***Sediment Pollution***

**What is Sediment?**

Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of a body of water. Sediment can come from soil erosion or from the decomposition of plants and animals. Wind, water and ice help carry these particles to rivers, lakes and streams.

**Facts about Sediment:**

* The Environmental Protection Agency lists sediment as the most common pollutant in rivers, streams, lakes and reservoirs.
* While natural erosion produces nearly 30 percent of the total sediment in the United States, accelerated erosion from human use of land accounts for the remaining 70 percent.
* The most concentrated sediment releases come from construction activities, including relatively minor home-building projects such as room additions and swimming pools.
* Sediment pollution causes $16 billion in environmental damage annually.

## **Sediment as a physical pollutant:**

## Global estimates of erosion and sediment transport in major rivers of the world vary widely, reflecting the difficulty in obtaining reliable values for sediment concentration and discharge in many countries, the assumptions that are made by different researchers, and the opposing effects of accelerated erosion due to human activities (deforestation, poor agricultural practices, road construction, etc.) relative to sediment storage by dam construction. Milliman and Syvitski (1992) estimate global sediment load to oceans in the mid-20th century at 20 thousand million t/yrs., of which about 30% comes from rivers of southern Asia (including the Yangtze and Yellow Rivers of China). Significantly, they believe that almost 50% of the global total comes from erosion associated with high relief on islands of Oceania - a phenomenon which has been underestimated in previous estimates of global sediment production. While erosion on mountainous islands and in upland areas of continental rivers reflects natural topographic influences, Milliman and Syvitski suggest that human influences in Oceania and southern Asia cause disproportionately high sediment loads in these regions.

## **Principal ways of Sediment:**

* High levels of**turbidity** limit penetration of sunlight into the water column, thereby limiting or prohibiting growth of algae and rooted aquatic plants. In spawning rivers, gravel beds are blanketed with fine sediment which inhibits or prevents spawning of fish. In either case, the consequence is disruption of the aquatic ecosystem by destruction of habitat. Notwithstanding these undesirable effects, the hypertrophic (nutrient rich) status of many shallow lakes, especially in developing countries, would give rise to immense growth of algae and rooted plants were it not for the limiting effect of light extinction due to high turbidity. In this sense, high turbidity can be "beneficial" in highly eutrophic lakes; nevertheless, many countries recognize that this situation is undesirable for both aesthetic and economic reasons and are seeking means to reduce both turbidity and nutrient levels. Box 4 presents the impact of sediment on coral reefs.
* High levels of**sedimentation** in rivers leads to physical disruption of the hydraulic characteristics of the channel. This can have serious impacts on navigation through reduction in depth of the channel, and can lead to increased flooding because of reductions in capacity of the river channel to efficiently route water through the drainage basin. For example, calculations by the UFRGS (1991) of erosion and sediment transport in the Sao Francisco River Basin, a large drainage system in eastern Brazil, demonstrate that the central portion of the river basin is now dominated by sediment deposition. This has resulted in serious disruption of river transportation, and clogs hydraulic facilities that have been built to provide irrigation water from the main river channel. The sediment largely originates from rapidly eroding sub-basins due to poor agricultural practices.

**Sediment as a chemical pollutant:**

The role of sediment in chemical pollution is tied both to the particle size of sediment, and to the amount of particulate organic carbon associated with the sediment. The chemically active fraction of sediment is usually cited as that portion which is smaller than 63 m m (silt + clay) fraction. For phosphorus and metals, particle size is of primary importance due to the large surface area of very small particles. Phosphorus and metals tend to be highly attracted to ionic exchange sites that are associated with clay particles and with the iron and manganese coatings that commonly occur on these small particles. Many of the persistent, bio accumulating and toxic organic contaminants, especially chlorinated compounds including many pesticides, are strongly associated with sediment and especially with the organic carbon that is transported as part of the sediment load in rivers. Measurement of phosphorus transport in North America and Europe indicate that as much as 90% of the total phosphorus flux in rivers can be in association with suspended sediment.

The affinity for particulate matter by an organic chemical is described by its octanol-water partitioning coefficient (KOW). This partitioning coefficient is well known for most organic chemicals and is the basis for predicting the environmental fate of organic chemicals (see Chapter 4). Chemicals with low values of KOW are readily soluble, whereas those with high values of KOW are described as "hydrophobic" and tend to be associated with particulates. Chlorinated compounds such as DDT and other chlorinated pesticides are very hydrophobic and are not, therefore, easily analyzed in water samples due to the very low solubility of the chemical. For organic chemicals, the most important component of the sediment load appears to be the particulate organic carbon fraction which is transported as part of the sediment. Scientists have further refined the partitioning coefficient to describe the association with the organic carbon fraction (KOC).

Another important variable is the concentration of sediment, especially the <63 m m fraction, in the water column. Even those chemicals that are highly hydrophobic will be found in trace levels in soluble form. Where the suspended load is very small (say, less than 25 mg/l), the amount of water is so large relative to the amount of sediment that the bulk of the load of the chemical may be in the soluble fraction. This becomes an important issue in the monitoring of hydrophobic chemicals as noted in Table 17.

Unlike phosphorus and metals, the transport and fate of sediment-associated organic chemicals is complicated by microbial degradation that occurs during sediment transport in rivers and in deposited sediment. Nevertheless, the role of sediment in the transport and fate of agricultural chemicals, both for nutrients, metals, and pesticides is well known and must be taken into account when monitoring for these chemicals, and when applying models as a means of determining optimal management strategies at the field and watershed level.

For this reason, models using the "fugacity" concept (uses the partitioning characteristics [Chapter 4] of chemicals as a basis for determining the environmental compartment - air, sediment, water, biota - in which the chemical is primarily found) has proven effective in predicting the environmental pathways and fate of contaminants (Mackay and Paterson, 1991).

**FIGURE 4 Schematic diagram showing the major processes that link rainfall and runoff**



**Conclusion:**

The role of sediment as a chemical pollutant is a function of the chemical load that is carried by sediments.

Organic chemicals associated with sediment enter into the food chain in a variety of ways. Sediment is directly ingested by fish however, more commonly, fine sediment (especially the carbon fraction) is the food supply for benthic (bottom dwelling) organisms which, in turn, are the food source for high organisms. Ultimately, toxic compounds bio accumulate in fish and other top predators. In this way, pesticides that are transported off the land as part of the runoff and erosion process, accumulate in top predators including man.

# **How Does Sediment Affect Ecosystems?**

## **Sediment Contamination:**

## One of the primary negative effects of sediment in the ecosystem concerns the nature of the sediment. Agricultural and urban runoff may contain toxic materials, which can damage or even kill the organisms within an ecosystem. According to the U.S. Environmental Protection Agency (EPA), runoff from farmlands is the main cause of pollution in U.S. waterways. The runoff can include sediment from pesticide and fertilizer applications as well as animal waste and bacteria.

## **Filter Feeders:**

## Some animal species are especially sensitive to the effects of sediment, with contamination quickly accumulating in animal tissues. Filter feeders such as mussels and clams get food by filtering water through their bodies, making them especially vulnerable to the presence of sediment. Other species such as salmon require clear waters in order to locate their prey. High levels of suspended sediment can interfere with their ability to find food, risking the health of the ecosystem by disrupting the prey-predator relationships.

## **Wetlands and Water Filtering:**

## Wetlands affect the sediment load in the ecosystem by slowing water flow, which allows suspended particles to drop down to ground level. This filtering action is an important environmental benefit because it removes the sediment from the water. In essence, the sediment, whether it contains contaminants or not, becomes locked into the sediment layer of the wetlands. The effects of the pollutants are then mitigated.

## **Soil Erosion:**

## One way in which sediment enters an ecosystem is through soil erosion. Water flowing over bare soils will easily dislodge sediment, where it will later be deposited within the environment. Impervious surfaces, such as roads and parking lots, facilitate soil erosion. Without plants to slow it, water flow increases, allowing it to dig deeply into stream banks.

## **Prevention/Solution:**

## The best way to control the negative environmental effects of sediment is to prevent its introduction into the environment. Planting dense groundcover along stream banks and coastal areas will help keep soils intact and prevent them from washing away. Restoration of wetlands within floodplains and other areas will improve water quality by removing suspended sediment from the water.

**References:**

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