

## **4 ENVIRONMENTAL FATE AND TRANSPORT OF PERSISTENT ORGANIC POLLUTANTS**

By definition, POPs are likely to be more persistent, mobile, and bioavailable than other substances. These properties are conferred by the structural makeup of the molecules and are often associated with greater degrees of halogenation. Included in this group of substances are some older chlorinated pesticides like DDT and the chlordanes, polychlorinated biphenyls, polychlorinated benzenes, and polychlorinated dioxins and furans. The physico-chemical properties of these compounds are such that they favour sufficiently high atmospheric concentrations that result in global redistribution by evaporation and atmospheric transport.

### **4.1 PHYSICOCHEMICAL PROPERTIES AND ENVIRONMENTAL PARTITIONING**

The physical properties of greatest importance are water solubility, vapour pressure, Henry's law constant (H), octanol/water partition coefficient (KOW), and the organic carbon/water partition coefficient (KOC). Persistence in the environment is the other important property of a substance since transport can extend the range of exposure to persistent substances far beyond the immediate area of use and/or release.

### **4.2 ENVIRONMENTAL INFLUENCES ON PERSISTENCE, MOVEMENT AND DEPOSITION**

Persistence can be reduced by environmental transformation processes. These are: biotransformation; abiotic oxidation and hydrolysis; and photolysis. The relative importance of these processes depends on the rates at which they occur under natural environmental conditions. These rates are, in turn, dependent on the chemical structure and properties of the substance and its distribution in the various compartments of the environment. As would be expected, environmental factors have little effect on the breakdown and transformation of POPs. In addition, those that might have some effect are less effective in polar regions. Given the continued use and release of POPs in other parts of the globe, the result of this is a net accumulation of POPs in the polar regions.

Some of the above physical properties are strongly dependent on environmental conditions. For example, temperature strongly affects vapour pressure, water solubility, and, therefore, Henry's law constant. The net exchange direction for substances in the open ocean also reflects differences in surface water temperature and atmospheric concentration. For example, net movement of POPs in the Bay of Bengal in the Indian Ocean is from the ocean to the atmosphere while that in polar regions is the reverse. Temperature may also affect deposition in other locations. The distribution of POPs is inversely related to vapour pressure, and thus to temperature. Lower temperatures favour greater partitioning of these compounds from the vapour phase to particles suspended in the atmosphere. This increases the likelihood of their removal and transport to the surface of the earth by rain and snow (Figure 3).

Countries in the tropics experience higher year-round temperatures than countries in the temperate and polar regions of the globe. The practice of using some pesticides in tropical agriculture during the warmer, wetter growing season may facilitate the rapid dissipation of POPs through air and water.

These and other observations suggest that inputs of POPs to tropical coastal water bodies through river discharge are less significant than in temperate zones. The residence time in the tropical aquatic environment is quite short and transfer to the atmosphere is greater in these areas. The relatively short residence time of POPs in the tropical water bodies might be viewed as favourable for local organisms. However, it does have more far-reaching implications for the global environment because these volatilized residues from the tropics then disperse through the global atmosphere.

The present-day distribution of POPs in the oceans is consistent with a major change in distribution pattern during the last decades. Until the early 1980s, there were higher concentrations of POPs (such as DDT, and PCBs) in the midlatitude oceans of the northern hemisphere, probably reflecting the large usage in developed countries such as Japan, Europe, and North America. This distribution has not been seen in the most recent samples.

Atmospheric transport and accumulation of POPs (PCBs, DDT, HCHs, and chlordanes) in the polar regions has been extensively documented. Accumulation in polar regions is partly the result of global distillation followed by cold condensation of compounds within the volatility range of PCBs and pesticides. These contaminants are continually deposited and reevaporated and fractionate according to their volatilities (Figure 3). The result is relatively rapid transport and deposition of POPs having intermediate volatility, such as HCB, and slower migration of less volatile substances such as DDT (Figure 4).

The characteristics of polar ecosystems intensify the problems of contamination with POPs. The colder climate, reduced biological activity and relatively small incidence of sunlight would be expected to increase the persistence of the POPs.

### **4.3 DEPOSITION**

Considerable data on concentrations of POPs in samples from the Arctic and the Antarctic are available and are summarized in the companion document to this assessment. Most of these data are published in summary form as means or means with ranges. It was not possible to access the raw data from which these means were calculated, however, the range of concentrations are presented in Table 4-1 for information. Inspection of this data showed indications of declines in concentrations since some of these POPs were banned or restricted. The maintenance of a central database of all analytical data on the POPs would greatly aid in determining spatial and temporal trends in the data and linking these to changes in use pattern of these substances.

Extracted from:

## **PERSISTENT ORGANIC POLLUTANTS**

**An Assessment Report on:  
DDT-Aldrin-Dieldrin-Endrin-Chlordane  
Heptachlor-Hexachlorobenzene  
Mirex-Toxaphene  
Polychlorinated Biphenyls  
Dioxins and Furans**

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