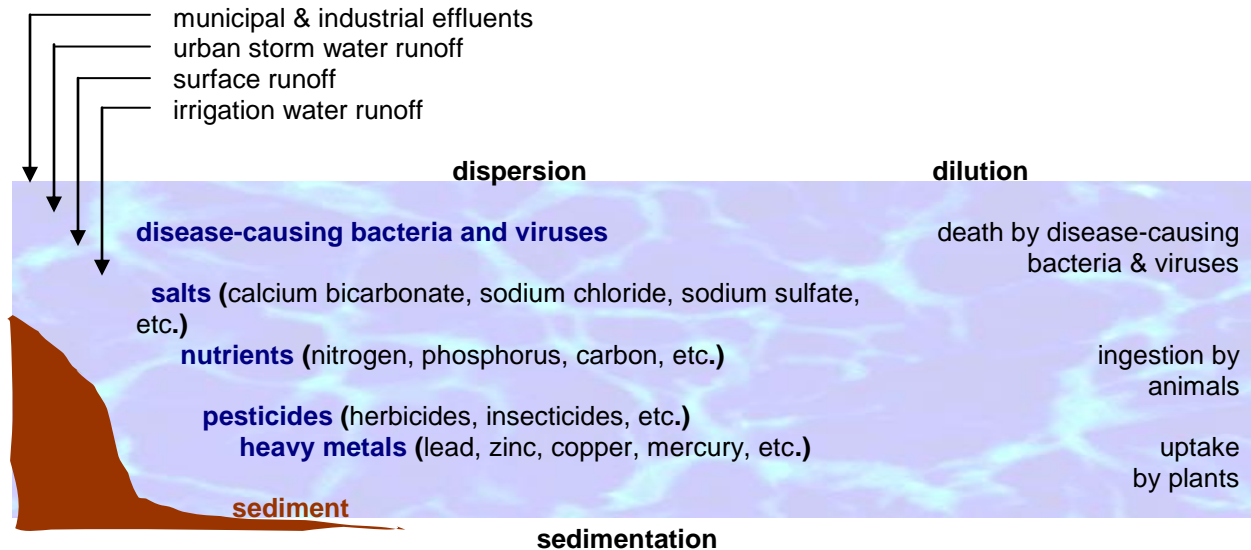


Concentration and Movement of Chemicals in the Environment

The source of a pollutant may be in one place, but it can show up in many other places around the world.

Changing the Concentration of Harmful Chemicals In the Environment

The concentration of chemicals in the environment can be changed using different techniques. **Dispersion** is the scattering of a substance away from its source. **Dilution** reduces the concentration of a pollutant by mixing it with large quantities of air or water. A fast flowing river or air mass can disperse and dilute a chemical very quickly. Regulations set by governments require that acceptable levels of pollutants be achieved. To do this **biodegradation** may be an effective alternative.



Biodegradation

Biodegradation occurs in the environment because living things (earthworms, bacteria and fungi) are actively breaking down organic substances, including many pollutants. Micro-organisms are especially important in the biodegradation of pollutants. The existing organic molecules provide carbon atoms, which are used to build biological compounds, such as carbohydrates and proteins. This is a multi-step process in which the large organic molecules are broken down (hydrolyzed) either inside or outside bacteria.

Bacteria

Some bacteria grow and reproduce only when oxygen is present. They use the oxygen for the process of **aerobic biodegradation**. When oxygen is not present – in an **anaerobic** environment (like deep in landfill sites) - some bacteria remove chlorine from harmful chlorine-containing compounds, such as **PCB's** (polychlorinated biphenyls - human made oils used in electrical equipment), by replacing them with hydrogen atoms – which can then be used as food for the bacteria.

Factors Affecting Biodegradation

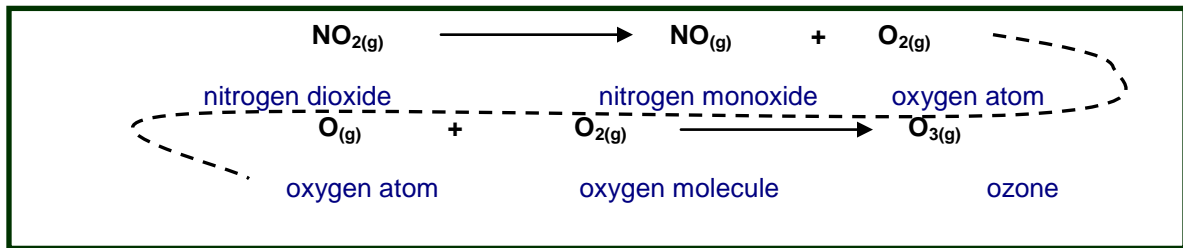
During the winter, biodegradation is slow, because *temperature* is one factor that affects the rate of biodegradation. Other factors include *soil moisture, pH, oxygen supply and nutrient availability*. Bioreactors are a new technology that speeds up the rate of biodegradation by adding water to organic waste in a sanitary landfill site. *Planting vegetation* also encourages faster biodegradation because the populations of bacteria and fungi are larger around plant roots and this higher level means more microbial activity.

Phytoremediation

Phytoremediation is a technique that can be used to reduce the concentration of harmful chemicals in the soil or groundwater. Plants have been used to clean up metals, hydrocarbons, solvents, pesticides, radioactive materials, explosives, and landfill leachate. The plants are able to absorb and accumulate large amounts of these chemicals. When the plants have matured, they are harvested, burned or composted. In some cases, the metal can be recycled. When most of the harmful chemicals are removed by phytoremediation from the soil, then other plants can be planted there.

Photolysis

Photolysis is the breakdown of compounds by sunlight. The formation of ozone is an example of this process (outlined below)



Another example of photolysis is photodegradable plastic. Photodegradable plastic is made of chemicals that react when exposed to sunlight. In three months, the plastic becomes a fine powder that is easier to dispose of. (This type of plastic will only degrade if it is exposed to sunlight – if it is buried, it will last in its original shape for hundreds of years.)

Transport of Materials Through Air, Soil and Water

There are three stages of transport of substances in the environment:

- **Release** of chemicals at the source
- **Dispersion** of the chemical into the atmosphere
- **Deposition** of the chemical in soil or water

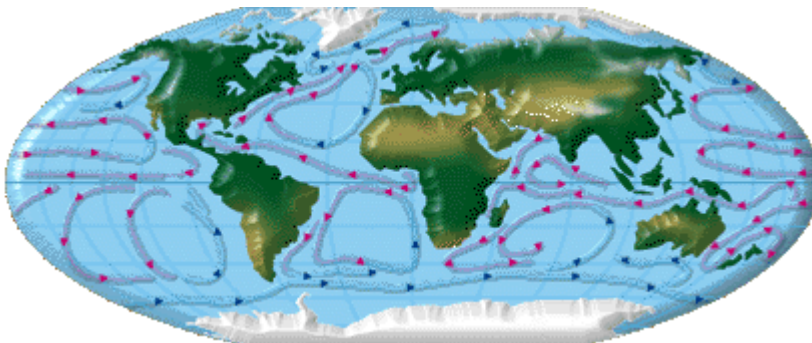
Transport In Air

The direction and distance that airborne chemicals travel are determined by various factors, including:

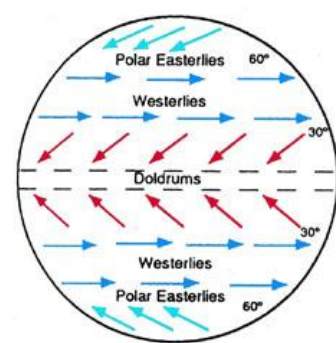
- The properties of the chemical pollutant
- The wind speed
- The direction of the prevailing winds

The distribution of particles may also be limited by lack of wind or precipitation.

Ocean Currents



Surface Winds



Transport In Groundwater

Water that soaks into the soil is collected in a zone called the groundwater zone. The top of the **groundwater** zone in the soil is called the **water table**. Groundwater moves sideways, up or down and can move very slowly (1 meter per year) or very quickly (1 meter per day). Certain contaminants can remain collected in the groundwater for long periods of time (because they are heavy metals), posing problems if the groundwater is used for drinking, agricultural purposes or industrial use.

Factors that affect the movement of contaminants in groundwater include the number and connection of **pores** (tiny spaces between soil grains) in the soil. When the pores are packed together very tightly and are not connected, the soil is considered **impermeable**. If the pores are connected the soil is **permeable** and water can move through easily.

Pollutants, which occur naturally or through human activities, can move more quickly through permeable soil.

Some Substances That Contaminate Groundwater

Substance	Source	Examples	Occurrence
Minerals	Rocks and Soil	Iron, Calcium, Selenium	Natural
Organic Substances	Soil	Pesticides, solvents	Natural & Human Activities
Leached Substances	Landfill sites, mines	Heavy metals, organics	Human Activities
Leaked substances	Underground storage tanks, pipelines	Gasoline, Natural gas, oil	Human Activities
Inorganic substances	Run-off	De-icing roadways, sewage, industrial processes	Human Activities
Micro-organisms	Septic tanks, sewage treatment ponds, runoff	Bacteria, viruses, Protozoan	Human Activities
Chemicals	Household	Nitrates, phosphates, detergents, cleaners	Human Activities

Transport In Surface Water

Hazardous chemicals can enter surface water from the air, the groundwater, runoff from agricultural fields and industrial sites and outflow from storm sewers and sewage treatment plants. A substance that dissolves in water easily may be carried by water a fair distance and dispersed over a wide area. Substances that do not dissolve easily may sink to the bottom and be concentrated close to the source, affecting organisms in the immediate area. Because humans use water for drinking and agricultural use, it's quality is monitored regularly.

Transport In Soil

Water is moved in one of four ways: evaporation, absorption by plants, runoff (into surface water) and soaking into soil dissolving substances (**leachate**). The type of soil plays an important role in how quickly water passes through it. Packed clay is impermeable (so fluids won't pass through it). That is why sanitary landfill sites use a layer of packed clay to prevent leaching. Organic material can absorb fluids and slow their movement through the soil. Hazardous chemicals can be changed by what other chemicals are present in the soil. (acids can be neutralized by naturally occurring bases – like limestone)

Transport of Hydrocarbons In Soil

The daily use of hydrocarbons in vehicles and industry contaminates the soil. Some of these hydrocarbon emissions are carried by the air into the soil, or are carried by water where they can clog up soil pores – usually close to the source of the contamination. Hydrocarbons are toxic to plants and animals

Hazardous Chemicals Affect Living Things

Chemicals can accumulate in living organisms. The increased concentrations mean that chemicals can remain in the environment for long periods of time.

Biomagnification

Biomagnification (or bioaccumulation) is the increase in the concentration of a chemical or element as it moves up the food chain.

