at two urban locations has also been conducted since mid-1997.

Extensive research on PCBs and other organochlorine chemicals, as well as many other pollutants, has been conducted at national as well as local governmental research centers, universities and other institutes, and a large amount of data have been reported.

The Ministry of Environment in Republic of Korea has conducted environmental monitoring of EDCs including POPs since 1999 and has been reporting monitoring data annually. Experimental methods of EDCs have been published in 1999 by National Institute of Environmental Research and revised in 2002. Overall results of environmental monitoring would provide the fundamental and scientific data on future EDCs research planning and also provide some rationale for decision-making for legislative and regulatory action.

In response to the inquiry of Stockholm Convention, the Ministry of Environment of Japan is now reorganising its environmental monitoring system, and will re-start POPs monitoring from from April 2002. Ten chemicals containing POPs (except PCDD/PCDF which are now monitored extensively in accordance with national legislation) in air, water, sediments and biological samples (especially bivalves) are analysed. A combination of ^{13}C-labeled internal standard techniques and GC/MS systems will be used in order to conduct precise and reliable analysis in order to provide a basis for the understanding of the status and trends of POPs pollution in the Asia-Pacific Region.

Regular monitoring of the PAHs (B(a)P) in air is conducted in all industrial cities of the Russian Federation and Kazakhstan. Regular monitoring of pesticides is conducted in foodstuffs, soils and fresh water in the Russian Federation, Kazakhstan , Kyrgyzstan, Tajikistan, Uzbekistan, and Mongolia.

5.2.3.2 Non-Regular Monitoring

Although most countries in the Region have not carried out routine monitoring of PTS in response to recognition of the potential harmful effects of PTS, ad hoc monitoring of certain PTS has been carried out by most governments within their limited capacity. For example, Hong Kong SAR has recently commissioned a study of PTS pollution of the marine environment.

Non-regular monitoring of PCDD/PCDF and PCBs sources and levels in the environment and humans are conducted in Asian part of Russian Federation. The periodical control of mercury and organic mercury compounds in the environment is conducted within gold mining areas (Chita oblast, Magadan oblast, Irkutask oblast, Irkutsk oblast).

5.2.3.3 Co-operation Between Countries in Monitoring PTS

Japan and the Republic of Korea are carrying out a joint research program to study EDCs such as PCDD/PCDF and PCBs. Research includes methods to monitor and techniques to test EDCs. Organisations taking part in the program include NIES of Japan and NIER of Republic of Korea.

5.2.3.4 Items for the Effects on Human Health

Of items monitored and studied, the analysis of PTS in the environment account for the greatest percentage. There are few cases of monitoring concerning PTS concentration in humans. There is only very scattered data resulting from investigations of epidemic diseases caused by PTS, due to the lack of funding.

5.3 EXISTING REGULATIONS AND MANAGEMENT STRUCTURES

5.3.1 Laws and Regulations

Management of PTS through legislation is the major means adopted by all nations in the Region. Many countries have modified regulations and rules in principle concerning the management—from production to

disposal—of hazardous chemicals including PTS. Analysis of legislation and regulation in different countries has shown disparities, especially in the intensity of measures taken owing to different levels of development and varying levels of recognition of the harm of PTS. A summary of the existing legislation and regulation is shown below in Table 5.2.

Table 5.2 Major Laws and Regulations Concerning PTS

Countries	Laws and Regulations (Effective Dates)
China	1. Code of Occupational Disease Prevention of PRC (1st May, 2002) 2. Regulations on Hazardous Chemicals Safety (15th March, 2002) 3. Regulations on the Management of Pesticides (8th May, 1997) 4. Regulations for Environmental Management on the First Import of Chemicals and the Import and Export of Toxic Chemicals (1st May, 1994)
Hong Kong SAR	1. Waste Disposal (Chemical Waste)(General) Regulation under the Waste Disposal Ordinance, Chapter 354 (1992) 2. Water Pollution Control Ordinance, Chapter 358 (1980) 3. Air Pollution Control Ordinance, Chapter 311 (1983) 4. Dangerous Goods Ordinance, Chapter 295 (1956) 5. The Pesticides Ordinance, Chapter 133 (15th July, 1977) 6. Import and Export Ordinance, Chapter 60 (1st January, 1972) 7. Factories and Industrial Undertakings Ordinance (Chapter 59) (1955) 8. Occupational Safety and Health Ordinance (Chapter 509) (1997)
Democratic People's Republic of Korea	1. Law on Environmental Protection (1986) 2. Law on Land (1977) 3. Law on Fishery (1995)
Republic of Korea	1. Toxic Chemicals Control act (1990) 2. Agrochemical Management Act 3. Waste Management Act (1997) 4. Air and Water Quality Preservation Act 5. *Soil Environment Preservation Act* 6. Industrial Safety Health Act
Japan	1. Law Concerning the Examination and Regulation of Manufactures, etc. of Chemical Substances (1973) 2. Agriculture Chemicals Regulation Law (1948) 3. Law Concerning Special Measures against Dioxins (1999) 4. Law for the Promotion of Environmentally Sound Destruction of PCB Waste (2001) 5. Law Concerning Reporting, etc. of Release to the Environment of Specific Chemical Substances and Promoting Improvements in their Management (2001)
Kazakhstan	1. Regulations about Licensing Import and Export of Goods (activities, services) in the Republic of Kazakhstan 2. Guideline for Organization of State Environmental Control over Use, Storage, Transportation and Disposal of Pesticides and Mineral Fertilizers 3. Sanitary Rules and Norms of Storage, Transportation and Use of Chemical Plant Protection Means 4. List Chemical and Biological Means of Pest, Plant Disease, and Weed Prevention, Defoliants, and Regulators of Plant Growth Allowed for Use in Agriculture and Forestry in the Republic of Kazakhstan in 1997-2001
Kyrgyzstan	1. Law on Chemicals and Plant Protection (1999) 2. Law about the Environmental Protection 3. Law on Atmosphere Air
Mongolia	1. Law on Protection from Toxic Chemical Substances (1995) 2. Law on Environmental Impact Assessment (1998)
Russian Federation	1. Law on Environment Protection (2002) 2. The Earth Code (2001) 3. The Water Code (1998) 4. Law on Air Protection (1999) 5. Law about Sanitary – Epidemiological Well-being of the Population (1999) 6. Law about Safe Handling with Pesticides and Agrochemicals

Tajikistan	1. Law on the Natural Reservation (1993) 2. Law on the Waste (2002) 3. The Earth Code 4. The Water Code 5. Law on the Atmosphere Air Protection
Turkmenistan	1. Law on the Environment Protection (1991) 2. Decree of President about Commission of the importation and usage of the pesticides (1997)
Uzbekistan	1. Law about Agricultural Plant Protection 2. About regulation of input in Republic of Uzbekistan and conclusion from its territory ecologically of dangerous production and solid waste (2000) 3. Law on Nature Reservation (1992) 4. Law on Atmosphere Air (1986) 5. Law on Waste (2002) 6. List Chemical and Biological Means of Pest, Plant Disease and Weed Prevention, Defoliants and Regulators of Plant Growth allowed for Use on Agriculture (2001-2005)

Some countries within the Region have no specific legislation concerning hazardous chemicals, although there may be some relevant stipulations in environment protection legislation and elsewhere.

The standards of some PTS have been set for some environmental media in the Region. A summary of these standards is shown below in Table 5.3 to Table 5.7.

Table 5.3 Major Environmental Standards on PTS

PTS	Environmental Standards
Aldrin	**Uzbekistan:** Air: 0.01 mg/m^3 Ground water: 0.002 μg/L
Chlordane	No information
DDT	**China:** Fishery water: 0.001 mg/L Ground water: (I)ND; (II)0.005 μg/L; (III)0.05 μg/L; (IV)1.0 μg/L Soil: (I)0.05μg/L; (II)0.5 μg/L; (III)1.0μg/L **Democratic People's Republic of Korea:** Soil: 0.1mg/kg **Russian Federation:** Air (working zone): 0.1 mg/m^3 Air: 0.005 mg/m^3 Soil: 0.1 mg/kg Water: 0.002 mg/L *Maximum allowed (permissible) level* Potato, vegetables: 0.1 mg/kg Meat, eggs, grain of the bread plants: 0.02 mg/kg Milk: 0.05 mg/L Fish: 0.2 – 0.3 mg/kg Plant oil: 0.25 mg/kg **Uzbekistan:** Air: 0.005 mg/m^3 Ground water: 0.002 μg/L Soil: 0.5 mg/kg
Dieldrin	No information
Endrin	No information
Heptachlor	**Russian Federation:** Air (working zone): 0.01 mg/m^3 Water: 0.001 mg/L Soil: 0.05 mg/kg *Permissible residual conc.:* Plant oil: 0.02 – 0.25 mg/kg For others food products – not permissible **Uzbekistan:** Ground water: 0.05 μg/L Soil: 0.05 mg/kg Air: 0.9 mg/m^3

Hexachlorbenzene	**Uzbekistan:** Air: 0.013 mg/m^3 Ground water: 0.05 μg/L
Mirex	No information
Toxaphene	**Russian Federation:** Air (working zone): 0.2 mg/m^3 Water: 0.002 mg/L Soil: 0.5 mg/kg *Maximum allowed level:* Beetroot: 0.1 mg/kg For others food product: not permissible
PCBs	**Japan:** Water: not detected (detection limit of the analytical method is set to 0.5 μg/L) **Russian Federation:** Air (industrial area): 1 mg/m^3 Water: 0.5 – 2.5 ng/L Soil: 0.1 mg/kg Fish: 0.1 mg/kg wet weight Milk: 1.5 mg/kg of lipid base
Dioxins	**Japan:** (Dioxins = PCDDs + PCDFs + co-PCB) Air: yearly average <0.6 pg TEQ/m3 Water: yearly average <1 pg TEQ/L Sediments: <150 pg TEQ/g Soils: <1000 pg TEQ/g Refer to Table 5.4, Table 5.5 **Republic of Korea**: Refer to Table 5.6, Table 5.7 **Russian Federation:** (TEQ) Air: 0.5 pg/m^3 Water: 20 pg/L Sediment: 9 ng/kg Soil: 0.33 ng/kg Fish: 88ng/kg of lipid base Meat: 3.3 ng/kg of lipid base Milk: 5.2 ng/kg of lipid base
	China: Air: 0.01μg/m^3; Surface water: (I)0.0025μg/L; (II)0.0025μg/L; (III)0.0025μg/L. Pollutants in sludge from agricultural use: 3mg/kg Wastewater discharged: 0.00003mg/L **Russian Federation** Air (working zone): 0.15 μg/m^3 Air: 1 ng/m^3 Water: 0.000005 μg/L Soil: 20 μ/kg
HCH	**China:** Ground water: (I)0.005 μg/L; (II)0.05 μg/L; (III)5.0 μg/L; (IV)5.0 Soil: (I)0.05 μg/L;; (II)0.5 μg/L; (III)1.0 μg/L **Uzbekistan:** Air: 0.03 μg/m^3 Ground water: 0.02 μg/L Soil: 0.1 mg/kg Air: 0.1 μg/m^3
γ-HCH	**China:** Fishery water: 0.002mg/L **Democratic People's Republic of Korea:** Soil: 0.1mg/kg
PCP	**China:** Wastewater discharged: (I)5.0 mg/L ; (II)8.0mg/L; (III)10mg/L; **Russian Federation:** Air (working zone): 0.1 mg/m^3 Air: 0.001 mg/m^3 Water: 0.3 mg/L Residual content in food: not permissible
PBDE	No information

Org. Hg compds.	**China:** Wastewater discharged: ND **Japan:** Water: not detected (detection limit of the method is set to 0.0005 mg/L) **Russian Federation:** Air (working zone): 0.005 mg/m^3 (diethylmercury, ethylmercury chloride) Air : 0.0003 mg/m^3 (diethylmercury) Water: 0.0001 mg/L (diethylmercury and ethylmercury cloride) Soil: 2.1 mg/kg (total mercury) Temporary allowed norms for food products (1989) Milk, juice: 0.005 mg/kg (total mercury) Fruits, grain, bread: 0.01 mg/kg (total mercury) Vegetables: 0.02 mg/kg (total mercury) Meat: 0.03 mg/kg (total mercury) Fish: 0.5 mg/kg (total mercury)

I, II, III, IV: Different environmental quality levels in China with I = Good; IV = Poor

Table 5.4 PCDD/PCDF* Emission Gas Standards in Japan (Unit: ng-TEQ/m^3)

Facility under Control		New	Existing	
			Until Nov. 2002	After Dec. 2002
Waste Incineration	>4 t/h-	0.1	80	1
	2-4 t/h	1	80	5
	<2 t/h	5	80	10
Steel Manufacturing by Electric Furnace		0.5	20	5
Sintering Process of Steel Industry		0.1	2	1
Secondary Production of Zinc		1	40	10
Secondary Production of Aluminum Alloy		1	20	5

* including PCDDs+PCDFs+co-PCBs

Table 5.5 PCDD/PCDF* Effluent Standards in Japan (Unit: pg-TEQ/l)

Facility	New	Existing	
		Until 14 Jan 2003	After 15 Jan. 2003
Bleaching facilities using chlorine compounds used for manufacturing sulfate pulps (kraft pulps) or sulfite pulps. Resolving facilities waste PCB or PCB-processed products. Cleansing facilities for PCB contaminated matter or PCB- processed products.	10	10	10
Cleansing facilities for waste gas and wet dust collecting facilities relating to roasting furnaces, melting furnaces or dry kilns used for manufacturing aluminum or aluminum-base alloy. Cleansing facilities for dichloroethane used for manufacturing vinyl chloride monomer.	10	20	10
Cleansing facilities, wet dust collecting facilities, and ash storing facilities which are related to waste incinerators (capacity of incineration is more than 50kg/h) and discharge sewage or waste solution.	10	50	10

* including PCDD+PCDF+co-PCBs

Table 5.6 PCDDs/PCDFs Emission Standard for MSWI in Republic of Korea (Unit: ng-TEQ/m^3)

Capacity (>2 t/h)	Standards	Effective Data
New	0.1	19 July 1997
Existing	0.5	1 July 1999 – 30 June 2003
Existing	0.1	After 1 July 2003

Table 5.7 PCDDs/PCDFs Emission Standard for Incinerator in Republic of Korea (except MSWI) (Unit: ng-TEQ/m^3)

Capacity	New	Existing	
		1 Jan. 2001 – 31 Dec. 2005	After 1 Jan. 2006
> 4 t/h	0.1	20	1
2 t/h – 4 t/h	1	40	5
0.2 t/h – 2 t/h	5	40	10

Table 5.8 Emission Standard of B(a)P for Coke Oven in China (mg/m^3) (GB 16171-1996)*

	Mechanized			Non-mechanized		
	(I)	(II)	(III)	(I)	(II)	(III)
Existing (until 1st July 1999)	0.0010	0.0040	0.0055	0.010	0.020	0.025
New (after 1st July 1999)		0.0025	0.0040		1.50	2.00

*GB: National Standard of China
I, II, III, IV: Different environmental quality levels in China with I the best and the bigger number the worse

Table 5.9 B(a)P Emission Standard in China (GB 16297-1996)*

	Threshold for Producing and Processing of Asphalt and Carbonate Produce (mg/m^3)	Maximal Permitted Emission Rate (kg/h)				Threshold on the Monitoring Sites about the non-point Emission Sources (μg/m^3)
		Height of Chimney (m)	(I)	(II)	(III)	
Existing (until 1st July 1997)	0.50×10^{-3}	15	Banned	0.06×10^{-3}	0.09×10^{-3}	0.01
		20		0.10×10^{-3}	0.15×10^{-3}	
		30		0.34×10^{-3}	0.51×10^{-3}	
		40		0.59×10^{-3}	0.89×10^{-3}	
		50		0.90×10^{-3}	1.4×10^{-3}	
		60		1.3×10^{-3}	2.0×10^{-3}	
New (after 1st July 1997)	0.30×10^{-3}	15	Banned	0.050×10^{-3}	0.080×10^{-3}	0.008
		20		0.085×10^{-3}	0.13×10^{-3}	
		30		0.29×10^{-3}	0.43×10^{-3}	
		40		0.50×10^{-3}	0.76×10^{-3}	
		50		0.77×10^{-3}	1.2×10^{-3}	
		60		1.1×10^{-3}	1.7×10^{-3}	

GB: National Standard of China
I, II, III, IV: Different environmental quality levels in China with I = Good; IV = Poor

5.3.2 Administrative Institutions

5.3.2.1 National Level

5.3.2.1.1 Responsible Government Organisation

As the management involves many sections and departments, it is hardly possible for any single department to execute all the necessary administrative requirements with regards to the management of PTS. In many countries there are three or four departments responsible for the management of PTS and in some countries there are as many as ten. Apart from the environmental protection department, governmental departments involved in the management of dangerous chemicals may also include departments engaged in agriculture, industry/economy, public health, and even foreign affairs when international relations such international conventions are involved. In general, the environmental protection department is the Focal Point/Competent Authority/Designated National Authority as stipulated in the Stockholm Convention. In a sense, the capacity of management of chemicals can be evaluated based on whether a country has set up special organisations and how many people are assigned to the task.

5.3.2.1.2 Inter-Government Co-ordination

Different countries have different ways to coordinate the management of chemicals between different departments. For example, Mongolia established its National Council for Chemical Safety (NCCS) in 1998, whose mandate is to regulate the implementation of governmental laws, resolutions of international conventions in which Mongolia takes part. NCCS are also involved with decisions concerning toxic and hazardous chemicals and to provide technical advice on the import of toxic substances and issue import licenses. They also serve as a steering committee to carry out projects concerning POPs. The present NCCS has 35 members and represents 16 ministries and organisations. It has a network of 21 aimages (Mongolian Regions), which are sub-divided into more than 300 soums (Mongolian counties), greatly improving co-ordination between different departments and organisations throughout the nation in the management of chemicals. The NCCS will serve as the steering committee for POPs activities.

Special inter-departmental committees are formed in some countries to implement certain legislation or to carry out certain tasks in the management of chemicals. Such committees are usually formed by technical and administrative specialists from different departments, who will make comprehensive assessments on certain chemicals from different points of view and put forward advice to concerned departments for the implementation of relative legislation. In addition, China has established a special inter-department co-ordination group for the International Forum of Chemical Safety (IFCS) as well as a POPs co-ordination group for the negotiation of the Stockholm Convention. Members of these groups are mainly administrative and academic specialists.

A summary of the various management agencies, departments and coordinating mechanisms for the various countries in the Region are shown in Table 5.10.

Table 5.10 Management Structures

Countries	Management Structures
China	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. State Environmental Protection Administration 2. State Economic and Trade Commission 3. Ministry of Agriculture 4. Ministry of Health 5. General Bureau of Quality and Technical Supervision **Co-ordinating Mechanism:** 1. Inter-ministerial Coordination Group on Chemical Safety in order to carry out the various tasks set out by the IFCS and effectively participate in IFCS activities 2. State Technical Coordinating Group of POPs for the negotiation of the Stockholm Convention 3. The Committee for the Standardization of Dangerous Chemicals under Regulations on the Control over Safety of Dangerous Chemicals 4. National Pesticides Register Review Board under The Regulation on the Management of Pesticides 5. The State Toxic Chemicals Review Board under Regulations for Environmental Management on the First Import of Chemicals and the Import and Export of Toxic Chemicals **The Focal Point for the Stockholm Convention:** State Environmental Protection Administration

Hong Kong SAR	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Environment, Transport and Works Bureau 2. Environmental Protection Department 3. Health, Welfare and Food Bureau 4. Agriculture, Fisheries and Conservation Department 5. Environmental Food and Hygiene Department
Democratic People's Republic of Korea	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Land and Environment Protection 2. Ministry of Chemical Industry 3. Ministry of Agriculture 4. Ministry of Metal and Machine Industries 5. Ministry of Building-materials Industries 6. General Bureau of Quality Control **Co-ordinating Mechanism:** The National Coordinating Committee for Environment. In general, Ministry of Land and Environment Protection is responsible for control of harmful chemicals. Other ministries obtain written agreement from the ministry of Land and Environment Protection with regard to production, use, storage, disposal, import and export of hazardous chemicals. Institute of Hygiene under the Branch Academy of Medical Sciences, Institute of Chemistry under the Academy of Agricultural Sciences and Institute of Environmental protection under the Ministry of Land and Environment protection undertake the activities for examination and registration of these chemicals. **The Focal Point for the Stockholm Convention**: Ministry of Land and Environment Protection
Republic of Korea	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Environment 2. Ministry of Labor 3. Ministry of Health and Welfare 4. Ministry Foreign Affairs and Trade 5. Rural Development Administration 6. Ministry of Maritime Affairs and Fisheries 7. Korea Food and Drug Administration **Co-ordinating Mechanism:** 1. Toxic Substance Management Committee **The Focal Point for the Stockholm Convention:** Ministry of Environment
Japan	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of the Environment 2. Ministry of Agriculture, Forestry and Fisheries 3. Ministry of Economy, Trade and Industry 4. Ministry of Health, Labor and Welfare **Co-ordinating Mechanism:** 1. Chemical Assessing Committee for the implementation of the *Law concerning the Examination and Regulation of Manufactures, etc., of Chemical Substances*. **The Focal Point for the Stockholm Convention:** Ministry of Foreign Affairs
Kazakhstan	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Economy and Trade 2. Ministry of Nature Resources and Environmental Protection 3. Ministry of Agriculture 4. Ministry of Healthcare 5. Customs Committee of the Ministry of State Revenues 6. Ministry of Energy and Mineral Resources
Kyrgyzstan	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Ecology and Civil Emergency 2. Ministry of the Health 3. Ministry of Agriculture

Mongolia	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Nature and Environment 2. Ministry of Health 3. Ministry of Labor and Social Welfare 4. Ministry of Food and Agriculture 5. Ministry of Trade and Industry **Co-ordinating Mechanism:** National Council for Chemical Safety (NCCS) headed by the Minister of Nature and Environment of Mongolia **The Focal Point for the Stockholm Convention:** Ministry of Nature and Environment of Mongolia through its Environment Protection Agency with representatives in each aimage
Russian Federation	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Natural Resources 2. Ministry of Health 3. State Committee for Hydrometeorology 4. Ministry of Emergency Situation 5. State Chemical Commission under Ministry of Agriculture 6. Center of the Registration of Chemical Compounds 7. Center of Registration and Safety Using of Pesticides **Co-ordinating Mechanism:** According to the order of Ministry of Natural Resources Center of the International Project is responsible for realizing the requirements of Stockholm Convention in Russian Federation. Center of the Registration of Chemical Compounds and State Chemical Commission conduct inter-department coordination between the Ministries of Natural Resources, Health and Agriculture
Tajikistan	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. Ministry of Natural Protection 2. Ministry of Agriculture 3. Ministry of Health 4. Commission on the Management of Chemicals
Turkmenistan	**The Ministries/ Agencies/ Committees Concerning PTS Problem** 1.Ministry of Natural Protection 2.Ministry of Agriculture 3.Commission on importation and usage of the pesticides
Uzbekistan	**The Ministries/ Agencies/ Committees Concerning PTS:** 1. State Committee for Nature Protection 2. State Chemical Commission 3. Ministry of Agriculture 4. Ministry of Healthcare **Co-ordinating Mechanism:** In general, State Committee for Nature Protection Other ministries obtain written agreement from State Committee for Nature Protection with regard to use, storage, and disposal of hazardous chemicals **The Focal Point for the Stockholm Convention:** State Committee for Nature Protection

5.3.2.2 Regional Level

There is currently no organisation in the Region in charge of the management of chemicals or co-ordination in this area. However, there is an organisation (located in Beijing, China) that is related to the management of chemicals: the Asia-Pacific Regional Center for Hazardous Waste Management Training & Technology Transfer under the Basel Convention. Their task is to take charge of affairs concerning technical training and transfer for the management and disposal of hazardous waste matters in the Region. Due to various reasons, the independence and functions of administration at the Regional level need further clarification.

5.4 STATUS OF ENFORCEMENT

Efforts have been made by all the countries in the Region to strengthen the management of PTS. Efforts are also being made for the prohibition or strict control of the production, use and emission of PTS in order to protect the eco-environment and human health in the Region and the global environment.

For some countries international cooperation projects are being used to strengthen the capacity for further enforcement. These projects concerning PTS are witnessing active participation and many are carried out through bilateral and multilateral funding and co-operation. In some countries inventories of PTS are being compiled. Table 5.11 shows PTS related programs and actions carried or being carried in the countries of the Region.

Table 5.11 PTS Related Programs and Actions

Countries	Programs and Actions
China	1. An investigation of typical hazardous organic pollutants in typical parts of the country and its eco-toxicity safety assessment (2000-2002) 2. Strategy and program on Reduction and Phase-Out of Pesticide POPs in China funded by Italian government (2002-2003) 3. National Implementation Plan (NIP) for Stockholm Convention PDF-B financed by GEF (2002-2003) 4. PCB phase-out strategy, funded by Italian government
Hong Kong SAR	1. Study of Toxic Substances Pollution in Hong Kong (1999-2003, Hong Kong SAR Environmental Protection Department)
Democratic People's Republic of Korea	1. Standards for environmental protection have been updated to take stronger measures for prevention of flow, stockpile and transfer of these chemicals 2. Production of DDT has been banned and production and use of HCB and PCP have been severely restricted
Republic of Korea	1. National dioxin emission inventory: the purpose is to identify emission sources of dioxin-like chemicals, -will be available by the end of 2003 (MoE) 2. Mid- and Long-Term Research Program on EDCs including POPs (from 1999) (MoE) 3. Ministerial Implementing Arrangement between Republic of Korea and Japan (April 7, 2001)
Japan	1. Stockholm Convention was acceded on 30th Aug. 2002 2. Extensive monitoring has been conducted in various chemicals in the environment (from 1974) 3. The law concerning special measures against Dioxins (Law No. 105 of 1999) took effect on January 2000 4. Ministry of Environment is now reorganizing their environmental monitoring system, and will re-start POPs monitoring from April 2002 5. Ministry of Environment has just started the survey on major sources of non-planer PCB and unintentionally-released HCB listed in Annex C of Stockholm Convention
Kazakhstan	1. Programme 058 "Environmental monitoring and environmental protection", Sub-programme "Conducting Environmental Monitoring". PTS: DDT and HCH in soil (twice a year) and water (4 times a year) 2. Preliminary POPs inventory was conducted in 2001 with the support of UNEP Chemicals
Kyrgyzstan	1. The project of "Destroying of prohibited and deteriorated pesticides in the Republic of Kyrgyzstan" has received the support of the state government

Mongolia	1. The first check and examination on storing and using of toxic chemical substances was conducted in 1994 2. In 1997, Ministry of Nature and Environment (MNE) updated a list of restricted or banned chemicals in Mongolia. Import of all of the POPs pesticides and industrial chemicals has been banned 3. The project on removing mercury from the relevant site was implemented by the Ministry of Nature and Environment and 25 kg mercury was separated from 400 m3 water of 4 hectare area in 2000 4. Some investigations are being conducted on the probability of PTS existence within the range of the environmental impact assessments made at some industries in accordance with the Law on Environmental Impact Assessment 5. Enabling activities to facilitate early action on the implementation of the Stockholm Convention on persistent organic pollutants (POPs)" Project US$ 492,000 has been approved by GEF in July, 2002 and is expected to start by the end of 2002
Russian Federation	1. Measurements of general dioxin toxicity in human milk conducted over the past years demonstrated a high risk of environmental pollution with PCB 2. Federal Target Program "Environment and Population Protection from Dioxins and Dioxin-like toxicants for 1996-1997" made a preliminary assessment of the general dioxin pollution level in Russian Federation. However no accurate data was obtained 3. In 1999-2000 the inventory of dioxin emitting sources was taken under US EPA financial support. It showed that there was at least 10 kg for total dioxin air emission in Russian Federation 4. The government has issued several Russian Federation State Environmental Reports in recent years 5. The PCB inventory taken under the AMAP program and based on official data supplied by industries show that there are still tens of thousands tons of PCBs in Russian Federation today. Russian Federation has been given a 25-year deferment for full destruction of PCBs
Tajikistan	No information
Turkmenistan	No information
Uzbekistan	1. The project "Inventory of Obsolete, Unwanted and Banned pesticides in the Republic of Uzbekistan" in 2000 with support of UNEP Chemicals 2. State Committee for Nature Protection entered 22 Substances of PTC in a list of restricted or banned chemicals in the Republic of Uzbekistan 3. Program "Environmental Monitoring of the Republic of Uzbekistan" (2001–2003)

5.5 ALTERNATIVES/MEASURES FOR REDUCTION

5.5.1 Intentionally Produced PTS

There are three main ways to reduce or eliminate emissions of intentionally produced PTS: first, substitutes can be identified, so that the production or use of PTS can be prohibited. For example, DDT and HCH were major pesticides in China during the 1970's and early 1980's. In the middle of the 1980's China began to replace organochlorine pesticides with organophosphate pesticides. Since 1983 DDT and HCH have been banned as pesticides. In Kyrgyzstan, DDT and HCH have been replaced by pyrethroid pesticides. The annual consumption of pyrethroids is about 33 t, which represents a replacement rate of about 75%. In addition to using substitutes for PTS pesticides, integrated pest management practices can be used to reduce the overall need for pesticide applications. Substitutes have also been identified for industrial chemicals such as PCBs. Alternatives to the UNEP POPs can be found on the UNEP web site at

http://dbserver.irptc.unep.ch:8887/irptc/owa/ini.init

Second, if substitution cannot completely replace a PTS, its use can be restricted to only essential applications. For example, DDT in no longer produced or used as an agricultural pesticide, but it is still allowed as an intermediate in the process of producing dicofol and produced for public health applications for the prevention of malaria. Chlordane can no longer be used in agriculture, but it is extensively used in structures, such as

buildings and dams to protect against termites.

Third, certain PTS components in products may be banned, so as to reduce or eliminate PTS components entering the environment. For example, compounds and mixtures containing HCH are now banned in China, but the production and use of lindane, an isomer with less toxicity and lower bioaccumulation potential is permitted in some special cases.

Replacing PTS is not a simple issue, as there may be monetary and social consequences. For Mongolia or other countries that do not produce any chemicals and depend entirely on imports, the replacement of PTS is relatively simple: directly import substitutes as long as the country can afford them. For China and other countries which have been producing and using PTS on a large scale, the solution may not be so simple. The prohibition and replacement of PTS may involve the closing down of manufacturing facilities or conversion of the facilities to make different products. This may also lead to other problems such as unemployment.

The replacement of PTS may have an impact on the country's infrastructure. For example, chlordane is widely used in many areas of China, especially in south China, where termites are causing extensive damage and affect many areas of China's national economy. Therefore, the Chinese government stipulates that prevention and treatment of termites must be carried out in the building, remodelling, reconstructing or expansion of any buildings in areas where termites are widespread. It is not affordable to frequently demolish or reconstruct buildings, especially large dams in water conservancy projects, so it is mandatory that the prevention of termintes in buildings be effective for more than ten years. An effective substitute for chlordane for this purpose has not been identified.

5.5.2 Unintentionally Produced PTS

Unintented byproduct emissions have been reduced through the implementation of stricter environmental standards. For example, the emission of PCDD/PCDF has been reduced in recent years in Japan because of the *Law concerning Special Measures against Dioxins* passed in 1999. The policy target of the law is that the total emission of PCDD will be reduced by 90% of that of 1997 by March 2003. The TDI was set up as 4 pg-TEQ/kg/day and the air, water and soil environmental quality standards were 0.6 pt-TEQ/m3, 1pg-TEQ/I and 1000 pg-TEQ/g respectively (the sediment environmental quality standard is to be decided.) In order to reach the policy targets, the Ministry of the Environment has set up emission and effluent standards (See Tables 5.4 and 5.5). Relevant governmental departments can tighten these emission and effluent standards when it is necessary and enforce these control standards through examination and inspection. Furthermore, the government also takes measures to control the discharge of ash and dust from incinerators (treatment standards for ash and dust from waste incinerators is 3 ng-TEQ/g) and standards for maintenance and management of the final disposal site of waste. Additional measures in other countries are required to reduce production of unintentional byproducts. These measures will result in costs to industry and as in the case of intentionally produced PTS, social and infrastructure costs.

5.6 TECHNOLOGY TRANSFER

Great difficulties for technology transfer exist in this Region. Major problems are as follows:

(1) Most countries in the Region are developing countries or countries with economies in transition and do not possess advanced techniques except for Japan and Republic of Korea.

(2) Most countries lack the funds for technology transfer.

(3) No proper mechanism for technology transfer has been established either at the Regional level or at the global level.

(4) Developing countries have limited choices for available techniques. For example, in Japan most refuse, including everyday refuse, is disposed of by incineration. In China, disposal of refuse by incineration is less than 3.5%, although in the future, this may be the main method for disposing everyday refuse. Currently China cannot yet afford to adopt techniques with high standards as those achieved by Japan. On the one hand, Japan's environmental standard is too high for China, a developing country, and on the other hand, some techniques may not be appropriate for developing countries. For example, China has introduced an incinerator from a developed country, but as the heat value of refuse is very low, 30 kilograms of oil per day is needed to maintain the normal operation of the furnace.

(5) Advanced administration and the training of specialised personnel should be mandatory to complement the

importation of techniques. For example, China has imported some advanced techniques and equipment from industrialised countries, however, because of the lack of advanced management and trained manpower, the efficiency is much lower than that in the original supplier countries.

5.7 IDENTIFICATION OF NEEDS

5.7.1 Overview of Status

As most of the countries in this Region are developing countries with relatively backward economies or their economies are undergoing transition, the capacity of the management of PTS is fairly weak and there is much need in this respect.

Japan and the Republic Korea are members of OECD. Japan has established a comparatively comprehensive, scientific, and strict legal system for the management of PTS and possesses large amount of data and relevant information. Japan has also been developing advanced techniques for the disposal of waste. Therefore, Japan has been far ahead than other countries in the Region on PTS management.

The Republic of Korea has established a system for risk/hazard evaluation, accident prevention and response, risk reduction, and chemical information management, under which there is a group of specialists engaged in formulating national action plans. It is now carrying out a 10-year national research program, whose work includes the compilation of a PCB and PCDD/PCDF inventory. A joint project with Japan on EDCs (including PCBs and PCDD/PCDF) is also in progress.

The environmental administration of chemicals has also begun in China, especially with the development of environmental management controls on the import and export of toxic chemicals since 1994. This is a direct result of the management of chemicals being brought into routine government proceedures. A number of scientific research institutes and institutions of higher learning have carried out scientific research and investigation on PTS. The Chinese government is now carrying out an inventory of POP pesticides and the PDF-B of national implementation plan (NIP) required by the Stockholm Convention.

Work has recently been initiated on the environmental management of chemicals in the Hong Kong SAR. The on-going study of toxic substances pollution in Hong Kong SAR, commissioned by the Environmental Protection Department, aims to identify the trade, usage, production and disposal of priority toxic substances in Hong Kong SAR and assess the potential impact that any such substances may pose to local aquatic life and human health.

The Mongolian government has also strengthened its management of PTS and promulgated several laws and regulations. In 1998**,** Mongolia established a coordination organisation: the National Council for Chemical Safety (NCCS) which greatly boosted the efficiency of the enforcement of legislation and regulations. Mongolia does not produce any chemicals and totally depends on import. This makes it easy to control and ban intentionally produced PTS.

In the Russian Federation, the environmental administration of chemicals and relevant research started some time ago. The Russian Federation has set up many environmental standards covering PTS. Investigations into the concentration of PTS in the environment and the human population have been carried out periodically. A PCB inventory under the AMAP program has also been compiled. During 1999-2000, the inventory of PCDD/PCDF emitting sources was compiled with financial support from the US EPA.

The management of PTS has also begun in central Asian countries such as Kazakhstan. The production and use of most pesticides containing PTS are now banned under relevant laws of these countries. With the support of the UNEP, a preliminary POPs inventory of chemicals in Kazakhstan was conducted in 2001.

The Democratic People's Republic of Korea has also begun their own management of PTS. Production of DDT has been banned and production and use of HCB and PCP are now restricted.

5.7.2 Existing Difficulties

Major difficulties involved in administering the management of chemicals for most countries in this Region include:

5.7.2.1 Lack of Funds

The management of PTS, including the elimination/reduction of PTS emissions requires large financial

resources. Large amounts of funds are also needed for the destruction of PCBs and the analysis and monitoring of PCDD/PCDF. Unfortunately, most countries in this Region lack enough funds to carry out these tasks although they realise the importance of such work.

5.7.2.2 Lack of Information

Most countries in this Region have not obtained necessary information for the management of PTS, including methods which can provide scientific comparable monitoring data, information about PTS sources, existing pollution caused by PTS, harm thus caused, and their substitutes. Developing countries and countries undergoing economic transfer seriously lack such information. In some countries, the situation has become more severe, as their government controlled the production and use of certain products under planned national economies, but now they can no longer control many products containing PTS under market economies. In addition, there are numerous privately owned small industries scattered throughout the country, which makes it harder for the government to obtain certain information.

5.7.2.3 Lack of Advanced or Best Available Technology

Taking the burning of refuse for example, - because the calorific value of refuse is much lower in China than that in developed countries, the technique of refuse burning is not suitable for China. There are large quantities of accumulated solid wastes cast away during mining, which are problematic to treat. Increasing the purity of certain products so as to reduce their content of PTS poses another problem for many countries. Without proper or best available technology it is impossible to eliminate or reduce the emission of PTS.

5.7.2.4 Insufficient Knowledge and Training of Special Personnel

The knowledge and techniques of those specialists in many countries in the Region can no longer meet the requirements of up-to-date administration or research. Competent specialists and experts are in great demand.

5.7.2.5 Low Public Awareness

Although almost all governments in the Region are aware of the harm that PTS may possibly cause and have been active in participating in the process of developing the Stockholm Convention, the general population, consumers and buyers in most counties lack awareness of the possible harm. They also lack information about the sources of hazardous chemicals and consequently do not know their long-term effects.

5.7.2.6 Difficulties in Co-ordination Within Government

As the management of PTS involves the whole process from production to disposal, including management of the products themselves, impurities they contain, sources, potential harms, many departments become involved. Therefore, the coordination and cooperation between these departments is of great importance. But such coordination and cooperation are still bureaucratic hurdles in many countries.

5.7.3 Capacity Building

Capacity to be built in the Region includes the following:

(1) A framework for administration, management systems and policy should be developed for the implementation of the Stockholm Convention. Institutional strengthening should be considered at the Regional level. A Regional PTS group should be set up to provide a co-ordination and co-operation mechanism with regularly held meetings.

(2) Capacity strengthening on PTS monitoring is a priority in the Region. Standardisation of monitoring methodologies and detection limits may be the initial steps towards capacity strengthening of monitoring of PTS.

(3) Capacity strengthening on technical assistance and promoting the transfer of technology is important especially for substitution, reduction, elimination, and safe disposal of PTS.

(4) The best available technique (BAT) and the best environmental practice (BEP) for developed countries and for developing countries or for countries with the economy in transition should be used and adapted to suit local situations.

5.7.4 Follow-up Activities

5.7.4.1 Tasks In the Near Future:

- Ratification of Stockholm Convention. To date, only Japan and DPRK have accession to the Stockholm Convention in the Region;
- The preparation or formulation of National Implementation Plans (NIP) for POPs;
- Co-ordination of monitoring methods and initiating monitoring projects for priority PTS in the Region;
- Compilation of source inventories for PTS, which shall include the present status related to production, stockpiles, and emissions;
- Demonstration of BAT and BEP and pilot schemes of substitute technologies;
- Public awareness promotion including involvement of NGOs and training – this should include the training of government officials, enterprise executives, and technical personnel, and raising public awareness;

5.7.4.2 Long-Term Tasks

- Development of action plans;
- R&D of alternatives to DDT, chlordane, HCH;
- Safe disposal of PCB, obsolete pesticides;
- Measures to reduce unintentional PTS;
- Suitable models to trace movement of PTS
- Risk assessments and investigations of PTS on environmental and human health.

6 CONCLUSIONS

6.1 IDENTIFICATION OF BARRIERS

The main barriers to reduction of PTS in Region VII involve difficulties in technology transfer. Most countries in the Region are developing countries or countries with their economies in transition, therefore due to relatively weak economies, these countries lack funds for technology transfer. A proper mechanism has not been established for technology transfer within this Region. For some countries, available human resources in the area of PTS management are weak. The knowledge base and techniques of specialists in parts of the Region cannot meet the requirements of up-to-date administration or research. Another barrier is the fact that there are no established disposal mechanisms for the safe elimination of PTS from the environment, therefore certain PTS such as obsolete pesticides may continue to remain buried or stockpiled. In some cases, there have been no adequate alternatives available. For example, although pyrethroids have been presented as an alternative to DDT, they are far more expensive and not as effective when compared to DDT.

6.2 IDENTIFICATION OF PRIORITIES

6.2.1 Sources

For all of the countries of the Region, there is generally more information available on the levels of PTS in the environment than on information pertaining to sources of PTS. In many cases, this is due to the fact that many of the developing countries or countries with their economies in transition have not established source inventories for PTS. In some cases, there is also insufficient monitoring of PTS, lack of programs on emission control and insufficient quality control.

In Region VII, the groups of chemicals that are of high priority are PCDD/PCDF, PCBs, PAHs, DDT and HCH as there is either:

- still major production of the chemical for local and export use,
- evidence of the chemical as a contaminant in large scale production of other chemicals,
- known emissions of the chemical from large scale incinerators or chlorine bleaching of pulp or other related combustion facilities,
- evidence of leakage from major stockpiles of the chemical,
- large-scale use of the chemicals throughout the Region, and/or
- spatial and/or temporal trends increasing Regionally from levels above threshold.

For these chemicals except for DDT and HCH, information on sources is also noticeably insufficient or unreliable. The substantial amount of obsolete PTS, such as DDT stored in some countries is a major concern for the Region.

6.2.2 Pathways

Due to the diverse meteorological and geographical natures of Region VII, there are special concerns for the development of effective transport models e.g. a relatively large ocean area. In addition, monitoring data do not exist in some countries to enable the assessment of long-range transport of PTS compounds. Some countries in the Region do have experience of transport assessment by modelling, including hemispheric models from MSCE-POP/EMEP, multimedia modelling by the Republic of Korea (POPsME and EDCSeoul) and Grid-Catchments integrated MMM by Japan. However, a complete picture concerning the transboundary transport of PTS across different countries within the Region is very much needed.

Substantial effort will be therefore necessary to fill the data and technical gaps and to assess the long-range transport of PTS chemicals in the Region:

- Source inventory data: This is especially important, not only from the view point of source identification, but also for extensive transport assessment.
- Monitoring data: This is especially important, not only from the view point of monitoring itself, but also

for developing reliable transport assessment.

- Modelling data: There is a need for reliable model tools to better predict the fate and effects of PTS in the Region. Co-operation with global experts is highly recommended.
- Source pattern and fingerprint: This point is not directly meant as a data gap, but it should be considered to be an important methodology to fulfill the gaps concerning PTS transport.

6.2.3 Environmental Levels, Toxicological and Ecotoxicological Effects

Some countries have been collecting PTS data for longer and more intensively than others, but most countries are in the process of developing their programs on PTS monitoring and inventories. Therefore, comprehensive spatial and temporal data on PTS monitoring are only available in a small number of countries in the Region, e.g. Japan, while there is a general lack of complete information related to the environmental levels of PTS in most countries.

Based on the reported data, DDTs, HCH, PCDD/PCDF, PCBs and PAHs are high priority chemicals among other PTS in this Region. Many monitoring data for these chemicals were reported for a variety of environmental media and biota, and frequently the concentrations of one or some of those chemicals were found to be relatively high compared with other chemicals.

Bioaccumulation and biomagnification are evident according to the measurement of PTS in living organisms of different trophic levels along food chains. A limited amount of studies in the Region revealed that levels of PTS in human breast milk samples tend to reflect their oral intake, e.g. through seafood consumption. It was also indicated that the use of biomarkers could be an effective tool to provide an early warning system of the potential threats imposed by different PTS. More monitoring data from the countries in this Region should be collected for the full understanding and accurate evaluation of the environmental levels of PTS in Region VII. International cooperation in this matter is urgently required.

6.3 RECOMMENDATION FOR FUTURE ACTIVITIES

A Regional organisation is recommended to be established for setting up a monitoring network. The organisation will ensure that monitoring methods among the countries within Region VII are coordinated and standardised. Above all, an integrated monitoring/modelling approach based on:

- Systematic monitoring,
- Measurement campaigns on national and international levels and
- Model assessments of contamination within the Region, should be established.

It is also essential for representatives of different countries to meet on a regular basis to update information and improve Regional communication. Collection of PTS information should be continued. There should be joint effort among different countries to closely monitor human health effects using effective and less invasive analysis such as PTS levels in human breast milk. This will provide information on the possible adverse impact of contaminants on future generations. Studies on the effects of different PTS on sensitive animal species are also essential. Development of various biomarkers could provide us with effective early warning systems.

In addition to collaboration amongst government, industry and NGOs, support from the public is important in contributing to the effective and efficient implementation of proposed actions towards the elimination of PTS. Hence, raising the awareness of the general public is an important issue that needs to be addressed. It is recommended that financial assistance should be actively sought from international funding agencies such as the World Bank and GEF for supporting technology transfer for studies into PTS and related activities.

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ANNEX 1

Table 1. Scoring for Prioritising PTS for Sources, Environmental Levels, Effects and Data Gaps

SCORING BY MATRIX								
Chemical	Sources	Data Gaps	**Env. Levels**	**Data Gaps**	**Ecotox Effects**	**Data Gaps**	**Human Effects**	Data Gaps
Aldrin	0	1	0	0	0	1	0	1
Chlordane	1	1	1	0	0	0	0	0
DDT	2	1	2	2	2	2	2	2
Dieldrin	0	1	0	0	0	0	0	0
Endrin	0	1	0	0	0	0	0	0
Heptachlor	0	1	0	1	0	1	0	1
HCB	1	2	1	0	1	1	1	1
Mirex	0	1	0	0	0	0	0	0
Toxaphene	0	1	1	2	0	1	0	1
PCBs	2	2	2	2	2	2	2	2
Dioxins	2	2	2	2	2	2	2	2
Furans	2	2	2	2	2	2	2	2
HCH	2	1	1	2	1	2	2	2
PCP	1	2	1	1	1	1	1	1
PAHs	2	2	2	2	2	2	2	2
Org. Mercury Compds.	1	2	1	1	1	1	1	2
Org. Tin Compds.	1	1	1	1	1	1	1	1
PBDE	1	2	1	1	1	2	1	2

Instructions:

1. Chemicals to be grouped by matrix (sources, environmental conc., etc.) and by score. **There is no total score for any chemical.**
2. An associated column for data gaps is attached to each matrix. For example, Sources has an accompanying column to score the degree of data gaps experienced for Sources.
3. A short summary with representative, specific data must be used to justify the score given. Use <50 words.
4. All chemicals selected for the study must have a score for each category
5. The guidelines attached provide a qualitative measure for scores. Scores are measured as follows:

Scores:

Score = 0 – chemical is of no concern/ supportive data is collected

Score = 1 – chemical has local concern/ supportive data is limited

Score = 2 – chemical has Regional concern/ supportive data is lacking

NB. The score given for a matrix on a chemical does not have to be the same score for data gaps on that matrix

Chemicals should be tabled according to their placement by score. For example, a table should be presented for chemicals under Sources of Regional concern (score 2) with the accompanying data gap score for Sources. An example of a chemical placed in the Score 2 table for sources for a particular Region is given below:

SOURCES: Regional Concern

CHEMICAL	DATA GAPS	COMMENTS
DDT	1	DDT used historically for > 30 years. Approximately 800,00kg now produced annually. 240,000kg used annually in the Region (6 countries) for malaria control (75%) and 80,000kg used in agriculture (8 countries).

Table 2. Guidelines for Scoring Issues Associated with Each Chemical

Issue	Score 0 = No concern	Score 1 = Local concern	Score 2 = Regional concern
Sources of the Chemical	No evidence of production or product contamination No evidence of air emissions No evidence of emissions from solid residues No evidence of chemical stockpiled No evidence of chemical being contaminant in production of other chemicals No evidence of use of the chemical No evidence of release from liquid effluent	Evidence of limited production Presence of small sources with possible emissions (e.g.,small incineration plants or bleached kraft/pulp mills using chlorine); Some limited evidence of releases but on a small scale invoking local concerns Some use of the chemical locally Over time, levels remain below threshold or are decreasing Use of chemical in agriculture or industry sub-Regionally Evidence of limited stockpiles of the chemical Increasing spatial and/or temporal trends from levels below threshold and localised	Major production of chemical for local and export use. Chemical evident as contaminant in large scale production of other chemicals Known emission of chemical from large scale incinerators or chlorine bleaching of pulp or other related combustion facilities Evidence of leakage from major stockpiles of the chemical poorly packaged Large-scale use of the chemical throughout the Region Spatial and/or temporal trends increasing Regionally from levels above threshold

Ecotoxicological Effects from exposure to the chemical	No fisheries closures or advisories due to chemical pollution No incidence of food/fisheries product tainting No unusual fish or wildlife mortality events	Inconclusive evidence of limited fish or wildlife mortality events on a local or sub-Regional scale Temporal trend shows constant or decreasing effect of chemical	Public health and public awareness of food/fisheries contamination problems with associated reduction in the marketability of such products either through the imposition of limited advisories or by area closures Large-scale mortalities of aquatic or wildlife species Temporal trend showing increase in effects of chemical Regionally
Human Effects from exposure to the chemical	No indication of any ill effects from exposure to the chemical No correlation between human diseases and chemical exposure	Odd incidence of ill effects that may be related to exposure to the chemical Evidence of localised effects from spot exposure to the chemical Temporal trend shows constant or decreasing effect of chemical locally	Indications of health effects resulting from use of pesticide/industry chemical Wide spread health effects from involuntary exposure to the chemical Temporal trend showing increase in effects of chemical Regionally
Data gaps	Full data sets established Evidence complete Ongoing monitoring data available	Limited data available Minimum data required to confirm findings Data available conflicting Further monitoring data required on a wider scale Limited anecdotal evidence of local human and environmental effects	Sparse data available Data unreliable No data available Only historical data (>20 years) available Limited data available shows major concern Widespread anecdotal evidence of human and environmental effects

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