

## **5.7 Effects of pesticides on biodiversity**

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The continuing intensive chemicalization of the world's agriculture introduces large amounts of pesticides into the planet's biosphere-the habitat of all living beings, including humans.

As environmental contaminants, pesticides are different from other types of chemicals:

- It is nearly impossible to prevent their circulation in the biosphere.
- They are biologically active. This creates potential dangers to nature and people.
- A large proportion of the human population comes into contact with pesticides.
- Many pesticides persist in natural conditions and are transferred along the food chain.
- Many pesticides can be accumulated in the bodies of organisms that come into contact with even low concentrations.

Pesticides can have both lethal and sub-lethal effects on organisms they come into contact with.

- The average crop loss resulting from insects, diseases and weeds has been calculated as high as 35% of the potential production of crops.
- Pesticide consumption in India for agriculture and public health has risen from 2000 tonnes a year in the fifties to over 80,000 tonnes.
- Annually in the world, there are about 750,000 reported pesticides poisonings with about 13,800 deaths. India accounts for 1/3 of pesticide poisoning cases in the world.
- In nine weeks, earthworms can accumulate 18 ppm of DDT from soil containing only 1 ppm of DDT. This demonstrates the serious big-accumulation effects of pesticides in the environment.

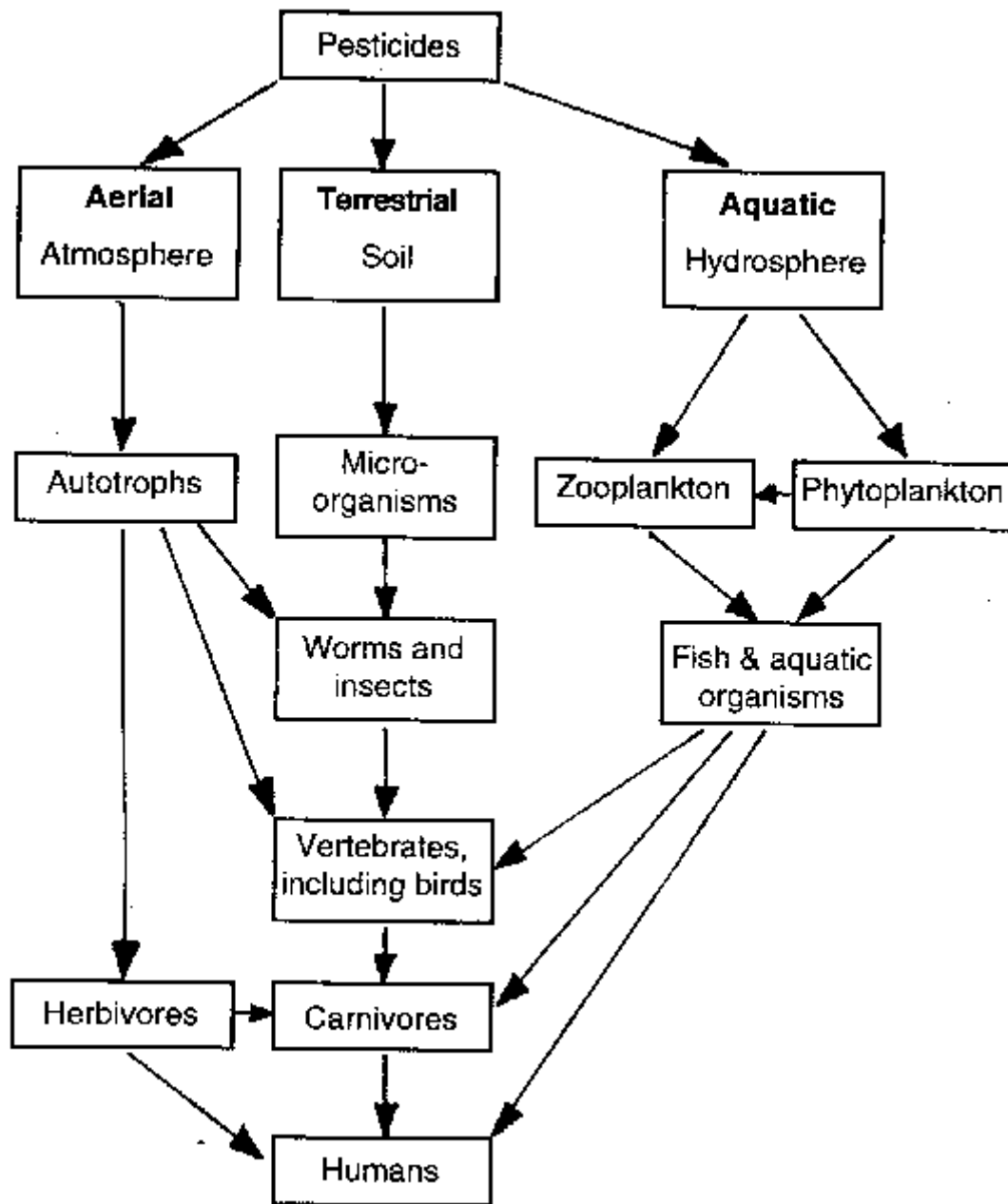
- Per average of 76 mg/kg of pesticide residues have been found in samples of cow's milk obtained from local vendors in Bombay. This level is more than 500 times higher than the maximum intake level of 0.15 mg/kg recommended by WHO.
- The "Handigodu Syndrome" in the population of many rural areas in Kamataka was traced to the victim's diet of crabs found in ponds and rice fields which were contaminated with pesticides (endrin and parathion). Victims were crippled; their limbs, lips and shoulders became deformed.
- The major source of dietary intake of pesticide residues is human milk and milk products, followed by oils and fats.

#### Effects of pesticides on the environment

Element	Potential effects
Abiotic	Presence of residual amounts in soil, water and air.
Plants	Presence of residual amounts. Damage due to phytotoxicity. Changes in vegetative development.
Animals	Presence of residual amounts in domestic and wild animals. Physiological actions (non-vitality of birds eggs). Extermination of some wild species. Development of second-generation pests.
Man	Presence of residual amounts in tissues and organs. Occupational diseases.
Food	Presence of residual amounts.
Organism being controlled	Development of resistance.

#### Biological transfer of pesticides

Pesticides enter a biological system by three main routes: aerial, terrestrial and aquatic.



Biological transfer of pesticides

Biomagnification of pesticides

The accumulation of pesticides in various biological systems is called "biomagnification". Some persistent pesticides accumulate in various biological system at levels much higher than those in their surroundings. For example, 1 kg of soil may contain only 1/1000 of a milligram of organochlorine pesticides-but a kilogram of carrots grown in the same soil may contain as much as 6 mg of pesticides.

## **Pesticides in the air**

Pesticides enter the atmosphere mainly through the treatment of agricultural crops, seeds, forests, and water basins. They get into the air together with soil dust' via wind erosion, during soil cultivation and crop harvesting. They are also evaporated from moist surfaces such as soil, water and plants. From the atmosphere, the pesticides and their metabolites get into water and soil and continue to circulate in the environment.

## **Aquatic environments**

Pollutants, including pesticides, accumulate in sediments which serve as a habitat for various organisms in the aquatic food chain, which ultimately involves fish. Even in insignificant concentrations, some pesticides may change the taste and odour of water, have a negative effect on the process of oxygen formation by phytoplankton, and affect the vital activities of the inhabitants of the water ecosystems.

Pesticides are dispersed in water and are picked up by living creatures. The chemicals enter the food chain and accumulate faster in living organisms through the aquatic route than through the other routes.

Pesticides can have both lethal and non-lethal effects on fish. Non-lethal effects include disturbed population dynamics and changed food habits and reproductive behaviour. Pesticides such as DDT reduce the ability of fish to adapt to changing temperatures. They also result in vertebral fractures and can deform fish backbones and fertilized eggs. Fish can be used to indicate the level of pesticide contamination in water.

## **Birds**

Sub-lethal dosages of pesticides can reduce the thickness of eggshells, making them fragile and reducing the number of eggs that hatch. Pesticides also cause hormonal changes in birds, influencing their courtship and nesting behaviours.

## **Pesticide degradation**

When pesticide residues get into the hydrosphere, some are volatilized and lost to the atmosphere, some are degraded, some are incorporated in the biota, and some move into the sediment.

Animals, plants and micro-organisms are responsible for degradation and detoxification of pesticidal residues. Pesticides are modified or completely decomposed in the soil as a result of physicochemical processes, microbiological

decomposition and absorption by higher plants and the soil fauna. The soils are rich in micro-organisms, which mostly include actinomycetes, fungi and bacteria. These micro-organisms play an important role in the degradation of pesticide residues from the soil. Many pesticides become detoxified by their adsorption by humus and other colloids or the formation of stable complexes in the soil. Poisonous chemicals are removed from the soil as a result of volatilization, evaporation with water vapour, migration beyond the root-habitat layer, washing out by rain water, melted snow, irrigation, ground and soil water.

### Biomagnification in the food chain

When a pesticide enters the food chain, it can be deposited in the bodies of organisms. Predators that prey on large numbers of these organisms can accumulate large quantities of the pesticide. For this reason, the maximum accumulations of the toxicant are found at the top of the food chain.

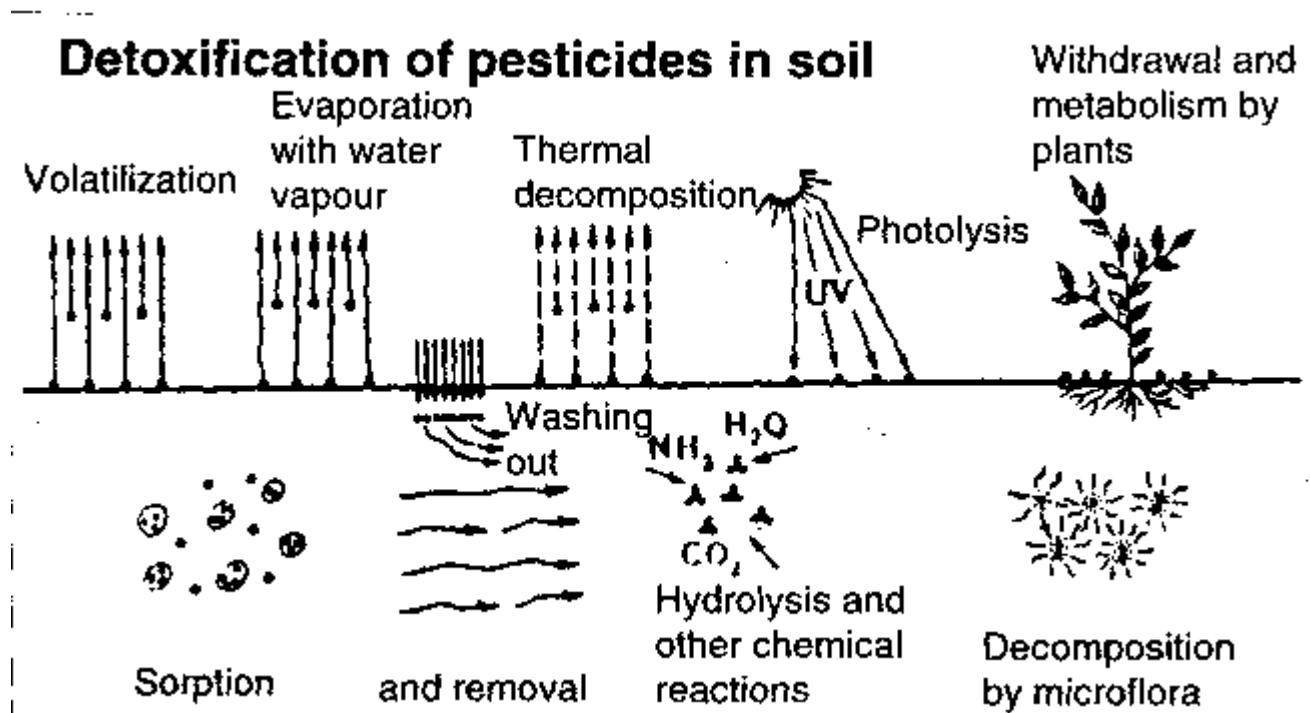
The species affected depend on the predator-prey relationships in the food chain. For instance, a pesticide in the soil that is picked up by earthworms may end up in snakes:

Earthworm-bird- salamander-snake

A pesticide picked up by soil insects may enter a different food chain that also ends with snakes:

Soil insects-predacious insects-toad-snake

Some types of pesticides persist in the environment because they are not broken down easily into harmless substances. The use of persistent organochlorine pesticides like DDT and HCH for agricultural and nonagricultural purposes should be discouraged. They should be replaced with easily degradable "soft" pesticides of organophosphates, carbamates and synthetic pyrethroid group. Better still, integrated pest management approaches that avoid pesticide uses should be used to control pests.

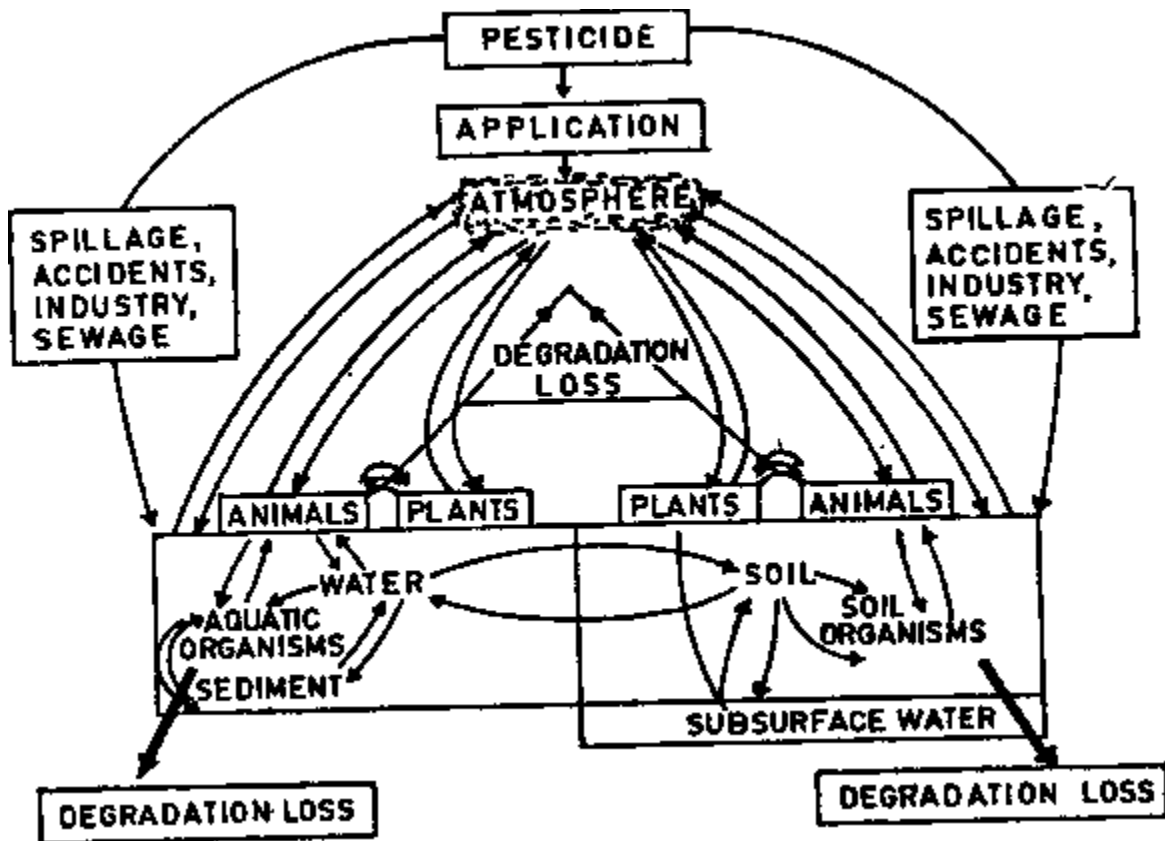


Detoxification of pesticides in soil

### Sources of pesticides

Pesticides can reach rivers, lakes, ponds and oceans from various sources:

- Industrial wastes and factory effluents
- Accidental spillage
- Spray drift at the time of field application
- Direct application to the soil for control of crop pests
- Atmospheric transport
- Agricultural wastes
- Sewage effluents.



Pesticide cycle in the environment

### Alternatives to chemical pesticides

The dangerous side-effects of a number of conventional pesticides on wildlife, their human health hazards and their pollution of the environment have forced the discontinuation of their use or manufacture. In addition, many harmful insects have become resistant to synthetic insecticides. It has become imperative to find other ways of controlling pests.

Various approaches are used to control pests. Those using natural predators, parasites and pathogens (biological control), sexual sterilization, sex pheromones and insect growth regulators (third generation pesticides) appear to offer the greatest opportunity for success- particularly if used in integrated pest management programs.

Micro-organisms that affect insects, or "entomo-pathogens", induce diseases that often suppress and, in some cases, completely eliminate natural populations of insect pests. Over 1000 such pathogens have been isolated from insects. Many are associated with major pests and could be developed into microbial insecticides.

Plants are the richest source of renewable bioactive organic chemicals. Plant-based pesticides are the oldest pesticides used by man. Recently there has been renewed interest in botanical pesticides.