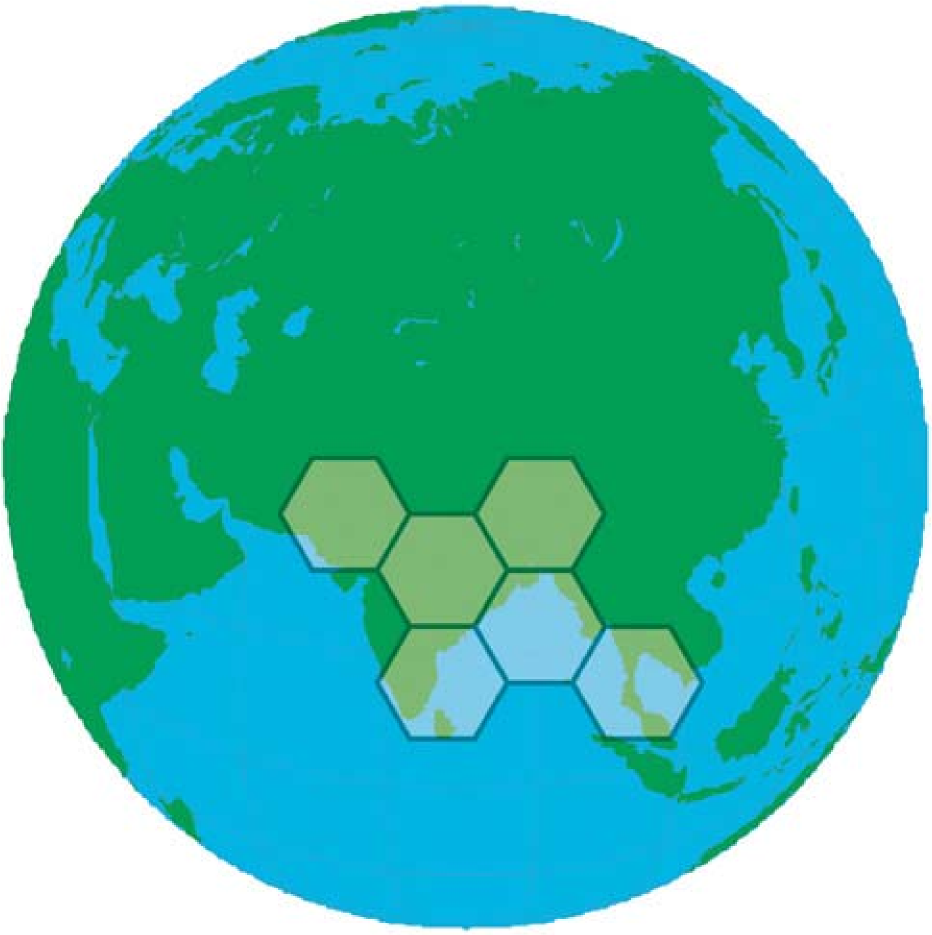
Toxics Link
for a toxics-free world

POPs in South Asia

Status and environmental health impacts



A survey of the available information of POPs in the South East Asian Region.
The information is examined to reveal the nature and extent of the POPs problem.

July 2004; Toxics Link

Acknowledgements: The report entailed extensive research work involving data collection from various research institutes and organizations. We have been much assisted in our endeavor at data collection by scientists from Industrial Toxicological Research Institute (ITRC), National Institute of Occupational Heath (NIOH), National Environmental Engineering Research Institute (NEERI), NIO, Regional Research Laboratory (RRL) Trivandrum, Consumer Education Research Center (CERC), Institute for Toxicological Studies (INTOX), Bhaba Atomic Research Centre (BARC), Malaria Research Centre (MRC), Ministry of Environment and Forest (MOEF), Indian Council of Agriculture Research (ICAR), Indian Council of Medical Research (ICMR), Central Electricity Authority (CEA), Power Grid Corporation, Ministry of Health and Family Welfare (MOHFW), Central Pollution Control Board (CPCB), Bose Institute, Centre for Study of Man and Environment (CSME), Centre for Science and environment (CSE), Bombay Natural History Society (BNHS), Salim Ali Centre for Ornithology and Natural History (SACON), Wildlife Institute of India (WII), National Anti Malaria Program (NAMP), Educational Research Institute ERI (Pakistan), The Central Pulp and Paper Research Institute (CPPRI), Confederation of Indian Industries (CII), Delhi University, Jadavpur University, Kolkata University, Kalyani University, All India Institute of Medical Sciences (AIIMS), Indian Institute of Technology (IIT) Bombay, Karachi University and Indian Agriculture Research Institute (IARI). We are also thankful to all the scientists who have spared their time, informally interacting with us and sharing their knowledge and experience.

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About Toxics Link

Toxics Link is an environmental NGO, dedicated to bringing toxics related information into the public domain, both relating to struggles and problems at the grassroots as well as global information to the local levels. We work with other groups around the country as well as internationally in an understanding that this will help bring the experience of the ground to the fore, and lead to a more meaningful articulation of issues. Toxics Link also engages in on-the ground work especially in areas of municipal, hazardous and medical waste management and food safety among others. We are also involved in a wider range of environmental issues in Delhi and outside as part of a coalition of non-governmental organizations.

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Executive summary

Mindful of the precautionary approach as set forth in Principle 15 of the Rio Declaration on Environment and Development, the objective of this Convention is the protection of human health from persistent organic pollutants.

Article 1, Stockholm Convention, 2000

Context of the Study

The Stockholm Convention on Persistent Organic Pollutants (POPs) has helped classify a set of chemicals, which are especially toxic both for the environment as well as human health. POPs are chemicals of first concern globally since though they may be locally manufactured and used, but have global impacts owing to their ability to transport long distances, through a variety of media and pathways. Their impacts have been recognized as deadly, since these chemicals are accumulated in animal fat, magnify up the food chain and do not break down. They cause a variety of serious short and lifelong health effects, especially impacting children and pregnant women. In fact they may be unsafe even at very low contaminations, the timing of the exposure being as critical as its dosage. Recognizing them as a global problem is the first step towards taking global action for their minimization and ultimate elimination.

The classification of a category of chemicals for global action also marks the advent of chemical safety as an important issue requiring resources, multi-stakeholder participation as well as political will. Till date chemicals have been dealt with locally and nationally and often data on their impacts, especially in developing countries, are insufficient. As this report reveals, the South Asia Region (SAR) data on POPs exists. but is scattered and scanty. The Convention also helps lever global resources to help national governments set priorities for action through a National Implementation Plan (NIP) process, to help them shift towards cleaner development alternatives.

More importantly, the POPs Convention forms the basis of a newly emerging chemical safety regime which is growing internationally through instruments such as the Basel Convention on the Transboundary Movement of Hazardous Wastes, the Rotterdam Prior Informed Consent Convention (PIC) and several other regional treaties and agreements. Other new focuses are some heavy metals such as mercury. Also, with the upcoming Strategic Approach to International Chemicals Management (SAICM) being proposed by UNEP and the IFCS (Inter governmental Forum for Chemical Safety), there will clearly be a new way of dealing with chemicals from now on.

The report examines available information in the SAR region, besides outlining the overall status of POPS in the region. It presents and evaluates the data in terms of sources, pathways and contamination, exposures, and effects.

Status of POPs in the region

This report reveals the nature and extent of data and data gaps in the available knowledge of POPs in the SAR region. Of the 10 intentionally produced POPs listed in the Convention, Toxaphene and Mirex have never been manufactured or used in the region. The main pesticide chemicals used have been DDT, Aldrin, Dieldrin, Heptachlor and Endrin. Of these, DDT has been used the most, and continues to be the main POPs chemical of usage to date. This could be one reason why the data on DDT is most prevalent in literature.

Of the POPs, the agricultural usage of all of them has been banned. Apart from an ongoing program involving DDT use for malaria control, Dieldrin usage for locust control has been allowed for India for a fixed time period. However there is reported illegal usage in agriculture as well. India remains as one of the world's three manufacturers of DDT. Toxaphene, HCB and Mirex have never been registered in India. The use of PCBs in electrical equipment has been banned in India since 1967.

Of the unintentionally produced POPs, viz, PCBs, HCBs, dioxins and furans, their status is unclear. These POPs are not regulated, and the testing facilities for dioxins and furans do not exist as yet, though two may be upcoming.

The data on POPs is varied, and not systematically generated. Studies conducted at different institutes and at different time periods with varying objectives are not comparable, and it presents the difficulty of drawing a conclusion of trends in the levels of these chemicals in the environment and in various species.

On the other hand, despite the various problems associated with the data, it can be found in environmental samples indicating the continued presence of POPs in the region. Export of Chlordane, Aldrin and Heptachlor has been reported from India even after the ban on manufacture, import and export. There are estimates of Endrin, Dieldrin, Heptachlor and DDT being smuggled into Bangladesh.

Sources and uses of POPs in SAR

Of the studies examined, it became clear that not only are there known sources of POPs in the region, but also those, which are yet to be documented. DDT manufacturing facilities, as well as the application of DDT for vector control is prime ongoing sources. The continued use of DDT appears to be both an issue of institutional mindsets as well as an inability to enter broader community based participatory approaches, which involve bioenvironmental techniques.

In the case of PCBs the situation is less clear. Though never used or manufactured in India, PCBs appear in various studies, showing that it did find its way into the region, probably as part of electrical equipment and transformer imports. New PCB sources include the massive shipbreaking activity at Alang (Gujarat, India) and at other places (Bangladesh, Pakistan), where 90% of the world's thirty-year-or older ships are broken down.

The unintentional releases of dioxins and furans, as well as HCBs and PCBs pose particular problems and challenges. For one, monitoring these is difficult and expensive. There are, for example, no known certified laboratories for testing dioxins and furans in the regions as yet, even though some new ones such as one at RRL Trivandrum (India) are gearing up to the issue. However future releases will depend on technology choices for various processes.

There are contradictions as well. Hence, while waste incineration has been identified as a major source for unintentional POPs internationally, Governmental schemes such as in India are providing subsidies for their installation. Other major emitters such as the pulp and paper industry, coal based thermal power plants, cement kilns etc. have had no emissions testing carried out, and many still use polluting processes. This portends to be an ongoing area of concern, especially since at no stage of new project clearance or expansion is there any incentive to promote clean (er) technologies.

Pathways and environmental contamination:

Though some pathway studies exist yet there are major gaps. There is for example a complete absence of studies, which deal with the behavior of POPs in the colder climes of India, say the Himalayas. This could be significant since POPs are transported to colder regions through convection currents where they persist for longer periods. The Himalayas, as a meteorological barrier could possibly be a major sink for POPs to reenter the ecosystem through rivers and the atmosphere.

Similarly, very few studies have been done on understanding atmospheric pathways, though a modeling scheme has been proposed by the ITRC. In the case of water studies, while there is data from the river-monitoring programs for the Ganga, Gomti, and Yamuna, the data is difficult to interpret. It reveals varying levels of POPs like DDT, Aldrin and Dieldrin different seasons and there is often a marked increase post-monsoon, which suggests either a re-suspension of sediments, or agricultural field runoffs or possibly a combination of both. Again, DDT appears widely throughout as a contaminant, probably owing to its continuing widespread usage, but also owing to it being more the focus of research than other POPs. Soil, sediments and marine sediments revealed the presence mainly of DDT and Dieldrin, and in one case of PCBs.

Food pathways also present a dismal picture. Indian dietary intake of DDT was found to be the highest in the world. Practices like the dermal application of DDT on cattle probably leads to its high levels in milk and dairy products. Surprisingly, dioxins were found in human breast milk (despite the general belief that dioxins are more an industrialized country problem) in Chennai at levels higher than in other Asian countries, as well as very high levels of DDT (7 times) and Aldrin (27 times) have been detected.

Almost all the listed POPs have been detected in various foodstuffs in the region, including in oils, spices and meat products. Aldrin, Dieldrin, DDT and Heptachlor continue to show up in food despite being banned or regulated. The only long-term monitoring program of the government of India, the All India Coordinated Research Project (AICRP) on pesticide residues, which conducts nationwide pesticide monitoring, has however reported falling DDT levels. This is not the case in other studies and studies Pakistan recorded high levels of DDT as well as Endrin in vegetables. In Bangladesh, dried fish samples showed high DDT levels and revealed the dangerous practice of using DDT as a preservative for dried fish. DDT was also detected in baby food, honey and herbs from different parts of the region. Overall, the food showed a wide range of contamination with no confirmation if the levels were changing or not.

Exposures:

Exposure studies in wildlife showed concentrations of DDT as well as the presence of dioxins and furans in freshwater and coastal fish,. River Dolphins (in the Ganga) recorded very high levels of DDT, which was also detected in zooplankton, a basic food for marine animals. As has also happened in the US, DDT was connected with eggshell thinning causing breeding failures in raptors in India.

Studies dealing with human exposures reveal widespread contamination. Breast milk, fat samples and human blood sam-

Almost all the listed POPs have been detected in various foodstuffs in the region, including in oils, spices and meat products. Aldrin, Dieldrin, DDT and Heptachlor continue to show up in food despite being banned or regulated

ples contamination due to DDT, HCB, Aldrin, Dieldrin, dioxin and furans, and PCBs have been detected. DDT has been detected in the blood of people from Himachal Pradesh despite the fact it is not used there for malaria control, reemphasizing to need to study the colder climes from a POPs perspective as also the possible illegal use in agriculture.

Health effects

Various studies have made associations of levels of DDT with rise in the blood pressure of mothers, Intra Uterine Growth Retardation, and placental transfers to the unborn foetes. In the case of animals, studies show low levels of DDT to have caused reduced oxygen consumption in fresh water fish, as well as mortality. Birds like the Sarus Crane have succumbed in large numbers owing to high dieldrin levels in brain tissues, while there is a suspected link between the recent vulture population decline and POPs like chemicals.

Emergent issues

Some key issues, which emerge, are:

1. Lack of policy focus

Though there are a number of legislations dealing with hazardous chemicals, say in India, chemical safety in general and of POPs in particular needs a cross sectoral policy focus. The issues deal with sectors of the environment, health, agriculture, chemicals and industry, besides NGOs and the public at large. However there is no forum or an examination of the problem as a multistakeholder issue, and there exists no particular policy addressing it. This also reflects in the scattered nature of the research, which has been carried out by various scientific institutes, as well as its quality.

Specific governmental or important user stakeholders interviewed had in some cases very little knowledge of the issue of POPs per se.

2. Data availability

Data from Industry in particular is either not present or inaccessible. It reflects the fact that the industry or its associations have not put any special emphasis on this issue. In fact the degree of awareness and participation of the industry on the issue seems to be poor.

1. Data and its reliability

The overall data available is scattered and scanty. It is difficult to analyse in terms of trends. In areas like effects and exposures, data in the region is scarce. Doubts have also been cast on the reliability of data, and on the uniformity of methods used across studies.

However, the data as is present is also very disturbing. Though not systemic, almost all studies show the presence of POPs in media such as air, water, soil, and even food. Levels of POPs in mother's milk, animal and birds, and human exposures have also been recorded. Source studies outnumber pathway and impact studies, showing the lack of research in examining the issue from a health and environment perspective

2. Status of stockpiles

There is almost no data on stockpiles of old and unused POPs. This could imply that they are non-existent or could also mean that they are undocumented or even used up. This is a critical area for further investigation and research.

3. Monitoring and regulations capabilities

There is a paucity or lack of testing facilities in the case of POPs like dioxins and furans. Many laboratories are now equipped to test for pesticide POPs, but their calibration and quality control may need to be evaluated. In the case of difficult issues relating to monitoring such as dioxins and furans, a couple of laboratories in India have taken the initiative to develop capabilities, however they may need time to come up to the required quality requirements and in-house capacity and experience.

4. New technologies

Currently there exist no evaluation done to ensure the installation of new clean technologies in India, which do not produce POPs. The directives in the Convention meant to encourage the installation of clean non-POPs creating technologies are not reflected in many national programs. In fact, in some cases, POPs producing technologies such as waste incinerators have the same degree of incentives as other cleaner options.

5. Public health usages

The use of POPs for public health purposes and its alternatives needs urgent attention. The changeover is an issue, which deals with both the choice of the alternative method, as well as one of the capabilities of existing institutions to adapt to such new approaches. In the past, initiatives taken for promoting alternative non-chemical approaches such as through a World Bank funded project has not been adequately implemented or monitored.

6. Impacts of existing processes

An important issue is the documentation of existing processes to evaluate their POPs generating potential as well as remedial action. Areas like dye and dye intermediaries, textiles, pesticides and chemical process have been inadequately documented as sources of POPs.

7. Community participation, information access and awareness

There is a need to catalyze community information and participation as a key driver to deal with the issue of POPs at the ground level. In the region as a whole there is very little being done in this area, and general public awareness of the issue is very low.

The Convention in its Article 10 lays down specific and extensive requirements regarding public information, awareness and education. Amongst these are provisions for "provision to the public of all available information on persistent organic pollutants," especially to "women, children and the least educated" on health and environmental effects and their alternatives. The Article also encouraged "public participation, including opportunities for providing inputs at the national level regarding implementation of the Convention."

There is recognition of the need to developing mechanisms like "pollutant release and transfer registers" for the collection and dissemination of information. Such registers have proved to be very effective tools not only information sources but also as regulatory aids.

Conclusions

In the overall picture the, data available shows reason for concern. The lack of focus on the environmental and health impacts of these chemicals stands out. Industry information is either not available or impossible to obtain. Governmental policy has also not addressed the issue substantially. Also community awareness is very low. The general refrain in the scientific community is that research in the area is waning and needs to be stimulated in a systematic and coordinated fashion.

Though the POPs treaty has thrown up a new focus as well as an opportunity for the region to proceed towards a chemical safety regime, there seems to be little activity on the ground. The Indian Industry is resisting the country ratifying the POPs treaty on the ground that it will harm their interests. The participation of NGOs and communities in this area has not been encouraged, and there is almost no public information. There needs to be an all-round stimulus for infusing fresh energy into this critical issue.

1. Introduction

1.1 Background

Persistent Organic Pollutants (POPs) mainly came into wide use after the second world war. However, soon their negative impacts started showing. Initially apparent in fish, birds and mammals in and around Great Lakes of North America, further studies revealed their presence in human beings with women, infants and children being particularly vulnerable.

For the first time, in 1997, efforts were taken undertaken on a global level to deal with the problems POPS posed under the United Nations Environmental Programme (UNEP) The first Intergovernmental Negotiating Committee (INC) for POPs held its first meeting in Montreal in June 1998, and agreed upon 12 chemicals as target for immediate action. This was followed by INCs in Nairobi, Geneva, Bonn and Johannesburg. A multilateral, internationally legally binding treaty was finally signed on May 23, 2001 at Stockholm by 87 countries to ban POPs, and has now come to be known as The Stockholm Convention. Although the treaty imposes an immediate ban on most of the POPs, country requested exemptions have been granted for various chemicals for specific uses. For example DDT needed by many countries to control malaria carries a conditional exception. Similarly for PCBs have been provided a time lease for governments to maintain existing equipments in such a way that prevents leakage until the year 2025.

Of the 12 POPs, 9 are chemicals manufactured and used in various types of industrial vector and pest control operations, while, Hexachlorobenzene (HCB), dioxins and furans and Polychlorinated Biphenyls (PCBs) come under the category of unintentionally produced POPs as byproducts of other types of activities.

The 12 POPs (commonly known as the dirty dozen) identified in the Stockholm Convention display have common properties causing harmful effects. These are:

- Toxicity – with adverse effects ranging from reproductive disorders, neurotoxicity and carcinogenecity
- Persistence – with long half lives and relative stability in the environment along with resistance to metabolic degradation
- Lipophilicity – being fat soluble, POPs have a tendency to biomagnify in the food chain and accumulate in the tissues of living organisms on moving up the food chain and especially in larger, longer lived organisms
- Transportability – POPs are transported in the atmosphere in steps via the 'grasshopper effect', which involves alternate phases of volatalisation and condensation, thus enabling transport over thousands of miles to regions far away from their source. POPs are also transported through water and to a lesser extent by migratory organisms making them a trans boundary problem.

POPs travel through various media like air, water, soil and food and reach the human environment. The gravity of the POPs problem is reflected in the fact that human infants are exposed to significant levels of POPs' concentrations through placental transfer even while in the womb. This exposure continues on to exposure through mother's milk and finally through foods, water and air. POPs have been in use, intentionally and unintentionally, for many decades now and it is very difficult to identify environmental segments, which have not been contaminated. Certain POPs like DDT, which have found extensive use in India are present ubiquitously, and show up in almost any survey of pesticide contamination in the region.

POPs exposure is a constant phenomenon in India through food, water, accidents and occupational environments. Apart from the manufacturing sector where workers in certain sectors are routinely exposed to POPs, there is also the issue of farmers' exposure due to pesticide spraying and DDT exposure as a result of public health spraying. High POPs pesticide exposure is also due to questionable practices in the transport and presentation of foodstuffs. In fact in the Indian context, the POPs problem is magnified manifold as a result of a lack of awareness and an absence of suitable protection mechanisms while handling them.

In the past, much effort has been expended on understanding

in the Indian context, the POPs problem is magnified manifold as a result of a lack of awareness and an absence of suitable protection mechanisms while handling them. POPs exposure is a constant phenomenon in India through food, water, accidents and occupational environments.

the significance and extent of pesticide contamination in the environment. With the banning and subsequent decline in the levels of POPs pesticides in the environment, the focus is bound to shift towards the significantly greater risk posed by the dioxin, furan and PCB menace largely in the form of unintentional releases. A dedicated and committed POPs elimination mechanism should be appropriately prepared to assess and counter POPs pollution in the South Asia Region.

In this report, a review of existing knowledge and capabilities on POPs in the South Asia Region is presented. There is an analysis of the information to generate insights into the nature of the problem. Based on a comparison with the efforts in other international studies, a data gap evaluation has been done to highlight areas of concern.

1.1.1 POPs chemicals

The Stockholm convention has identified 12 POPs of concern. This report focuses on these chemicals in the context of the South Asia Region.

These POPs are – DDT, Aldrin, Dieldrin, Endrin, Chordane, Heptachlor, Mirex, Toxaphene, Hexachlorobenzene (HCB), PCBs, Dioxins and Furans. Out of these, 9 are organochlorine pesticides. PCBs are compounds with varied industrial application, while HCB, PCBs, Dioxins and Furans are produced unintentionally, industrially as well as otherwise. In the following section a brief description of certain characteristics of the 12 POPs is given.

1.1.2 Pesticide POPs

Organochlorine pesticides are highly hazardous chemicals and find extensive use in the region due to their being easy to manufacture, relatively inexpensive and highly effective on target pests. Organochlorines' commercial preparations are commonly dissolved in petroleum distillates, which form emulsions when added to water. The toxicity of the pesticide will depend on the nature of its formulation[1]. Organochlorines affect the CNS nerve cells. They are absorbed via inhalation, orally and transdermally. Presence of lipids enhances oral absorption, which is generally efficient. However the dermal absorption varies from compound to compound. While DDT is poorly absorbed by skin, dieldrin is efficiently absorbed through the skin[2]. Symptoms to exposure include nausea, vomiting, headache, dizziness, hyperesthesia, paresthesia, muscle incoordination, tremors, confusion, agitation and ataxia and convulsions. Severe poisoning can cause coma, respiratory depression and death[3]. A description of the uses, persistence and toxicity of the various POPs are listed in table 1.1a

1.1.3 Industrial compounds, unintentionally produced POPs

Hexachloro Benzene (HCB)

HCB has been used for a variety of applications apart from that as an insecticide. HCB is used to make fireworks, ammunition and synthetic rubber. Presently, its main source is in the form of an unintentional byproduct during the manufacture of pesticides, industrial chemicals (particularly lower chlorinated benzenes and solvents) and industrial processes (chlor alkali plants that use graphite in their electrolytic cells, aluminium manufacture, pyrotechnic production etc.). HCB often appears as a contaminant in chlorinated pesticides and is also used as a chemical intermediate in dyes and in wood preservation. HCB can also be released due to the incineration of waste contaminated with it. In India, the estimated average daily intake has been estimated at 0.13 micrograms per kg of body weight.[4]

Polychlorinated biphenyls (PCBs)

PCBs are produced commercially by the chlorination of biphenyl. Depending on the duration of the chlorination process, upto 209 cogeners of PCBs can be synthesised. PCBs were manufactured and used widely in industry as heat transfer fluids, hydraulic lubricants, dielectric fluids for transformers and capacitors, organic diulents, plasticisers, pesticide extenders, adhesives, dust reducing agents, cutting oils, flame retardants, sealants and in carbonless copy paper.

The unique chemical properties, which led to their use, are also contributive to their status as environmental pollutants. PCBs are persistent in the environment and are readily transported from localised or regional sites of contamination to remote areas, which have led to their presence in almost every compartment of the environment.

Most PCB cogeners are extremely persistent in the environment. They are estimated to have a half life ranging from six weeks to two years in air and more than six years in aerobic soils and sediments. In adult fish, PCBs have been known to have a half life of upto ten years. The International Agency for Research on Cancer (IARC) has classified PCBs as possible carcinogens.[5]

The complex nature of PCB mixtures complicates the risk evalu-

With the banning POPs pesticides in the environment, the focus is bound to shift towards the significantly greater risk posed by the dioxin, furan and PCB menace largely in the form of unintentional releases. A committed POPs elimination mechanism should be prepared to assess and counter POPs pollution in the South Asia Region

Table 1.2: Sources identified for unintentionally produced POPs by the Stockholm Convention

Industrial sources listed in Annex C – Part II with potential for comparatively high formation and release of POPs

- Waste incinerators, including co-incinerators of municipal, hazardous or medical waste or sewage sludge
- Cement kilns firing hazardous waste
- Production of pulp using elemental chlorine or chemicals generating elemental chlorine for bleaching
- Thermal processes in the metallurgical industry including, secondary copper production, sinter plants in the iron and steel industry, secondary aluminum production, secondary zinc production

Other sources listed in Annex C – Part III

- Open burning of waste including burning of landfill sites
- Thermal processes in the metallurgical industry not mentioned in Part II
- Residential combustion sources
- Firing installations for wood and other biomass fuels
- Specific chemical production processes releasing unintentionally formed POPs, especially production of chlorophenols and chloranil
- Crematoria
- Motor vehicles, particularly those burning leaded gasoline
- Destruction of animal carcasses
- Textile and leather dyeing (with chloranil) and finishing (with alkaline extraction)
- Shredder plants for the treatment of end of life vehicles
- Smoldering of copper cables
- Waste oil refineries

ation for humans, fish and wildlife. Hazard assessment of technical mixtures of PCBs underestimates the actual risks of weathered PCB mixtures. Studies on the effects of weathered PCB mixtures however involve various confounding parameters.

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs)

The dioxin family consists of about 210 compounds, of which about 17 are considered toxic. They are formed as result of combustion processes including waste incineration, metallurgical processes like steel production, foundry operations and metal recovery, and combustion of wood, coal or petroleum derivatives. Dioxins can be generated as by- products in the production of chlorine and its compounds - pentachlorophenol, PCBs, phenoxy herbicides, chlorobenzenes, chlorinated aliphatic compounds and halogenated diphenyl ethers. Dioxins appear in the liquid effluent and solid waste of paper pulp bleaching and from pesticides contaminated with dioxins during the manufacturing process. Apart from these sources, in the South Asia Region, it is expected that open, uncontrolled burning will also be a major source of dioxin releases.

In air, dioxins adsorb to particulate matter and are borne by air currents. Though hydrophobic, dioxins adsorb to benthic sediment (especially organic). Dioxins are strong adsorbent to soils and degrade through photo degradation. In soils, dioxins tend to remain near the surface and move towards bodies of water through erosion and bioaccumulate in aquatic life.

Furans are similar to dioxins in their production mechanisms and toxicological effects; however, the IARC has not classified furans as potential carcinogens to humans. Humans are exposed to dioxins and furans through their diet, mainly through fats and animal foods.

1.2 Objectives

- To obtain a comprehensive overview of sources of POPs
- To identify known and suspected exposure pathways of POPs
- To obtain documented evidence on the environmental and health burden of POPs

The above will be examined in the in the South Asia Region consisting of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, through secondary sources.

1.3 Methodology

The study involved mainly information gathering, analysis and presentation.

The methods utilized in this exercise were a survey of available literature, informal interactions with various stake holders and experts and accessing the internet.

The central focus of the report is on India with other SAR countries represented using available information and key regional informants.

The major outcomes of this exercise are in terms of compiling existing information and identifying significant data gaps. It is expected that it might help in resource identification and the setting of priorities for further, intensified efforts in knowledge generation.

1.4 Report Structure

The first section of the report gives an overview of the POPs chemicals of interest, a description of the region as well as a summary of international and previous local efforts at understanding POPs.

The second section examines the *status* of POPs in the region with specific reference to activity in terms of production, import and export of POPs especially after the bans. An overview of the capabilities in the region is presented along with the key issues and possible data gaps. The second section also examines the *sources* of POPs in the region. The section separately looks at pesticide POPs and unintentionally released POPs. The section on pesticide POPs looks at the two main concern areas, one being agricultural usages and the other being usages in the public health sector. The sectors reviewed for unintentional releases of POPs are incineration, the pulp and paper industry, iron and steel smelting, thermal power plants, cement manufacture and chemical industries.

The third section deals with the *exposure pathways* of POPs within the region. Air, water and marine transport are evaluated as the main pathways and a review is presented of identified monitoring studies of environmental levels of POPs in the region. Food, which is a critical pathway, is then presented, especially with reference to dietary exposure and infants' exposure. A review is presented of monitoring efforts in the region for POPs contamination in food. It has been found that, apart from monitoring of residues levels, there has been very little in terms of connecting the sources to the measured levels and modeling potential routes and transport mechanisms.

The fourth section examinesthe critical aspect of exposure of POPs in *wildlife and human populations* in the region. Aquatic and terrestrial wildlife contamination by POPs is presented. In the data on humans, studies are presented on the monitoring of POPs in human breast milk, adipose tissue and blood samples.

The fifth section studies the extent of information and resources available in the region to assess the *impacts* of POPs exposure and contamination. Studies have been identified and presented that bring out instances of documented effects of POPs on the wildlife as well as on human populations.

Finally, **the sixth section** of the report concludes with a comment on the various sections as well as the *key findings* of the POPs situation on the basis of the present project.

Throughout the report, available data is presented in a tabular format and wherever relevant, the viewpoints of experts are incorporated. Whereever possible data has been analysed to identify possible trends or indications.

Appendices provide information on the acceptable limits of various POPs chemicals to enable comparison and evaluation of data presented in the tables. Certain data segments have also been presented in the appendices. Important resource persons and institutions are also listed along with a list of documents referenced.

▲ Separate **annexures** are displayed at the end of the report to highlight related issues. For example, annexure 1 deals with the other chemicals of concern, which might come into the focus in the near future. Annexure 2 highlights the possible indirect effects of industrially released POPs with a focus on the Paper and Pulp industry. Annexure 3 presents some facets of sustainable approaches to vector control with emphasis on bioenvironmental techniques.

▲ Industrial hotspots, which show the regional distribution of unintentionally released POPs are marked on maps. This is part of Box no. 4.

▲ An overview of international efforts at understanding POPs on the basis of the recently completed GEF-UNEP regional Persistent Toxic Substances (PTS) survey is presented along with a compilation of key parameters associated with POPs. The overview is presented in Appendix 3.

References

1 Discussion with Dr P.Y. Naik, INTOX, Pune

2 Report of the NPIC, AIIMS

3 Report of the NPIC, AIIMS

4 Indian Ocean 2002

5 The International Agency for Research on Cancer (IARC) is a program designed to evaluate the carcinogenic risk of chemicals to humans. Overall evaluations of carcinogenicity are made following a review of appropriate literature on a particular agent, including structure-activity information, genotoxicity studies, carcinogenicity bioassays, and biologic and epidemiologic data. The IARC classifications include:
Group I - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans
Group 2B - Possibly Carcinogenic to Humans
Group 3: Not Classifiable As to Its Carcinogenicity to Humans
Group 4: Probably Not Carcinogenic to Humans

2.0 Status of POPs in South Asia

2.1 Current regulatory framework

2.1.1 Pesticides

Most of POPS chemicals are banned in the South Asian region for use in agriculture.

In the case of vector control, DDT is allowed in India on a restricted basis for malaria control, the maximum usage ceiling being 10,000 MTPA. Before this ban came into being, there was extensive usage of DDT in agriculture. Widespread usage has led to its residues being distributed in almost every environmental niche in the region. The persistent nature of DDT and its continued usage has led to its continued presence. Among the other countries in the region, DDT continues to be used for public health purposes in Pakistan, Bangladesh and Nepal.

Dieldrin has been allowed for purposes of locust control till the product has date expired or for a period of two years after the ban on manufacture (period expires on 17th July 2003). Dieldrin use is restricted in Bangladesh and Nepal and the status of chlordane use is unknown in Bhutan.[1]

Among pesticide POPs, Dieldrin, Aldrin, Heptachlor, Chlordane and Endrin have also been used in the region, but in quantities smaller than those of DDT.

All 9 Pesticides listed as POPs in the Sockholm Treaty, are banned for use in agriculture in the entire region. Table 2.1 (on the next page) gives the dates of the bans and information on pesticide POPs related issues in the various countries of the region.

2.1.2 PCBs

In the electrical sector, PCBs have been banned for use in electrical transformers in India since 1967. The Indian government contends that transformers and capacitors manufactured in India do not contain PCBs.[7] However, it is possible that imported transformers or transformers in use from before the ban contain PCBs. The presence of PCBs has been reported in certain soil samples collected from beneath transformers. A study in Trivandrum[8] has revealed the presence of certain PCB cogeners from near transformers installed after the ban.

The ship breaking sector and the metal recycling industry (due to the rerolling of paint) are the other main PCB contaminators in the region. Further details are given in Section 2.3.2.

2.1.3 Dioxins/furans

There is very little awareness on the release of dioxins and furans in the South Asia Region. Given the fact that many of the dioxin releasing industries in India use outdated technology with high inefficiencies, it is expected that dioxin and furan releases will be considerable. The main shortcomings in terms of dioxin and furan knowledge seems to be the lack of monitoring facilities and the lack of awareness and knowledge of the nature of possible dioxin exposure. At present, the latest emission standards for hazardous waste incinerator set by the CPCB mention the maximum permissible levels of dioxins and furans emitted from incinerator stacks[9] as less than or equal to 0.1ng TEQ/Nm^3 corrected to 10% oxygen while operating properly at 100% rated capacity. Sampling period shall be minimum six hours and maximum eight hours. Analysis of dioxins and furans as well as reference measurement systems shall be carried out as given by CEN-standards. If CEN-standards are not available, ISO standards, National or International Standards that will ensure the provision of data of an equivalent scientific quality shall apply.

But this step needs to be matched with the ability to monitor dioxins to be effective. The main issues involved in the setting up of a dioxin monitoring facility in the region seem to be the procurement of chemical standards, suitably trained manpower, equipment and the establishment of isolated clean facilities for the safe handling, extraction, clean up, concentration and disposal of dioxin contaminated substances. The cost involved in setting up such a facility is estimated to be in the order of 3-3.5 crore rupees.[10]

Dioxin monitoring capabilities (either existing or upcoming) have been identified in the Regional Research Laboratory

Most POPS chemicals are banned in the South Asian region for use in agriculture. All 9 Pesticides listed as POPs in the Sockholm Treaty, are banned for use in agriculture in the entire region. DDT continues to be used for public health purposes in India, Pakistan, Bangladesh and Nepal

(RRL), Trivandrum, National Environmental Engineering Research Institute (NEERI), Nagpur and National Institute of Occupational Health (NIOH), Ahmedabad. The facilities at RRL seem to have reached an advanced stage of operation with the generation of some baseline data from sediment and aquatic life samples in Kerala. The facilities at RRL are positioned to function as the pilot regional dioxin facility.[11]

In its initial assignment directed by the MoEF, the laboratory is going to monitor medical waste incinerator stack emissions from 4 hospitals in Delhi (AIIMS, Batra, Lohia, Deendayal) and one hospital each in Ludhiana and Hyderabad. The year-

Table 2.1: Information on regulatory status of pesticides POPs in SAR countries

Chemical	India[2]	Nepal[3]	Pakistan[4]	Bangladesh[5]	Srilanka
	Comments	**Comments- Pesticide laws started 1989.**	**Comments**	**Comments Pesticide laws started 1971-85**	
Dieldrin	a) Use restricted to locust control in desert areas under the direction of the Plan Protection Advisor. (15th May 1990) b) Complete ban on manufacture, import and export (17th July 2001) c) Marketing and use permitted for two years from date of ban on manufacture, or date of expiry, whichever is earlier	Banned from 1998 according to PIC[6] list.	Banned in 1979	Banned according to PIC list.	Banned
Aldrin	Complete ban on manufacture, use, import and export. 20th September 1996	Banned from 1998 according to PIC list.	Banned in 1974	Banned according to PIC list.	Banned
Endrin	Complete ban on manufacture, use, import and export 15th May 1990	Banned from 1998 according to PIC list.	Banned in 1979	Banned according to PIC list	Banned
Chlordane	Complete ban on manufacture, use, import and export. 20th September 1996	Banned from 1998 according to PIC list.	Banned in 1974	Banned according to PIC list.	Banned
Heptachlor	Complete ban on manufacture, use, import and export. 20th September 1996	Banned from 1998 according to PIC list.	Banned in 1974.	Banned according to PIC list.	Banned
DDT	Banned for agricultural use, and restricted use in the public health sector (10,000 MT per annum). 26th May 1989	Banned from 1998 according to PIC list.	Banned in 1972.	Banned according to PIC list.	Banned
Toxaphene	Never registered	–	Banned in 1982	–	Never Registered
Mirex	Never registered	–	Banned in 1976	–	Never Registered
HCB	Never registered	–	None	–	Banned
PCB	Banned	Banned	Unintentional by product	Banned	Banned

Table 2.2 : A Summary of the status of POPs in the region (Indian Ocean 2002)

POP	Details
Aldrin	Import for India (622 MT 1995-2000), Sri Lanka (1500 MT, 1996) and Pakistan (13500 MT, 1970-92). Small stockpiles in India (Aldrin dust 0.8 MT), Nepal (2 MT), Bhutan (0.4 kL)
Chlordane	Small quantities imported for agriculture – India(31 MT 1995-99, 65 MT, 1995-2000). 1.35 MT of obsolete stock reported in Nepal
DDT	India imported 12 MT during 1996-98 and exported 554 MT during 1995-2000. The average annual production was 4190 MT (1995-2001). Stockpiles of 3.0 MT from Bhutan and 5.3 MT from Nepal.
Dieldrin	Stockpiles in India (Tech 19.5 MT, 18-EC 17.0 KL) 0.155 MT of dieldrin as old stock in Nepal
Endrin	1.2 kL stockpile in Nepal
Heptachlor	India, Pakistan imported Endrin in 1996
PCBs	Reported burden 2000-4000 MT in India. 2000L in Nepal identified. Shipbreaking industry in India, Pakistan, Bangladesh. A merchant ship generates 0.25-0.8 MT of PCBs. Rerolling of paint contaminated scrap metal, used oil import, transformers, capacitors
PCDD/Fs	Hospital, municipal waste incineration, automobiles, peat burning, coal, wood burning, PCB manufacture, paper pulp, PVC manufacture, sintering process in the iron & steel industry, tanneries, burning of garbage, crematoria, waste oil burning, chemical processes, power generation.

Source: Extracted from Indian Ocean 2002, Communication from Dr M.Y. Hayat

long project is expected to begin in a few months time.[12] NIOH is scheduled to begin testing human tissue (milk, blood, serum) from samples in western India for dioxins and furans as part of a project funded by the MoEF.[13] The NEERI project on dioxins is funded by the CPCB and proposes to look for dioxin presence in incinerators and crematoria. It is hoped that the results of these monitoring programs will provide the much needed information for the setting up of a dioxin inventory in India and the region.[14]

2.1.4 Monitoring efforts

Although there remains much to be done in understanding sources and pathways of POPs in the region, the final impact of POPs on various environmental segments can be gauged from the levels of POPs detected in samples. This helps analyse the outcome of efforts at reducing POPs exposure as well as in raising the alert on possible, unidentified POPs releases and subsequent contamination. In the sense of giving meaning and actionability to the regulations concerning POPs, it is essential to ensure that a proper system of monitoring of environmental parameters is in place.

There have been many studies to study POPs pesticide and PCB residues in the environment and in human tissues. But these studies have been scattered far and wide both in terms of geography as well as the environmental segment sampled.[15] There has been no standardization of the various studies concerned and there is much uncertainty expressed as to the quality of the results generated. Most data generated in the region does not necessarily meet strict norms and peer review standards for published material may not always be dependable.[16] In most cases anomalies in data need to be properly justified and follow up action needs to be taken on the field to ascertain the reasons behind the measured values of POPs concentrations.[17]

Usually, the range of commodities examined have been study specific and in many cases, the objectives have been very narrow, conducted in isolation by single government agencies/ institutions and have little consideration of the broader and significant national objectives. Most of the studies do not have a regional focus with resource intensive and expensive studies not being harmonized amongst locations to help understand the overall picture. In many studies, the sampling methods and Daily Intakes (DI) estimated are made on individual assumptions and the sample sizes are very small. The results of the monitoring studies need to be treated with the above in mind.[18]

However, the results are indicative of the widespread problem of POPs contamination. Given the paucity of alternate credible information as well as the absence of any standards to evaluate the quality of the results, in this report, the results of all the available studies are presented so as to enable an analysis of the nature of POPs levels in the region.

2.1.5 Summary of status of POPs in the SAR

See Table 2.2 on the left.

2.2 Sources: production, imports and stockpiles

Sources of POPs can be classified according to their type.

Pesticide POPs have similar source characteristics. PCBs have specific uses in different industrial sectors and have source char-

Table 2.3: Summary of various aspects of pollution due to the pesticide industry

Environmental media	Pollutants	Source
Air	Particulate, pesticides solvents	Manufacturing stages of pesticide and formulation i ndustry, volatalisation from crops and soils, spray application of pesticides, entrainment as dust, evapora tion from water, disposal process
Water	Raw materials, metabolites,	Manufacturing stages of pesticides and formulation industry, isomers, pesticides, intermediates application of pesticides on soil, pesticide runoff, storage, transportation
Soil	Solid wastes, pesticides	Manufacturing stages of pesticide and formulation industry, application of pesticides Application generated Pesticides Application of pesticides

Source: Mall 2003

acteristics accordingly. Similarly, unintentionally produced POPs have commonalities in terms of kinds of sources and release mechanisms.

2.2.1 Pesticides

Pesticides sources can be typically characterized as point and non point.

Point sources of POPs pesticides are in the form of pesticide manufacturing facilities (both technical grade manufacturers as well as formulators) and stockpiles of obselete, unwanted or date expired pesticides.

Non point sources arise due to the general application of pesticides (such as in agriculture) resulting in crop run offs or leaching into ground water reserves. Since all POPs pesticides have been banned for use in agriculture, there is no data being generated or available on this aspect. In the context of the SAR, the use DDT as part of the malaria program also constitutes a non-point source.

2.2.1.A Production

Given the fact that all POPs pesticides excepting DDT are banned for production in India, potential hotspots might exist in closed factory premises, which might still house stocks of manufactured chemicals. It is expected that the environment around such sites might also wear the scars of exposure to toxics during the period of manufacture. Such contamination of the area was indicated by a report on the effect of the Udyogamandalam plant of Hindustan Insecticides Ltd. (HIL) where DDT is manufactured.[19]

HIL has been producing pesticides in this site since 1956 at Udyogamandalam and still continues to produce DDT. Sedi-

Table 2.4: Information and data on current production facilities of HIL

Name	Year of commission	Installed capacity (MT/KL)	
		Technical DDT	Formulation DDT
Udyogamandalam	1956	1,344	2,688
Rasayani	1980	5,000	10,000

Source: http://chemicals.nic.in/chem_hil.htm

Table 2.5: The annual production figures for technical grade DDT

Year	Production (technical grade, MT)
1992–93	6,721
1993–94	5,961
1994–95	4,252
1995–96	6,016
1996–97	4,149
1997–98	4,215
1998–99	3,359
1999–2000	3,828
2000–01	3,786
2001–02	3,716

Source: HIL annual reports

ment samples collected 10m downstream from HIL contained residues of DDT and its metabolites in contrast to upstream samples, which showed no contamination. DDT was also detected in the areas surrounding the pesticide plant, indicating a possible effect of the presence of the factory on its surrounding areas.

DDT production unit : Hindustan Insecticides Limited (HIL)

HIL is Government of India Enterprise under the Department of Chemicals & Petrochemicals, in the Ministry of Chemicals and Fertilizers. The company diversified into agro pesticides to meet the requirements of agriculture sector, and has grown manifold, with a turnover of 1148 million rupees in 2001-02. It is the sole DDT producing unit in India.

DDT is l under production at HIL's Udyogamandalam

(Kerala) and Rasayani (Maharashtra) centers. Previously, HIL had a Delhi unit, which was set up in 1954 for the manufacture of DDT. The capacity of this unit was 2744 MTPA of technical DDT and 5488 MTPA of formulation DDT. The Delhi plant has been closed as per an order of the Supreme Court and has stopped functioning wef 1.12.1996.

2.2.1.B Imports

India

Tables 2.2, 2.3, 2.4 provide information on the reported commercial activity on POPs pesticides. It is interesting to note that chlordane has been imported subsequent to the date of its ban while aldrin, chlordane and heptachlor have been exported subsequent to the ban.

The export of POPs from India subsequent to their ban is an indication of the continued existence of possible hotspots in India in terms of production and storage facilities. Details regarding the amounts and destination of some of these exports are given n the Table on the next page.

Bangladesh

Pesticide use in Bangladesh is largely targeted at increasing production of the single principal staple crop – rice. There are frequent reports in literature of persistent, banned organochlorine pesticides used for the control of soil borne insects. These are obtained illegally through cross border transfer and local formulation. Many of the products are marketed without labels or other identification. The adulteration of products is also reported either with other (generally illegal) products or inert ingredients.[21] Bangladesh has a DDT manufacturing plant in Chittagong that has been closed.[22]

In Bangladesh, an estimate has been made of smuggled pesticides.

Nepal

Chemical pesticides were introduced in Nepal in the 1950's for use in malaria control and agriculture. The consumption of pesticides per unit area is estimated to be 142 g/Ha. 100-108 MT of formulated pesticides are consumed annually. Fungicides (54.5 MT) are imported maximum followed by insecticides (47 MT). Due to an open border with India, it is reported to be very difficult to control the influx of illegal pesticides. There are reports of pesticides being illegally distributed by unregistered dealers directly to farmers.[23]

In Nepal[24], pesticide containers are also disposed in open

Table 2.6: Production, import-export data of DDT, heptachlor and chlordane[20]

Activity (Values in MT Technical grade)	1995–96	1996–97	1997–98	1998–99	1999–2000
Production–DDT	6,017	4,147	4,215	3,357	3,638
Import–DDT	0.00	6.00	6.00	0.00	0.00
Export–DDT	54	133	175	16	64
Import–Heptachlor	0.30	0.00	0.00	0.00	0.00
Export–Heptachlor	48	17	0	0	0
Import–Chlordane	9.00	1.00	10.00	0.00	0.00
Export–Chlordane	9	3	29	4	8

Source: Presentation by Dr P S Chandurkar, Plant Protection Adviser to the Govt. of India during the regional meeting of the UNEP-GEF PTS regional priority setting meeting, September 2002

Table 2.7: POPs pesticides exports from India for the period Apr 1998–Dec 1999

Product	Country (tonnes)	Quantity
DDT	Australia	22
FRGI	20.150	
Israel	20	
Bangladesh	40	
Belgium	1	
Chinese Taipei	11.5	
Italy	48.2	
Japan	16	
Nepal	1.695	
Spain	1	
USA	4	
Total	**185.595**	
Aldrin	Bangladesh	8.3
Brazil	5.130	
ChineseTaipei	17.550	
PRC	6	
Denmark	9	
Egypt	4.6	
France	15.640	
Germany	1.760	
Italy	13	
Kenya	0 .376	
Korean Republic	0.1	
Mexico	10	
Netherlands	84.340	
Saudi Arabia	10.800	
Singapore	0.1	
Turkey	13.173	
UAE	12.500	
USA	0.023	
Vietnam	0.2	
Zambia	0.25	
Total	**212.,847**	
Chlordane	Bangladesh	16
Egypt	27	
Total	**43**	

Source: Trojan Horses 2000, Toxics Link

dumping places and public garbage containers. A survey of 120 farmers in 1995 revealed that villagers use aldrin as fishing bait in streams and ponds. The chemical kills the fish, which after surfacing are collected by the fishermen. People eating the contaminated fish later complained of illness.[25]

Pakistan

In a study in Pakistan[26], it was noticed that the use of pesticide was shifting from cotton towards fruits and vegetables and that the pesticides recommended for the cotton crop only are also used on vegetables. Pesticide consumption in Pakistan has gone up from 665 MT in 1980 to 45680 MT in 1999 with 74% of the total pesticides used in Pakistan being insecticides. DDT was being manufactured locally and its consumption in 1984 was 111MT.[27]

2.2.1.C Stockpiles

There is scant information on stockpiles in the South Asia Region. In India, although most experts were accepted the presence of stockpiles, there is almost no confirmed data on old and unused stockpiles of pesticides. Certain stockpile information in the region is mentioned in the table given in the summary at the end of Section 2.

There is also no known government program to monitor stockpiles though the State Pollution Control Boards have the responsibility to identify and notify sites storing hazardous material.

In India, POPs have been listed as hazardous substances in the Schedule 1 of the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989. Schedule 5 of the same document indicates that it is the duty of the Central Pollution Control Board (CPCB) or the SPCBs for enforcement of directions and procedures in respect of isolated storage of hazardous chemicals. The duties include the notification of sites and a detailed report containing various aspects of the sites of hazardous stockpiles.

Interactions with officials of the MoEF[28] and the CPCB have revealed that there is no available knowledge on stockpiles. India has 617 on site secured landfills for storing hazardous wastes[29] but the nature of hazardous wastes stored is not mentioned.

The only program to survey pesticide disposal sites identified is conducted by the FAO. A FAO report on pesticide stockpiles released in 2001 has mention of just one location ie., a

The export of POPs from India subsequent to their ban is an indication of the continued existence of possible hotspots in India in terms of production and storage facilities. There is no known government programme to monitor stockpiles though the State Pollution Control Boards are responsible to identify and notify sites storing hazardous material

godown Vatwa in Ahmedabad with technical grade DDT manufactured in 1992 stored in a drum. The quantity of DDT stored and the number of containers are not mentioned.

2.3 Uses and releases

2.3.1 Pesticides

Pesticide POPs' usage has been dealt with under two subsections – Health and Agriculture. The main officially continued usage of pesticide POPs (DDT) is in the malaria control program. Agriculture usage has seen large amounts of POPs pesticides released into the South Asian environment during the few decades of their useage and is attributed with the almost ubiquitous presence of certain POPs in various environmental segments.

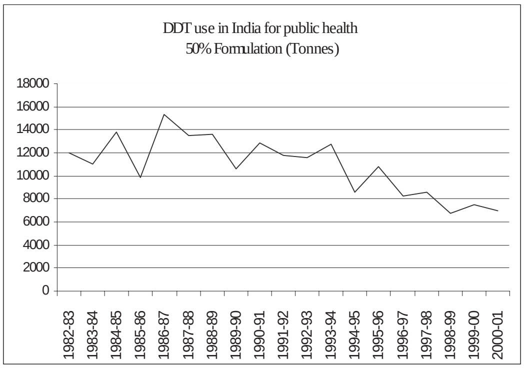
2.3.1.A Health sector

The first civilian use of DDT in India was in 1944 for malaria control. Following this, large scale trials were started during 1946-1952 for malaria control and it was used widely during the relocation process due to the formation of Pakistan.

In 1954, HIL's plant in Delhi was commissioned to manufacture DDT. With the first signs of malaria resistance surfacing in 1952, all out efforts were made from 1958 onwards as part of the National Malaria Eradication Program (NMEP) to eradicate the disease before widespread resistance made it impossible. By 1965, 14 insect pests of public health and veterinary importance had become resistant to DDT. 8 out of 14 pests that account for 80% of the malaria cases in India are reported to be resistant to DDT.[30]

At present, the National Anti Malaria Program (NAMP) professes that 'there is now an increasing realization that a multi sectoral approach and active involvement of the community are essential components of the malaria control strategy.' It is a fact that 35% of India's health budget is used in tackling malaria.[31] However, although there is no dearth of funds to procure DDT, its usage has been declining reflecting that possible widespread resistance is reducing the efficacy of DDT. Due to continuous usage of DDT, HCH and other insecticides in the vector control program, Anopheles Culicifacies, a mosquito species, has become resistant to DDT in 286 districts, DDT and HCH in 233 districts, DDT, HCH and malathion in 71 districts and synthetic pyrethroids in two districts. This species is responsible for about 60-70% of the new malaria cases each year.[32]

Figure 2.1 Trend of DDT usage in India



Pesticides in India: Environment and Health Sourcebook, Toxics Link

The usage of DDT is not uniform throughout the country. In keeping with the requirement of each state, annually, a certain amount of DDT is allocated for malaria control. The usage of DDT has been stopped in urban areas and as of now, DDT is being used only in rural areas.[33] The statewise distribution of DDT for public health purposes during 1998-99 and 1999-2000 (in MT) is given in Table 2.8b.

Considering that the widespread resistance to DDT was ascertained as long back as 1982[34], the continued usage of DDT is considered to be difficult to justify considering the recognized harmful effects on the environment.[35] One reason given for the usage of DDT is the cost factor that makes DDT the cheapest single alternative.

However, considering the growing inefficacy of DDT and the

Table 2.8: Estimates of smuggled pesticides in Bangladesh

Trade name	Common name	Pkt size	Smuggled price (tk)	Estimated quantity smuggled
Eldrin 20 EC	Endrin	1 litre	235	25 KL
Dieldrin 20 EC	Dieldrin	1 litre	235	25 KL
Chlordane 20 EC	Chlordane	1 litre	235	35 KL
DDT	DDT	1 Kg	30	100 MT
Heptachlor 40 WP	Heptachlor	1 Kg	30	60 MT

Source: Pesticide Association of Bangladesh Report. Communication from Dr Hayat

Table 2.8b: DDT usage state-wise 1999-2000 (metric tonnes)

State	1998–99	1999–2000
Andhra Pradesh	130	250
Assam	1050	850
Arunachal Pradesh	100	100
Bihar	500	400
Gujrat	0	0
Goa	0	0
Haryana	0	0
Himachal Pradesh	30	40
Jammu & Kashmir	45	50
Karnataka	100	50
Kerala	0	0
Madhya Pradesh	207	728
Maharashtra	0	0
Manipur	250	100
Meghalaya	150	116
Mizoram	100	100
Nagaland	100	100
Orissa	300	230
Punjab	150	100
Rajasthan	1,750	1,100
Sikkim	10	10
Tamil Nadu	0	0
Tripura	250	200
Uttar Pradesh	300	250
West Bengal	250	200
Andaman & Nicobar	20	20
Chandigarh	7	5
Delhi	0	0
Dadar & Nagar Haaveli	0	0
Daman & Diu	0	0
Lakshadweep	0	0
Pondicherry	1	1

Source: Trojan Horses, Toxics Link, 2000

deleterious effects of DDT residues in the environment, mere concerns of cost savings need not justify its continued use for malaria control. In view of the persistence of organochlorine insecticides like DDT in the environment and the biomagnification of the insecticides in non target organisms including humans, it was decided by the Govt. of India to phase out the use of DDT and BHC in the National Malaria Eradication Program (NMEP).[36] From 1996 to 2002, the use of DDT (in terms of population covered) was to be reduced by 64% with an eventual ban on the use of DDT in public health from 2005 onwards.[37] In 1997 the World Bank tried a different method to combat malaria. It submitted a Project Appraisal Document on major proposed credit to India by the International Development Association (IDA), for an 'enhanced' malaria control project (EMCP) to be implemented by the National Anti Malaria Programme (NAMP) of the government of India (GOI). The objective of EMCP was to shift the financial focus of the existing programme from indoor residual spraying (IRS) to a more diversified approach involving a higher percentage of spending on areas such as medicated mosquito nets, institutional strengthening, epidemic response and intersectoral collaboration, and secondly, to shift from malaria eradication to malaria control (hence the word 'eradication' was droped from NMEP, which became NAMP).

However, the annual situation report of the National Anti Malaria Programme (NAMP) (Table 2.11a) shows that about 52.5 million people have been covered by DDT spraying in 2001, which, indicates that the targeted phase out of DDT is not proceeding as per plan.

Another important issue associated with the use of DDT is its stated pilferage and its clandestine use in agriculture. Experts expressed differing opinions with the majority suggesting that there is in fact significant diversion of NAMP acquired DDT. This view can be supported by the data on incidence of DDT levels in areas where it is not being sprayed for malaria control.

In an effort to understand the effect of DDT spraying and the residues in the area being sprayed, the NAMP has commissioned National Environmental Engineering Research Institute (NEERI) to evaluate the its impact on the environment and the health of the people residing in and around areas in Mizoram. The project is expected to take one year to complete and attempts to study DDT levels in 5 water bodies (biotic and abiotic segments) and birds, and diversity indices and ecological health of the water bodies are to be evaluated followed by an impact analysis. The health status of people in sprayed and non sprayed areas is also to be evaluated using blood tests, medical examinations and questionnaires. Preliminary investigations have revealed widespread contamination of DDT in the environmental indices monitored in the state of Mizoram.[38]

2.3.1.B Agriculture Sector

There exists no recent data on the agricultural usage of POPs

An important issue associated with the use of DDT is its stated pilferage and its clandestine use in agriculture. Experts suggest that there is in fact significant diversion of NAMP acquired DDT. This view can be supported by the data on incidence of DDT levels in areas where it is not being sprayed for malaria control

Table 2.9: Comparison of cost of DDT with other available alternatives

Insecticide (Concentration)	Total in MT per 1 million population	Cost per MT	Cost of insecticide /million population Rs in lakhs excluding operational costs	Cost of insecticide /million population Rs inlakhs including operational costs
DDT (50%)	150	84,857	127.3	169.48
Lindane (6.5%)	336	50,000	168.00	225.25
Malathion (25%)	900	46,341	417.07	542.98
Deltamethrin (2.5%)	60	751,250	450.75	490.07
Cyfluthrin (10%)	18.75	2,404,000	450.75	488.00
Lambdacyhalothrin (10%)	18.75	2,404,001	450.75	488.00

Source: Mitra 2002

Table 2.10: Population to be protected under chemical insecticides (million population)

DDT use	1997–98	98–99	99–00	2000–01	2001–02
Malaria	54	50	40	40	20
Kala Azar	48	40	26.6	26.6	14

Report on Epidemology and Control of Malaria in India 1996. Published by the NMEP, DGHS, Ministry of Health and Family Welfare

pesticides in India. It is expected that the usage of certain quantities of old and illegally acquired POPs pesticide still persists but there is no credible data on its monitoring.

In general, 25-30% of the cropped area is exposed to pesticides. Insecticides are the most used pesticides. India is the third largest pesticide consumer in the world despite usage declining from 80000 MT in 1994-95 to 54135 in 1999-00. The decline is attributed primarily to the ban on the usage of OCs pesticides like DDT, BHC and Aldrin.[39]

Among the states in India, Uttar Pradesh is the largest consumer followed by Punjab, AP, Haryana, Gujarat and West Bengal. The average consumption is calculated at 288 g/hectare. In comparision, Bangladesh consumes 30 g/hectare, Pakistan consumes 90 g/hectare and SriLanka consumes 400 g/hectare on an average.[40]

Pesticides find their way into the environment through agricultural use during handling, application and storage. Pesticides are available mainly in powder, liquid and granular form and are applied mainly through manually operated machines. However, the use of power sprayers, dusters and mist sprayers is increasing. Aircrafts are used to a limited extent in certain areas on cotton, jowar, rice, sugarcane, cashew nut and groundnut. The maximum application of aerial spraying has been in locust control.[41]

The hot climate as well as low awareness amongst farmers makes the use of protective clothing unpopular. Manually operated equipment used by the farmers, mostly men, is such that it exposes them to fairly heavy contamination. Women participate in the process mainly for the preparation of the pesticides for spraying or dusting. In a survey by the CERC[42], it was found that pesticide sprayers used by farm workers are not safe. It was found that there were leakages from some sprayers resulting in pesticides spilling over onto the bodies of sprayers. Adverse health effects were also observed in farm workers after using the sprayers.

Table 2.12: Pesticide usage amongst various crop segments in India

Crop	Pesticide usage
Cotton	45%
Rice	22%
Vegetables	9%
Plantations	7%
Wheat	4%
Pulses	4%
Others	9%

Source: Mall 2003

In many parts of the region, empty pesticide containers are used for other purposes like storage leading to an increased risk of exposure. In India, as in other countries of the region, it has been noticed that basic WHO norms like the prohibition of women from pesticide related work during their reproductive stage are commonly flouted.

Considering the fact that organochlorine pesticides are relatively easy to manufacture[43], there exists the possibility of widespread illegal manufacture in small scale units in the region. Certain pesticides like Aldrin and DDT are said to be freely available from hardware shops in Delhi.[44] Farmers might continue to prefer these banned chemicals due to their immediate efficacy and proven past track record. Lower costs also contribute to the continued patronage of certain POPs chemicals by the farming community.

However, many of the illegally available pesticides might have altered properties resulting in either lower efficacy or higher mammalian toxicity. Better enforcement of the regulations and monitoring of the ground situation is needed to ensure that the intended effect of bans (reduction of undesirable toxins from the environment) is achieved.

2.3.2 PCBs, dioxins and furans

While a variety of industrial applications exist for PCBs (fig 2.3a), the electricity and the ship breaking sector have been identified as the major sources of PCBs in India.[45] Other possible major sources are unintentional releases in which PCBs, dioxins and furans are released into the environment. The major sectors discussed in this category are the paper and pulp industry, the iron and steel sintering process in the metallurgical industry, the cement industry, power generation by thermal power plants and certain chemical industries.

2.3.2.A Electricity transmission

PCBs were used in transformers and capacitors due to its unique properties of heat conductance and electrical insulation. Realising their potential harm to the environment, they have been banned in India in 1967, by the Ministry of Petroleum and Natural Gas, for use in transformers and capacitors. PCBs are being replaced by 'Dowtherm' (a mixture of biphenyl and biphenyl oxide) as well as mineral oil produced by petroleum refineries.[46]

It is generally contended by the government that PCBs have been banned since 1967 and are not a matter of concern. However, imported electrical equipment and other heavy hydraulic equipment, including steel plants of Russian origin, are said to contain PCBs estimated to be approximately 2000 tonnes to 4000 tonnes.[47] The presence of PCBs in a landfill site[48], river water and sediment[49] as also in various environmental media in India[50] indicates that PCB wastes are going unregulated owing to a sense of complacency.

Transformer oil in India is manufactured by the refining of Transformer Oil Feed Stocks (TOFS) which are obtained as a first distillate under vacuum distillation of reduced crude oil, after taking out lighter products like gasoline, kerosene and diesel.[51] New transformers are therefore not expected to pose a problem as far as PCBs are concerned. PCB laden transformers are expected to originate from imported stocks as well as old transformers. Considering the relatively shorter life spans of transformers in India (maximum 35 years) and the ban on PCB usage in manufacture of transformers since 1967, it is expected that most of the leakage/ release of PCBs from the electricity sector has already occurred or may be in old transformer stockpiles.

However, in a study in Trivandrum conducted by the Regional Research Laboratory (RRL), it was found that transformers installed after the ban (as recently as 1998) showed significant PCB concentrations in soil samples due to transformer oil leakages. It is also possible that the PCBs present in these locations may be due to leakages from previous transformers.

Significant PCB concentrations in turtle body tissues and eggs detected in Veli estuary off Trivandrum have also been linked to possible PCB leaks from transformers.[52] These recent studies reveal that the ban on PCB use in transformers and capacitors does not ensure an effective prevention of PCBs' entry to the environment.

A report on PCBs in India[53] indicates that there are no systems in place to deal with PCB wastes in India. PCB laden transformer sites were identified by the Maharashtra State Electricity Board, Tata Electric Company, Bombay Suburban Electric Supply Ltd, Power Grid Corporation of India and the Badarpur plant of the National Thermal Power Corporation. The most significant problem is indicated to be due to transformer oils, which are present in large quantities. Considering the fact that a lot of other materials will be contaminated, the contaminated material can be far in excess of the 3500 tonnes of transformer oils estimated. Capacitor based PCBs might not be as great a risk and the quantity has been estimated to be 1000 tonnes.

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resulting in a large number of transformers being dumped. There is no available information on the material used as transformer oil and there is no program to track imported and older vintage transformers. Defunct transformers are piled up and typically end up in the hands of small scale waste dealers. There are no special dumping grounds maintained. In the process of use, many transformers develop leaks and transformer oil leaks out into the environment.[55] The lack of awareness of possible PCB leakage into the environment and its consequences is very noticeable.

2.3.2.B The ship breaking sector

In India, till the 1960s, ship breaking involved mainly dismantling of small, disused barges and coastal wretches. However, during the 1970's, the ship breaking activity registered dramatic growth. Later by the year 1979, it had been recognised as a full fledged small scale industry.

The activity, which was mainly confined to Mumbai and Kolkata, spread primarily on the western coast and other parts of the country, especially Alang in Gujarat. India is now a major shipbreaking site. The demand for re-rollable and melting scrap and other items has supported this growth, which is mainly owing to low wages, and extremely poor environmental standards at the ship breaking yards. In fact, the world's ship breaking activities have shifted to the Indian subcontinent, with India, Pakistan and Bangladesh accounting for more than 90% of total ship disposals during 1998.[56]

Ships that come up for demolition now were most probably constructed in the 1970's, considering they have a working life of 20 to 25 years. The use of PCBs was greater at that time. These older ships contain PCBs in their electrical systems, paints and coatings, cables, lubricants, engine oils etc. It is also possible that subsequent to the ban in the 1970's, some of the ships might have converted to non PCB alternatives, as they went through successive repairs and replacements over their working lives. However there is no available inventory of PCBs on board ships that come up for demolition.

In a study[57], it was estimated that the typical merchant ship to be dismantled for scrap contains between 250 Kg – 800 Kg of PCBs, found principally in the paint, as well as in the machinery, on the vessel. In the South Asia Region, the lax monitoring of waste disposal as well as the non existent protection measures for the workers associated with the industry compound the problem of PCB wastes in dismantled ships.

The major centers for ship breaking activities in the region are given in Table 2.13.

Private entrepreneurs undertake the ship breaking activity and it is labour intensive. PCBs are mainly contained in paint chips and oil. Table 2.14 presents some figures, as an idea of the scale of the industry and the trend over a few years.

Out of the ships broken in India, more than 85% of the total LDT (Light Displacement Tonnes) broken in the period 1992-93 to 1998-99 was in Alang. During 1998-99, about 3.0 million LDT of ships were broken at Alang, taking its share to 90% of the all India figure.[58] During 2002-3, 300 junk ships with a total of 2.4 million LDT were demolished in Alang.[59] A study[60] detected PCBs in certain samples of surface water at Alang, ballast and bilge water at Alang, sediments at Alang

Table 2.13: The major centres for ship breaking activities in the region

No.	State/ Country	Locations
1	Andhra Pradesh	Vishakapatnam
2	Gujarat	Alang (largest in the world, breaking 50% of the world's fleet or over 300 ships each year)
3	Gujarat	Sachna
4	Karnataka	Tadri
5	Karnataka	Mangalore
6	Karnataka	Malpe
7	Kerela	Baypore
8	Kerela	Cochin
9	Kerela	Azhical
10	Maharashtra	Mumbai
11	Tamilnadu	Tuticorin
12	West Bengal	Kolkata
13	Pakistan	Gaddhani (Near Karachi)
14	Bangladesh	Chittagong

Source: Parivesh 2001, Toxic Legacies 1998

Table 2.14: Ships broken by principal countries in GRT

Country	1993	1994	1995	1996	1997	1998
Bangladesh	1.4	2.2	2.6	2.6	2.4	2.6
China	5.5	3.0	0.9	0.1	0.2	0.6
India	1.8	3.9	3.8	4.7	5.9	6.3
Pakistan	0.9	2.2	1.7	2.1	0.9	2.2
Worldwide	9.6	11.2	8.9	9.4	9.4	11.6

Source: Mecon 2001

Table 2.15: PCBs detected in various wastes

Sample	PCB Type				
	1260	1254	1242	1232	1221
Paint (mg/kg)	2.311	–	0.354	–	–
Cable insulation (mg/kg)	–	–	0.260	–	–
Hydraulic oil (mg/l)	–	–	–	–	0.502
Lubricatin oil (mg/l)	–	–	–	–	0.240

Source: Mecon 2001

and at Kolkata. However, most of the samples at these sites surveyed revealed PCB levels below detectable limits. PCBs were detected in paint wastes, cable insulation wastes, hydraulic oil wastes and lubricating oil wastes. These results are shown in backside Table 2.15.

2.4 Unintentional releases

A variety of industrial and nonindustrial processes (typically involving high temperatures) result in the release of POP chemicals (Dioxins, Furans, PCBs and HCB) into the environment. Among these POPs, dioxins and furans are of most concern because of their significant toxicity as also the fact that the factors leading to their production are less understood and their levels are presently not sufficiently monitored in the region.

In most cases, dioxins and furan releases are accompanied with PCBs and HCB releases as well. Considering that almost any combustion process involving chlorine leads to dioxins and furan release, the problem and its proportions are very much unstudied in the South Asia Region where combustion processes for agriculture, industry and for waste disposal are very commonplace and largely unregulated. Apart from the widespread prevalence of unchecked open air burning and vehicular emissions, various industries such as paper and pulp manufacture, metallurgical industries and certain chemical manufacturing industries contribute significant dioxin emissions.

This section considers these two issues of incineration and burning as well as industrial releases. There is not much awareness or information available on the issue of unintentional releases and most of the inferences are based on the basis of indicative information.

2.4.1 Incineration and burning

There is no quantitative data available on the releases of dioxins and furans in the South Asia Region. It is hoped that with the

Table 2.16: The projected availability (as on 1998) for availability of ships (in GRT)

Year	India	Pakistan	Bangladesh	Others	Total
2000	8,787,000	3,514,800	3,514,800	1,757,400	17,574,000
2001	11,435,500	4,574,200	4,574,200	2,287,100	22,871,000
2002	14,385,500	5,754,200	5,754,200	2,877,100	28,771,000
2003	17,142,000	6,856,800	6,856,800	3,428,400	34,284,000
2004	17,187,500	6,875,000	6,875,000	3,437,500	34,375,000
2005	13,930,500	5,572,200	5,572,200	2,786,100	27,861,000
2006	10,604,000	4,241,600	4,241,600	2,120,800	21,208,000
2007	8,883,500	3,553,400	3,553,400	1,776,700	17,767,000
2008	8,282,000	3,312,800	3,312,800	1,656,400	16,564,000
2009	8,730,500	3,492,200	3,492,200	1,746,100	17,461,000
2010	9,504,500	3,801,800	3,801,800	1,900,900	19,009,000
2011	9,696,500	3,878,600	3,878,600	1,939,300	19,393,000

Source: Mecon 2001

establishment of the various dioxin monitoring facilities, the establishment of some baseline data will be achieved. Various studies have been proposed, especially to collect dioxin data from the vicinity of incinerators and to evaluate their release potential for dioxins. In a recently finalized standard (yet to be notified) for emissions from hazardous waste incinerators, at 100% rated capacity, the system is to emit dioxins and furans less than 0.1 ng TEQ/ cubic meter corrected to 10% oxygen.[61]

In India, 50,000 – 60,000 MT/day of Municipal Solid Waste (MSW) is generated from 299 class-I cities with an overall per capita contribution of 0.4 kg/day.[62] The quantity of medical waste generated from hospitals in India is between 250 and 500 MT/ day. In addition, more than 4.4 million tones of hazardous wastes are generated from 13,000 hazardous waste generating units in the country, of which 4.1% are slated for incineration.[63] There are 120 incinerators operating for the management of industrial wastes in India. However no quantitative data is available to evaluate the dioxin generation potential. The MoEF has generated a list of hazardous waste disposal sites and incineration capabilities in various states in India. Maharashtra, Andhra Pradesh and Himachal Pradesh have the highest number of hazardous waste incinerators as indicated in table 2.17a.

Srishti, an environmental NGO working on bio-medical waste management has conducted a survey of incineration facilities in Delhi hospitals in 2002 and has come out with the results given in table 2.18a.

In a larger survey involving Chennai, Mumbai, Delhi and Kerala (conducted by Srishti, Citizen Consumer and Civic Action Group, Mumbai Med Waste Action Group and Thanal conducted in 2000)[64] Srishti surveyed 27 hospitals in Delhi using incinerators or sending it to a shared facility. The number of incinerators surveyed was 18, out of which 11 were operating at the time of visit by the Srishti team, out of these only 1 was operating at the mentioned temperatures. The reduction in the number of incinerators from 2000 to 2002 is explained by the shutting down of incinerators owing to many hospitals opting for centralised incineration facilities. All the incinerators in Mumbai, Chennai and Kerala were burning mixed waste. 80% of the incinerators surveyed in Mumbai and all the incinerators in Chennai (CAG) and Kerala (Thanal) were not functioning according to the standards laid down in the rules. All the incinerators in Kerala were single chambered. Tables 2.19a a,b,c and d provide information on the results of the survey.

Apart from waste incinerators, the region also has the problem of open air unregulated burning. This assumes significance in the burning of PVC products. In many cases, discarded electrical wires are burnt to retrieve the copper wires.[65] Burning of old tyres and plastic refuse for warmth during winter is also very common in winters in colder regions.[66] Due to religious reasons, the practice of cremating the dead is sacrosant in India. All these are unfortunately known to be sources of dioxins and furans and are expected to pose as possible dioxin and furan pollutants in the region.

2.4.2 Industrial sources

Certain industrial processes have been identified as being significant contributors to dioxin and furan levels in the environment. However, owing to the lack of monitoring facilities and also the general lack of awareness of the problem, there is no confirmed information available on known and documented sources of industrial emissions of dioxins and furans.

It is not possible to directly use the priority list of other countries or regions due to the variation in the concern areas identified for each global region arising from the specific characteristics of each region.[67] However, the list of concern sectors listed in the Stockholm Convention does provide a starting point towards understanding the possible point sources of unintentional POPs in the region. It appears that areas of maximum concern in the South Asia Region would include waste incineration, fuel burning, power generation, metallurgical processes, the paper and pulp industry and the cement industry. Out of these, combustion processes, power generation and metallurgical processes lead to releases into the air while the paper and pulp industry, chemical processes and certain waste water discharges lead to water releases. Land contamination might occur primarily through use of dioxin contaminated pesticides and the use of wood preservatives.

It is not possible to assign individual priorities to each one of these sectors without further investigation involving the generation of monitoring data. The UNEP-GEF regional PTS survey has suggested that the paper and pulp industry and the sintering processes in the iron and steel industry are potential sources of PCDD/Fs in India. Few of the important sectors are examined from the point of their construing possible significant sources of dioxins and furans in India. Considering that a large fraction of the industrial activity in the region is situated in India, it is expected that the information would be relevant to the rest of the region as well.

Combustion processes, power generation and metallurgical processes lead to releases of dioxins into the air while the paper and pulp industry, chemical processes and certain waste water discharges lead to water releases. Land contamination might occur primarily through use of dioxin contaminated pesticides

2.4.2.A Paper and pulp industry

The paper and pulp industry in India represents a major possible source of unregulated dioxins and furans (apart from PCBs and HCB) in the region's environment. The use of elemental chlorine contributes 70-80% of the total Adsorbable Organic Halides (AOX). Unlike developed countries, which have gradually phased out chlorine use, Indian paper mills have continued with the use of elemental chlorine for production of bleached grades of papers due to economic reasons. Large mills use chlorine in the range of 35-60 kg/t of pulp. Small agro based mills, in the absence of chemical recovery produce pulp of high lignin content and a major part of the lignin is removed in subsequent bleaching processes.[68] An estimate indicates that approximately 2.5 million tones of chemical pulp is produced in India. 60% of this is high brightness bleached pulp mostly bleached by chlorine and chlorine based chemicals. The nature and extent of the formation of chlorophenolic compounds (which include dioxins and furans) is determined primarily by the residual lignin content in the pulp, the type of bleaching chemicals employed and the age of the facility.

The major source of dioxins has been found to be the chlorination stage, and their formation is mainly dependent on:

- Kappa number of brown stock (which is the measure of thelignin content in the pulp)
- Active chlorine multiple present
- Mixing conditions during chlorination
- Carryover of COD along with washed unbleached pulp and
- Wash water quality

Dioxins and furans are formed when unchlorinated dibenzodioxin and dibenzofuran present in unbleached pulp are chlorinated with elemental chlorine during the bleaching stage. They constitute less that 0.1% of the total Adsorbable Organic Halides (AOX). AOX is the most commonly performed and accepted test for halogens in paper mill effluents. Presently AOX monitoring capabilities exists in the Central Pulp and Paper Research Institute (CPPRI), CPCB, Thapar Institute, Tamil Nadu Papers Ltd. (TNPL), APPM and the Century Mills.[69] Measures for the reduction/ control of AOX include adoption of new technologies like oxygen delignification and chlorine dioxide substitution as well as the upgradation of existing technologies by adopting controlled pulp mill operation, improved pulp washing, oxidation alkali extraction bleaching and improved chemical mixing. Other measures like effective ETP functioning, recycling and regular environmental audits are essential to ensure compliance to the norms. It is expected that Elemental Chlorine Free (ECF) processes can reduce the emissions of organic halide to a fifth.

Table 2.20: Effluent discharge limits (AOX) for chlorinated organic compounds in various countries

Country/Agency	Limits in Kg/T
World Bank	0.4
European Union	0.25
Germany	0.35
Austria	0.50
France	1.0
Sweden and Finland	<1.5*
Japan	<1.5#
India	2.0**

* Current level 0.2 Kg/t
\# Current level 0.8 Kg/t
** As TOCL (Total Organic Chlorine)

Source: Central Pulp and Paper Research Institute, Interaction Meet Environmental Impact of Toxic Substances Released in Pulp and Paper Industry, 29th October, 2002

In India, in many cases, raw materials are not fixed, making it difficult to standardize the production process and make it efficient. At present, even in the large modern mills, elemental chlorine continues to be used. The problem is magnified in smaller mills, which use more chlorine per tonne of paper produced. Effluent discharge limits (AOX) for chlorinated organic compounds in various countries are compared in Table 2.20. It is clear that in terms of the standards, India allows for comparatively higher emissions.

In terms of the actual emissions of AOX due to the Indian Paper mills and their comparison with international standards, the information in Tables 2.21a and 2.22a indicates that smaller agro based mills manufacturing writing and printing paper produce emissions far in excess of allowable limits. Their poor technical capabilities such as the lack of oxygen delignification and imporved bleaching processes lead to higher emissions of organic halides.

The age of the mill, production volume and raw materials used (agro material, forest products or wood) play an important role in the amount of dioxins produced.[70] Since dioxin production is due to the use of chlorine for bleaching, the problem is limited to factories that produce bleached paper. Table 2.23 a lists the main plants (capacity greater than 30000 TPA) producing cultural paper (which requires bleaching). Most of the larger mills are concentrated in South India followed by Western India.

2.4.2.B Metallurgical industry – iron ore sintering,

steel production

Among metallurgical processes, the iron ore sintering process and steel manufacturing are high in terms of dioxin and furan releases in most countries' dioxin inventories. It is expected that with a long history of iron and steel production in India (the tenth largest steel producer in the World), the Iron and Steel sector will be a significant contributor to dioxin and furan releases in the South Asia Region.

Halogenated compounds also may result in the formation of dioxins and furans if they enter sinter plants in the feed materials (coke breeze, salt content in the ore) and in recylcled material (such as PVC, plastics, rubber, oil, paints and pigments). The sinter plant, plays a central role in an integrated iron and steel plant for making use of production residues which would have to be disposed otherwise. Slags from steel production, filter dusts of diverse flue gas cleaning systems and various iron containing material from residual treatment are recycled in the sinter plant. Some residue materials like roll mill scale may be contaminated with organic compounds (oils) that could act as precursors for dioxin and furan formation.

In India, till the period of liberalization, most of steel plants were aging and using outdated and inefficient technologies. In the post liberalization scenario, steel plants based on world class capacity and state of the art technologies were commissioned while the inefficient and non competitive mills continue to close down[71].

Details of iron and steel production as possible sources of dioxins and furans including major manufacturers, combustion and heat generation etc. are listed in table 2.24a. All the plants shown have sinter plants associated.

2.4.2.C Other sources – power sector, cement, chemical

Other sectors identified for the unintentional releases of dioxins and furans in industrial processes include the power sector, certain chemical industries and cement manufacturing.

Apart from this list, combustion processes including domestic uses, wood and biomass burning for heating and vehicular emissions (especially from those using leaded petroleum) are areas of significant dioxin and furan releases. Due to the nonpoint nature of these latter mentioned releases as also the lack of any information on these sources, it is not possible to document locations or provide estimates of releases.

Thermal power

Power plants represent a type of combustion activity involving the continuous usage of large volumes of fuel burning. In India, a large portion of the thermal power generated uses coal as a primary fuel. In most cases, the coal is of such quality that it contains many impurities including salts. This could lead to significant dioxin and furan releases during their operation. It is however required to monitor thermal power stations for possible releases of dioxins and furans. At present there is very little awareness of the possibility of POPs due to such facilities. Table 2.25a gives the statewise distribution of thermal power generated with also the type of fuel used indicated. Maharashtra, Gujarat, West Bengal and Tamil Nadu are the leading producers of thermally generated electricity. Coal based power generation is most prevalent among thermal power plants in India.

Cement

India is the world's second largest cement producer after China. The industry is characterized by a high degree of fragmentation that has created intense competitive pressure on price. This situation is reflected on the minimal nature of environmental measures that companies claim they can afford. Spread across the length and breadth of the country, there are 120 large plants belonging to 56 companies with an installed capacity of around 135mn tons as on March 2002.[72]

Cement companies in the region typically use coal as a fuel in cement kilns. It is expected that similar to power plants, the burning of inferior quality coal which contains halogenated compounds as impurities will lead to significant dioxin and furan releases in the region due to the functioning of a large number of cement kilns. Most of the cement manufacturing is concentrated in a few large corporations. 33% of the factories are in the south of India with Andhra Pradesh accounting for 15% of the total capacity of the country. Table 2.26a lists the state wise distribution of cement manufacturing capacity.

Chemical industries

In the chemical manufacturing sector, it is important to consider most specifically those sectors, which might utilize chlorine as part of the manufacturing process. 2,4,5-Trichlorophenol (TCP), Pentachlorophenol (PCP), Chloranil, chlorinated

Cement companies in the region typically use coal as a fuel in cement kilns. It is expected that similar to power plants, the burning of inferior quality coal which contains halogenated compounds as impurities will lead to significant dioxin and furan releases in the region

aromatics and vinyl chloride manufacture have been identified as industries which might release dioxins and furans.[73] Other sectors include pesticide manufacture, pentachloronitrobenzene (used as a herbicide), chlorinated paraffin wax (used in plastics), hexachloro cyclopentadiene (used in pesticide manufacture - endosulfan), vinyl sulphone (inputs for reactive and solvent dyes of textiles) and dinitro cresol (byproduct in the nitration of toluene) for dioxin releases and pthalocyamine pigments (used as solvents) for the release of PCBs.[74]

With respect to chlorophenols, ortho, para and dichlorophenols are produced in small and medium scale industries in Maharashtra and Gujarat. Pentachlorophenol is produced by Durgapur Chemicals Ltd, a West Bengal Govt. undertaking near Kolkata. Vinyl sulfone is produced in a number of small and medium scale units in Maharashtra and Gujarat. Chlorinated paraffin wax is produced by a number of small scale units. Dinitro cresol is a byproduct released during the nitration of toluene producing mononitrotoluene isomers, dinitrotoluene and TNT. Mononitrotoluene is a basic raw material for drugs, dyes and pesticides. Mononitrotoluene is produced by Hindustan Organic Chemicals Ltd., Rasayani (Maharashtra). Dinitrotoluenes are produced by both the Ordinance Factory, Kirkee at Pune and by Gujarat Narmada Chemicals Ltd at Bharuch, Gujarat. Pthalocyamine pigments are produced by a number of small scale, medium and large scale industries. Of late, some units are making efforts to switch over to alternate solvents to prevent the formation and release of PCBs.

It is possible that during the production of drugs, dyes and pesticides, POPs may be released into wastewater. A confirmation of this will involve a detailed study as part of a long term monitoring project. Apart from these sources mentioned, waste oil refineries are potential sources of hazardous chemicals. A number of oil refining units based on imported waste oil have come up in India during the last decade.[75]

Table 2.27: List of some pesticide manufacturing plants based on organochlorines

Name	Product	Location
Excel India Ltd. (Gujarat)	Endosulfan	Bhavnagar
HIL Delhi (closed)	DDT, BHC	Delhi
HIL Udyogam-andalam	DDT, Endosulfan	Alwaye (Kerala)
HIL Rasayani	DDT, Malathion	Rasayani (Maharashtra)
(closed)	DDT	Chittagong (Bangladesh)
Kanoria Chem-icals and Indust-ries Ltd	Lindane	Renukoot (UP)
Indian Expo Ltd ACCI	Paraquat	–

Source: Pesticides Industry in India –IIM Ahmedabad, Wastewater Management in Pesticides Industry: CPCB

Given the large number of unregulated industries as well as the open, uncontrolled burning of garbage (including chlorinated plastics and PVCs), it is extremely difficult to identify and inventorise all the possible unintended releases of dioxins and furans in the region. The information mentioned in this section is meant to serve as an indication of possible dioxin release sources. Further monitoring and confirmation is required to confirm and inventorise the sources.

Conclusion

The status of POPs in the region reveals that in terms of statutory regulations, there have been stringent guidelines laid down with respect to the usage of POPs pesticides and PCBs.

In terms of dioxins and furans, the recent guidelines for incinerator emissions by the CPCB lay down some standards for stack emissions. These regulations however would serve no purpose without a dedicated, well coordinated and reliable monitoring system.

In terms of the sources of POPs in the region, the use of DDT for malaria control seems to be the main area of concern in terms of intentional usage of POPs. There have also been indications of illegal use in agriculture. Import and export data of pesticides in India indicate commercial activity in certain POPs subsequent to their dates of banning.

Stockpile data in the region appears to be very inadequate considering the large volumes of usage in the past.

Unintentional release of POPs in the region is an area where future concern needs to be focused. With a lack of regulation and awareness combined with that of of developed monitoring facilities, the problem of unintentional releases of dioxins and furans into the South Asian environment has only just beun to be understood.

This section looked at certain possible areas of concern highlighting the extent and spread of the industries identified. It can be said that the issue of POPs in the region is very much a present problem with many contentious areas that need to be understood better to comprehend the impact of these hazardous chemicals in the environment.

References

1 Indian Ocean 2002

2 Singh 2000, Needs Report 2002

3 Regional PTS assessment. Communication from Dr Hayat

4 Regional PTS assessment. Communication from Dr Hayat

5 Source: Regional PTS assessment. Communication from Dr Hayat

6 The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.

This convention requires that importing countries give 'prior informed consent' to imports of "pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons".

7 Interaction with V. Kumar, Chief Engineer, Central Electricity Authority

8 Interaction with Dr A. Munusamy, Scientist, RRL Trivandrum

9 Emission Standards for Hazardous Waste Incinerator, 2002, approved by CPCB in its 124 th Meeting on 20.01.03

10 Interaction with Dr J. Behari, ITRC and Dr A Munusamy, RRL Trivandrum

11 Interaction with Dr A Munusamy

12 Interaction with Dr A Munusamy

13 Interaction with Dr VK Bhatnagar, NIOH, Ahmedabad

14 Interaction with Dr N Thacker, NEERI, Nagpur

15 Interaction with Dr PK Seth, Director, ITRC

16 Interaction with Dr R.L Kalra, Residue analysis expert

17 Interaction with Dr R.L Kalra, Residue analysis expert

18 Interaction with Dr M.K.J Siddiqui, Head, Analytical Toxicology, ITRC

19 Labunska 1999

20 This information on imports and exports is presented considering the authority of the source and the fact that it has been presented in the UNEP-GEF PTS regional priority setting meeting. Other sources (Pesticide Association of India - PAI) have indicated figures that are different from this information (eg. Chlordane export for 95-96 in the PAI data is 21 MT whereas in the data presented by Dr Chandurkar, it is 9 MT.)

21 Interaction with Dr K. Bentley

22 www.greenpeace.org

23 Palikhe 2001

24 Palikhe 2001

25 Palikhe 2001

26 Hayat 2000

27 Hayat 2000

28 Interaction with M. Sengupta, Advisor Moef and D.D Basu Senior Scientist of CPCB

29 http://164.100.194.13/hsmdweb/inter.htm

30 Mehrotra 1994

31 Agarwal 2000

32 Profile of MRC (1997-2002), Malaria Research Center.

33 Trojan Horses 2000

34 Malaria and its control in India. Volume 1. Directorate of NMEP, 1986

35 Interaction with Dr V P Sharma, Ex Director, MRC

36 Report on Epidemology and Control of Malaria in India 1996. Published by the NMEP, DGHS, Ministry of Health and Family Welfare

37 Report on Epidemology and Control of Malaria in India 1996.

38 Interaction with Dr Tapan Chakrabarty, NEERI

39 Agnihotri 2000

40 Publication of the Pesticide Association of Bangladesh and communicated by Dr Hayat.

41 Consumers Forum 1993

42 CERC 1999

43 Interaction with Dr KP Singh, Tomar 1998

44 Trojan Horses 2000

45 Interaction with Dr B Sengupta, Adviser, MoEF

46 Interaction with Dr Arur, Chemicals Expert

47 S. Knight 1996

48 Thacker 2002

49 Parivesh 2001

50 Interaction with Dr M Anbu, Scientist, Environmental Technology Division, RRL, Trivandrum

51 8th International Conference on pursuit and quest for excellence in transformer technology on global horizon organized by Indian Transformer Manufacturers Association (ITMA) – May 1st -2nd, 2003

52 Interaction with Dr M Anbu, Scientist, Environmental Technology Division, RRL, Trivandrum

53 S. Knight 1996

54 Interaction with Mr Vijoy Kumar, CEA

55 Interaction with Mr V. Kumar, CEA

56 Mecon 2001

57 Needs Report 2002

58 Mecon 2001

59 The Economic Times, 5 May 2003

60 Mecon 2001

61 Communication from Dr D B Boralkar, CPCB

62 Indian Ocean 2002

63 Indian Ocean 2002

64 Srishti, Citizen Consumer and Civic Action Group, Mumbai Med Waste Action Group and Thanal are NGOs working on medical waste management in India

65 Interaction with Dr M Sengupta,, Adviser, MoEf

66 Interaction with Dr M Sengupta,, Adviser, MoEf

67 UNEP – Dioxin and Furan Inventories – National and Regional Emissions of PCDD/ PCDF, May 1999

68 Interaction with Dr S Pawar, CPPRI

69 Interaction with Dr S Pawar, CPPRI

70 Interaction with Dr S Pawar, CPPRI

71 Ministry of Steel, Annual Report – 2001-02

72 www.indiainfoline.com

73 Needs Report 2002

74 Communication from Dr P V Arur, Chemical processes expert.

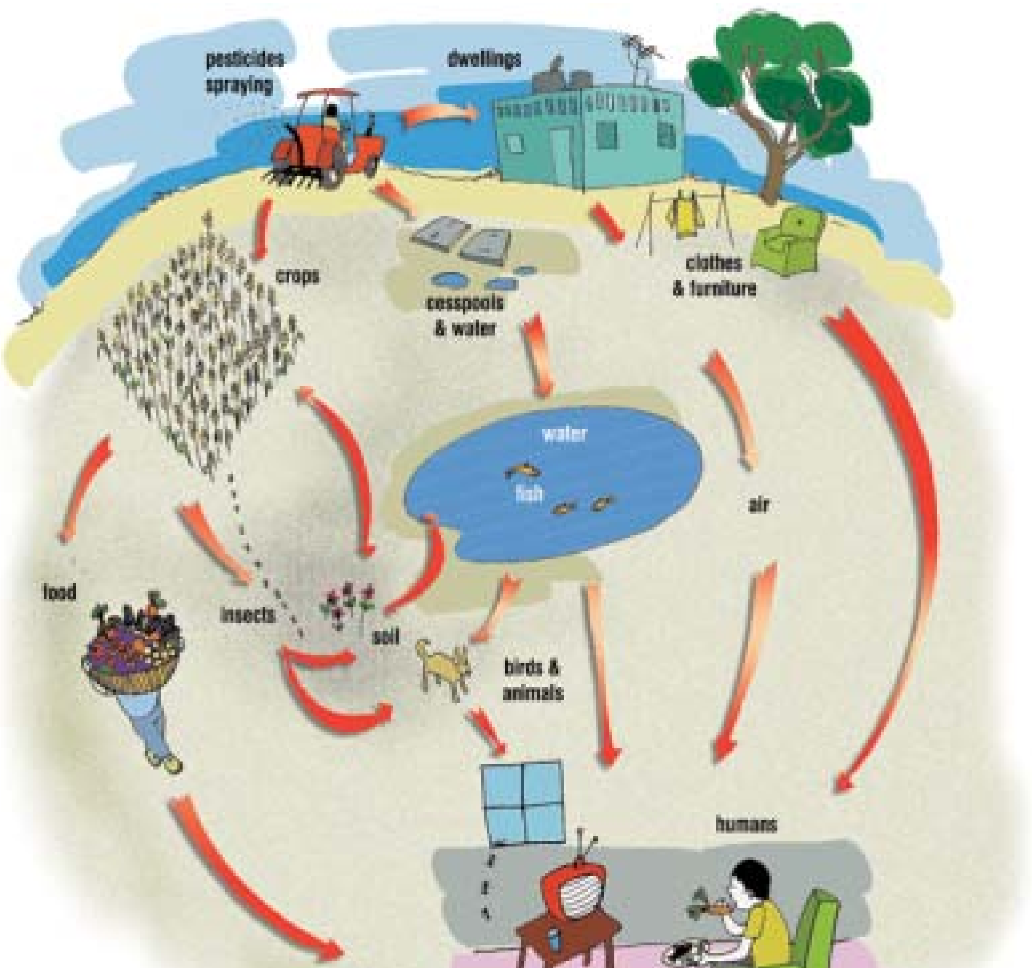
75 Interaction with Dr P.V Arur

3.0 Pathways and contamination

POPs pervade the environment through a variety of media. Pesticides, though intended for the target pest species, end up in the food chain, water and air and into non-target species and ecological systems. Unintentional and industrial POPs are often released in an unregulated manner and are assimilated into environmental systems owing to their properties of persistence, lipophilicity and volatility. Understanding the nature of these exposure pathways is crucial to determine and evaluate POPs' impact on the environment, human habitats and the economy.

Pesticide POPs exposure to humans can be intentional (suicides and homicides) and unintentional (accidental, occupational and non occupational exposure from water, air and food). Amongst unintentional exposures in the environment are the direct toxic effects during application to non target groups like pollinators, predators, wildlife etc as well as post application hazards due to pesticide residues in food, air and water. Pesticide POPs can get into the ecosystem at various junctures such as production, transport, storage and application. In terms of environmental management, there are many stages in the product life cycle of pesticide POPs where care needs to be taken to prevent the contamination of the environment.

Flow chart 3.1a describes the environmental management of pesticides during manufacture and application. Flow Chart



Flow Chart 3.2 Pathways of pesticides in the environment after release

3.2 describes the pathways of pesticides in the environment.

The risks due to POPs are magnified in developing countries, where industry is lax about environmental controls, regulation is weak and thre are inadequate mechanisms to inform users train them or provide them with any type of appropriate protective devices. Also standards are often too weak or inappropriate for deal with the problem, and testing facilcites poor.

The residue levels in human tissues are measures of exposure, occupational or incidental. In comparison to data from other parts of the globe, very high levels of organochlorine insecticides have been reported in human blood, fat and milk samples in India[1].

3.1 Transport mechanisms

Once in the environment, POPs are transported within the region mainly through natural media like fresh water systems (rivers and streams), atmospheric currents (usually adsorbed to suspended sediment) and marine currents.

Fresh water

In India, long range transport and bioaccumulation of POPs occurs in flowing water bodies. Streams receive pesticide runoffs from agricultural fields and industrial waste. Considering the high human activity along flowing water bodies in the region, rivers and streams assume significance in terms of transport and exposure of POPs. The process of POPs transport by streams involves an influx into the stream system by runoffs, precipitation and drains. Owing to their hydrophobic nature, POPs are transported mainly by adsorption with sediment and organic matter in the streams with certain amount of POPs remaining in the water.

Contamination of POPs in the fresh water systems enter the food chain through consumption of fish raised in contaminated water bodies and to a certain extent by the direct consumption or secondary consumption of contaminated water. Flow chart 3.3a illustrates some of the possible pathways of POPs in streams.

Streams also serve as transport conduits for a variety of industrial and municipal wastes, which might contain unintentionally released POPs like PCBs, HCB, dioxins and furans.

There has been few identified documentation of such POPs in streams. Rivers like the Gomti, Yamuna and Ganga have had programmatic monitoring for certain POPs pesticides carried out over several years. The Yamuna is the only identified river with an ongoing monitoring program for certain POPs compounds. It is amongst the most polluted rivers in the region, receiving municipal, industrial and agricultural wastes and runoffs. Other monitoring reports consist of mostly one time analysis of water for pesticide contamination. There have also been a few studies on river and stream sediments. Details of the surveys are mentioned in section 3.2 dealing with environmental contamination.

Air

Although not well documented in the region, transport by air could play an important role in the long range transport of POPs in India. POPs represent a class of semi volatile compounds and the role of atmospheric transport is important for their dispersal within a region. Air transport can also occur through precipitation and the movement of air dust particles with adsorbed POPs. Considering the high temperatures and localized, intense air circulations in the South Asia Region, the conditions are ideal for transport of POPs through the atmospheric pathway. Almost no work has been done in the region on understanding the significance and contribution of atmospheric pathways[2]. The Indian Toxicological Research Institute (ITRC) is developing a manual to enable the modeling of POPs through the atmospheric route.

Though most of the pesticide POPs have been banned for manufacture or use in the South Asia Region, their persistence in soil/sediments may result in their re- suspension and re-mobilization back to the atmosphere under favourable high temperature conditions through volatilization and to the surface waters through runoffs during monsoon /flood periods. Through this mechanism the POPs pesticides are again made available for atmosphere/hydrosphere transport enabling depo-

Table 3.1: Results of monitoring air samples in the region

Location(year)	Sampletype	DDT level Mean (range)	Other POPs level Mean (range)	References
India (NA)	–	micrograms/m3 (0.076–528)	Aldrin (1.0–240)	Ramesh 1989
Delhi (1985)	Airborne dust	ng/mg 3.32 (1.3–7.14)		Kaushik 1991
		ng/m2/day 10.38 (4.06–22.31)	–	
Ahmedabad (NA)	–	ng/m3 7.21–51.19	–	Bhatnagar 2001

sition in the colder regions through condensation.[3]

The monitoring situation of POPs in the atmosphere over the South Asia Region is in contrast with the situation in Europe where air releases of dioxins and furans are much better documented through several monitoring programs and modeling efforts. The monitoring reports identified are presented in section 4.2 dealing with environmental contamination.

Marine

Marine pollution by POPs assumes significance owing to the importance of sea food as well as the threat to the delicate ecosystems off shore. Most inflows into the marine environment occur due to the outflows of rivers into the Arabian Sea and the Bay of Bengal. This discharge is due to the high sediment loads in Indian rivers (especially the Ganga and Brahmaputra) and the possible presence of adsorbed POPs in them.

POPs fluxes into the sea also occur due to direct discharges into the sea, ship traffic, ship scrapping and through the atmospheric route. There is also the potential for a minor transfer (though significant in terms of human dietary exposure) of POPs through migratory fishes from sources outside the region. There have been few studies undertaken by the NIO[4] to understand PCB, DDT and Aldrin levels in ocean sediments but apparently none interlinking the pathway potential of rivers and ocean currents or the phenomenon of transport along the coastline due to offshore currents.

3.2 Environmental contamination

Residues of POPs have been measured in various environmental media like water, soil and air. Biological sampling might not always be feasible, but water, air and soil samples give a ready method to estimate the base levels of POPs in the environment. In certain cases as in the Yamuna, Ganga and Gomti, there have been programs, which regularly monitor levels in water. Environmental media, if properly monitored and tracked can also provide an idea of the kind and levels of transportation of POPs within the region as well as from outside it through long distance pathways.

3.2.1 Air

The few samples of air sampling in India do not allow for the identification of any specific characteristic in the air contamination of the region. The NIO study suggests the possibility of long range transport within the region by the atmospheric pathway. The few studies indicate the presence of DDT and Aldrin in the air over the region. However to understand the regional nature of the air contamination by POPs, a coordinated study over regular time intervals is required.

- Monitoring of airborne dust in Delhi from May-July 1985[5] revealed residues of DDT. This pollution was attributed to the transport of these residues in the atmosphere from places around Delhi where these pesticides are constantly being used in mosquito abatement. Another possible source indicated was the DDT factory located within the Delhi city limits.

- Seasonal variations of airborne levels of organonochlorine insecticides were also studied in Porto Novo, Tamilnadu[6]. It was observed that the concentrations of DDT in air at Porto Novo on the south east coast of India were higher during the period of Aug-Jan than the rest of the year.

- In National Institute of Oceanography (NIO), during 1996, air sampling for DDT was performed on land and at sea as part of an internal NIO project to determine the correlation of DDT levels in the air and in marine animals to understand the significance of atmospheric pathways[7]. The results also indicated a significant correlation between the levels of DDT measured in the air and the levels of DDT measured in offshore biota suggesting the air pathway as being significant.

- In air samplings for DDT levels in Ahmedabad[8], residue levels were reported to be higher in summer than winter and lowest in the monsoon season[9].

3.2.2 Water

On the basis of the literature survey and interactions, it was found that water samples like rainwater and other forms of precipitation have not been sufficiently studied in the region. In general, fresh water sources and agricultural and industrial effluents need to be monitored on a continuous basis to understand the extent of the releases of POPs pollutants into the environment. A study also shows that there is a significant increase in contamination of water sources due to anti malaria DDT spraying. This suggests that the effects of the DDT spraying of the anti malaria program should also be studied in

The monitoring situation of POPs in the atmosphere over the South Asia Region is in contrast with the situation in Europe where air releases of dioxins and furans are much better documented through several monitoring programs and modeling efforts

better detail.

Surface water

A majority of the studies identified were concentrated in the northern parts of India. The studies indicate a connection between POPs pesticide presence and the monsoon, indicating their usage for agriculture. The high levels of DDT at Nainital and Khurpatal lakes suggest the illegal use of DDT for agriculture, especially as the high concentrations coincide with the monsoon. This phenomenom of possible DDT usage for agriculture during the monsoon has been observed on the Hindon

Table 3.2: Results of monitoring surface water samples in the region

Location (year)	Sample type	DDT level ppb (Mean (range))	Other POPs level ppb Mean (range)	Reference
Delhi (1980–82)	Rain water	(0.22–108)		Agarwal 1987
Delhi (NA)	Rain water		1.92 (0–5.97)HCB	Nair 1989
Faridabad (NA)	Rain water		0.96 (0.33–1.59)HCB	Nair 1989
Ganga (1986–91)	River	(0–5.8082)		Singh 1992
Andhra Pradesh (1993)	Agri, River, Tank, Canal	(0–251)	(0–10.96)Aldrin (0–17.43) Dieldrin	Reddy 1997
Nainital (NA)	Lakes			
March		(2.13–25.85)		Dua 1998a
July		(5.85–37.17)		
November		(3.43–15.08)		
Nainital (NA)	Tap water	(2.75–15.82)		Dua 1998 a
Gomti (1993-99)	River	(0–7.81)	(0–0.059) Aldrin	Singh 1996, Singh
Yamuna (1995-2001)	River	(0–1.44)	(0–0.129) Dieldrin (0–0.237) Aldrin	CPCB 2000
Yamuna (1995-99)	Drain	(0–4.0)	(0–0.383) Dieldrin (0–1.39) Aldrin	CPCB 2000
Yamuna, Delhi (1999)	Urban, River	(0.190–1.92) PCB ng/l		Parivesh 2001
Yamuna, Delhi (1999)	Urban, Drain	(0.288–6.545) PCB ng/l		Parivesh 2001
Kumaon (1999)	Stream	(0–0.07)		Sarkar 2002
Hindon post monsoon (NA)	River	(0.46–11.46)		Ali 1998-99
Yamuna, Delhi (NA)	Urban, River	0.12	0.000008 Chlordane 0.041 PCB	Anbu 2002
Cooum, Chennai (NA)	Urban, River	0.0016	0.001 Chlordane 0.0015 PCB	Anbu 2002
Ulsoor, Bangalore (NA)	Urban, Lake	0.0031	0.00054 Chlordane 0.048 PCB	Anbu 2002
Mandori, Goa (NA)	Suburban, River	0.0011	0.000035 Chlordane 0.0026 PCB	Anbu 2002
Hooghly, Kolkata (NA)	Urban, River	0.0015	0.00018 Chlordane 0.00045 PCB	Anbu 2002
Ganges, Varanasi (NA)	Urban, River	0.135		Anbu 2002
Ganges, Farukkabad (NA)	Agri, River	0.832		Anbu 2002
Trivandrum (NA)	Well		Aldrin 2 Dieldrin 2	Communication from Dr CSP Iyer
Nagpur (NA)	Canal, Lakes,	(0–1.65) Ponds		Communication from Dt N Thacker
Kolleru, Andhra Pradesh (NA)	Lake	(0–0.198)	(0 – 0.086) Dieldrin	Rao 2000
Gujarat (NA)	Agriculture + Malaria control; Agriculture	0.00756 0.00427		Kashyap 2002

River as well. The excessively high levels monitored at Mehboobnagar for DDT and Krishna District for Aldrin suggest a localized problem of excessive release into the environment in Andhra Pradesh. The high levels recorded in the waterbodies of the Bharatpur bird sanctuary highlight the potential dangers to fragile ecosystems due to POPs pollution. The river monitoring studies on the Ganga, Yamuna and Gomti do not indicate excessively high DDT or aldrin values except in the cases when the drinking water standards of the WHO have been exceeded pesticides could be considered a health hazard.

- The Yamuna river has been monitored for pesticides by the CPCB at 15 stations along the river from 1995 onwards[10]. Overall, the levels of these POPs pesticides show lower levels as compared to measurements in 1995. Nizamuddin, Agra canal and Mathura water samples show the highest levels of DDT during recent measurements. These micropollutants have a tendency to be adsorbed on the surface of organic and inorganic particles and settle down in the river or drain bed. This may be the reason for their reduced concentration in water[11]. Details of the measurements are presented in Table 3.3a.

- During the study of the Yamuna River, samples of water from 13 major drains entering the river were also analysed for Aldrin, Dieldrin and DDT contamination between 1995 and 1999. Najafgarh Drain has been identified as the largest contributor of pesticides with other drains showing significant levels of DDT[12]. In general, the levels measured in the drains and river water of the Yamuna at certain stations are comparable and the high values recorded at Nizamuddin Bridge seem reflective of the fact that it lies downstream from many polluting drains. Details of the observations are presented in Table 3.4a.

- PCB levels in water have been assessed at five locations of Delhi stretch of River Yamuna and five major drains joining River Yamuna during May, 1999[13]. The results are given in Table 3.5a. The results indicate that after the mixing of Civil Mill drain and the Power House drain with the river Yamuna, the PCBs level in the water increased from 0.190 ng/l (at old Yamuna bridge) to 1.926 ng/l (Okhla) indicating that the PCBs are contributed by the drains along with the wastewater. The level of PCBs again decreased to 0.501 ng/l downstream from Okhla. This may be due to the dilution of PCBs or due to removal by bioaccumulation. Considering US EPA standards of 14.0 ng/l for freshwater, the analysis indicates that the PCB levels in water at all the locations of the river Yamuna as well as its drains are well within the limit[14].

- The Hindon river is the most polluted river in western Uttar Pradesh. A large part of its basin experiences pesticide usage and it flows into the Yamuna at Delhi, which results in an increase of the Yamuna pollution load. 34 pre-monsoon and post-monsoon samples were collected from Hindon water, sediments and its tributaries and effluent drains [15]. Concentrations of DDT were higher compared to the maximum permissible limits of the WHO drinking water standards. Agriculture is the main source of pesticides in the Hindon river. Besides this, the presence of pesticides in the tributaries and effluent drains indicate point source of pollution in the Hindon river. No DDT was detected in pre monsoon samples and the increase in pesticide levels in the river post monsoon is reflective of the higher amounts of pesticides used and subsequently released during the monsoon. The results are as follows are given in Table 3.6a.

- In a monitoring program of DDT residues in the Ganga and its tributaries during 1986-1991 as part of the Ganga Action Plan[16], the levels measured in 1986 were higher than those measured during subsequent years. It is not possible to make out a trend in the data. Higher levels have been recorded in 1990-91 as compared with 1989-90. Higher concentrations were recorded in Kannauj, Kanpur and Khurji. During 1988-89, in Kannauj, the water samples show levels of DDT higher than the acceptable standards of drinking water by the WHO. Details of the measured levels are provided in Table 3.7a.

- The ITRC had monitored the Gomti river and its catchment for the presence of DDT and aldrin between 1994 to 1999[17]. The levels show a significant reduction since high levels in December 1993. During 1993-95, DDT was detected in more than 70% of the samples with DDT exceeding the WHO guideline value in many cases with the number of samples violating the guideline value increasing towards 1998[18]. Sultanpur and the downstream of Mohan Meakin Limited had recorded the highest concentrations in 1993. Details of the findings are provided in Table 3.8a

- Water from 5 lakes of Nainital district was monitored for DDT presence[19]. No insecticide was used in the vicinity of these lakes for vector control. DDT contamination was found to be maximum in July and minimum in March. The high post monsoon levels may be due to the magnitude of agriculture areas near the lake command area. It was mentioned

Studies indicate a connection between POPs pesticide presence and the monsoon, indicating their usage for agriculture. The high levels of DDT at Nainital and Khurpatal lakes suggest the illegal use of DDT for agriculture, especially as the high concentrations coincide with the monsoon

in the study that small agricultural farms where the illegal use of DDT is quite common surround Nainital and Khurpatal lakes. Results are given in Table 3.12a.

- In a systematic survey[20] carried out in 9 rivers and streams of the Kumaon Himalayas, levels of DDT in water and fish samples were examined. The concentration of total DDT was much higher in snow fed rather than rain fed rivers both for water samples and fish samples. Comparing with the EPA standards for freshwater aquatic life, all the fish and water samples exceed the standards. The results are represented in Table 3.16a.

- In another study[21], rainwater samples were regularly collected from 3 sites: Netaji Nagar, Moti Nagarand Town Hall within the Delhi city area from July 1980 to June 1982. Residues of DDT were found to be generally higher during October to December. This seems to be due to its extensive use in mosquito control during the monsoon season. The first few showers contained a higher concentration of DDT and the subsequent ones had less. This indicates that rain brings down the insecticides to the ground. Residues of DDT were high in Moti Nagar which is situated near a DDT factory. The results are summarized in Table 3.26a.

- A nation wise survey of rainwater and agricultural water in 2001 by the AICRP are summarized in Table 3.27a.

- 2 areas were identified in Gujarat on the basis of pesticide usage in agriculture and public health[22]. In area 1, pesticide were used for both agriculture and public health, while in area 2, only agricultural usage was prevalent. Water was collected from 20 sites in each area and tested for DDT. The results represented in Table 3.28a indicates that there is much higher DDT detected in sites where it continues to be used for vector control.

The studies identified for fresh water contamination by POPs are randomly distributed and do not offer a thorough analysis of the status of contamination in the region. A better understanding of the contamination situation in the region requires a programmatic survey of important rivers and waterbodies in the region to study the temporal and spatial trends in POPs contamination of freshwater in the region.

Ground water

In India, it is estimated that most of the aquifers have been contaminated due to human activities. Aquifer contamination is a practically irreversible process and it is important to identify affected sites to effect suitable interventions and ameliorations. The problem assumes significance as most of the aquifers in India are interconnected and in a period of 10-15 years it is expected that the problem would acquire a state or nation level significance[23]. It is expected that POPs contamination, either due to pesticide use or industrial activity might have effected groundwater in the region. A few studies have been identified that bring out the POPs contamination of groundwater in the region

- In 1995, the CPCB conducted a survey of groundwater contamination in heavily polluted problem areas in India[24]. Among pesticides, Aldrin, Dieldrin and DDT were monitored. Results of the survey are presented in Table 3.18a. Samples from Dhanbad (Jharkhand), Durgapur (West Bengal), Hooghly (West Bengal) and Kala Amb (Himachal Pradesh) showed unexplained excessively high concentrations of DDT aldrin and dieldrin far in excess of the standards. It is possible that the excessively high figures suggest a data anomaly, however this is not verified.

- Groundwater from Farukkabad in the vicinity of the Ganga river in northern India was monitored for organochlorine pesticides for one year (1991-92)[25]. Almost all samples were found contaminated with DDT. Residues of Aldrin and Heptachlor were also detected in a large number of samples. The concentrations of aldrin greatly exceeded the WHO standards for drinking water and the concentrations of heptachlor and DDT also occasionally exceeded limits. Migration of pollutants through ground water recharge with polluted Ganga water and monsoon rains carrying un degraded residues downwards from the soil surface were suggested by the study to be important sources of groundwater contamination.

- A study[26] on the pollution of groundwater in the flood affected areas of Delhi, conducted in 1995, highlighted the groundwater quality in a few selected localities of flooded areas in Delhi. Samples were collected during September 22-28 when floodwaters had receded. 17 samples of groundwater were collected. All samples were drawn from hand pump sets except for one instance of a tube well. The range of pesticide residues was on the higher side. Aldrin was found to exceed WHO standards in 2 locations. The results are summarized in Table 3.19a.

- A few of the locations of the previous mentioned study co-

In India, it is estimated that most of the aquifers have been contaminated due to human activities. The problem assumes significance as most of the aquifers in India are interconnected and in a period of 10-15 years the problem would acquire a state or nation level significance

Table 3.17: Results of monitoring ground water samples in the region

Location (year)	Sample Type	DDT level ppb Mean (range)	Other POPs level ppb Mean (range)	Reference
Faislabad, Pakistan (1987)		(0–3.7)	(1.3–1.8) Aldrin (0–0.6) Endrin (3.1–10.3) Dieldrin	Jabbar 1993
Faislabad, Pakistan (NA)			0.17 (0.1–0.2) Endrin	Jabbar 1993
Singrauli, UP (1994)		(0.063–0.403)	(0.001–0.271) Aldrin (0.001–0.26) Dieldrin	CPCB 1995a
Parwanoo, HP (1994)		(0–0.276)	(0–0.063) Aldrin (0–0.008) Dieldrin	CPCB 1995a
Kala Amb, HP (1994)		(4970–197,130)	(0–30500) Aldrin (0–152000) Dieldrin	CPCB 1995a
Najafgarh, Delhi (1994)		(0–0.274)	(0–0.138) Aldrin (0–0.0745) Dieldrin	CPCB 1995a
Andhra Pradesh (1994)		(0.115–0.298)	(0.166–0.965) Aldrin (0.034–0.389) Dieldrin	CPCB 1995a
Karnataka (1994)		(0–114.422)	(0–7.5) Aldrin (0–0.043) Dieldrin	CPCB 1995a
Madhya Pradesh (1994)		(0.066–1.098)	(0.001–0.023) Aldrin (0.001–0.134) Dieldrin	CPCB 1995a
Dhanbad (1994)		(2,990–66,669)	(0–582) Aldrin (0–193) Dieldrin	CPCB 1995a
Durgapur (1994)		(959–44,851)	(0–173) Aldrin (0–125) Dieldrin	CPCB 1995a
Howrah (1994)		(1,554–6,128)	(19–198) Aldrin (166–265) Dieldrin	CPCB 1995a
Delhi (1994-95)		(0–1.867)	(0–0.16) Aldrin (0–0.428) Dieldrin	CPCB 1995
Delhi (1995)		(0–0.6204)	(0–0.3543) Aldrin (0–0.0387) Dieldrin	CPCB 1995
Agra (NA)		(0.202–0.686)	(0.012–0.104) Aldrin (0.091–0.412) Dieldrin (0.008–0.112) Heptachlor	Singh 2001a

incided with those of a previous CPCB study on ground water quality between, Dec '94 – Jun '95. This overlap was used to compare pre and post monsoon data. Certain locations show an increase subsequent to the monsoon while others display reduced levels. This could be owing to the agricultural use and the dilution of the pesticides due to the monsoon. The results are given in Table 3.20a.

▲ The CERC is presently involved in a project for the Gujarat Ecology Commission to measure pesticide contamination (including DDT, aldrin, heptachlor and dieldrin) in ground water in Gujarat[27].

The ground water contamination studies carried out in India indicate high levels of POPs in excess of the permitted concentrations in many locations in the country.

The studies in Pakistan however indicate that the problem is not as rampant. Considering the few studies available for review, it might not be able to make any definite conclusions about the nature of groundwater pollution in the region apart from the identification of the few locations (industrial areas in

West Bengal and Jharkhand, Agra, Delhi) where data points to a severe case of groundwater contamination by POPs pesticides. Since ground water is increasingly being used for a variety of purposes, including drinking, it is necessary to ensure, through regular studies, the level or the presence of POPs contamination. Given the lack of suitable remedial techniques and the slow spread of contamination in underground aquifers, if unchecked, the problem might extend to unmanageable proportions.

Drinking water

- Drinking water samples from Lucknow contained DDT (7.5 ng/l) and in Ahmedabad, the total DDT ranged from 10.9 – 315 ng/l[28].

- The Consumer Education Research Center (CERC) had conducted a survey of pesticides in bottled water in 1998. On testing 13 brands of bottled drinking water[29], it was found that all brands were free from pesticide residues.

- During a period from June to December 2002, 34 samples of bottled water consisting of 2 samples each of 17 major brands were taken from the markets of Delhi, Gurgaon and Meerut and analysed by Center for Science and Environment (CSE)for residues of pesticides. DDT was detected in 70.6 % of the samples 33. According to Indian Standard for packaged drinking water IS 14543:1998 and natural mineral water IS: 13428:1998 — pesticide residues covered under the relevant rule of the Prevention of Food Adulteration Act, 1954 should be "below detectable limits" when tested in accordance with the relevant methods. The highest concentration was detected at 37 times higher than the 0.0001mg/l limit for individual pesticide in Directive 80/778/EEC. Metabolites of DDT (DDE and DDD) were also detected in the bottled water samples analysed[30].

Table 3.24: Drinking water samples tested for DDT

Location	DDT concentration
Delhi	5.26
Agra	3.1
Kanpur	2.0
Ahmedabad	0.2
Mumbai	3.02
Chennai	10.4
Nagpur	1.63
Kolkata	0.56
Varanasi	0.13
Allahabad	0.2

Communication from Dr N Thacker, NEERI

- Studies by NEERI[3131] Communication with Dt Neeta Thacker, NEERILocation DDT Concentration (ppm)

The studies on drinking water identified have been far too few and disparate to afford any meaningful analysis. There have been studies conducted by agencies like the AICRP for pesticides in drinking water, however it has not been possible to access the data. Water from Delhi, Mumbai, Chennai and Nagpur show contamination higher than the WHO drinking water recommendations. Considering the importance of ensuring safe drinking water, it is essential to ensure better information availability on the status of POPs contamination in drinking water.

Soil and sediment

Considering that POPs chemicals are known to adhere to soil and organic particles, it is expected that their extensive use in the region will be reflected in the soil levels measured. The data identified is difficult to interpret. The results are obtained from a variety of sources and the locations and time periods of sampling are distributed randomly. Furthermore, most of the samples in India have been derived from urban areas and the data does not reflect the nature of contamination due to POPs pesticides in agricultural soil.

- Samples of bottom sediments and biota were periodically collected from 4 sites of the river Yamuna during 1976-7831. Moderate to high levels of DDT residues were detected. The runoff from surface soils, excessive use for malaria control and the presence of the DDT factory are all potential factors. A major source is the Najafgarh drain. Results are discussed in Table 3.30a.

- The CPCB has been analysing the sediments of the Yamuna river for pesticide contamination at various impact stations between 1995-99. The levels are lower in general as compared with the levels of the previous survey of 1976-78. Samples from Agra Canala and Nizamuddin Bridge show higher levels of DDT. Details of the analyses are presented in Table 3.31a.

- In the monitoring of the sediment of drains emptying into the Yamuna, the levels of aldrin and dieldrin and DDT were generally low and showed an overall decreasing trend. High levels were recorded from the Barapulla and Etawah drains. Details of the monitoring are presented in Table 3.32a.

- In a study monitoring organochlorines in the Yamuna sediment in Delhi[31] Table 3.33a, the concentration decreased considerably during and after the monsoon.

- During a 1999 CPCB study of PCB in the sediments of the Yamuna, minimum sediment levels were at Palwal and

Table 3.29: Results of monitoring soil and sediment samples in the region

Location (year)	Sample type	DDT level ppm Mean (range)	Other POPs level ppm Mean (range)	Reference
INLAND				
Yamuna (1976–78)	Urban, River sediment	(0.007–5.63)		Agarwal 1986
Delhi (NA)	Urban		0.024 (0–0.165) HCB	Nair 1991
Delhi (NA)	Urban		0.004 (0.0002–0.03) Dieldrin 0.013 (0.0003–0.12) Aldrin	Nair 1991
South India (1988)	Agri	(0.022–0.068)		Kannan 1997
South India (NA)	Sediments	(0–0.0038)	(0–0.0018) PCB (0–0.0002) HCB (0–0.2) PCB (0–0.0012) HCB (0–0.0005) Chlordane	Senthilkumar 2001
Yamuna (1995–99)	River sediment	(0–0.306)	(0–0.047) Dieldrin (0–0.006) Aldrin	CPCB 2000
Yamuna (1995–99)	Drain sediment	(0–1.026)	(0–0.217) Dieldrin (0–0.316) Aldrin	CPCB 2000
Yamuna (1999)	Urban, River sediment		(0.0006–0.0089) PCB	Parivesh 2001
Yamuna (1999)	Urban, drain sediment		(0.0002–0.281) PCB	Parivesh 2001
Ganges (NA)	River sediment	0.0001–0.036	(0–0.0049) Chlordane 0.0041 PCB	Senthilkumar 1999
Yamuna (NA)	River sediment	0.018–0.236		Sethi 1999
India (2001)	Agri	(0.005–0.049)		Indian Ocean 2002
Agra (NA)	Urban	(0.42–1.78)	(0.25–1.39) Dieldrin (0.10–0.68) Aldrin (0.07–0.69) Heptachlor	Singh 2001
Multan, Pakistan (NA)	Agri	(1.3–5)		Hayat 2000b
NWFP, Pakistan (NA)	Agri	(0.2–0.59)		Hayat 2000b
Faislabad, Pakistan (NA)	Agri	(0–0.0002)	(0.0013–0.0018) Aldrin (0.0031–0.0096) Dieldrin (0.0002–0.0006) Endrin	Hayat 2000b
Nagpur (NA)	Landfill		(0.496–1.2) PCB	Thacker 2002
Haleji Lake,Pakistan (1999–2000)	Pristine	0.007	0.0011 HCB	Sanpera 2003
Taunsa Barrage	Agri		0.0006 PCB	Sanpera 2003
Karachi, Pakistan(1999–00)	Industrial	0.0078	0.0022 PCB	Sanpera 2003
Trivandrum (2002)	Transformer soil		(0.007–0.256) PCB	Interaction with Dr M Anbu

continued on next page

maximum sediment levels at Palla for Yamuna river. Overall, the highest sediment levels were measured in the Civil Mill drain as indicated in Table 3.34a.

- In a detailed study of sediments at 10 stations along the Ganges river31, DDT and chlordane compounds were detected. Higher levels were observed at Kahalgaon station while all the other stations showed concentrations at the lower end of the range. The results are given in Table 3.35a.

- Soils collected from tea and coffee growing areas in South India in 1988 contained DDT concentrations in the range of 22 – 68 ng/g suggesting their use in coffee and tea31. However, relatively low residues in coffee and tea may result from decomposition during processing, which involves fermentation, curing and roasting.

- In a monitoring of pesticide residues by the ICAR in 200131, 224 samples collected from cotton-wheat cropping systems, rice soil, local orchards and vegetable fields

Table 3.29: (continued): Results of monitoring soil and sediment samples in the region

Location (year)	Sample type	DDT level ppm Mean (range)	Other POPs level ppm Mean (range)	Reference
MARINE				
West coast (1980's)	Marine	(0–0.179)	0.00088 Dieldrin (0.00095–0.035) Aldrin	Sarkar 1987
Bay of Bengal (NA)	Marine	(0.020–0.790)	(0.050–0.510) Dieldrin (0.020–0.530) Aldrin	Sarkar 1988
India (NA)	Marine	(0–0.14)	(0–0.81) Aldrin	Indian Ocean 2002
West Coast (NA)	Marine, Estuarine	(0.0011–0.017)	(0.0007–0.0033) Dieldrin (0.0001–0.00026) Aldrin	Sarkar 1997
East Coast (1998–00)	River mouths	(0.05–0.22)	(0–0.25) Dieldrin (0–0.35) Aldrin (0–0.0014) PCB	Sarkar 1998
	Coastal	(0.02–0.4)	(0–0.175) Dieldrin (0–0.15) Aldrin (0–0.0011) PCB	
Srilanka west coast (NA)	Coastal	(0.00009–0.0016)		Bhattacharya 2003
Hooghly (1998–00)	Estuarine	(0–0.08)		Bhattacharya 2003

were analysed. Most of the samples contained DDT with a range of 0.005 – 0.049 mg/kg.

- An abandoned waste dumpsite near Nagpur was tested for the presence of PCBs31. The dumpsite had been receiving all kinds of domestic, industrial and commercial wastes. The study suggests that such landfill sites should be tested on a routine basis for PCB pollution as on abandonment, these sites are used for rehabilitation for human beings and other purposes. The distribution of PCB levels suggests an air borne mode of transport from the source. Results are given in Table 3.41a.

- In study in Pakistan, organochlorines were measured in sediments from three ecologically sensitive areas in Pakistan, which form the foraging areas of little egrets the results of which are shown in Table 4.42a. Higher levels of DDTs and PCBs were measured from the Karachi port area reflecting greater agricultural activity and the possible result of ship breaking activities.

- In a recent study conducted by the RRL, Trivandrum[31], sediment samples were collected from 3 sites in the Veli lake near Trivandrum and analysed for dioxins and furans. Dioxins and furans were detected in all the samples. The most commonly found cogeners were 1,2,3,7,8,9 HCDD and 1,2,3,7,8 PCDF. It was conjectured that the source of the dioxins could be from waste incinerators or the leakage of oil from electrical equipments. In another study by RRL, Trivandrum31, soil samples were collected from Trivandrum city during August-October 2002 from near transformers at substations. The results are comparable to a previous study[31]. A significant outcome of the study was the presence of relatively high levels of PCBs in soil near samples installed as late as 1998. It is noticed that high levels were detected from near transformers installed after 1990. The PCB cogener with the highest detected presence was 2,2',5,5'-Tetrachlorobiphenyl. The results are given in Table 3.43a.

Marine sediment

- In a study by the NIO[31], DDT, aldrin and dieldrin were determined in marine and estuarine sediments along the west coast of India. DDT was amongst the most dominant OCs in both estuarine and offshore sediments. The highest

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concentration of DDT was found at the mouth of the Kali estuary. Aldrin was also detected in abundance in most of the sediments whereas Dieldrin and Endrin were detected at the mouth of the Zuari, Damanganga, Diu, Cannanore and Ponnani estuaries along the west coast of India.The sediments were higher in estuarine sediments as compared to offshore sediments. Results are given in Table 3.46a.

- During March 1998 to August 2000[31], samples of surface sediment were collected from the mouth of the Hooghly estuary. The study concluded that the Hooghly estuary is not grossly polluted by organochlorines. This conclusion stands in contrast with the CPCB study identifying groundwater in the Hooghly area to be grossly contaminated with DDT. It was estimated, based on international studies, that about 50 tonnes of DDT are transported annually to the seas around India through river discharge. Based on the published information, it is difficult to make out any seasonal trend in the data. Results of the study are as given in Table 3.49a

- Based on the identified data, pesticide contamination in Delhi appears to have problem areas like the Najafgarh drain and Civil Mill drain and river locations at Palla and Nizamuddin. There is a decline in DDT levels in Delhi after the monsoon period. Agra has also recorded high levels of DDT, Dieldrin, Aldrin and Heptachlor in the soil. High levels of DDT were measured from Multan and NWFP in Pakistan.

- PCB levels monitored in Delhi revealed high levels in the Civil Mill Drain. PCB contaminations due to transformer oil leakage and in landfill sites have been reported from parts of South India and Nagpur. This connection signifies the continuing potential of PCB releases due to transformers and capacitors. This warrants further investigation for a better understanding of the problem. Residue data from Pakistan for PCB does not reflect magnitudes of contamination comparable with those from Indian sites.

In the case of marine sediments, it is noticed that the concentrations of different POPs contaminants in sediments along the east coast of India were much higher than those along the west coast of India.

3.3 Food – A critical pathway of exposure

Amongst the pathways that expose humans to pesticide POPs, dietary exposure takes precedence over other pathways like air, water and dermal exposure[31]. Humans represent the top of the food chain and at the time of human dietary intake, POPs have been through stages of bioaccumulation to reach significant levels. This rule of primary exposure by dietary pathways is however not applicable in certain specific situations like occupational and accidental exposure where dermal, atmospheric and water pathways can assume significance.

3.3.1Dietary exposure

Table 3.50: Exposure to pesticides through different food items

Food items	Percent contribution of pesticide residues
Dairy products	80
Cereals	6
Pulse	5
Flesh foods	4
Spices	2
Vegetables	2
Fats and oils	1

Source: Sarkar

Table 3.51: Average dietary intake of DDT

Country	Average dietary intake of DDT omplex mg/day/person
Australia	20.0
Canada	10.8
Germany	149.0
UK	12.0
USA	6.5
Yugoslavia	98.0
India	
(Vegetarians)	238.1
(Non–vegetarians)	224.1

Source: Sarkar 2001

In India, the exposure to pesticides through different food items is given in Table 3.50. It is expected that the contributions would apply in the case of POPs pesticides as well.

Table 3.50 exposure to pesticides through different food items. The Table 3.51 demonstrates the high levels of DDT intake through dietary consumption in India in comparison with other parts of the world.

Dairy products

Dairy products represent a significant portion of the POPs pesticide intake by the population of the region. Chief among other factors that contribute to this situation are:- Dermal application of pesticides to bovines to ward off insects[31]- Indiscriminate DDT spraying in cattle sheds and on cattle fodder[31]

The seriousness of the problem can be gauged from the comparison of contamination levels in butter from 23 countries given in Table 4.52a. DDT levels are the highest in India while HCB and PCB levels are still comparable with those of many other countries.

- In a study[31], the excretion of DDT in milk of Indian Buffaloes after oral and dermal exposure to technical DDT was studied. Dermal and oral application of technical DDT resulted in significant residues in milk. It was noticed that a higher milk fat content resulted in higher DDT residues as show in results in the Table 3.53a.

- In another study[31], it was found that the rate of excretion through milk may depend on several factors like species, quantity of milk fat produced, amount of pesticide consumed, duration of the exposure and nature of the pesticide. The study looked at the extent of movement of OC pesticides into milk of cows and buffaloes when subjected to moderate ingestions for short time duration. DDT levels fell drastically after exposure was stopped and returned to previous levels within a week. It was observed that for a given level of pesticide ingestion, animals with lower milk yield might produce milk with higher residues.

These studies confirm the possible pathways of DDT and other POPs pesticides that are present in bovine milk. The curbing of practices like the dermal application of DDT and the excessive spraying of cattle sheds might lead to a reduction in the high levels of POPs pesticides in milk.

Other food products and total diet

In terms of the other food products, there have been no studies identified which deal with the understanding of the pathway of POPs exposure from application to consumption. In this context, the All India Coordinated Research Project on Pesticide Residues (AICRP) conducts field trials to arrive at recommended application schemes for pesticides. It is however a widely recognized fact that these recommended procedures are rarely adhered to and they do not reflect the actual ground situation with regard to the pathways due to the field application of pesticides on crops.

Apart from this, it is also noted that there are also certain unscrupulous activities like the dipping or spraying of cultivated grain, vegetables and fish to enhance their shelf life and visual appeal[31]. These remain poorly understood and investigated and represent a definite pathway for pesticide POPs exposure. Food products are also a possible mode of long range conveyance of POPs with the onset of improved communication and storage technologies which enable the long range transport of processed and raw food products from one part of the region to another.

Studies have been identified which estimate the dietary intake of certain POPs pesticides.

- In a study[129], 20 samples of total diet were collected from in and around Kanpur during July-Oct 1999 and analysed. 90% were contaminated with pesticide residues as represented in Table 3.54. The magnitude of DDT contamination was found to be more in vegetarian diet than in non-vegetarian whereas the opposite was reported in the case of Aldrin, Dieldrin and Chlordane. HCH, Aldrin and Dieldrin were identified as the main contaminants and the average daily intakes of the pesticides were reported to be more than WHO recommended ADIs. In another study conducted by the NIOH in Ahmedabad, the average DDT consumed daily by an adult was estimated at 1,9.24 micrograms.

- In a nationwide study by the AICRP on pesticide residues in 2001 and 2002, samples of vegetarian and nonvegetarian diet were analysed for pesticide contamination. The results are given in Table 3.46.

In an assessment undertaken in Coimbatore[31] the maximum

Table 3.54: Average daily intakes (ìg/person/day) of pesticide residues through different diets

Pesticide	Mean residue level		Average daily intake		FAO/WHO (1991) Acceptable daily intake
	Vegetarian	Non vegetarian	Vegetarian	Non vegetarian	
Aldrin	0.015	0.046	32.52	95.93	6.0
Dieldrin	0.017	0.176	36.86	367.02	6.0
Chlordane	0.020	0.091	43.36	189.77	300
DDT	0.075	0.045	162.60	93.84	1,500

Source: Shukla, 2002

Table 3.55: AICRP study on pesticide residues in 2001 and 2002 on samples of vegetarian and non-vegetarian diet

Commodity	Results
264 samples for Vegetarian nated with DDT. 11% ADI levels. reported of the	75% samples contami samples above DDT presence from most parts country.
243 samples for non veg diet	72% samples contami nated mainly with DDT. 15% were above ADI values
199 vegetarian diet samples	26% contained DDT. Its levels are declining
175 non veg diet samples	17% contained DDT

Source: Communication with Dr DB Saxena

pesticide consuming area of Tamil Nadu, samples were taken from volunteers to correspond exactly to the dietary intake. The study reported no significant difference noticed between rural and urban samples. In both cases, the expected daily intakes are close to the PTDI limit set by the WHO. The results are given in Table 3.56a.

The presence of DDT as a portion of the diet is apparent in studies from various parts of India. In some of the cases, studies show intakes of DDT in excess of the allowable daily intakes prescribed by the WHO. Aldrin and Dieldrin have also been shown to exceed the WHO ADIs. The presence of POPs in undesirable amounts as a portion of daily food intake by the population of the region is a cause of concern and it is necessary to initiate a better understanding of the pathways and possible ways of checking this regular exposure to POPs. Studies need to be undertaken to assess the intake potential of PCBs, Dioxins and Furans.

3.3.2 Food contamination

Considering that dietary intake is the chief form of POPs exposure to humans, it is an important and necessary task to continuously monitor food samples to detect any possible contamination so that remedial action can be taken. There have been many surveys identified for the monitoring of foodstuffs in the region. Most of the studies have been from India and have been randomly conducted by many individual research groups and testing laboratories. There has been no overall coordination between the different studies. The differences in the sampling approach and methodology makes it very difficult to combine the data for an effective analysis of the food contamination issue in India and the South Asia Region.

In a review of monitoring activities in India[31], it was found that DDT concentrations were less in field-collected grain than in stored wheat, suggesting post harvest contamination of cereal grains in storage facilities. Contamination of wheat grains and straw arising from their storage in premises treated with DDT for mosquito control has been documented. Data suggests that DDT is being used for commercial crops like cotton[31]. Leafy vegetables collected from Mumbai during 1975 – 1979 had greater incidences of contamination and also had multiple residues.

Next to DDT and HCH, Aldrin and Dieldrin were the most frequently encountered OC pesticides in Indian foodstuffs[31]. Dieldrin concentrations in vegetables were more than that of Aldrin. Aldrin and Dieldrin are used for the control of crop pests and termites in agricultural fields. Heptachlor in sediments off the Chennai coast exceeded safety limits in 1989. The pesticides may be used in vegetables sporadically and therefore, their concentrations are occasionally high in vegetables.

In a nationwide study[31] of foodstuffs collected in 1989 from New Delhi, Bombay, Calcutta, Madras, Chidambaram and Parangipettai, significant leveles of DDT, Aldrin and Dieldrin contamination was found throughout India. Diary products and livestock meat were found to be the chief sources of dietary exposure. Concentrations of these OCs were above the MRLs of the FAO/WHO and the average intake was found to be above the ADI of FAO/WHO. Contamination due to HCB, Heptachlor and PCBs were relatively low and Chlordane levels were too low to be detected. The source of PCBs in Indians' intake had significant contributions observed from cereals and vegetable oils as well as from dairy products. The results of the study are given in Table 3.62a.

The AICRP data on pesticide residues is the only regular, concerted food monitoring program identified in the region. AICRP was initiated during the year 1984-85. The main aim of the project is to develop protocols for the safe use of pesticides by recommending good agricultural practices, based on multi location supervised field trials so that the residues in

The presence of POPs in undesirable amounts as a portion of daily food intake by the population of the region is a cause of concern and it is necessary to initiate a better understanding of the pathways and possible ways of checking this regular exposure to POPs

the food commodities remain within the prescribed safe limits[31].Monitoring of pesticide residues in market and farmgate samples of food commodities and environmental samples has been carried by the AICRP from the health point of view.

The project consists of 17 centers at Solan (HP), Ludhiana (Punjab), Jaipur (Rajasthan), Kalyani (West Bengal), Samasthipur (Bihar), Anand (Gujarat), Bhubaneshwar (Orissa), Bangalore (Karnataka), Coimbatore (TN), Rahuri (Maharashtra), Hisar (Haryana), New Delhi, Vellayani (Kerala), Kanpur (UP), Jabalpur (MP), Jorhat (Assam) and Hyderabad (AP).

AICRP laboratories are yet to have certifications of good laboratory practices and are presently coming out with a manual for analytical procedure to test for chemicals[31].

A summary of the findings of the AICRP for the last two years has been presented in Table 3.55.A survey of DDT in food commodities has been in progress in Nepal since 1981 by the Central Food Research Laboratory (CFRL) (Kathmandu)[31]. 900 samples of various food materials were analysed between 1981 and 1986. These samples were collected from retailers at the main markets of the terai region and Kathmandu valley, Nepal Food Corporation godowns, agricultural farms and livestock farms. The samples analysed included rice, wheat, milk, cereals, legumes, oil seeds, fats, vegetables, meat and spices. During1992-93 and 1995-96, DDT residues exceeded limits in tea and chick pea. Few samples of legumes were also detected for DDT, which was found from traces – 7.5 ppm.

The CFRL, Nepal studied DDT residues in various food articles in the Kathmandu valley in 1999-00. 54 samples were collected. None of them were reported to contain DDT although other pesticides were detected[31].

Apart from these coordinated nationwide studies covering commodities in different parts of the region, there have been numerous reports of localised monitorings of particular types of foodstuffs. These findings are listed under different heads.

Fruits, spices, vegetables, honey, tea and other products

Fruits, vegetables and other plant products represent a class of food products with widespread consumption in the region. In terms of pesticide usage, fruits and vegetables are subject to intense application. It is expected that this might result in significant POPs concentrations in this class of food. POPs have been detected even in recent surveys indicating the need to undertake detailed regionwide monitoring surveys. The data accessed has been shown in the table in the next page.

- Vegetables were tested for pesticides during the years 1993 – 96 in Jaipur[31] and the residues of a number of samples above the limit of tolerance prescribed by the WHO/FAO. It was observed that pesticide accumulation takes placethrough the spraying of chemical pesticides on the vegetable field. During winter, the influence of heat, wind and rains are low and hence the dissipation is less intense. The report states that the incidence of contamination has increased during the last two decades but does not supply previous data. The report also indicates that certain vegetables have high incidence of contamination at the beginning of the season while other show higher contamination at the end of their season. The results are given in Table 3.66a

- During 1982-83[31] a study of wholesale market fruits and vegetables was conducted for organochlorine pesticide residues in Pakistan. In 1984, a study of pesticide residues in food samples was brought out. Pesticides were present in 100% samples and Endrin, a banned product, was also detected. During 1988-90, 59 fruits and vegetables from the Karachi wholesale market were analysed for DDT residues. 37.2% were contaminated out of which 48% exceeded the limit. During 1990-91, fruits and vegetables of 5 districts of NWFP (Peshawar, Mardam, Swabi, Charsadda, Manserha and Malakand Agency) and Islamabad markets were analysed for pesticide residues. DDT was present in almost all the samples analysed. During September 1992, fruits and vegetables samples from the grower's fields and main selling points in Quetta/Pashin district of Baluchistan province were collected and analysed for pesticide residues. 38% were found contaminated and 5% exceeded the WHO/FAO limits. Results are given in Table 3.69a.

Cereals and pulses

Being the staple carbohydrate intake of the population, POPs' presence in cereals, even at comparatively lower levels is a reason for concern. Pulses too constitute an integral prtion of the diet for a majority of the population and are consumed in large quantities on a regular basis. A number of studies monitoring

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Fruits, vegetables and other plant products represent a class of food products with widespread consumption in the region. In terms of pesticide usage, fruits and vegetables are subject to intense application. It is expected that this might result in significant POPs concentrations in this class of food

Table 3.64: Results of review of monitoring activities in India on fruits, spices vegetables, tea, honey and other products

Location (year)	Sample	DDT ppm mean (range)	Other POPs ppm mean (range)	Reference
Fruits and Vegetables				
Punjab and AP (1970s)	Fruits	0–1.5		Kannan 1997 (review)
Delhi (1972)	Veg	0–35		Kannan 1997 (review)
Maharashtra (1975-79)	Veg	0.2–7.4	(0.16–3.12) Aldr and Dield (0.34–0.71) Heptachlor	Kannan 1997 (review)
UP (1983)	Veg	0–0.03		Kannan 1997 (review)
UP (1983)	Fruits	0		Kannan 1997 (review)
Pakistan (1984)	Veg	0.424	0.032 Aldrin 0.062 Dieldrin 0.107 Endrin 0.013 Heptachlor	Hayat 2000
Pakistan (1984)	Fruits	0.52	Aldrin present 0.039 Dieldrin Heptachlor present	Hayat 200
Faislabad, Pakistan (1984)	Veg		(0.13–0.669) Endrin	Hayat 2000
Delhi (1984-86)	Veg	(0.08–0.7)	(0–0.04) Ald. and Dield. (0–0.41) Heptachlor	Kannan 1997 (review)
India (NA)	Veg	0.1 (0–1.09)	0.03 (0–0.08) Aldrin	AICRP 1999
Jorhat (NA)	Veg	(0–0.039) Upto	(0.004–0.0186)	Goswami 1995
Islamabad,Pakistan (1990-91)	Veg	(0–8.6)		Hayat 2000
Islamabad,Pakistan (1990-91)	Fruits	0.19		Hayat 2000
Sri Lanka (NA)	Tobacco	(0–0.00025)		Indian Ocean 2002
Sri Lanka (NA)	Chillies, Onions		(0–0.000051) Dieldrin (0–0.00009) Endrin Heptachlor present	Indian Ocean 2002
Jaipur (1993-96)	Veg	(0.009–2.205)	(0–0.597) Aldrin (0.257–20.262) Heptachlor	Bakore 2002
Jaipur (1999-00)	Fruits		(0.02–0.03) Dieldrin	Singh 2001
Pune (2000 – 01)	Fruit	(0–0.012)	(0–0.001) Aldrin	WHO 2001
Pune (2000 – 01)	Veg	(0.001 – 0.012)	(0–0.003) Aldrin	WHO 2001
Kolkata (2000 – 01)	Fruit	(0–0.004)	Aldrin present	WHO 2001
Kolkata (2000 – 01)	Veg	(0–0.0038)	Aldrin,Dieldrin, Heptachlor present	WHO 2001
Hyderabad (2000-01)	Veg	(0–0.001)		WHO 2001
Tea and Coffee				
Sri Lanka (NA)	Tea Leaves	(0.011–0.342)	(0.02–0.079) Aldrin (0.008–0.319) Dieldrin (0.027–0.278) Endrin (0.109–0.155) Heptachlor	Indian Ocean 2002
Hyderabad (1994)	T/Coffee	(0–0.024)	(0.004–0.044) Aldrin (0.003–0.004) Dieldrin (0.007–0.024) Heptachlorepoxide	CERC 1994

continued on next page

Table 3.64: (continued) Results of review of monitoring activities in India on fruits, spices vegetables, tea, honey and other products

Location (year)	Sample	DDT ppm mean (range)	Other POPs ppm mean (range)	Reference
Kolkata (2000–01)	T/ Coffe	(0–0.0075)	Aldrin present	WHO 2001
Cochin (2000–01)	T/Coffe	(0–0.023)	(0–0.007) Aldrin (0–0.024) Heptachlor (0–0.003) Endrin	WHO 2001
Pune (2000–01)	T/ Coffe	(0–0.045)	(0–0.001) Aldrin	WHO 2001
Spices				
India (1989)	Spices	0.062 (0.075–0.22)	0.024 (0–0.041) Dieldrin 0.003 PCB (0.00009–0.0093) 0.00022 HCB (0–0.00054) 0.0021 (0–0.041) Aldrin 0.00046 Heptachlor (0–0.0011)	Kannan 1992
Kolkata (2000–01)	Spices	(0–0.1)	Aldrin present	WHO 2001
Hyderabad (2000–01)	Spices	(0–0.058)	Dieldrin present	WHO 2001
Pune (2000–01)	Spices	(0.001–0.086)	(0–0.002) Aldrin	WHO 2001
Cochin (2000–01)	Spices	(0–0.199)	(0–0.007) Aldrin (0–0.029) Heptachlor (0–0.006) Endrin (0–0.002) Dieldrin	WHO 2001
Hyderabad (2000–01)	Dry Frts	(0–0.078)		WHO 2001
Honey				
Haryana (NA)	Honey	(0–0.14)	(0–0.1)Aldrin	AICRP 1999
Punjab (NA)	Honey	0.056		AICRP 1999
Ludhiana (NA)	Honey	0.082		AICRP 1999
Hyderabad (NA)	Honey	0.02		AICRP 1999
Solan HP (NA)	Honey	0.004		AICRP 1999
Fruit and Vegetable Products				
Sri Lanka (NA)	Can P'apple	(0–0.000016)	Heptachlor present	Indian Ocean 2002
Hyderabad (1994)	Jam		0.001 Aldrin (0–0.006) Dieldrin	CERC 1994
Hyderabad (1994)	Ketchup		0.002 Aldrin 0.004 Dieldrin	CERC 1994
Hyderabad (1994)	Fruit Juice	0.04	0.009 Aldrin	CERC 1994

POPs chemicals in cereals and pulses have been identified and listed below. It is noticed that in the recent years, there have been very few monitoring efforts published, which help bring out the current status of POPs contamination of cereals and pulses in the region.

Meat products

Meats and poultry have been considered to be a high-risk food category internationally due to the elevated concentrations of POPs in animal tissues. In India and the South Asia region, the problem assumes relegated significance owing to the fact

Table 3.73: Results of a review of pesticides in cereals and pulses

Location (year)	Sample	DDT ppm Mean (range)	Other POPs ppm Mean (range)	Reference
Punjab and AP(1970s)	Cereals	(0–10)		Kannan 1997 (review)
Punjab and AP (1970s)	Pulses	(0–8)		Kannan 1997 (review)
Maharashtra (1975–79)	Cereals	(1–8.9)	(0.05–0.1) Ald,Dield	Kannan 1997 (review)
UP (1983)	Cereals	(0.03–0.31)		Kannan 1997 (review)
UP (1983)	Pulses	(0.02–0.06)		Kannan 1997 (review)
India (1989)	Cereals	0.0035 (0.017–0.054)	0.00045 PCB (0.00021–0.00064) 0.00003 HCB (0.00001–0.00004) 0.0013 Aldrin (0.00017– 0.0023) 0.00075 Dieldrin (0.00028–0.0014) 0.00008 Hept (0.00004–0.00011)	Kannan 1992
India (1989)	Pulses	0.02 (0.0011–0.04)	0.0012 PCB (0.00011 – 0.0029) 0.00007 HCB (0.00002–0.00016) 0.0013 Aldrin (0.0008 – 0.0016) 0.0021 Dieldrin (0.00082–0.0033) Hept. 0.00009 (0–0.00027)	Kannan 1992
Gujarat (1990s)	Cereals, Pulses	(0.01–0.02)		Kannan 1997 (review)
Hyderabad (1994)	Rice	(0–0.01)	(0–0.01) Aldrin	CERC 1994
Hyderabad (1994)	Wheat	Op’ (0.03–0.12) (0–0.05)Pp’	(0.02–0.03) Dieldrin (0–0.03) Heptachlorepoxide	CERC 1994
Hyderabad (1994)	Pulses	Op’ (0–0.016) Pp’ (0–0.01)	(0–0.01) Aldrin (0–0.01) Dieldrin	CERC 1994
India (NA)	Wheat flour	(0–0.169)	(0–0.002) Aldrin Heptachlor	Insight May–Jun 2000
Cochin (2000–01)	Cereals	(0–0.023)	(0–0.004) Aldrin (0–0.035) Heptachlor Endrin–Dieldrin	WHO 2001
Cochin (2000–01)	Pulses	(0–0.009)	(0–0.006) Aldrin (-.006–0.320) Heptachlor Endrin	WHO 2001
Hyderabad (2000–01)	Cereals	(0–0.018)		WHO 2001
Hyderabad (2000–01)	Pulses	–	Dieldrin present	WHO 2001
Kolkata (2000–01)	Cereals	(0–0.009)	Aldrin present	WHO 2001
Kolkata (2000–01)	Pulses	(0–0.004)	Aldrin present	WHO 2001
Pune (2000–01)	Cereals	(0.001–0.015)	(0–0.007) Aldrin	WHO 2001
Pune (2000–01)	Pulses	(0.001–0.022)	(0–0.009) Aldrin	WHO 2001

that meats occupy a relatively lower position to plant origin products in terms of the consumption patterns of the population. However, certain individual cases of extremely high levels of POPs in meat products in the region indicate that the data available is not sufficient to the task of determining the significance of POPs in meat products. The data from the accessed studies is presented below.

- In an instance of unscrupulous usage of DDT powder, there is a report of DDT being directly applied on dried fishes in Bangladesh. In a study31, laboratory analysis of stored and marketed dried fish showed the presence of DDT. In certain cases it was exceptionally high and was hazardous for human consumption. DDT content was measured as hydrolysable chlorine. The use of DDT on drying fish was first reported in Bangladesh by the Aquatic Research Group, Institute of Marine Sciences, Chittagong University. DDT is banned in Bangladesh, but it is reported to be procured for the malaria control program. Results of the study are presented in Table 3.80a

Dairy products

Contamination of dairy products by DDT has been alarming. Surveys show that the residue limit has been often exceeded. The routes to milk are mainly through contaminated animal feed and to a certain extent, skin absorption following dermal treatment of animals with spray or dust. Application of DDT for mosquito control in cattle sheds is also common in India. When milk is processed into butter, residue levels are magnified. Butter is often contaminated with POPs pesticides in levels far in excess of those in developed nations.

When milk is processed into butter, residue levels are magnified. Butter is often contaminated with POPs pesticides in levels far in excess of those in developed nations.

- During 1993-9631, 75 samples each of dairy and buffalo milk were collected at random in Jaipur city during summer, rainy and winter seasons. Winter samples were found to have more pesticide residues probably due to the maximum use of pesticides on winter vegetable crops. Also, the diet of cattle during winter is mainly oilcake, which is a source of high OCP contamination. Summer levels can be explained in terms of greater transport by air and the dry-

Table 3.76: Summary of studies on meats

Location (year)	Sample	DDT ppm Mean (range)	Other POPs ppm Mean (range)	Reference
Calcutta (1975–76)	Meats	1.5		Kannan 1997 (review)
Delhi (1979)	Meats	1.0		Kannan 1997 (review)
Bombay (1979)	Meats	–		Kannan 1997 (review)
Punjab (1980–81)	Meats	0.25		Kannan 1997 (review)
Uttar Pradesh (1981–83)	Meats	0.24		Kannan 1997 (review)
Pakistan (1984)	Poultry	1.629	0.253 DieldrinAldrin present	Hayat 2000
Pakistan (1984)	Meats	(0.63–1.436)	(0.019–0.16) Dieldrin	Hayat 2000
Bangladesh (NA)	Fish	(0.7–452.02)		Khan 1998a
India (1989)	Fish and Prawn	0.015 (0–0.14)	0.0035 (0–0.11) PCB (0–0.00055) HCB (0.0013 (0–0.0061) Aldrin 0.00180–0.0085) Dieldrin (0–0.0005) Heptachlor	Kannan 1992
India (1989)	Meats, animal fat	0.1 (0.0001–0.82)	0.0036 (0–0.033) PCB (0–0.0048) HCB 0.0024 (0–0.023) Aldrin 0.0083 Dieldrin (0–0.037) Heptachlor	Kannan 1992
India (NA)	Poultry	(0–0.0988)	(0.0012–0.2563) Aldrin	AICRP 1999
Kolkata (2000–01)	Meats	(0–0.00456)	Aldrin and Dieldrin present 0.0079 Max DDE	WHO 2001
Pune (2000–01)	Meats	(0.002–0.093)	(0–0.008) Aldrin	WHO 2001

ing of lakes, exposing pesticide residues in their sediments and vegetation. The levels of DDT and its metabolites were well below the prescribed tolerance limit of WHO. High levels of Aldrin and Heptachlor were ascribed to their possible improper use. Results are given in Table 3.87a.

- In a study[31] estimating the seasonal variation in the concentration of DDT residues in dairy milk in Ludhiana and Patiala districts of Punjab, 92% in Ludhiana and 2.8% of the samples in Patiala exceeded the MRLs. DDT residue trends correlated mainly with its usage for the control of mosquito vectors in India. Levels in

Table 3.81: Summary of contamination in milk and milk products

Location (year)	Sample	DDT ppm mean (range)	Other POPs ppm mean (range)	Reference
Milk				
Punjab (1977)	Milk	(0.01–0.63)		Kannan 1997 (review)
Punjab (1979)	Milk	(0.05–1.51)		Kannan 1997 (review)
Punjab (1980)	Milk	(0.01–0.55)		Kannan 1997 (review)
Punjab (1980–81)	Milk	(0.14–0.36)		Kannan 1997 (review)
UP (1980–81)	Milk	(0.01–0.07)		Kannan 1997 (review)
UP (1983)	Milk	0.22		Kannan 1997 (review)
Pakistan (1984)	Milk	0.653	Dieldrin 0.137 Endrin present	Hayat 2000
Hisar (NA)	Milk	0.04 (0–0.11)		Kathpal 1992
Himachal Pradesh (1986–91)	Milk rural Milk urban Milk combined	0.093 (0.006–0.75) 0.09 (0.01–0.490) 0.091 (0.006–0.750)		ICMR 1993
Punjab (1986–91)	Milk rural Milk urban Milk combined	0.146 (0–1.11) 0.066 (0–0.370) 0.111 (0–1.11)		ICMR 1993`
Haryana (1986–91)	Milk rural Milk urban Milk combined	0.026 (0–0.33) 0.019(0–0.080) 0.022 (0–0.330)		ICMR 1993
Uttar Pradesh (1986–91)	Milk rural Milk urban Milk combined	0.040 (0–0.652) 0.019 (0–0.374) 0.030 (0–0.652)		ICMR 1993
Madhya Pradesh (1986–91)	Milk rural Milk urban Milk combined	0.034 (0–0.300) 0.05(0–0.360) 0.042 (0–0.360)		ICMR 1993
Maharashtra (1986–91)	Milk rural Milk urban Milk combined	0.089 (0.020–0.965) 0.067 (0.02–0.135) 0.080 (0.02–0.965)		ICMR 1993
Gujrat (1986–91)	Milk rural Milk urban Milk combined	0.100 (0.025–0.200) 0.082 (0.015–0.195) 0.091(0.015–0.200)		ICMR 1993
West Bengal (1986–91)	Milk urban	0.021 (0–0.282)		ICMR 1993
Bihar (1986–91)	Milk rural Milk urban Milk combined	0.036 (0–0.250) 0.046 (0–0.800) 0.041 (0–0.800)		ICMR 1993
Andhra Pradesh (1986–91)	Milk rural Milk urban Milk combined	0.220 (0–2.224) 0.195 (0–2.224)		ICMR 1993
Karnataka (1986–91)	Milk rural Milk urban Milk combined	0.035 (0–0.380) 0.055 (0–1.079) 0.047 (0–1.079)		ICMR 1993

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Table 3.81: (continued) Summary of contamination in milk and milk products

Location (year)	Sample	DDT ppm mean (range)	Other POPs ppm mean (range)	Reference
Kerala (1986-91)	Milk rural Milk urban Milk combined	0.030 (0–0.070) 0.029 (0–1.080) 0.030 (0–1.080)		ICMR 1993
India (1986-91)	Milk rural Milk urban Milk combined	0.087 (0–2.224) 0.064 (0–1.446) 0.075 (0–2.224)		ICMR 1993
TN (1989)	Milk	(0.02–0.05)		Kannan 1997 (review)
Indian (1989)	Milk	(0.4–0.86)		Kannan 1997 (review)
Milk				
Gujarat (1990)	Milk	0.0014 (0–0.0052)	0.00052 (0-0.0017) PCB (0-0.0001) HCB (0-0.00017) Dieldrin Heptachlor – (0-0.00003) Aldrin	Kannan 1992
Delhi (1992-93)	Milk	(0.1–0.22)	(0.03–0.048) Aldrin	Kannan 1997 (review)
Hyderabad (1994)	Milk		(0.004–0.016) Dieldrin Heptachlorepoxide (0 –0.01)	CERC 1994
Jorhat (NA)	Milk	0.078		Deka 1995
New Delhi (NA)	Milk	0.377		AICRP 1999
Hisar (NA)	Milk	0.274		AICRP 1999
Ludhiana (NA)	Milk	0.028		AICRP 1999
AAU Jorhat	Milk	0.029		AICRP 1999
Bhubaneswar (NA)	Milk	0.037		AICRP 1999
Rahuri (NA)	Milk	0.094		AICRP 1999
Kanpur (NA)	Milk	0.073		AICRP 1999
Bihar (1986-91)	Milk	0.036 (0–0.250)0.046		ICMR 1993
Anand (NA)	Milk	5.03		AICRP 1999
Pusa (NA)	Milk	0.014		AICRP 1999
Hyderabad (NA)	Milk	0.027		AICRP 1999
Bangalore (NA)	Milk	0.021		AICRP 1999
Coimbatore (NA)	Milk	0.092		AICRP 1999
Vellayani (NA)	Milk	–		AICRP 1999
Jaipur (NA)	Milk	0.021		AICRP 1999
Karaikal (NA)	Milk	(0.004–0.145)		Adiroubane 1996
Ludhiana (NA)	Milk	0.1–0.256)		Battu 1996
Patiala (NA)	Milk	(0.012–0.06)		Battu 1996
Himachal Pradesh (NA)Foothills MidHills High Hills	Milk	 0.234 0.067 0.031		Kumar 1996
Lucknow (NA)	Milk	(0.01–0.033)		Nigam 2001
Jaipur (1993-96) Summer	Milk	(0.061–0.533)	Aldrin (0.378–0.735) Heptachlor (1.142–7.204)	John 2001
Jaipur (1993-96) Rainy	Milk	(0.044–0.457)	Aldrin (0.056–0.173) Heptachlor (1.508–3.330)	John 2001
Jaipur (1993-96) Winter	Milk	(0.192–0.797)	Aldrin (0.674–1.255) Heptachlor (1.596–6.818)	John 2001
Ahmedabad (1999)	Milk	(0–1.06)	Heptachlor 0.003 Aldrin, Dieldrin	Insight Jan–Feb 1999

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Table 3.81: (continued) Summary of contamination in milk and milk products

Location (year)	Sample	DDT ppm mean (range)	Other POPs ppm mean (range)	Reference
Butter				
India (1977)	Butter	2.15–6.44		Kannan 1997 (review)
India (1978-79)	Butter	0.97–6.79		Kannan 1997 (review)
India (1980)	Butter	2.35–3.28		Kannan 1997 (review)
India (1981)	Butter	0.32–6.33		Kannan 1997 (review)
India (1981)	Butter	5.31–10.8		Kannan 1997 (review)
UP (1983)	Butter	4.85		Kannan 1997 (review)
Pakistan (1984)	Butter	1.10		Hayat 2000
India (1989)	Butter	1.4 (0.78–3)	PCB 0.006 (0.0024–0.0093) 0.0017 HCB (0.00086-0.0024)Aldrin 0.042 (0.0077–0.140) 0.740 (0.0089–2.9) Dieldrin (0–0.00007) Heptachlor	Kannan 1992
India (NA)	Butter	(0.02–1.65)		Shah 1992
Gujarat (1987-89)	Butter	(1.65–5.84)		Shah 1992
Hyderabad (1994)	Butter	(0.026–0.13)	(0.079–0.85) Aldrin (0.13–0.47) Dieldrin (0.05–0.078) Heptachlorepoxide	CERC 1994
India (1999)	Butter	(0–0.01)	(0.01–0.07) Heptachlor	Insight Jul-Aug 1999
Ghee				
Andhra Pradesh (1978)	Ghee	2.1		Kannan 1997 (review)
Punjab (1980s)	Ghee	4.0		Kannan 1997 (review)
Uttar Pradesh (1980s)	Ghee	6.0		Kannan 1997 (review)
Uttar Pradesh (1983)	Ghee	3.8		Kannan 1997 (review)
Gujarat (NA)	Ghee	2.63		Shah 1992
Gujarat (1987-89)	Ghee	2.375 (0.017–7.623)		Shah 1992
Hyderabad (1994)	Ghee	(0.048–0.135)	(0.113–0.773) Aldrin (0.076–0.233) Dieldrin (0.007-0.058) Heptachlorepoxide	CERC 1994
Jorhat (NA)	Ghee	Max 0.8467		Deka 1997
Kolkata (2000-01)	Ghee	(0.0145–0.422) Max DDE 1.005	Aldrin present	WHO 2001
India (2001)	Ghee	(0.08–1.01)	0.01 Heptachlor	Insight Jul-Aug 2001
Other Milk Products				
Pakistan (1984)	Cheese	0.477		Hayat 2000
Hyderabad (1994)	Cheese	(0.118–0.247)	(0.177–0.247) Aldrin (0.107–0.279) Dieldrin 0.037 Heptachlorepoxide	CERC 1994
Hyderabad (1994)	Paneer	(0.003–0.29)	(0.031–0.14) Aldrin (0.031–0.034) Dieldrin	CERC 1994
Hyderabad (1994)	Icecream	(0.007–0.096)	(0.034–0.17) Aldrin (0.06–0.103) Dieldrin	CERC 1994
India (2002)	Icecream		(0–0.21) Heptachlor	Insight May-Jun 2002
Bombay (1994)	Shrikhand	(0.038–0.055)	(0.031–0.079) Aldrin (0.003–0.023) Dieldrin 0.002 Heptachlorepoxide	CERC 1994
Jorhat (NA)	Cream	0.0187		Deka 1997
Jorhat (NA)	Curd	0.0031		Deka 1997
Pune (2000-01)	Milk Product	(0.024–0.184)	(0–0.027) Aldrin	WHO 2001

Ludhiana were reported to have declined from January to July, increased sharply from August – September and remained constant till December. The results are given in Table 3.88a.

Oils and fats

Along with dairy products and meats, oils and fats represent a class of foodstuffs with significant levels of POPs detected in the various monitoring surveys accessed. Considering the widespread use of oils in domestic use as well as in the food processing industry, it is important to effect a more largescale and thorough knowledge of the presence of POPs in oils and fats. Considering the fact that oils and fats, like most other processed food in the region, is transported over long distances before finally arriving at the point of usage, it is difficult to determine from the data if the locations of the sampling might be connected with the usage of POPs in the locality. In any case, the continued presence of POPs in oils and fats as indicated by recent surveys does indicate that the problem exists in some form. The data accessed is presented in Table 3.99 on page 52.

Baby food

Baby food represents the dietary intake by a very vulnerable section of society. In this stage, the levels of POPs in infant food needs to be monitored regularly and ensured to be at a level that can be considered to be safe. The available data indicates the presence of POPs in baby food even in recent surveys. The few previous surveys taken in the 1980s and early 1990s have indicted significant levels of POPs in baby food. It is necessary to have a revision of the data to understand the present status of the nature of the contamination. The data collected on baby food contamination is given in Table 3.105.

Cattle and poultry feed

Cattle and poultry feed constitute an important pathway for the movement of POPs into human food products, especially dairy products.

The results from the 1984 monitoring of foodstuffs in Pakistan indicate that the contamination levels are comparable with Indian foodstuff levels sourced from the same time period. The 1989 nationwide study in India[1] indicates that spices, milk products, oils and meat products are most heavily contaminated with all the POPs chemicals as compared with cereals and pulses. This trend of high contaminations in milk products, oils and meat products is applicable to other surveys as well. It is difficult to confirm region wide time trends from these few individual studies. The latest findings of the AICRP claim declining trend of POPs pesticide residues in the region but it has not provided the data time trends to corroborate the

Table 3.83: Extent of contamination of dairy milk samples with DDT residues* in different states of India

State	No. of samples analysed	No. of samples above detection limit (%)	No. of samples with residues above MRL (%)
Himachal Pradesh	120	120 (100)	67 (55.8)
Punjab	263	257 (97.7)	133 (50.6)
Haryana	120	116 (96.6)	6 (5.0)
Uttar Pradesh	240	137 (57.1)	26 (10.8)
Madhya Pradesh	240	230 (95.8)	52 (21.7)
Maharashtra	299	299 (100)	222 (74.2)
Gujrat	120	299 (100)	84 (70.0)
West Bengal	120	43 (35.8)	15 (12.5)
Bihar	120	115 (95.8)	23 (19.2
Andhra Pradesh	240	208 (86.7)	137 (57.1)
Karnataka	203	45 (22.2)	36 (17.7)
Kerala	120	115 (95.8)	11 (9.2)
Combined	2205	1805 (81.9)	812 (36.8)

Source: Kalra 1999

Table 3.105 Contamination in baby food

Location (year)	Sample	DDT ppm Mean (range)	Other POPs ppm Mean (range)	Reference
India (1977–81)	Infant Milk	(0.04–2.7)		Kannan 1997 (review)
India (1989)	Infant formula	0.3 (0–4.33)		Kalra 1991
Gujarat (NA)	Infant Milk	(0.163–0.326)		Kumar 1991
Bombay (NA)	Infant Milk	(0.139)		Kumar 1991
Rajasthan (NA)	Infant Milk	(0.031–0.081)		Kumar 1991
New Delhi (NA)	Infant Milk	(0.038–0.101)		Kumar 1991
Hisar (NA)	Baby Food	0.071 (0.070–0.765)		Kathpal 1992
Gujarat (1990–92)	Bby mlk pwdr	0.242 (0–0.509)		Raj 1994
N Delhi (1990–92)	Bby mlk pwdr	0.134 (0.033–0.299)		Raj 1994
Maharashtra (1990–92)	Bby mlk pwdr	0.023 (0–0.092)		Raj 1994
Himachal Pradesh (NA)	Baby Milk	(0–0.839)		AICRP 1999
Hyderabad (NA)	Baby Milk	(0.021–0.32)		AICRP 1999
Hyderabad (2000–01)	Infant Milk	0	Dieldrin present	WHO 2001
Kolkata (2000–01)	Infant Milk	(0–0.010) 0.0048 DDE max	Aldrin, Dieldrin present	WHO 2001
Pune (2000–01)	Infant Food	(0.003–0.017)	Aldrin (0–0.004)	WHO 2001

same.

DDT, Aldrin, Dieldrin, Chlordane, Heptachlor, Endrin and PCB residues are still being detected throughout the region in recent surveys and the levels are being measured as above the MRLs in certain places. The recent FAO study in 200-01 shows low concentrations of DDT, but relatively higher concentrations of DDE. This suggests that POPs in the environment might be getting broken down to their metabolites. Thus studies and reports which suggest declining levels of DDT and other POPs in the environment need to be corroborated with information on their metabolites, which might still be persistent and potentially harmful.

There has also been no study on Dioxin and Furan contamination in food. The significance of the problem of POPs contamination in food might infact is underplayed by the lack of sufficient data. Such lack of data could be attributabed to waning academic interest and lack of funding available to undertake analyses of POPs contamination.

Conclusion

POPs in the environment reach humans through a variety of pathways. Chief transport mechanisms identified are freshwater, air and marine transportation, which enable the movement of POPs chemicals in the environment over long distances within the region. In terms of contamination levels of POPs in various environment niches, there have been numerous monitoring studies identified, but they reveal a very patchy (in terms of spatial and temporal spread) picture of the state of POPs in the region. It is difficult to extrapolate meaningful inferences from this information. In effect, with contradictory claims and in some cases, high levels of POPs even in recent years, it is difficult to arrive at a settled conclusion with regard to trends or effects of the imposed bans.

The nationwide food contamination surveys, reports and com-

The available data indicates the presence of POPs in baby food even in recent surveys. The few previous surveys taken in the 1980s and early 1990s have indicted significant levels of POPs in baby food. It is necessary to have a revision of the data to understand the present status of the nature of the contamination

Table 3.99: POPs residues in oils and fats

Location (year)	Sample	DDT ppmMean (range)	Other POPs ppm mean (range)	Reference
Punjab and AP (1970s)	Oils	0–26		Kannan 1997 (review)
Punjab (1978)	Oils	0–1.6		Kannan 1997 (review)
Uttar Pradesh (1983)	Oils	0.21–2.4		Kannan 1997 (review)
Pakistan (1984)	OilHydr. oil	0.494 0.309	0.099 Dieldrin	Hayat 2000
Uttar Pradesh (NA)	Oils	0.04–42		Kannan 1997 (review)
India (1989)	Oils	0.021 (0.0018–0.057)	0.011 (0.0026–0.015) PCB 0.0015 (0–0.0028) HCB 0.019 (0–0.047) Aldrin 0.024 (0–0.047) Dieldrin (0.00008–0.0016) Heptachlor	Kannan 1992
Gujarat (1990s)	Oils	0.25–0.51		Kannan 1997 (review)
Lucknow (NA)	C'nut oil Mstrd oil	1.4–10.91.3–1.6		Indian Ocean 2002
Lucknow (NA)	G'nut oil	1.96	0.292 Aldrin	Indian Ocean 2002
Sitapur, Uttar Pradesh (NA)	G'nut oil	2.96	0.89 Aldrin	Indian Ocean 2002
Anand (NA)	G'nut oil	0.157		AICRP 1999
Rahuri , MP (NA)	G'nut oil	0.15		AICRP 1999
Anand (NA)	Ctn sd oil	0.068		AICRP 1999
Rahuri (NA)	Ctn sd oil	0.09		AICRP 1999
Anand (NA)	Sesme oil	0.505		AICRP 1999
Rahuri (NA)	Sesme oil	1.33		AICRP 1999
Anand (NA)	Rapesd oil	0.19		AICRP 1999
Anand (NA)	Palm Oil	0.019		AICRP 1999
Anand (NA)	Castor Oil	0.052		AICRP 1999
Anand (NA)	Hydr oil	0.008		AICRP 1999
Rahuri (NA)	Saffl. oil	0.06		AICRP 1999
Rahuri (NA)	Linsd Oil	0.17		AICRP 1999
Rahuri (NA)	Sunfl. Oil	0.02		AICRP 1999
Rahuri (NA)	Soybean	0.08		AICRP 1999
Rahuri (NA)	Veg. ghee	0.012		AICRP 1999
Hyderabad (2000–01) Kolkata (2000–01)	Oils and Fats Oilsds	 (0–0.012)	Dieldrin present Aldrin, Heptachlor, Dieldrin	WHO 2001 WHO 2001
Kolkata (2000–01) 0.87	Oils	(0–0.667)Max DDE	Heptachlor present	WHO 2001
Pune (2000–01)	Oils	(0–0.018)	(0–0.008) Aldrin	WHO 2001
Pune (2000–01)	Oilsds	(0.001–0.01)	(0–0.001) Aldrin	WHO 2001

Table 3.111 Residues in animal feed

Location (year)	Sample	DDT ppmMean	Other POPs ppm mean (range)	Reference mean (range)
Anand (NA)	Straw	0.098		AICRP 1999
Bhubaneswar (NA)	Straw	–		AICRP 1999
Coimbatore (NA)	Straw	0.03		AICRP 1999
Hisar (NA)	Straw	–		AICRP 1999
Hyderabad (NA)	Straw	0.015		AICRP 1999
Jabalpur (NA)	Straw	ND		AICRP 1999
Jaipur (NA)	Straw	ND		AICRP 1999
Jorhat (NA)	Straw	0.008		AICRP 1999
Kanpur (NA)	Straw	0.199		AICRP 1999
Ludhiana (NA)	Straw	0.35		AICRP 1999
Bihar (NA)	Straw	–		AICRP 1999
New Delhi (NA)	Straw	0.125		AICRP 1999
Rahuri, MP (NA)	Straw	0.017		AICRP 1999
Anand (NA)	Feed Conc.	–		AICRP 1999
Bhubaneswar (NA)	Feed Conc.	–		AICRP 1999
Coimbatore (NA)	Feed Conc.	0.122		AICRP 1999
Hisar (NA)	Feed Conc.	–		AICRP 1999
Hyderabad (NA)	Feed Conc.	0.067		AICRP 1999
Jabalpur (NA)	Feed Conc.	ND		AICRP 1999
Jaipur (NA)	Feed Conc.	ND		AICRP 1999
Jorhat (NA)	Feed Conc.	0.034		AICRP 1999
Kanpur (NA)	Feed Conc.	0.595		AICRP 1999
Ludhiana (NA)	Feed Conc.	0.087		AICRP 1999
Bihar (NA)	Feed Conc.	0.111		AICRP 1999
New Delhi (NA)	Feed Conc.	0.052		AICRP 1999
Rahuri, MP (NA)	Feed Conc.	0.322		AICRP 1999
Solan hp (NA)	Feed Conc.	0.047		AICRP 1999
Unspecified (NA)	Poultry feed	(0–0.29)	Aldrin, Dieldrin (0 – 0.281)	AICRP 1999
Punjab (NA)	Feed Conc.	0.1 (0.01–0.28)		Battu 1996
Punjab (NA)	Straw	0.36 (0–6.7)		Battu 1996
Punjab (NA)	Green Fodder	0.08 (0–0.36)		Battu 1996
Ludhiana (NA)	Feed Conc.	0.08 (0–0.58)		Kang 2002
Ludhiana (NA)	Green Fodder	0.01 (0–0.18)		Kang 2002

pilations indicate that POPs are being detected even in recent surveys. Dairy items, oils, fats and meat products have been identified as categories with higher levels of contamination than other categories. Given the magnitude of consumption and the level of contamination, it is expected that dairy products will warrant maximum consideration. In certain cases, the levels have been recorded above MRLs. This indicates that despite the ban and the expected reduction of POPs (especially DDT), the issue of food contamination by POPs continues to be an issue of concern. A combination of lax regulations and implementation of the ban and the continued use of largely ineffective DDT for malaria control is resulting in unsafe levels of POPs in food.

Recent investigations of daily intakes have also indicated that populations in India might be exposed to 'undesirable' levels (in fact any level may be undesiarable) of POPs contamination. Since food is a principal pathway for human exposure of POPs, the situation warrants better investigation to ascertain the extent and localization of the problem so that effective monitoring and control measures can be taken to ensure that the health of the regions' population is not unduly affected by high (or any) levels of POPs exposure through food.

References

1 Bhatnagar 2001

2 Interaction with Dr C Venkataraman, CESC, IIT Bombay

3 Interaction with Dr C Venkataraman, CESC IIT Bombay

4 Interaction with Dr A Sarkar, NIO

5 Kaushik 1991

6 Ramesh 1989

7 Interaction with Dr M.S Shailaja, NIO

8 Bhatnagar 2001

9 Interaction with Dr V.P Bhatnagar, NIOH, Ahmedabad

10 CPCB 2000

11 Interaction with Dr RC Trivedi, CPCB

12 CPCB 2000

13 Parivesh 2001

14 Parivesh 2001

15 Ali 1998-99

16 Singh 1992

17 Singh 1996, Singh 1999

18 Singh 1999

19 Dua 1998a

20 Sarkar 2002

21 Agarwal 1987

22 Kashyap 2002

23 Interaction with Prof. S Asolekar, CESE, IIT Bombay

24 CPCB 1995a

25 Mohapatra 1995

26 CPCB 1995

27 Interaction with Prof. M. Shah, CERC

28 Indian Ocean 2002

29 Insight Jan-Feb 1998

30 Mathur 2003

31 Communication with Dt Neeta Thacker, NEERI

32 Agarwal 1986

33 Sethi 1999

34 Senthilkumar 1999

35 Kannan 1997

36 Indian Ocean 2002

37 Thacker 2002

38 Interaction with Dr A. Munusamy, RRL, Trivandrum

39 Interaction with Dr A. Munusamy, RRL Trivandrum

40 Senthilkumar 2001

41 Sarkar 1997

42 Bhattacharya 2003

43 Interaction with Dr M Sengupta, MoEF

44 Interaction with Dr D.B Saxena, AICRP on pesticide residues

45 Interaction with Dr Kalra

46 Kapoor 1989

47 Nath 2000

48 Interaction with Dr D.B Saxena, AICRP ; Khan 1998a

49 Shukla 2002

50 Balasubramani 2000

51 Kannan 1997

52 Kannan 1997

53 Kannan 1997

54 Kannan 1992

55 Interaction with Dr D.B Saxena, AICRP

56 Interaction with Dr O.P Dubey, ADG(PP), ICAR

57 Palikhe 2001

58 Palikhe 2001

59 Bakore 2002

60 Hayat 2000

61 Khan 1998a

62 John 2001

63 Battu 1996

64 Kannan 1992

4.0 Exposures

POPs in the region's environment have been detected in various human tissue samples and animal samples. The presence of POPs residues in human and animal samples is probably the most effective way to confirm the exposure and magnitude of POPs in the population of the region. There have been no regular studies in the region to cover a long term monitoring of the population on a systematic basis. Most of the studies have been one time studies and confined to a geographical location. It is hence not possible to make estimates of the extent of POPs presence in the region on human and wildlife populations.

However the studies identified show widespread presence of POPs in both human and animal samples, often in higher concentrations, and as such are a matter of concern. It must be remembered that POPs exposures even at low doses (the timing of the exposure being as important as the dosage) can cause undesirable helath effects, especially in the more vulnerable populations such as pregnant mothers, and in young children.

The results of the various studies are compiled in this section dealing with levels in human tissues and levels in animal samples.

4.1 Wildlife

Animals samples, both wildlife and domestic animals have been tested in the region. Animal samples, especially wildlife samples and samples from hunting species at the top of the food chain give an understanding of the levels of contamination experienced by the location under consideration. Such monitoring is also essential to understand the effect of POPs contamination on the ecosystem and to understand POPs pathways and accumulation in uninhabited areas.

4.1.1 Aquatic species

The incidence of pesticide residues in fish should be viewed seriously due to the possibility of further accumulation. Fish are both an indicator of contamination of the waterways as well as a source of food showing bio-accumalation. Studies indicating POPs loads in aquatic species have been summarized in Table 4.1.

Zooplankton and fish samples from different locations in the northern Arabian Sea before and during the southwest monsoon were examined for residues of DDT, its metabolites and Dieldrin[1]. During the monsoons, the concentrations of total DDT and Aldrin in zooplankton were 4 and 5 times higher respectively than pre-monsoon concentrations and the corresponding increases in fish were 10-30 times and 3-40 times.

The presence of considerable amounts of primary DDT in samples obtained during the monsoons, coinciding with peak agricultural activity on land, indicated that (a) the pesticide residue levels in the organisms reflected their pattern of use on land and (b) the pesticide compounds entering this environment were rapidly disseminated.

Also, feeding habits of fishes dictated accumulation. Pelagic (living in the open sea) varieties accumulate more residues than the demersal (living near the sea bottom) ones during the pre monsoon season while the opposite is true for the monsoon season.

It was recognised in the study that a large portion of the pesticides used on land reaches the oceans through atmospheric transport and river discharges. Samples were collected in 1991 in March (pre-monsoon) and September (post-monsoon). Results are given in Table 4.7a.

- In a study on the Ganga canal in 1997[2] from where Delhi sources part of its water supply, benthic macrovertebrae were tested for pesticide residues. The biota consisted of crustaceans, tricoptera, ephemeroptera, polycentropede, odonta etc. among insects. The biomagnification factor was estimated by the ratio of the concentrations in the biota to the concentration in water and given in Table 4.3a. The existence of pesticides in biota reflects that they are still in use in the catchment area of the Ganga canal or they are persisting in residual form. The DDT concentration was maximum in the month of March and Dieldrin in the month of February. Aldrin was non traceable during the entire period of sampling.

- In a recent study conducted by the RRL, Trivandrum[3],

The presence of considerable amounts of primary DDT in zooplankton and fish samples obtained during the monsoons, coinciding with peak agricultural activity on land, indicate that the pesticide residue levels in the organisms reflected their pattern of use on land

Table 4.1: Studies indicating POPs loads in aquatic species

Location (year)	Tissue Sample	DDT ng/g mean(range)	Other POPs ng/g mean (range)	Reference
Delhi (NA)	Clam Fish	40 (30–82) 122 (47–267)	-	Nair 1989
Marine (NA) 1989	Marine Fish	Op' (0–7) Pp' (0–42)	(0.1–4) Heptachlor (2–90) Aldrin (0–1) Dielrin (3–80) Endrin	Radhakrishnan
Tamil Nadu (1987–91)	Fish Turtle Crab	(0.86–75) (0.52–1.4) (5.8–59)	(0.75–40) PCBs (0–0.2) HCB (3.4–6.9) PCBs (0.01–0.02) HCB (2.9–29) PCBs (0–0.03) HCB	Ramesh 1992
Eastern Arabian Sea (1987–88)	Coastal Fish Open Ocean Fish	(0–54.3) (0–204.5)		Shailaja 1989
Southern Bay of Bengal (1990–91)	Zooplankton	(4.0–6.2)	(0.19–0.78) Aldrin	Shailaja 1994
Northern Bay of Bengal (1990–91)	Zooplankton	(268.73–1587.76)	(ND) Aldrin	Shailaja 1994
Bay of Bengal (1990–91)	Fish	(1.31–30.03)	(0–1.03) Aldrin	Shailaja 1994
Arabian Sea (Pre–Monsoon, 1991)	Zooplankton Fish	(3.36–38.4) (0.43–32)	(0–11.21) Aldrin (0–4.53) Aldrin	Shailaja 1997
Arabian Sea (PostMonsoon,1991)	Zooplankton Fish	(31.8–140) (48.3–435)	(0–13.5) (0–6.73)	Shailaja 1997
Delhi (1989–93)	Fish	(1.6–27)	(0.77–110) PCBs (1–15) Ald&Dield (0.14–2.1) Chlord	Kannan 1995
Bombay (1989–93)	Fish	(6.1–140)	(0.38–6.8) PCBs (0.5–2) Ald&Dield (0.47–2.2) Chlord	Kannan 1995
Kolkata (1989–93)	Fish	(4.2–62)	(1.6–9.5) PCBs (0.37–3) Ald&Dield (0–0.27) Chlord	Kannan 1995
Patna (1989–93)	Fish	160	20 PCBs 5.4 Ald&Dield 30 Chlordane	Kannan 1995
Bengal (NA)	Fish	(0–892)	(0–169.3) Aldrin	Joshi 1996
Ganges (1988–92)	Dolphin	(77–13000)	(0.06–7.2) HCB (0.11–29) Aldrin (0.16–59) Dieldrin (0.06–8.7) Hept (4.6–620) PCBs (1.1–76) Chlord	Kannan 1994
Ganges (1988–92)	Fish	160	0.24 HCB 2.7Aldrin 2.9 Dieldrin 3.5 Hept 20 PCBs 30 Chlord	Kannan 1994
Ganges (1992–96)	Dolphin	(750–64000)	(1.9–240) Chlord (0.4–9) HCB (180–13000) PCBs	Senthilkumar 1999
Ganges (1993–96)	Fish	(60–3700)	(0.8–18) Chlordane (65–270) PCBs (0.07–0.5) HCB	Senthilkumar 1999

Table 4.1: Studies indicating POPs loads in aquatic species

Location (year)	Tissue Sample	DDT ng/g mean(range)	Other POPs ng/g mean (range)	Reference
Ganges (1993–96)	Benthic Invertibrates	(250–740)	(3–30) Chlord (34–47) PCBs (1–21) HCB	Senthilkumar 1999
Ganges (1996)	Dolphin	(171.9–13700)	(4.0–9.2) Aldrin	Kumari 2002
Ganga, Patna (1997)	Fish	(13.6–1665.9)		Kumari 2001
Gang Canal (Near Delhi, 1997))	Benthic Macrovertebrae	(501.22–2786.67)	(0–308.73) Dieldrin	Sharma 2001
Haleji Lake, Pakistan (1999–2000)	Fish	23.6	11.5 HCB, 2.9 PCBs	Sanpera 2003
Taunsa Barrage, Pakistan (1999–2000)	Fish	78.4	7.4 HCB–PCBs	Sanpera 2003
Karachi, Pakistan (1999–2000)	Fish	32.1	5.8 HCB–PCBs	Sanpera 2003
North India (NA)	Dolphin Fish		(0.015–0.22) Dioxin (0.011–0.42) Furan (8.4–123.48) PCBs (0.04–0.082) Dioxin (0.017–0.048) Furan (16.01–32.63) PCBs	Senthilkumar 2001a
South India (NA)	Fish		(0.009–0.033) Dioxin (0.002–0.004) Furan (2.18–4.12) PCBs	Senthilkumar 2001a
Trivandrum	Turtle		(0–0.004) Dioxin (0–0.124) Furan	Unpublished Dr M Anbu

turtle, fish and crab samples were sampled from the Veli estuary near Trivandrum during January 2003 and analysed for the presence of PCBs, dioxins and furans. The study reported levels of concentrations of dioxins and high concentrations of furans in the lake with a maximum of 3.99 ng/kg 1,2,3,6,7,8 HCDD in turtle tissue, 124.25 ng/.kg 1,2,3,7,8 PCDF in turtle tissue and a maximum of 362.575 ng/kg 2,4,4' trichlorobiphenyl in turtle tissue. In terms of dioxin and furan contamination, turtle samples contain higher levels than fish and crab samples.

▲ During December 2002, in a study conducted by the RRL, Trivandrum[4], samples of fish and clam were collected from the Chaliyar river in Kerala were collected and analysed for the presence of dioxins, furans and PCBs. The sampling site was chosen as the effluents of a paper mill were discharged into the Chaliyar river in that area. A few cogeners of dioxins and furans and different cogeners of PCBs were detected in the fish samples. The presence of PCBs was more abundant in the fish. 1,2,3,6,7,8-HxCDD was found in the Eri variety of fish at 0.027 pg/g while 1,2,3,7,8-PeCDF was detected in the Eri fish sample at 0.2215 pg/g. The highest PCB level was detected in the Chemballi variety of fish at 3.0917 micrograms/g of 2,6-DCB.

The tissue of Dolphins have been found to contain excessively high levels of DDT and other POPs like Chlordane, Aldrin, Dieldrin, Heptachlor, HCBs and PCBs much in excess of the codex standards for edible meat. Dioxins and Furans have also been detected in dolphin tissue. Such high levels in dolphin tissue (probably as a result of bioaccumulation from fish) would indicate significant damage to dolphin populations due to POPs contamination. High levels of PCBs have also been measured in turtle and fish tissue near Trivandrum with a possible connection to transformer oil leaks in the region. Dioxins and Furan levels measured in Trivandrum and in fishes in North and South India indicate their presence in the environment. Further sampling and analysis of dioxins and furans are required to understand the effect of industrial activity in the region.

4.1.2 Terrestrial species and avifauna

The levels in the studies identified indicate the presence of POPs in terrestrial animals and avifauna in the region. The levels of POPs in bird eggs in certain areas of Pakistan indicate a relatively high exposure to wildlife and the environment. These levels (in bird eggs) analysed in Pakistan seem comparable to similar levels in India. A study has indicated that the levls of PCBs in birds are increasing[5]. On the whole, DDT accumulation is of great concern in birds migrating to India.

Table 4.18: Summary of the studies on tissue sample of terrestrial species and avifauna

Location (year)	Tissue Sample	DDT ng/g mean(range)	Other POPs ng/g mean (range)	Reference
Delhi (1988–89)	Earthworm		13 (5–18) HCB	Nair 1989
	Pigeon		10 (6–13) HCB	
Tamil Nadu coastal (1987–91)	Lizard	(4.1–7.7)	(4.7–13) PCBs	Ramesh 1992
			(0.03–0.31) HCB	
	Bird (Resident)areas	(0.6–1800)	(2.9–76) PCBs	
			(0–0.57) HCB	
Tamil Nadu (NA)	Wild Bird Eggs	(96–624)		Regupathy 1992
		Poultry Eggs	11 (0 – 1316)	
	Tamil Nadu coastal	Birds (Resident)	(120 –1000) PCBs	
Senthilkumar 1999	areas (1995)	Birds(Local Migrant)	(190 – 890) PCBs	
	Birds (Migrant)		(80–2000) PCBs	
	Bat		(190–330) PCBs	
South India Agri areas (NA)	Bat"	(0.4–670)	(3.8–230) PCB	Senthilkumar 2001
			(0–5.6) HCB	
			(0–2.1) Chlordane	
	Birds(resident)	(0.8–3600)	(6.5–940) PCB	
			(0–1.2) HCB	
			(0–12) Chlordane	
	Birds local migrants	(67–13000)	(30–640) PCB	
			(0–2) HCB	
			(0–2.3) Chlordane	
	Birds migrants	(9.2–3300)	(18–4400) PCB	
			(0–4.7) HCB	
			(0–10) Chlordane	
	Egg yolk	(10–8700)	(56–1700) PCB	
			(0–33) HCB	
			(0–78) Chlordane	
Haleji Lake, Pakistan (1999–00)	Egret eggs	728.3	16.3 HCB	Sanpera 2002
			1.4 PCBs	
Taunsa Barrage, Pakistan (1999–00)	Egret eggs	2943.4	1.7 HCB	Sanpera 2002
			100.4 PCBs	
Karachi, Pakistan (1999–00)	Egret eggs	2665.9	10.3 HCB	Sanpera 2002
			4203.8 PCBs	
All India (NA)	Chicken		0.011Dioxin	Senthilkumar 2001
			0.014 Furan	
			0.11 PCBs	
	Lamb		0.013 Dioxin	
			0.018 Furan	
			0.313 PCBs	
	Goat		0.019 Dioxin	
			0.023 Furan	
			0.242 PCBs	
	Birds (Raptors)		(0.24–2.7) Dioxin	
			(0.019–1.00) Furan	
			(10.05–99.7) PCBs	

Low concentrations of PCBs in local birds in India indicates that their contamination is lower than that due to DDT. A preliminary estimate by comparing bird eggs' concentration to that in birds indicates that more than 20% of the organochloriness are transferred via eggs[6].

- Egret eggs were studied during 1999-2000 to study the effect of POPs in three wetland regions of Pakistan – Taunsa barrage (agricultural pollution), Karachi harbor (industrial activities) and Haleji lake (pristine)[7]. Concentrations were also determined in several prey in its diet and in the sediments collected in foraging areas. Differences in egg pollutant concentrations were significant. Differences in bioconcentrations were very small suggesting that eggs were reliable indicators of pollution in the environment. The values reported are generally lower than those reported from North America and the Mediterranean and about the same order of magnitude as mid size egrets from other parts of the world. Pollutant transport to the Haleji lake is expected mainly through the air owing to its remote location. Overall, DDTs were the OC compounds that reached the highest concentration with the exception of PCB found in the samples from Karachi. The results are given in Table 4.25a.

4.2 Humans

No segment of the population is completely protected against exposure to pesticides and the potentially serious health effects, though a disproportionate burden is shouldered by the people of developing countries and by highrisk groups. Factors that influence variations in levels include intensity, efficiency of absorption, species, age, nutritional status and integrity of the organs. In the absence of a suitable animal, tissue culture or human biomarker model of biological evidence to provide objective evaluation, the pharmacological interpretation of small amounts of pesticide in the human body is not possible[8].

Biological monitoring is becoming an increasingly important tool in field studies designed to evaluate the magnitude of risk from occupational pesticide exposure. The primary objectives of biological monitoring are to (i) prevent health impairment, (ii) assist in the assessment of risk and (iii) to evaluate the effectiveness of environmental controls. With our limited knowledge with indirect/ inferential information, the domain of pesticides illustrates certain ambiguity in a situation when people are undergoing life long exposure.

Numerous studies in India and some studies in Pakistan have been identified which tested human tissues for the presence of POPs chemicals.

4.2.1 Breast milk

DDT residues in human milk have been compiled from various locations in different time periods in the South Asia region. Most of the studies identified have been from the 1980's or early 1990's. The relative paucity of syudies in recent years, considering the continued detection of POPs chemicals in recent surveys, indicates the need to perform better coordinated, comprehensive nationwide surveys to ascertain the true levels of contamination in human milk. This information is important as it also has a bearing on the health of the infants who are to be nursed on the milk. The results are represented in Table 4.27

- In a study[153], samples of maternal blood, breast milk and cord blood from 25 mothers in Delhi were collected and tested for Aldrin and Dieldrin. A high correlation was found between the Aldrin concentration in breast milk and cord serum. However, no correlation was observed between maternal serum and cord serum. The results are given in Table 4.29a.

- In a study, 10 samples each of mother's milk samples were collected from rural and urban areas in Varanasi and analysed for DDT residues[10]. DDT was present in all the samples and it was found that mothers' milk from urban areas was comparatively heavily contaminated. It is reported that in Varanasi, DDT is used for public health frequently without maintaining the proper dose and schedule. The results of the study shown in Table 4.30a.

- In Himachal Pradesh (HP), 51 samples of mother's milk were sampled and tested for pesticide contamination[11]. All samples contained DDT and in 15% of the cases, the daily intake of DDT was found to be above the ADI. The study noted that there was a significant negative correlation between DDT levels and the number of children born to a mother. Districts with higher use of DDT for malaria spraying were found to contain higher concentrations of DDT. In HP, the mean total DDT in the samples were higher than those reported from other states. This may be due to the lower temperature in HP. Colder climates are known to result in slower degradations. The residues of DDT were found statistically independent of the dietary intake habits and the background of the mothers.

In terms of infants' exposure through the consumption of infant formulations and processed baby milk powder, it has been reported that in many commercially available brands, the contamination level results in an unacceptably high intake by infants fed on the formulations

Table 4.27: Residues in human milk have been compiled from various locations

Location (year)	DDT (ppm)Mean(range)	Other POPs (ppm)Mean(range)	Reference
Lucknow (1978–79)	0.127		Bhatnagar 2001 (review)
Ludhiana (1980)	0.51		Bhatnagar 2001 (review)
Ahmedabad (1982)	0.305		Bhatnagar 2001 (review)
Bangalore (1983)	0.053		Bhatnagar 2001 (review)
Calcutta (1983)	0.114		Bhatnagar 2001 (review)
Bombay (1983)	0.224		Bhatnagar 2001 (review)
Delhi (1986)	0.344		Bhatnagar 2001 (review)
Delhi (NA)		0.449 (0–2.102) HCB	Nair 1989
Faridabad (NA)		0.035 (0.029–0.043) HCB	Nair 1989
Delhi (NA)		0.0004 Aldrin 0.00013 Dieldrin	Dureja 1991
Unspecified (1988–89)	3.74 (0.36–5.5)		Nair 1991
Delhi (1989–90)		0.000003 Aldrin 0.00006 Dieldrin	Nair 1992
Multan, Pakistan (1992)	Pp' (0–0.903) Op' (0.413 – 1.41)		Hayat 2000
Varanasi Rural (NA)	(0.003–0.139)		Raha 1996
Varanasi Urban (NA)	(0.004–3.125)		
Delhi (NA)	1.27 (0.33–4.11)		Nair 1996
Lucknow (1996)	0.54	0.01 Aldrin	Siddiqui 2002
Himachal Pradesh (NA)	0.51 (0.074–2.142)	Dioxin 270 (pg/g fat wt)Furan	Gupta 2001
Chennai (NA)		42 (pg/g fat wt)PCBs (190–23000) (pg/g fat wt)	Kunisue 2001
Sri Lanka (NA)	0.087	0.025 Dieldrin	Indian Ocean 2002
Punjab (1999)	(0.44–0.7)		Joia 2000

4.2.2 Infant exposure

Of particular concern is the exposure of the fetus and newborn infants to POPs through placental blood, breast milk and baby food. Considering their vulnerability and low body weight, the exposure of the fetus and infants to the POPs burden of their mothers is significant.

Not much is understood on this aspect of POPs exposure. There is a need to recognise this problem and address the issue of POPs exposure not just as limited to humans in general, but by different age groups and development status[12]. There have been a few studies identified to understand the aspects of POPs exposure on the fetus and infants.

- In a study[135] comparing Dioxin related compounds in human breast milk from Asian developing countries, Indian samples showed the highest levels. The samples were taken

Table 4.27: a Comparison of dioxin related compounds in human breast milk of women in Asian developing countries

Chemical (pg/g fat wt)	India	Cambodia	Philippines
PCDDs	270	74	190
PCDFs	42	39	20
Non Ortho PCBs	190	45	80
Mono Ortho PCBs	23,000	3,600	7,800

Kunisue 2001

from near a municipal dumping site in Perungudi, Chennai. Toxic Equivalency Factors (TEQs) recorded in India were more than those recorded in USA and Japan but less than those recorded in certain European countries. Results are given in Table 4.27a.

- In a study in Lucknow in 1996, it was discovered that the daily intake of DDT and Aldrin by neo natals was many times greater than their respective ADI set by the WHO[14]. The study showed that in Lucknow, there has been a remarkable elevation in levels over 14 years, presumably due to the usage of DDT in health programs. However, bottle feeding as an option was considered to be a greater risk of pesticide exposure to babies. The results of the study are presented in Table 4.27b.

- Another study[15] indicated that exposure of pregnant women to organochlorine pesticides may increase the risk of Intra Uterine Growth Retardation (IUGR), which is a contributing factor for infant mortality in India. In the study in Lucknow, there was a significant negative correlation between body weight of newborn babies and p.p'-DDE in maternal blood and p.p'-DDE in cord blood.

- There have been other studies in India in the past which showed the transfer of DDT, aldrin and dieldrin from pregnant mothers to their developing fetus[16]. A higher level of these pesticides was detected in mothers undergoing premature labour or abortions than in those undergoing full term normal delivery.

Table 4.27:b Daily intake of DDT and aldrin by neo-natals

Pesticide	Mean +-SD	Calculated daily intake microgram per kg		ADI (WHO)
		1986 Study	1981 Study	
Total DDT	0.54+-1.46	146.7	34.56	20.0
Aldrin	0.01+-0.01	2.72	8.09	0.1

Source: Siddiqui 2002

- In a study in Delhi[17], it was found that breast milk after the first feeding showed 80% more residues of DDT as compared with maternal serum. Consumption of such a feed would involve 88% more residues in the new born to its preexisting levels. This shows that breast milk is the main source of contamination to new borns. However, the placenta was also no barrier to the movement of OCPs to the fetus since the levels of pesticides in the maternal serum were almost identical to that of the cord serum. Further, it was found that contamination levels were higher in first time mothers (primigravides) as compared with mothers with previous childbirths (multigravides) indicating that the mother is transferring her load of pesticides during childbirth. The results of the study are as shown in Table 4.59a.

- In a study in Himachal Pradesh[18], the frequency of occurrence of DDT residues above acceptable daily intake (ADI) in mother's milk for infants less than one month old (2.652 Kg average weight) taking on an average 0.530 L milk per day, was estimated. It was found that in 85% of the cases, the ADI was exceeded and in 30% of the cases, the ADI was exceeded by more than five times.

In terms of infants' exposure through the consumption of infant formulations and processed baby milk powder, it has been reported that in many commercially available brands, the contamination level results in an unacceptably high intake by infants fed on the formulations.

- 186 samples of 20 different brands of infant formula manufactured in India were collected in 1989 from Mumbai, Pune, Mysore, Lucknow and Ludhiana and tested for DDT[19]. Estimated DDT intakes by infants through consumption of recommended amounts of infant formula were within their acceptable limits. Results are represented in Table 4.60a.

- However, in another study, 100 samples including human and bovine milk, butter and baby food milk from Hisar were monitored for DDT contamination[20]. 8 out of 10 human milk samples contained DDT. All the baby food samples were highly contaminated with DDT. Based on an average 850 ml/day production of a normal mother, this level of contamination may lead to a maximum theoretical residue intake of 60.35 micro grams of DDT. Since a zero MRL is fixed for any baby food, this high level of contamination may cause drastic disorders in sensitive infants. The results are given in Table 4.61a.

The studies indicate the contamination of infants and the unborn fetus in the region. In many cases, the intakes exceed the ADI set up by the WHO for healthy adults. The ADI is a measure of the levels of intake that, over a long time period, do not significantly increase the risk of adverse health impacts on humans. It is difficult therefore to readily ascertain the significance of this high intake over a short time period by the developing infant based only on a comparison with the WHO ADIs[21]. It is a serious matter of concern that infants are being subject to high doses of POPs during vulnerable stages of their development. This issue needs to be investigated further to understand the implications and to check such exposures.

4.2.3 Adipose tissue

Studies have been identified which indicate the levels of POPs chemicals in human fat tissue. Since POPs are lipophilic, the information is indicative of the cumulative effect of the background exposure of populations. In the case of the utilization of fat reserves as in situations of deprivation, the accumulated fat dissolved POPs would enter the blood stream resulting in exposure and affecting the health of the individual. As is the case with other data, the information is very inadequate and does not allow an analytical consideration to provide substantial insights into geographical or time trends. The data accessed is presented below in Table 4.32.

- In a study[22], thigh fat, shoulder fat and breast fat were collected from candidates from the states of Tamil Nadu, Kerala and Karnataka in South India and tested for PCBs, Dioxins and Furans. The concentrations were found to be lower than that for developed countries. It was found that there is an increase of concentrations with age for males and a constant decrease with age for females. The results are given in Table 4.33a.

Table 4.32: Summary of studies on adipose tissue

Location (year)	DDT (ppm)Mean(range)	Other POPs (ppm)Mean(range)	Reference
Delhi (1964)	26.0		Bhatnager 2001 (review)
Delhi (1973)	21.8		Bhatnager 2001 (review)
Delhi (1976)	4.7		Bhatnager 2001 (review)
Chandigarh (1980)	20.03		Bhatnager 2001 (review)
Agra (1980)	12.02		Bhatnager 2001 (review)
Bombay (1980)	6.15		Bhatnager 2001 (review)
Calcutta (1980)	6.5		Bhatnager 2001 (review)
Bhopal (1980)	9.14		Bhatnager 2001 (review)
Ahmedabad (1980)	21.81		Bhatnager 2001 (review)
Bangalore (1980)	7.82		Bhatnager 2001 (review)
Meerut (1981)	4.7		Bhatnager 2001 (review)
Delhi (1984)	22.25		Bhatnager 2001 (review)
Delhi (NA)		0.0122 (0–0.064) HCB	Nair 1989
Faridabad (NA)		0.28 HCB	
Delhi (1988–89)	3.03 (0.17–9.12)	(0.059–0.83)	Nair 1991
Delhi (1989–90)		0.00005 Aldrin 0.0001 Dieldrin	Nair 1992
Pakistan, various locations (NA)	25	0.047 Dieldrin	Hayat 2000a
Quetta, Pakistan (NA)	10.1		Hayat 2001a
South India (NA) Male Female		 (0.00016–0.0012) Dioxin (0.00017–0.0013) Furan (0.0024–0.0366) PCBs (0.00022–0.0013) Dioxin (0.00023–0.0013) Furan (0.0007–0.0407) PCBs	Senthilkumar 2001a

4.2.4 Blood

The levels of POPs in the human bloodstream are expected to have a bearing on the overall health of the individual. In fact, it gives an estimate of the actual extent of exposure, which the various organ systems of the individual are being exposed to. Given the criticality of the information, it is required to ensure the availability of better information, especially in terms of non DDT POPs like dioxins and furans. It is also necessary to obtain contamination details from across regions and occupations to evaluate the relative risk among different populations in order to generate effective response mechanisms.

- During the Kumbh Mela in Haridwar in 1992, finger prick blood samples were tested for the presence of DDT[23]. 47 samples were taken from occupationally exposed people employed for spraying DDT for public health purposes and 37 samples were taken from the general population. DDT levels were 2.8 times higher in the occupationally exposed group. The wide range in the occupationally exposed group was due to the nature of their duties and the extent of their involvement in spraying operations. The results are given in Table 5.35a.

- A total of 632 subjects in the Hooghly estuary area were tested to study the impact of pollution on the health of the residents of the area[24]. A few random samples of blood were examined for organochlorine pesticide residues. The mean value of DDT in the blood of the local population was significantly higher in the study subjects than in the general population living in the non estuarine region. The estuary receives significant amounts of pollution from agricultural discharges, industrial activity and shipping activities among others. Results are shown in Table 4.36a.

- In a study[169] attempting to evaluate DDT levels from skin lipid samples as a non invasive, ethically acceptable method as compared with blood, urine, adipose or breast milk samples, samples of skin lipid and blood were collected in 1994 from the Mathura district of UP (Table 4.37a). There is an extensive use of DDT in Mathura for malaria control due to its endemecity. 24 samples were taken from the general population and 15 samples from occupationally exposed individuals involved in the spraying of DDT for malaria control. It was found that the whole blood and skin lipid samples from occupationally exposed individuals contained 1.3 and 1.9 times higher values than the general population.

- The levels of DDT are reported in human blood from populations residing in Nainital during March, July and November[26]. At the time of sampling, DDT was not used

Table 4.34: Summary of studies on blood

Location (year)	DDT (ppm)Mean (range)	Other POPs (ppm)Mean (range)	Reference
Lucknow (1980)	0.02		Bhatnager 2001 (review)
Delhi (1982)	0.71		Bhatnager 2001 (review)
Lucknow (1983)	0.028		Bhatnager 2001 (review)
Delhi (1985)	0.301		Bhatnager 2001 (review)
Delhi (1989–90)		0.000004 Aldrin	
Nair 1992		0.000002 Dieldrin	
Multan, Pakistan (1992)	Pp' (0–0.64) Op' (0–1.44)		Hayat 2000a
Hooghly estuary (NA)	0.0098 (0–0.0735)0.0016		Shrivastava 1993
Hooghly non estuary (NA)	(0–0.0088)		
Haridwar, General population (1992)Haridwar Occupationally exposed population (1992)	0.0210.058		Dua 1996a
Ahmedabad rural (1992)	0.048		Bhatnager 2001 (review)
Ahmedabad urban (1997)	0.032		Bhatnager 2001 (review)
Nainital March (NA)	2.73 mg/l	Dua 2001	
Nainital July (NA)	l6.92 mg/l		
Nainital Nov. (NA)	l4.59 mg/l		

for vector control in the area and its use for agriculture had been banned. DDT was higher in July as compared to March suggesting its illegal use in agriculture. It is also possible that the area facilitates a longer half life for DDT than the plains. The results are presented in Table 4.38a.

Conclusion

The studies identified on aquatic fauna in the region are mainly concentrated to India. As with most of the other data, the information is very disperses both temporally and spatially and it is not possible to understand the overall picture of contamination of fish and other aquatic life from these limited samplings. However, recent samplings indicate that there continues to be widespread DDT residues in fish. Significant values of DDT and other POPs such as PCBs and dieldrin have been detected in both inland as well as offshore fish samples. Recent evidence of POPs pesticides in fish samples might also point to their continued usage in agriculture despite the ban. Further evidence is essential to understand the nature and extent of such activity.

Apart from bird related samples, there have been very few studies identified for other terrestrial animals. In the few cases, levels in birds are significant indicating a greater risk of exposure in birds. Birds can also be used as sensitive biomarkers in terrestrial ecosystems to detect the presence of POPs[27]. Considering that birds are extremely vulnerable to environment stresses and pesticide poisoning, with reports of declining bird populations in the region, POPs exposure needs to be better understood and documented to ensure the future health of diverse ecosystems in the region.

In terms of DDT contamination in human milk in India, the levels indicate an increasing trend with time with recent studies indicating levels beyond 500 ppb. In a study identified in Pakistan, the levels in Multan were extremely high and comparable to the highest levels reported from India. Levels recorded in Sri Lanka are lower than those recorded in India and Pakistan. PCB, Dioxin and Furan levels recorded at Chennai have been found to be higher than those from nearby Asian countries. High levels of DDT have been reported from Varanasi, Himachal Pradesh, Multan and Delhi as compared to other locations in the region.

However, it is not possible to comment on the regional distribution and time trends with any sense of certainty without a more thorough and comprehensive study of the region involving a periodic monitoring program from different parts of the region. It is a matter of concern that POPs levels have been detected in significant levels in various parts of the region. This is an indication that infant health and the future well being of the population of the region are at a risk.

It is not possible to make out any trends in adipose tissue samples from the region. Higher levels of DDT have been reported from Delhi, Karachi, Quetta, Ahmedabad and Chandigarh relative to other locations in the region. Dieldrin and Aldrin have been detected in Delhi and Karachi while PCB, dioxins and furans (at levels lower than developed countries) have been detected in south India. There have been few identified studies after 1984 and none in the recent past. Since it is expected that POPs, being lipophilic, will accumulate in the adipose tissues, regular monitoring of human fat samples can help indicate potential areas of concern.

Blood sample monitoring does not show any specific trend. The low number of available reports and the random nature of sample location and period of sampling does not lend to an understanding of the nature of blood contamination of POPs in the region.

Recent monitoring of DDT blood levels in Nainital (where DDT is not used for vector control) has recorded higher levels of DDT post monsoon indicating their possible agricultural usage despite the ban. Studies indicate relatively high levels of DDT in Delhi, Nainital, Mathura, Multan and Quetta. Other POPs like Aldrin, Dieldrin, Heptachlor and Chlordane and HCB have also been detected in blood samples in the region. Since blood presence indicates the level of exposure and the magnitude of the possible effects in the populations, it is of crucial importance to enhance the quality of data in this segment.

References

1 Shailaja 1997

2 Sharma 2001

3 Interaction with Dr Munusamy Anbu, RRL, Trivandrum

4 Interaction with Dr Munusamy Anbu, RRL, Trivandrum

5 Senthilkumar 1999

6 Senthilkumar 2001

7 Sanpera 2003

8 Bhatnagar 2001

9 Dureja 1991

10 Raha 1996

11 Gupta 2001

12 Interaction with Mr Alexander Hildenbrand, WHO, SEARO office

13 Kunisue 2001

14 Siddiqui 2002

15 Siddiqui 2003

16 Siddiqui 2003

17 Nair 1996

18 Gupta 2001

19 Kalra 1991

20 Kathpal 1992

21 Interaction with Dr Siddiqui, ITRC

22 Senthilkumar 2001a

23 Dua 1996a

24 Shrivastava 1993

25 Dua 1998

26 Dua 2001

27 Interaction with Dr S A Akhtar, EIA Cell, BNHS

5.0 Environmental and health effects

There have been few identified studies on the effects of POPs on humans and the environment. In many cases, there have been contradicting opinions or ambiguities of the actual cause lrelationship between POPs and their effects.

This section examines the available documented information on studies related to evaluating the effect of POPs chemicals on humans and environmental compartments in the South Asia Region.

The potential human effects of individual POPs are listed below. These effects have been confirmed scientifically only to a limited extent.

In general, there have been very few field based evaluations in the region, which are important to evaluate the nature of POPs' effect in the specific climatic conditions of the region as also consequences of synergisms between multiple contaminants in the environment.

In a study in India[172], it was found that a combination of DDT and HCH was much more potent than DDT alone indicating the possibility of synergistic effects. The higher temperatures in the region might affect the persistence of POPs by shortening their half lives[2].

India is presently working on a project for monitoring environmental health parameters in 9 cities with an intention to understand pollution levels and health consequences[3]. It is expected that certain POPs issues will also be covered.

In terms of pesticide exposure, in India, a National Poisons Information Center (NPIC) has been working on providing solutions to poisoning cases nationwide. It has been noted that certain cases of exposure to banned pesticides like Aldrin[4] have also been reported indicating their continued usage. Out of the total poisoning cases, 35% cases were reported in children[5] Organochlorines are relatively minor causes possibly due to their relative lower acute toxicity. Organochlorines' contribution appears to be around 10%.

Ignorance about pesticides and their poisoning aspects is not only phenomenally high among common Indians, rural and urban, illiterate and educated, but also alarmingly high among the doctors and general practitioners of PHCs. In a survey of PHC physicians[6], the awareness on treatment, diagnosis and general issues concerning pesticide poisoning was found to be very low. Lack of awareness among medical practitioners leads to wrong diagnoses at times[7].

In India, a large number of pesticide poisoning cases have been encountered, but no countrywide statistics are available. This is owing to the fact that poisoning case reporting is not obligatory in India. It has also been noted that there is a paucity of essential medication and antidotes for dealing with acute poisoning cases in many places[179]. In general, there is not much

Table 5.1: Potential human effects of individual POPs

Effects	Aldrin Dieldrin	Chlordane	DDT	Toxaphene	Mirex	BHC	PCBs, Dioxins Furans
Reproduction and development	✔	✔	✔	✔	✔	✔	✔
Cytochrome P450 system	✔	✔		✔	✔	✔	✔
Porphyria						✔	✔
Immune system	✔	✔	✔	✔	✔	✔	✔
Adrenal effects			✔	✔		✔	✔
Thyroid and retinal effects			✔	✔		✔	✔
Mutagenic							
Carcinogenic effects	✔	✔		✔	✔	✔	✔
Skeletal changes				✔			✔

Source: North America 2002

information in the region on deaths and diseases due to pesticides[180].

Chronic exposure is more difficult to detect than acute exposure and in most cases, confounding factors like the presence of other possible causes make the task of affixing cause – effect linkages complicated. In addition, most toxicological data in the region is adapted from western countries[10], which does not necessarily reflect the climatic conditions, physical and health status of the inhabitants of the region. Toxicity data is also dependent on the manufacturing process and formulation type as well as methods of application, all of which have features unique to the region.

There is also insufficient work done on specific impacts on children and other vulnerable population groups. Considering their high food intakes (in terms of body weight) and vulnerability, such investigations are necessary[11] to ensure not overlooking this critical segment.

There have also been few studies done which examine the effect of POPs exposure to the environment. Such investigations are crucial in understanding the relationship between POPs and the declining quality of ecosystems. Many pristine areas are especially vulnerable as intricate relationships in terms of feeding habits ensure rapid assimilation and bioconcentration. For humans, there is no regional data to confirm direct correlation between exposures and health effects[183].

This section deals with the documented aspects of POPs effects on wildlife and on humans in the South Asia Region.

5.1 Wildlife

Organochlorine pesticide pollution (including POPs) has been considered to be of a serious nature with respect to wildlife. However, due to the lack of regular monitoring efforts in the region, the acuteness of the problem is not well understood[13]. A few studies have been identified that bring out certain documented instances of POPs effects on wildlife in the region.

5.1.1 Aquatic species

Studies have been identified on evaluating POPs exposure to certain organisms under laboratory conditions. Although these studies do not reflect the true ground situation exposure, they give some idea of the nature of response to different doses as well as the kind of experimental activity underway in the region.

- On treatment with DDT[14], low LDH (lactate dehydrogenase) activity was observed in mature and immature adult female Cybister confusus, a variety of fish. Increased LDH activity has been observed in Human serum and muscles under stressed conditions.

- DDT's sublethal concentrations' effects were observed in the fish Labeo rohita[186]. DDT is also used to control arthrophod parasites of cultured fish. It was found that there are quantitative changes in the fish, rohu, exposed to sublethal concentrations. There were non specific effects on metabolic pathways.

Table 5.2: The effect of DDT on mortality of the fish

DDT (ppm)	Rate of mortality (%)
0.1	50
0.2	60
0.3	70
0.4	80
0.5	100

Source: Gurusamy 2000

Table 5.3: Acute toxicity values

Pesticide	LC50 value (ppm)
Aldrin	1.00
DDT	0.0012

Source: Khan

- Effluents from certain pesticide companies including HIL, New Delhi (DDT) was tested for toxicity on zebra fish[187]. The results of the study suggest that all untreated effluent samples were more toxic than the respective treated effluents. The reduction in toxicity was greater than 90% for the POPs pesticides factory's effluents.

- Fresh water fish (Lepidocephalichthys thermalis) were exposed to different concentrations of DDT for 10 days[17]. The rate of oxygen consumption was noted to be decreasing with increasing duration of exposure and concentration level. Decreased rate of oxygen consumtion was noted even in the lowest concentration of DDT (0.02 ppm). Usually such a reduction is due to hypoxia and the interference of DDT with the respiratory metabolism. The effects on the mortality of the fish are given in Table 5.2:

- Aldrin and DDT toxicity was tested on Daphnidae, a type of cladocerans or small aquatic crustaceans also called water fleas[18]. They form an integral part of the food web in the aquatic environment. Acute toxicity values were estimated and are given in Table 5.3.

- The effect on reproduction of chronic exposure revealed that there was a decrease in the rate of reproduction proportional to increasing concentrations of DDT and aldrin. Comparing the two, DDT was found to be more toxic than aldrin.

Fishes from the Palayakayal estuary in Tuticorin, TN were exposed to PCB concentrations of 0.6, 2.0, 4.0 and 6.0 mg/kg[19]. Low doses of PCB enhanced mocrosomal protein content in the liver and heart which subsequently decreased in higher concentration. Thus it was concluded that PCB 1232 at higher doses brings about significant changes. It was noted that with lower PCB doses, the fish systems try to restore the normal condition with an initial increase of the constituents of the drug metabolizing system

The studies indicate that POPs, even in low concentrations, are a hazard to aquatic life. Effects that have been documented include decreased oxygen consumption (indicating stress), altered metabolic pathways, reproduction rates and alterations in protein content in the heart and liver. Given the presence of POPs in river, stream, pond and marine water and sediments in the region, aquatic species are being exposed to POPs on a continual basis. This would imply that the continued presence of POPs in aquatic environments poses a distinct threat to the preservation of aquatic fauna.

5.1.2 Terrestrial species and avifauna

The effect of POPs toxicity to wildlife as mentioned in the Handbook of Toxicity of Pesticides to Wildlife published by the US Fish and Wildlife Service is listed in Table 5.4a

Pesticides and insecticides are highly bioacumulative and can make egg shells thin, lead ing to death of the embryo, and breeding failure among raptors like the vulture, which are slow breeders.. Pesticides like DDT, Dieldrin and Aldrin are used extensively in India and have a significant impact on bird populations.

- Vulture populations and distribution including the nesting distribution was studied between, 1985 - 1988, 1990 - 1992 and 1996 - 1999 in Keoladeo National Park, Bharatpur[20]. A decline of 96% was recorded in the population of the white backed vulture and 97% in long billed vulture. The population of King and Egyptian vultures remained stable over the decade as is expected in the case of large and long lived birds.
- The King and Egyptian vultures feed on small animals whereas the other two species are communal feeders and are usually seen in huge numbers near large animal's carcasses. Agricultural fields of about 14 villages surround the park where pesticides are used extensively. Vultures are on the top of the food chain and are among the most affected species. At sub lethal levels of only a few ppm, OCs can disrupt the breeding of certain birds.
- Circumstantial evidence suggests pesticidal contamination and disease as the most likely causes of vulture population decline[21]. The vulture population has shown symptoms of pesticide contamination like breeding failure due to non hatching, breaking of eggs in the nest, failure to lay and death of nestlings. High adult mortality is also recorded. It is possible that due to a different metabolism, the vulture accumulates pesticides faster than other species. The few vulture tissue samples from the Park analysed so far have, however, not shown any significant load of pesticides. Detailed investigation of the pesticide load in the vulture and its food has been suggested.
- Apart from vultures, in Rajasthan, sarus cranes have succumbed in large numbers to pesticide poisoning. In Bharatpur alone, 18 carcasses of sarus cranes were found within three years (1987-90). The birds had fed on wheat treated with Aldrin[22]. Between 1987-88 and 1989-90, 18 Sarus Cranes, more than 50 Collared Doves and a few Black Rock Pigeons were found dead during winter in Bharatpur, which coincided with the application of Aldrin in the crop fields around the park[23]. Very high levels of Dieldrin and Aldrin at much higher levels than the lethal level (4 – 5 ppm) clearly indicate that Dieldrin, after being metabolized from Aldrin, was responsible for the deaths. A decline in the breeding population of Sarus Cranes in Bharatpur has been noticed, and is suspected to be an indication of its general population trend. The results are shown in the Table below.
- In 1988, organochlorine pesticides were measured in the

Table 5.5: Effect of pesticides on Sarus cranes and other birds in Bharatpur

Bird	Dieldrin in brain tissues	Dieldrin in other tissues	Aldrin in gastro tract
Sarus Cranes	19.33 ppm	0.78–92.26 ppm	89.75 ppm
Collared Doves	15.19 ppm	3.44–66.17 ppm	104.00 ppm
Blue Rock Pigeons	20.42 ppm	16.92–20.99 ppm	–

Source: Muralidharan 1993

Table 5.6: POPs load in bird species of Bharatpur

Chemical	Presence
DDT	Indian Shag (0.80 ppm), Painted Stork (0.66 ppm), Grey Heron (0.39 ppm)
Heptachlor	Grey Heron (0.99 ppm) and three other species
Dieldrin	Grey Heron (5.96 ppm), Painted Stork (5.78 ppm), All other species

Source: Muralidharan 1992

eggs of eight species of colonial water birds breeding at the Keoladeo National Park, Bharatpur[24]. The total organochlorine load was highest in the eggs of the grey heron and lowest in the cattle egret. Although neither DDT nor any other organochlorine was reported to have a significant correlation with eggshell thickness in any of the species, the residue levels were high enough to raise concern and warrant intensive study. The results are sown in the Table above.

- Due to its geographical location, the Corbett National Park and Tiger Reserve harbours a high diversity of resident, long distance and altitudinal migrant raptor species. There is a high rate of natural predation affecting some of the less aggressive species, but most raptors remain vulnerable mainly due to loss of forest cover and chemical contamination of the riverine ecosystem and agricultural areas outside the park. A study[25] examined samples of eggshells of raptors (the lesser fish eagle) for the presence of DDT, Dieldrin and PCBs and found alarmingly high levels. This has also been coupled with observations that the breeding of the lesser fish eagle has been severely affected with eggs not hatching and fledglings dying within a few days.

- In an article[197], an indirect consequence of the use of pesticides on natural environments has been presented. Until the early 1950s, the Terai region (around the Corbett National Park) was thinly populated except for the tribal Thurus. Virulent malaria protected it from human interference until DDT permitted colonization of the Terai and its subsequent conversion from grasslands to croplands and settlements.

The studies on avifauna in the region indicate strong documented evidence (in Corbett and Bharatpur) of high levels of POPs pesticides being responsible for the deaths of birds. Given the high levels of DDT, PCBs and Aldrin detected in their body tissues, raptors are particularly vulnerable and have been affected by POPs exposure. In an indirect effect of POPs usage, the use of DDT for vector control in forested areas have opened up previously pristine areas for human settlement thus endangering the native wildlife.

5.2 Humans

POPs have been connected with a variety of health effects in humans like cancer, reproductive disorders, immunological deficiencies, endocrine disruption and neurotoxicity.

Excessive use of pesticides, lack of education, inappropriate labeling, inadequate agricultural extension services and the discomfort of using protective clothing in hot and humid climates increase the risk of poisoning in agricultural workers in the region. Indiscriminate use of pesticides results in health impairment due to direct or indirect exposure to hazardous chemicals.

It is estimated that in Pakistan over ten thousand farmers and field workers are poisoned annually by pesticides[27]. Exposure to pesticides occurs during loading, mixing, application of pesticides and manual activities in treated crops. Accidental exposure occurs from incorrect storage of pesticides and the use of pesticides' containers to store water. In a survey[28] amongst female cotton pickers in Multan and Bhawalpur in southern Punjab (Pakistan), it was found that the majority of the workers did not protect themselves ag ainst adverse effects due to lack of awareness. 86% ate and 100% drank with contaminated hands while 67% breastfed their babies while picking and 89% stored pesticides in the living room. During picking pesticides enter into the blood through the skin, inhalation or ingestion.

In the context of the region, there have been few documented studies linking or aiding the understanding of POPs effects on human health.

5.2.1 Pregnant women / newborn effects

- A study in Lucknow[29] showed a correlation between mothers with systolic blood pressure greater than 115 mmHg had greater levels of DDE than those with systolic pressure less than 115 mmHg. It is speculated that because of the cardiovascular effects of DDT, there might be an underlying association between the levels of DDT and the blood pressure of mothers.

Table 5.7: DDT and IUGR

Tissue	DDT conc. (ppb) in normal case	DDT conc. (ppb) in IUGR case
Maternal Blood	20.0	23.42
Placental Tissue	33.93	40.16
Cord Blood	25.73	33.25

Source: Siddiqui 2003

▲ In a study in Lucknow[30], it was concluded that exposure of pregnant women to organochlorine pesticides may increase the risk of Intra Uterine Growth Retardation (IUGR), which is a contributing factor for infant mortality in India. Here, IUGR is taken to mean a birth weight below the 10th percentile of birth weight for gestational age. There was a significant negative correlation between body weight of newborn babies and p.p'-DDE in maternal blood and p.p'-DDE in cord blood. The results show that the levels of DDT in the blood samples of mothers with normal babies was lower than for those mothers whose babies showed IUGR (See table on previous page).

There have been studies in India in the past which showed the transfer of DDT, aldrin and dieldrin from pregnant mothers to their developing fetus. A higher level of these pesticides was detected in mothers undergoing premature labour or abortions than in those undergoing full term normal delivery[31].

5.2.2 Other Effects

The serum levels of thyroxine and thyroid simulating hormones in 103 rural subjects with respect to blood levels of organochlorine pesticides and occupations was examined in a study[32]. 24.3% of study subjects had depleted thyroxin levels in association with significantly lower organochlorine pesticide residues in blood. Sex, nutritional status, thyromegaly or handling of pesticides in the course of work were not found to be factors contributing to depleted thyroxine levels. The results of this study show that organochlorine pesticide levels in blood are inversely associated with circulating levels of thyroid hormones.

▲ In a study[204] that brings forth the immunosuppression aspect of POPs exposure, it was stated that symptoms like fatigue, lethargy, increased sensitivity to cold, constipation and breathlessness were found to be significantly lower in people with lower depleted serum T4 levels (depleted T4 levels indicates hypothyroidism). The results of the study show that organochlorine pesticide levels in blood are inversely associated with circulating levels of thyroid hormones. Results are shown in Table 5.8.

▲ A study[205] was conducted to assess the burden of organochlorine pesticides and their influence on thyroid function in women. 123 women from Jaipur city in 1997-98 were tested. 100 women had normal thyroid hormone levels while 23 women had depleted T4 and high TSH levels (high TSH levels indicate hypothyroidism). Dieldrin was found to be significantly high in the hypothyroid subjects. It has been suggested that chlorinated hydrocarbons may be goitrogenic chemicals that disrupt hormone activity. Women of lower age groups had higher pesticide levels. This could be due to greater exposure of the younger generation as well as the excreting of pesticide by older women during menses and childbirth. Results are shown in Table 5.9.

Table 5.8: Comparison of pesticide levels (ppb) in sujects with normal and depleted T4 levels

Pesticide Levels (Mean ± SE)	Normal T4 (Mean ±SE)	Depleted T4
Total DDT	3.26± 0.47 *	1.09±0.18*
Aldrin	3.80 ± 0.37 *	1.26±0.17*

* $p < 0.05$

Source: Shrivastava 1995

Table 5.9: DDT and TSH in Jaipur

Pesticides (ppm)	Normal T_4 (n=100)	Depleted T_4 (n=23)
Dieldrin	2.5	5.38
Heptachlor	1.41	1.18
Total DDT	6.91	8.43

Source: Rathore 2002

The few documented instances of human health effects of POPs in the region bring out the reproductive and thyroid effects of DDT. Although documented evidence might be scarce, it is important to highlight the connection between elevated levels of POPs in human tissue and their undesirable ill effects. Since high levels (significantly above MRLs) have been found in various food commodities in the region, it is expected that there might be a variety of health disorders due to POPs in the region, which are not being properly documented or diagnosed.

Exposure to immunotoxic POPs chemicals in the environment may be expected to result in more subtle forms of immunosuppression that may be difficult to detect, leading to increased incidences of infections such as influenza and common cold[35]. POPs exposure is also expected to occur due to occupational exposure due to agricultural use, vector control spraying or in industrial environments (ship breaking, chemical processes that release dioxins etc.). The box on the effects of pulp and paper mill effluents bring out possible areas where, though not properly implicated, POPs might be the cause of serious undesirable effects on populations and ecosystems in the region. It is necessary to conduct a focused health and environmental study to understand the extent and significance of POPs exposure in humans and the environment of the region.

Pesticide levels in female subjects from urban, semi-urban and rural areas

	Urban		Semi-urban		Rural	
Pesticides (ppm)	**Normal T_4**	**Depleted (n=97)**	**Normal T_4 T_4 (n=17)**	**Depleted T_4 (n=19)**	**Normal T_4 (n=3)**	**Depleted T_4 (n=14)**
(n=3)						
Dieldrin	2.41	5.5	3.64	7.92	1.35	2.2
Heptachlor	1.34	1.16	1.71	1.12	1.31	1.42
Total DDT	6.67	7.65	6.68	8.28	8.34	13

Source: Rathore, 2002

Conclusion

It is an established fact that POPs are potentially extremely harmful to the environment and to human health. In fact the very reason that the Stockholm convention has identified these 12 chemicals indicates the priority assigned to their phase out. The presence of POPs chemichals in various environmental niches, human and animal tissues indicates to the potential risk to the population and environment of the region. POPs have been identified even in recent surveys in food, blood samples and animal tissues apart from water and soil samples. In many cases they have been found to be above the recommended limits.

Such a situation should imply that one ought to encounter various cases of harmful health outcomes resulting from POPs' exposure. However, very few cases have been identified which corroborate the links between POPs' presence and deleterious health outcomes. One reason is expected to be the paucity of the actual field investigations undertaken to establish or evaluate the connection between POPs' exposure and possible outcomes. This is also reflected in the fact that there have been no nationwide or comprehensive studies undertaken. The few sample studies in scattered, unconnected investigations however do indicate the presence of instances of POPs related environmental and health fall outs. Evidence has been accessed and presented on the effect of POPs in laboratory tests on aquatic species and bird populations. Effects of humans documented include effects on pregnant women, newborn infants and the effects of POPs chemicals on thyroid imbalances. However, it is important to mention that most of the studies revolved around the effects of DDT and other common POPs pesticides. The effects of dioxins, furans and PCBs, thought to contaminate most areas of regions have been left unstudied. The picture that emerges from these different studies is far from complete and only a focused and well directed approach can help bring out the many obvious, but unrecorded instances of POPs' effects on the South Asia Region.

References

1 Saxena 1989

2 Interaction with Dr K P. Singh, ITRC

3 Interaction with Dr M. Hota, Director, Health Unit, MoEF

4 Interaction with Dr S. Peshin, Research Scientist, NPIC

5 Interaction with Dr S. Peshin, Research Scientist, NPIC

6 Kanungo 1997

7 Interaction with Dr A. Dewan, Incharge, Poisons Information Center, NIOH, Ahmedabad

8 Interaction with Dr S. Peshin, Research Scientist, NPIC

9 Interaction with Dr A.T Dudani, former scientist ICAR, ICMR, FAO

10 Interactions with Dr P.Y Naik, INTOX and Dr Kanungo, DPPQS

11 Interaction with A. Hildenbrand of the WHO, SEARO office

12 Interaction with Dr D. Kanungo, Consultant and Chief, CIL

13 Interaction with Dr S.A Akhtar, EIA Cell, BNHS

14 Khan 1998

15 Rajmannar 2000

16 Ruparelia 2001

17 Gurusamy 2000

18 Khan -

19 Selvarani 2002

20 Prakash 1999

21 Prakash 1999

22 Vijayan 2003

23 Muralidharan 1993

24 Muralidharan 1992

25 Naoroji 1999

26 Rahmani 2001

27 Hayat 2000a

28 Hayat 2000a

29 Siddiqui 2002

30 Siddiqui 2003

31 Siddiqui 2003

32 Shrivastava 1995

33 Shrivastava 1995

34 Rathore 2002

35 Karnik 2001

6.0 Key findings, data gaps

The key findings are presented here in terms of sources, environmental pathways, dietary pathways, exposures and health effects.

6.1 Status of POPs in South Asia

Assessing the status of POPs in the South Asia region, certain noteworthy issues of concern include the ubiquitous presence of POPs detected in almost all environment parameters. Although POPs pesticides have been banned for agricultural use, DDT is still being used for malaria control and the excessive use of POPs chemicals in the past and the continued illegal use of POPs pesticides in agriculture could be responsible for the problem. In perusing the data on commercial activity in POPs pesticides, it is noticed that export of Chlordane, Aldrin and Heptachlor and the import of Chlordane have been reported in India subsequent to the date of complete ban on manufacture, import and export. Estimates of Endrin, Dieldrin, Heptachlor and DDT smuggled into Bangladesh have also been obtained

The status of the unintentionally released POPs is still largely unknown. This is due to a general lack of awareness among the stakeholders coupled with the lack of monitoring and testing facilities in the region. The use of PCBs in electrical transformers has been banned in India since 1967 but it is suspected that old and imported transformers might contain PCBs. Shipbreaking sector in the region is an important source of PCBs. In general there is a lack of awareness of the problem of unintentional releases of dioxins and furans. Dioxins and furans are important in incineration, open burning, pulp and paper, metallurgical industries, cement, power and chemical industries. Laboratories in RRL, Trivandrum, NEERI and NIOH identified with upcoming programs for dioxin monitoring

6.2 Sources and hotspots of POPs in the region

The follwing points indicate the major sources of POPs chemicals in the region with separate emphasis on pesticide and unintentionally released POPs.Pesticide POPs

- ▲ Old manufacturing sites of POPs pesticides might be potential hotspots
- ▲ The DDT plant at Udyogamandalam has contaminated the surrounding area
- ▲ HIL is the only manufacturer of a POPs compound (DDT) in the region
- ▲ HIL has factories in Udyogamandalam (Kerala) and Rasayani (Maharashtra)
- ▲ There is scant information on stockpiles in the region
- ▲ DDT is used for vector control, despite widespread vector resistance
- ▲ Use of DDT for public health is reducing
- ▲ Rajasthan, Madhya Pradesh and Assam were the largest users of malaria control DDT in 1999-00
- ▲ Bioenvironmental techniques provide a sustainable method to control malaria
- ▲ Low awareness among farming community and climatic conditions lead to greater occupational exposure while spraying pesticides

PCBs

- ▲ PCBs in electrical transmission and steel plant equipment estimated to be 2000 – 4000 tonnes
- ▲ PCBs have been detected in environmental segments indicating the presence of sources
- ▲ Recent study in Trivandrum has detected PCBs near recently installed transformers
- ▲ No systems in place to deal with PCBs from the electrical sector
- ▲ Noticeable lack of awareness about the PCB problem in transformer oils
- ▲ India, Pakistan and Bangladesh accounted for 90% of ship breaking activities of the world
- ▲ Ship breaking activities are expected to increase in the coming years

Unintentional releases

- ▲ Incineration and open burning of wastes (especially PVC) is an important source of dioxins and furans
- ▲ 128 hazardous waste incinerators identified with maximum (60) in Maharashtra followed by Andhra Pradesh (29)
- ▲ Number of medical waste incinerators identified in Delhi (33), Mumbai (10), Chennai (11) and Kerala (57)

- Many of the medical waste incinerators were not functioning properly and were burning mixed waste
- Indian paper and pulp mills use conventional chlorine based bleaching and release higher organochlorine effluents compared to international levels
- Most large iron and steel plants are located in the Eastern part of India
- Coal based thermal power plants are most prevalent in India leading to possible dioxin releases
- A large number of potential POPs releasing chemical industries are located in Maharashtra and Gujarat

6.3 Environmental pathways and contamination

POPs have been detected in the South Asian region as evidenced from a variety of studies accesses over many time periods and geographical locations. Even recent studies have detected the presence of DDT, Dieldrin, Aldrin, PCBs, dioxins and furans. Although the significance of the reported levels might be a point of contention, it is nevertheless important to take cognizance of the fact that POPs are still finding their way into the environment. This is especially an issue of concern as the studies and reports have been conducted in a very piecemeal manner and a more thorough investigation of the region's contamination might reveal widespread and in some cases, dangerous levels of POPs' presence. It is to be noted that no studies on POPs in colder regions. Considering the fact thet POPs have a lower half life in colder regions, they are expected to accumulate in low temperature zones[1]. There is a proposed plan to study residues of DDT in a detailed manner in areas in the Himalayan regions of Garhwal, Kumaon and HP[2]. It is hoped that such a study will bring to light the nature of POPs contamination in the colder areas of the region.

Dietary exposure is probably the single most important pathway affecting human populations. In India, diary products are the maximum contributor to pesticide residue intake through diet. Dermal application of pesticides on cattle and indiscriminate spraying in cattle sheds lead to high POPs pesticides levels in milk products. Indian dietary intake of DDT is among the highest in the world. Food products' transport within the region could be a cause for POPs exposure in localities where POPs are not used. High levels of DDT in food have also been reported in oils, fats and meat products. Evidence to that end has been reported from a variety of studies. However, the number of reported studies has reduced in recent years. The present extent and nature of contamination in food is hence limited and does not offer opportunity to make knowledgeable inferences.

6.4 Exposures

Knowledge of POPs' exposure in wild life and humans in the region has been based on the number of studies accessed on the subject. Widespread DDT residues in fish have been reported while Dolphins' tissues recorded levels of DDT orders of magnitude (100-1000 fold) higher than those in fish. A study in Trivandrum detected dioxins, furans and PCBs from fishes and turtle tissues. Levels of DDT in zooplankton and fish from the North Arabian Sea reflected a connection with their use on agriculture on land. Among terrestrial species, DDT, PCBs, HCB, Aldrin and Dieldrin were detected in bird tissue and egg samples in India and Pakistan with DDT contamination of concern to birds migrating to and from India.

In monitorings of human tissues, Breast milk samples over different periods from the region have been found to contain DDT, HCB, Aldrin, Dieldrin, dioxins, furans and PCB. Fat samples over different periods from the region have been found to contain DDT, HCB, Aldrin, Dieldrin, Dioxins, Furans and PCBs and blood samples over different periods from the region have been found to contain DDT, Aldrin and Dieldrin. Higher levels of DDT found in the blood of those occupationally exposed due to spraying operations. DDT has been detected in the blood of people residing in Himachal Pradesh in areas where it is not being sprayed for malaria control indicating possible illegal usage for agriculture especially as the levels were higher in the post monsoon season.

In the case of new born infants, the problem of POPs contamination is especially of concern given the vulnerability of the age group and the relatively high POPs exposures (with respect to body weight) that is experienced. Exposure to POPs is generally through breast milk and placental transfers while in the womb. Dioxins in human breast milk from Chennai found to be higher than other Asian countries. DDT was 7 times and Aldrin 27 times the ADI for exposure of infants through breast milk in Lucknow (1996) and Intra Uterine Growth Retardation and other birth related problems have been associated with high DDT levels in mothers. Placental transfer has been confirmed by the presence of DDT in cord blood.

6.5 Effects

Considering the presence of POPs chemicals detected in the region, it is expected that there must be an outcome in the form of deleterious effects on the environment and population. However, there have been only a few documented evidences available which hint at a possible linkage between POPs' presence and harmful outcomes. It was found that increasing levels of DDT and Aldrin were found to lead to reduced reproduction rates in fish. There was a possible connection indicated between declining vulture populations in Bharatpur and the usage of organochlorine pesticides in the surrounding fields. Dieldrin levels higher than the lethal levels have been found in the brain tissue of sarus crane carcasses that succumbed in large numbers in Bharatpur (1987-90). The lesser fish eagle has been found to contain significant levels of DDT, Dieldrin and

Table 6.1: Key Issues and possible data gaps

Key Issues

- Potential manufacturing sites exist
- There has been excessive and indiscriminate use in agriculture
- DDT is used for vector control
- Logging industry is big, indicating use of wood
- Chlordane possibly used for building termite control
- There is a high potential of stockpiles
- There is a high potential for industrial use
- There is a high potential for industrial use
- There is a high potential for excessive use of pesticides
- Certain populations are at risk due to diet, lifestyles

Existing Data gaps

- Standardisations of methodologies
- Testing must meet international criteria
- Models should be calibrated to available data
- ADIs should be developed for most sensitive life stages preservatives
- Synergistic effects of POPs to be studied
- Models of exposure scenarios
- Better estimates of environmental and biological levels
- Experiments need to be conducted on biotic and abiotic transformation of pesticides
- Discovery of ecosystem species that depict early signs of toxicity to act as indicators
- Expansion of monitoring programs
- Capacity building of regional laboratories
- Toxicological information of pesticide degradation compounds

List of Tables, Figures & Flowcharts

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Annexure 1: Other chemicals of concern

Apart from the list of 12 POPs identified by the Stockholm convention for the purpose of immediate action and management, there are other chemicals which are persistent in nature and possessing the similar POPs traits of lipophilicity and transportability. Some of these chemicals are used extensively in the region and might warrant a similar concern in the future as is being presently focused on the 12 identified POPs chemicals. Two chemicals, HCH and Endosulfan are presented as possible chemicals for inclusion in an enlarged POPs list.

HCH and Lindane

Hexachlorocyclohexanes (HCH) – HCH is also commonly referred to as Benzenehexachloride (BHC) which leads to its often being confused with Hexachlorobenzene (HCB). There are two principal formulations of HCH. Technical HCH, which is a mixture of the alpha, beta, gamma and delta isomers of HCH and 'lindane', which is pure gamma HCH. It is one of the most widely used insecticides in the world and is used against a variety of insects including sucking, chewing insects, ground and soils pests, household pests and wood preservation. HCH is relatively persistent, relatively less lipophilic as compared to the other POPs and is capable of being transported over long distances.

HCH has been used extensively in the region. Along with DDT, a large amount of information on residue analysis and possible effects is available on HCH. HCH residues are widespread and are reported from almost every environmental niche in the region.

In India, HCH was banned on April 1997[1] and is reported to be banned in all the other South Asia countries[2]. Lindane however continues to be manufactured in India and used for crop protection. It has been reported[3] that in many cases, during the process of manufacture of Lindane by separating it from the other isomers of HCH, the alpha, beta and gamma isomers of HCH are produced as waste products and often, sufficient safeguards are not taken to ensure their containment. Restricted use of Lindane has been reported from Bangladesh and Nepal and its import into Sri Lanka in a ready to use form exists[4]. Stockpiles of HCH, 10 Dusting Powder (234.5 MT), HCH 80 Tech (27.5 MT) and HCH 50 Wettable Powder (3.12 KL) have been reported from India[5].

Endosulfan

Endosulfan is an organochlorine pesticide used on a wide variety of food and non food crops. Apart from commercial agriculture, Endosulfan is also used for gardening purposes and wood preservation. Endosulfan is mildly persistent and is moderately to highly toxic to birds and very toxic to aquatic organisms.

The use of Endosulfan in India is permitted but its use is presently under review. Endosulfan has been manufactured in Inda since 1996-97 at an average of 8206 MTPA[6]. 12180 MT have been exported in 1999-00. Endosulfan is used in Bangladesh and Nepal but banned in Pakistan and Sri Lanka.

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

The persistence of PAHs varies with molecular weight. The low molecular weight PAHs are most easily degraded. The half lives reported for low molecular weight PAHs are between 9–83 hours in soil whereas those for higher molecular weight PAHs extend upto several years in soils/ sediments.

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in humans.[7] The Department of Health and Human Services (DHHS), USA has determined that some PAHs may reasonably be expected to be carcinogens.

References

1 Singh 2000

2 Indian Ocean 2002

3 Interaction with Dr AT Dudani

4 Indian Ocean 2002

5 Indian Ocean 2002

6 Indian Ocean 2002

7 www.atsdr.cdc.gov

Annexure 2: Effect of paper and pulp mill effluents

In an effort to understand the possible nature of dioxin laden effluents from industrial activities, certain published documents were identified which deal with the effect of pulp and paper mill effluents. This sector seems to be more studied than other POPs emitting industries. The results are very indicative and are not to be interpreted as the result of specific investigations on arriving at linkages between POPs' exposure and their effects. In general, the effect of paper and pulp mill effluents can be described as on the diagram on the next page.

- A study[1] dealt with the impact of Nagaon paper mill on the neighboring area. Out of 13 villages with 5644 acres of cultivable land along with a population of 7281 people, 7 villages with 3079 acres and 4546 people were severely affected.. The fish yield in the nearby wetland has been reduced considerably. The rice yield in the nearby agricultural field has also been reduced fue to irrigation with polluted water. Further diseases of the skin and stomach in poultry, livestock and humans due to exposure to polluted water had also led to economic hardships.

- The case of a small paper mill on the banks of the river Sone at Shadol, Madhya Pradesh was examined[2]. A combined survey of 69 villages situated along the river bank indicated that the dark brown discharges made the river water unusable upto 40 km downstream. Cattle were affected with a decrease in breed quality and resistance to diseases. Physical contact with the water caused pain in the hoofs and swelling in the mouths and nostrils. After drinking the water, the animals would feel dizzy, lose appetite, pass blood in the urine and stool with a strong stench and odour. Even humans would show signs of effects including cracks and fissures in the skin, brittle discolored and upturned nails, rashes, scabs and boils. The forest industry in the region near the mill had become almost non existent. The average height of the plants was decreased by about three feet. The plants were discolored, withered and dry.

- Experimentation on paper mill effluents' effects on the germination on different varieties[3] of groundnut shows that in general, an increase in paper mill effluent concentration leads to decrease in seed germination, seedling growth and seedling dry weight. Paper mill effluents have effects on the mitotic index in plants that deals with divisions and genotoxicity and experiment has proved their harmful effect to plant systems[4].

- Fishes are sensitive to contaminants of water and pollutants. In a study to explore the effect of paper mill effluents on the biology of fishes[5], the effluents contained chloride concentrations of 10-50 mg/l. The study indicated increase in the cholesterol in tissue of exposed fish indication dysfunction of several physiological, biochemical and behavioral processes in fish due to indication. Paper mill effluents can adversely effect larvae and eggs, physiological implications, skeletal deformity and histopathological lesions in some fishes.

- Effects of the paper mill effluents from the Nagaon Paper Mill, Assam was observed on the freshwater edible crab – Paratelphusa spinigera[6]. In Assam, crab meat is considered a cheap food for nourishment as well for medicinal properties. Normal crabs have a pattern for surfacing. They have bright appeaarence of the eyes with whip like gentle, rhythmic movements of antenna and antennules. On exposure to the effluent, the crabs exhibited fast and jerky movements, frequently surfacing to gulp fresh air, excessive secretion of mucus over the body surface and decolorisation. There was an abnormal colour of the eyes with fast novement of antenna and antennules, rapid movements of caudal region accompanied by sudden jerks. After exposure for 60 days to 45.5 ppm (effluents), the salient features observed were oedematous lamelle with dense accumulation of heaemocytes, lamellar cell swelling and lesions in the lamelle. Severe damage was observed in the primary and secondary lamelle with necrosis, shrinkage of respiratory surface and cyst formation. Thus paper mill effluents even at very low concentrations induced severe behavioral and pathological changes in the crab.

- The effluent from the TNPL Pugalur mill was collected and so also water samples from surface and ground water[7]. Soil samples were also collected from different villages to assess the impact on crop patterns. High chloride content in raw effluent (187.44 mg/l) and in treated effluent (146.26 mg/l) indicates toxicity to plants if present in irrigation water. Clean surface water was observed to have diversity in phytoplankton. The site where the effluent canal joins the irrigation canal is devoid of the biological species normally found.

References

1 Baruah 2000

2 Mudakavi 1999

3 Sundaramoorthy 2000

4 Reddy 2000

5 Mishra 2001

6 Kalita 2002

7 Gupta 1997

The effect of paper and pulp mill effluents

Industry	Environmental Components	Overall effect
Paper Mill	Water	▲ Drinking water contamination
		▲ Degradation of water quality
		▲ Decline in productivity of aquatic bodies
		▲ Water
		▲ Fish migration
		▲ Reduction in fish catch
		▲ Loss of commercial value of fishes and poultry
		▲ Damage to fishing gears, nets etc.
		▲ Diseases in cattle and poultry
		▲ Paper Mill
		▲ Reduction in milk yield and labour potential in cattles
		▲ Diseases in human beings
	Air	▲ Respiratory diseases
		▲ Organic Odour
	Soil	▲ Change in soil characteristics
		▲ Decrease in soil
		▲ Low agricultural output
		▲ Siltation
		▲ Solid waste pollution

Source: Baruah, 2000

Annexure 3: Sustainable approaches to vector management

The use of bioenvironmental means has led to many successes in controlling malaria in various industrial townships and rural areas. Such methods include the use of larvivorous fish such as Guppy and Gambusia, use of polystyrene beads, filling up low lying areas, covering open tanks, using treated bednets and the health education of local residents through workshops and live demonstrations.[1]

At one intervention site, at the Bharat Heavy Electricals Ltd. (BHEL) campus in Haridwar, the incidence of malaria has reduced from 3000 cases to 10 by the use of such means alone.[2] Bioenvironmental methods to control malaria are also being implemented in the industrial townships of Indian Drugs and Pharmaceuticals Ltd. (IDPL) Rishikesh, Indian Oil Corporation Ltd. (IOCL) Mathura, National Thermal Power Corporation (NTPC) Rihandnagar, (NTPC) Unchahal and (NTPC) Thalcher[3]. It is however recommended[4] that there be a judicious mix of chemical and bioenvironmental means to tackle malaria owing to the superiority of chemicals in combating epidemic cases. Considering that eventually all insecticides are prone to inducing resistance in mosquitoes, the use and importance of bioenvironmental means is bound to gain significance[5].

In terms of costs, according to a study conducted by NEERI, the per capita cost of bioenvironmental control is Rs 7.1, whereas application of DDT and HCH costs Rs 9.91 and Rs 8.97 respectively[6]. Bioenvironmental controls also have attached employment and income generation schemes such as fish culture and social forestry. These cost estimates of bioenvironmental methods do not take into account the long term savings from better health, hygiene and an environment free of toxins.

There have been only few documented and published sources of information on the comparison of bioenvironmental control measures with reference to the use of DDT. In a comparison of DDT concentration in soil, water and whole blood in two adjoining areas with one using bioenvironmental means and the other using DDT, residual levels were 73.5 times higher in soil and 8.1 times higher in whole blood samples in the case of the latter.[7]

Table 3.8: Mean DDT concentrations)

Sample (units) area	No of Samples	Spray area	Bio control
Soil (micrograms/kg)	28	270.5	3.68
Water (micrograms/l)	10	0.07	0.00
Blood (micrograms/l)	36	38.13	4.71

Source: Dua 1996

This is indicative of the level of reduction in DDT residual levels that can be effected by using bioenvironmental control methods and the effect of DDT spray for malaria control.

In terms of actual implementation, while in the short run, there had been high success in controlling malaria in the project areas of Goa, Pondicherry, Chennai, Kheda, Kolar and Hassan, in the longer term, the projects failed owing to a lack of follow up in terms of involving the community and community based organizations. The most crucial aspect that appears to influence the success of bioenvironmental malaria control techniques seems to be the participation of local people and the sustained practice of preventive activities.[8]

References

1 Interaction with Dr VK Dua, MRC, Haridwar

2 Interaction with Dr VK Dua

3 Interaction with Dr VK Dua

4 Interaction with Dr VK Dua

5 Interaction with Dr VP Sharma

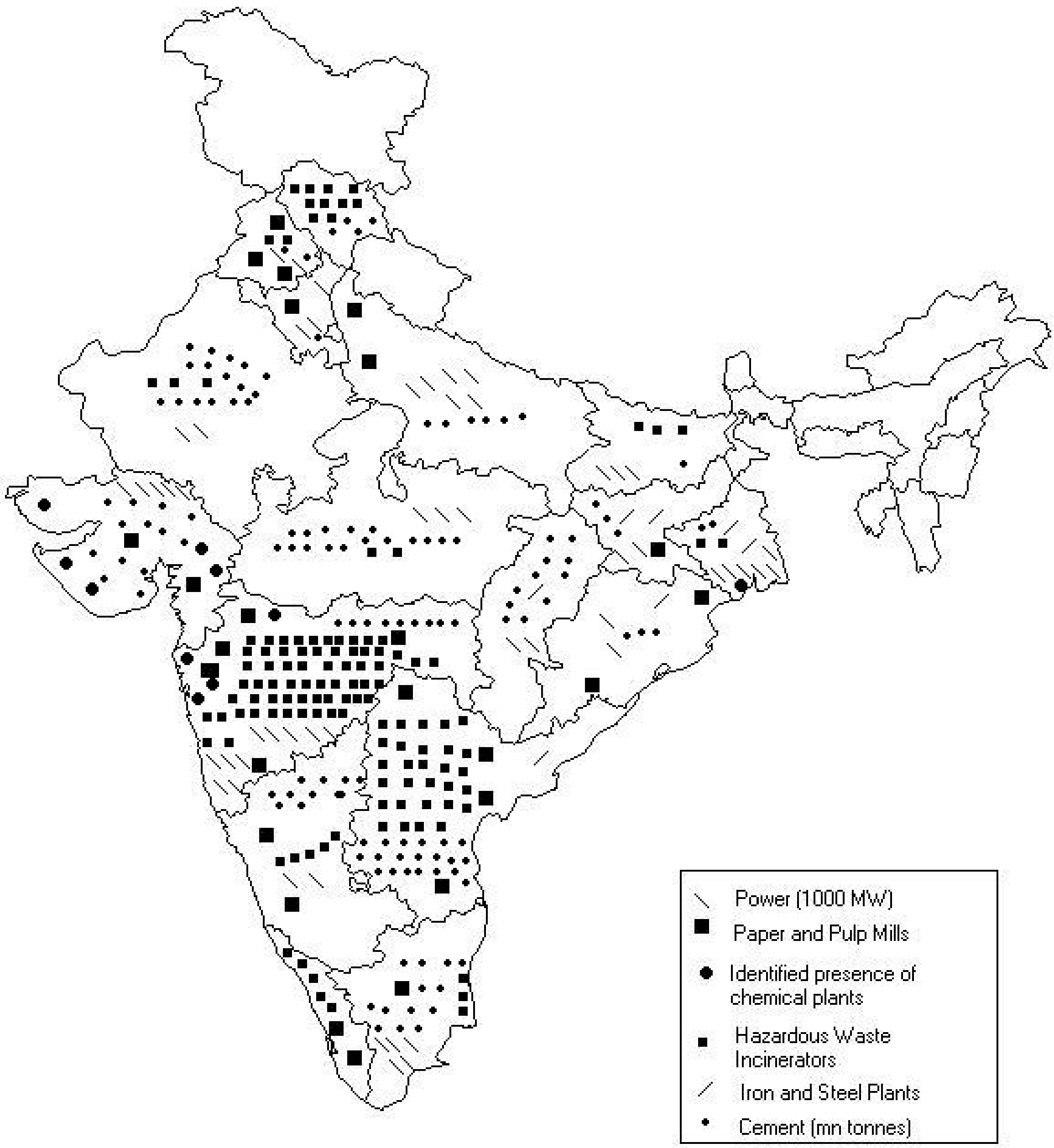
6 Down To Earth, July 15, 1998

7 Dua 1996

8 Interaction with Dr VP Sharma

Annexure 4: Industrial hotspots identified

The following map represents the main identified industrial hotspots and on site hazardous waste incinerators listed in this report in section 3. The information is in a statewise form and the locations of the dots indicate only the statewise concentrations and not the exact geographical location of a hotspot. In cases (like power generation and cement production) the information is represented in multiples of a certain unit (for example 1000 MW in the case of power generation). In the case of Pulp and Paper Mills and Iron and Steel Plants, the points indicate the presence of a factory in that state. A rough estimate of the chemical industries, which are clustered in Maharashtra and Gujarat, is indicated by the locations of the indices in those states. The map attempts to indicate the relative concentration of various identified main POPs releasing industries on a statewise basis in the region.



References

1 Interaction with Dr VK Dua, MRC, Haridwar

2 Interaction with Dr VK Dua

3 Interaction with Dr VK Dua

4 Interaction with Dr VK Dua

5 Interaction with Dr VP Sharma

6 Down To Earth, July 15, 1998

7 Dua 1996

8 Interaction with Dr VP Sharma