

Persistent Organic Pollutants: A Review

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Abstract: Persistent organic pollutants (POPs) are toxic chemicals that adversely affect human health and the environment around the world. Most of the POPs are released due to anthropogenic activities, while others are produced as a result of secondary emission. Because they can be transported by wind and water, most POPs generated in one country can and do affect people and wildlife far from where they are used and released. They persist for long periods of time in the environment and can accumulate and pass from one species to the next through the food chain.

Keywords: Persistent Organic Pollutants, Pesticides, Hazards

I. INTRODUCTION

Over the last many years there has been increasing concern all over the world over the health impacts of the population caused by environmental pollution. According to WHO (world health organization) one third of the diseases which mankind is facing is due to the prolonged exposure to the environmental pollution. Among various types of the pollutants which are emitted in the environment, there is one category of the pollutants which is very much talked about now-a-days because of the hazards they cause, are the Persistent Organic Pollutants (POPs). POPs are the organic compound that are resistant to environmental degradation through chemical, biological and photolytic processes. As they are persistent, they undergo the phenomenon of biomagnifications and bioaccumulations. Despite of significant reduction in emission or bans of many persistent organic pollutants (POPs), over the past few years, POPs continue to contaminate the environment and accumulate in food chains. Because of their persistence, POPs have a great potential to be transported to great distances which enables them to migrate from the mid latitudes to the Arctic regions. The global production of PCBs started around 1930, peaked around 1970 and ceased in the early 1990s. Because of their persistence and semi-volatility POPs have a great potential for long-range atmospheric transport which enables them to migrate from the mid latitudes to the Arctic regions. The global production of POPs was started around 1930, peaked around 1970 and ceased in the early 1990s. They also pose a risk of causing adverse effects on human health and environment. As these chemicals can be transported to the areas where they are never produced, they cause threats to the entire global community. POPs can enter the gaseous phase under certain environmental temperatures and volatilize from soils, vegetation and water bodies into the atmosphere, resisting breakdown reactions in the air and travel long distances before being re-deposited.

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In a nutshell persistent organic pollutants can be described as:

- persistent in the environment and resistant to biodegradation
- highly toxic to the man and environment
- taken up and bioaccumulated in the terrestrial and aquatic ecosystem
- capable of long range transport and deposition.
- have a tendency to remain in fat rich tissues

II. TYPES OF POPS

Many POPs were widely used during industrial revolution after World War II. However many of these chemicals proved to be beneficial in pest and disease control, but they had unforeseen effects on human health and environment. Many people are familiar with some of the most well known POPs, such as PCBs, DDT, and dioxins. POPs include a range of substances that include:

1. Intentionally produced chemicals currently or were once used in agriculture, manufacturing, disease control or industrial processes. For eg. PCBs, which have been used in industrial applications and DDT, which is still used in the control of mosquitoes in many parts of the world.
2. Unintentionally produced chemicals, like dioxins that are result of combustion of medical waste, incineration and some industrial processes.

A dirty dozen list of the frequently used POPs is:

- a) Aldrin- an organochlorine insecticide which is widely used to protect crops like potatoes. It is a carcinogen as well as a mutagen. Causes headaches, dizziness, nausea, vomiting, muscle twitching and convulsions.
- b) Chlordane- a manufactured broad spectrum pesticide used in agriculture as well as to control termites. It can damage nervous and digestive system.
- c) DDT- Probably the most infamous POP. It is a synthetic pesticide and is toxicant. It has been banned in most of the countries due to reason that it gets bioaccumulated significantly in humans and other aquatic species.
- d) Dieldrin- an insecticide accumulates as it passes through the food chain. It is linked to Parkinson's disease, breast cancer and immune, reproductive and nervous system damage. Currently it is banned in most of the countries.
- e) Endrin- an insecticide/rodenticide used on cotton, maize and rice. It can bioconcentrate in the fatty tissues. Food contaminated with endrin can cause poisoning worldwide, especially children.
- f) Heptachlor- an insecticide, and has a very stable structure and can remain in environment for decades. It is a possible human carcinogen.

- g) Hexachlorobenzene- a fungicide which was formerly used for seed treatment especially that of wheat. It can cause liver disease, skin lesions, ulceration, hair loss and thyroid damage. It is extremely toxic to aquatic creatures.
- h) Mirex- an insecticide, flame retardant is used to control fire ants and as a flame retardant in plastic, rubber, paints, paper and electronics. Mirex can also be transported through placenta and can pass from mother to child through breast milk. It induces pervasive long term physiological and biological disorders in vertebrates.
- i) PCBs (polychlorinated biphenyls) are used as coolants/insulating fluids, used in flexible PVC coating of electrical wiring, pesticides, flame retardants, hydraulic fluids, paints and carbon less copy paper. Although banned in 1970 PCBs still persist in the environment due to their bioaccumulation and toxicity. The effects of PCBs are transgenerational, as they can persist in mother's body upto 7 years. They alter estrogen level of the body and contribute to reproductive problems. They effect liver, stomach, thyroid, immune system etc. recent studies have shown that PCBs are also associated with cancer
- j) PCDDs (polychlorinated dibenzodioxins) can cause effects on reproductive/sexual development, immune system damage, thyroid disorders, nervous system disorders, diabetes etc. It enters the food chain through food items and readily climbs the food chain. It has also been linked with increasing female births as compared to male births.
- k) Polychlorinated dibenzofurans- They are the product of high temperature processes such as incomplete combustion and waste incineration. Structurally they are similar to dioxins. They persist in the environment and classified as possible human carcinogen.
- l) Taxophene- an insecticide which is highly toxic. Human exposure primarily results from food. Its exposure can cause damage to lungs, nervous system, kidneys and can be fatal.

III. SOURCES OF POPS

Asia is facing a threatening scenario of historic, current and potential poisoning by the most dangerous variety of persistent poisons in the form of POPs. This situation is a result of extensive use of pesticides, the continuing production of organochlorine and other chemical pesticides. Investigations conducted between April and August 1998 in seven Asian countries, including Bangladesh, India, Nepal and Pakistan, revealed that - Stocks of about 5000 metric tons or more of harmful banned pesticides, including POP chemicals are stored in extremely dangerous conditions in more than a thousand sites in Pakistan and Nepal. A sizeable portion of these pesticides have been reported to have arrived as part of aid packages from Western countries.

India exports nearly 800,000 kilograms of POP pesticides including aldrin, DDT, BHC, and chlordane to many countries, including countries where their usage is banned. Some of the pesticides such as aldrin are not permitted to be even manufactured in India.

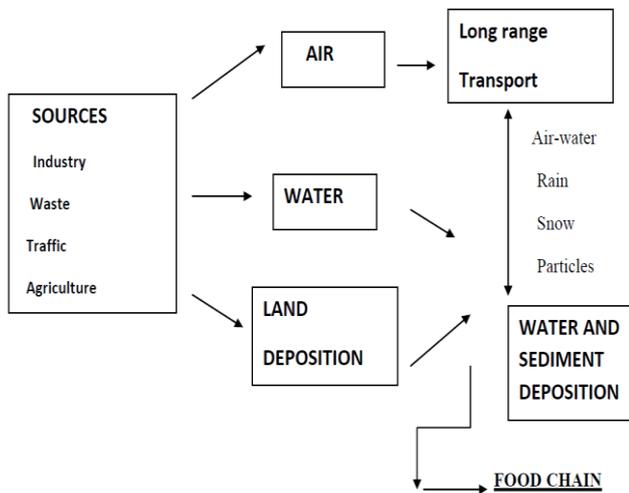
In Pakistan, India, Nepal and Bangladesh, locally banned or severely restricted pesticides are freely available. It has been found DDT, BHC, Dieldrin and Heptachlor are openly sold in the markets of Pakistan. Hardware stores in New Delhi stock the deadly pesticide aldrin whose registration was withdrawn more than three years ago. POPs are a class of synthetic toxic chemicals that cause severe and long-term effects on wildlife, ecosystems and human health. POPs have been implicated in the rising incidence of certain cancers (e.g. breast, prostate, endometriosis, etc.), reproductive deficits such as infertility and sex linked disorders, declining sperm counts, foetal malformations, neurobehavioral impairment, and immune system dysfunction. Because of major threats to human health, the UNEP process has shortlisted an initial twelve substances for elimination which include organochlorine pesticides, (DDT, chlordane, mirex, hexachlorobenzene, endrin, aldrin, toxaphene, heptachlor) industrial chemicals like the cancer-causing PCBs (polychlorinated biphenyls), and the super-toxic dioxins and furans.

IV. TOXICITY OF POPS

Studies have shown that increased concentration of POPs is linked with diseases, decline or abnormalities in a number of species of fish, birds and mammals. In addition to this behavioural, developmental, reproductive, neurological, endocrine and immunological adverse health effects have been linked to POPs. People are mainly exposed to POPs through contaminated food, contaminated water or with direct contact with the chemicals. A large number of populations are at particular risk whose diet includes fish or wild foods that are high in fat tissues as POPs are lipophilic and hydrophobic, i.e. they are fat soluble while resistant to breakdown in water. This tendency enables them to concentrate in the fatty tissues of the organisms which ends up in the bioaccumulation in the food chain. It has been noted that organisms that are at higher trophic levels like polar bears, predatory birds, mammals etc. have much higher concentrations (sometimes upto thousand times more) as compared to their surroundings. Colborn, Dumanoski and Myers stated that "These synthetic chemicals move everywhere, even through the placental barrier and into the womb, exposing the unborn during the most vulnerable stages of development...when a new mother breastfeeds her baby, she is giving him/her more than love and nourishment, she is passing on high doses of persistent chemicals as well" POPs reach their highest concentrations in the organisms living in the cooler regions of the world.

V. POPS IN THE ENVIRONMENT

For more than half a century of extensive production, use and release, POPs are now ubiquitous in the environment. The major source of air pollution which contributes to the accumulation of POPs includes the manufacture and usage of certain pesticides, the production and use of some chemicals and the formation of certain byproducts of combustion, land fillings, ore extractions etc. Scientific studies have indicated that each living organism on earth, whether animal or plant, contains sizeable amounts of POPs.



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VI. MAJOR CHALLENGES

The POPs cause many adverse health effects and they can also alter the function of almost every organ. Different mechanisms are involved in the functioning of these chemicals, which ranges from induction of enzymes, altered gene regulation, exhibiting endocrine activity and changes in nervous system function. Most POPs and other pesticides are not directly mutagenic, but cause DNA damage indirectly by the generation of nascent oxygen in the body. Therefore, the existence of POPs in our environment is a global challenge and a global issue. *“It is unfortunate that while governments in the region are still grappling for ways to dispose of their stockpiles of obsolete imported pesticides, the continuing production and trade of these chemicals goes on unabated. This could only lead to an endless cycle of poisoning whose unwitting and eventual victims are communities and future generations,”* said Jack Weinberg, international toxicological campaigner with Greenpeace. Further studies must be conducted to investigate and quantify the adverse effects of POPs on the living organisms. In recent times, several remedial techniques for POPs have emerged, like thermal, chemical, and biological techniques and their combinations, such as green nanotechnology and magnetic-biochar. However, many cost effective, less time consuming, and environmentally friendly techniques are in initial stages of experimentation. In general, the research concerning POPs is not very extensive and needs further studies to be conducted to increase the knowledge in this area. In addition to this, the health impacts and environmental issues of these techniques need to be addressed before their implementation. Governments should aim for an eventual phase-out of such polluting practices and push for international cooperation in developing viable and sustainable non-chemical alternatives.”

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