INTRODUCTION

According to the American College Dictionary, pollution is defined as: "to make foul or unclean; dirty."
Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. When it is unfit for its intended use, water is considered polluted.

Comprising over 70% of the Earth's surface, water is undoubtedly the most precious natural resource that exists on our planet. Without the seemingly invaluable compound comprised of hydrogen and oxygen, life on Earth would be non-existent: it is essential for everything on our planet to grow and prosper. Although we as humans recognize this fact, we disregard it by polluting our rivers, lakes, and oceans. Subsequently, we are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate. In addition to innocent organisms dying off, our drinking water has become greatly affected as is our ability to use water for recreational purposes. In order to combat water pollution, we must understand the problems and become part of the solution.

Water pollution has many sources and characteristics. Humans and other organisms produce bodily wastes which enter rivers, lakes, oceans and other surface waters; in high concentrations these wastes result in bacterial contamination and excessive nutrient loading (eutrophication). Industries discharge a variety of compounds such as heavy metals, and wastewater, sometimes in toxic concentrations, from industrial process may also be too hot or too low in dissolved oxygen to support life. Silt-bearing runoff from construction sites and farms can inhibit the penetration of sunlight through the water column, hampering water organisms in their ability to photosynthesize.

Groundwater pollution is more difficult to clean up than surface pollution because groundwater can move hundreds of miles through unseen aquifers. Porous, fine-grained aquifers such as sands and sandstones naturally purify water of bacteria by simple filtration (adsorption and absorption), dilution, and, to a lesser extent, chemical reactions and biological activity. Groundwater that moves through cracks and caverns is not filtered and can be polluted just as easily as surface water. In fact this can be aggravated by the human tendency to use sinkholes in areas of Karst topography as dumps.

Sources of Water Pollution

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. The sources of water pollution are categorized as being a point source or a non-source point of pollution.

Point sources of pollution

Occur when the polluting substance is emitted directly into the waterway. A pipe spewing toxic chemicals directly into a river is an example. The oil spill best illustrates point source water pollution. Direct sources include effluent outfalls from factories, refineries, waste treatment plants etc.. that emit fluids of varying quality directly into urban water supplies. In the United States and other countries, these practices are regulated, although this doesn't mean that pollutants can't be found in these waters. The technology exists for point sources of pollution to be monitored and regulated, although political factors may complicate matters.

Non-point source of pollution

Occurs when there is runoff of pollutants into a waterway, An example of this type of water pollution is when fertilizers and pesticides from a field are carried into a stream by rain, in the form of run-off which in turn affects aquatic life. Non-point source of pollution delivers pollutants indirectly through environmental changes. Sources are much more difficult to control. Pollution arising from non-point sources accounts for a majority of the contaminants in streams and lakes. Indirect sources include contaminants that enter the water supply from soils/groundwater systems and from the atmosphere via rain water. Soils and ground-waters contain the residue of human agricultural practices (fertilizers, pesticides, etc..) and improperly disposed of industrial wastes. Atmospheric contaminants are also derived from human practices (such as gaseous emissions from automobiles, factories and even bakeries). Contaminants can be broadly classified into organic, inorganic, radioactive and acid/base. Examples from each class and their potential sources are too numerous to discuss here.

Specific Sources of Water Pollution

Farming:
Farms often use large amounts of herbicides and pesticides, both of which are toxic pollutants. These substances are particularly dangerous to life in rivers, streams and lakes, where toxic substances can build up over a period of time. Farms also frequently use large amounts of chemical fertilizers that are washed into the waterways and damage the water supply and the life within it. Fertilizers can increase the amounts of nitrates and phosphates in the water, which can lead to the process of eutrophication. Allowing livestock to graze near water sources often results in organic waste products being washed into the waterways. This sudden introduction of organic material increases the amount of nitrogen in the water, and can also lead to eutrophication. Four hundred million tons of soils are carried by the Mississippi River to the Gulf of Mexico each year. A great deal of this siltation is due to runoff from the exposed soil of agricultural fields. Excessive amounts of sediment in waterways can block sunlight, preventing aquatic plants from photosynthesizing, and can suffocate fish by clogging their gills.

Business:
Clearing of land can lead to erosion of soil into the river. Waste and sewage generated by industry can get into the water supply, introducing large organic pollutants into the ecosystem. Many industrial and power plants use rivers, streams and lakes to dispose of waste heat. The resulting hot water can cause thermal pollution. Thermal pollution can have a disastrous effect on life in an aquatic ecosystem as temperature increases decrease the amount of oxygen in the water, thereby reducing the number of animals that can survive there. Heat is a pollutant because increased temperatures result in the deaths of many aquatic organisms. These decreases in temperatures are caused when a discharge of cooling water by factories and power plants occurs. Water can become contaminated with toxic or radioactive materials from industry, mine sites and abandoned hazardous waste sites. Acid precipitation is caused when the burning of fossil fuels emits sulfur dioxide into the atmosphere. The sulfur dioxide reacts with the water in the atmosphere, creating rainfall which contains sulfuric acid. As acid precipitation falls into lakes, streams and ponds it can lower the overall pH of the waterway, killing vital plant life, thereby affecting the whole food chain. It can also leach heavy metals from the soil into the water, killing fish and other aquatic organisms. Because of this, air pollution is potentially one of the most threatening forms of pollution to aquatic ecosystems. Petroleum often pollutes water bodies in the form of oil, resulting from oil spills. The previously mentioned Exxon Valdez is an example of this type of water pollution. These large-scale accidental discharges of petroleum are an important cause of pollution along shore lines. Besides the supertankers, off-shore drilling operations contribute a large share of pollution. One estimate is that one ton of oil is spilled for every million tons of oil transported. This is equal to about 0.0001 percent. Radioactive substances are produced in the form of waste from nuclear power plants, and from the industrial, medical, and scientific use of radioactive materials. Specific forms of waste are uranium and thorium mining and refining.

Homes:
Sewage generated by houses or runoff from septic tanks into nearby waterways, introduce organic pollutants that can cause eutrophication. Fertilizers, herbicides and pesticides used for lawn care can runoff and contaminate the waterway. As with agricultural fertilizers, home fertilizers can lead to the eutrophication of lakes and rivers. Improper disposal of hazardous chemicals down the drain introduce toxic materials into to the ecosystem, contaminating the water supplies in a way that can harm aquatic organisms. Leaks of oil and antifreeze from a car on a driveway can be washed off by the rain into nearby waterways, polluting it.

CLASSIFYING WATER POLLUTION

The major sources of water pollution can be classified as municipal, industrial, and agricultural. Municipal water pollution consists of waste water from homes and commercial establishments. For many years, the main goal of treating municipal wastewater was simply to reduce its content of suspended solids, oxygen-demanding materials, dissolved inorganic compounds, and harmful bacteria. In recent years, however, more stress has been placed on improving means of disposal of the solid residues from the municipal treatment processes. The basic methods of treating municipal wastewater fall into three stages: primary treatment, including grit removal, screening, grinding, and sedimentation; secondary treatment, which entails oxidation of dissolved organic matter by means of using biologically active sludge, which is then filtered off; and tertiary treatment, in which advanced biological methods of nitrogen removal and chemical and physical methods such as granular filtration and activated carbon absorption are employed. The handling and disposal of solid residues can account for 25 to 50 percent of the capital and operational costs of a treatment plant. The characteristics of industrial waste waters can differ considerably both within and among industries. The impact of industrial discharges depends not only on their collective characteristics, such as biochemical oxygen demand and the amount of suspended solids, but also on their content of specific inorganic and organic substances. Three options are available in controlling industrial wastewater. Control can take place at the point of generation in the plant; wastewater can be pretreated for discharge to municipal treatment sources; or wastewater can be treated completely at the plant and either reused or discharged directly into receiving waters.

CAUSES OF POLLUTION

Many causes of pollution including sewage and fertilizers contain nutrients such as nitrates and phosphates. In excess levels, nutrients over stimulate the growth of aquatic plants and algae. Excessive growth of these types of organisms consequently clogs our waterways, use up dissolved oxygen as they decompose, and block light to deeper waters. This, in turn, proves very harmful to aquatic organisms as it affects the respiration ability or fish and other invertebrates that reside in water. Pollution is also caused when silt and other suspended solids, such as soil, wash-off plowed fields, construction and logging sites, urban areas, and eroded river banks

when it rains. Under natural conditions, lakes, rivers, and other water bodies undergo Eutrophication, an aging process that slowly fills in the water body with sediment and organic matter. When these sediments enter various bodies of water, fish respiration becomes impaired, plant productivity and water depth become reduced, and aquatic organisms and their environments become suffocated. Pollution in the form of organic material enters waterways in many different forms as sewage, as leaves and grass clippings, or as runoff from livestock feedlots and pastures. When natural bacteria and protozoan in the water break down this organic material, they begin to use up the oxygen dissolved in the water. Many types of fish and bottom-dwelling animals cannot survive when levels of dissolved oxygen drop below two to five parts per million. When this occurs, it kills aquatic organisms in large numbers which leads to disruptions in the food chain. Pathogens are another type of pollution that proves very harmful. They can cause many illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. Pathogens include such organisms as bacteria, viruses, and protozoan. These pollutants enter waterways through untreated sewage, storm drains, septic tanks, runoff from farms, and particularly boats that dump sewage. Though microscopic, these pollutants have a tremendous effect evidenced by their ability to cause sickness.

The causes of water pollution can be divided into two groups:
Anthropogenic sources of pollution are those due to human choices, and natural sources are those resulting from forces intrinsic to the environment.

Anthropogenic sources include:
Discharge of poorly-treated or untreated sewage; runoff from construction sites, farms, or paved and other impervious surfaces e.g. silt discharge of contaminated and/or heated water used for industrial processes acid rain caused by industrial discharge of sulfur dioxide (by burning high-sulfur fossil fuels) excess nutrients added by runoff containing large amounts of detergents or fertilizers

Natural sources include:
seasonal turnover of lakes and embayments; siltation due to floods; eutrophication of lakes due to seasonal changes acid rain caused by natural volcanic discharges or smog from factories acid pollution of rivers and lakes by runoff from naturally acid soils carbon dioxide discharges and runoff, volcanic or mineral

Major Water Contaminants

Contaminants may include organic and inorganic substances.

Organic water pollutants include:
Bacteria, as from sewage or livestock operations; fertilizers, in runoff from agricultural fields or forestry; food processing waste; tree and brush debris from logging operations.

Inorganic pollutants include:
Metals, acid mine drainage, acid rain caused by industrial or volcanic discharges, acid pollution of lakes by runoff from acid soils, carbon dioxide discharges and runoff,

volcanic or mineral, chemical waste industrial byproducts silt in storm-water runoff from cleared land.

The toxic chemicals and particles are carried out by the rivers into the ocean. In some areas of the world the influence can be traced hundred miles from the mouth, like in front of the Hudson River. As indicator filter feeding animals are used by the oceanographers, like copepods in the map of New York Bight. The highest toxin loads are not directly in front off New York but 100 km South, because it takes a few days to be incorporated in the tissue of the plankton. The Hudson water flows south along the coast due to the coriolis force. The second map shows areas of oxygen depletion, caused by chemicals using up oxygen and by heavy algae blooms, caused by too much nutrients, when the cells die, sink and decompose. Heavy fish and shellfish kills have been reported. The toxins make their way up the food chain when small fish eat the copepods, then large fish, each step concentrating up ca. 10 times.

Types of Water Pollution

Toxic Substance -- A toxic substance is a chemical pollutant that is not a naturally occurring substance in aquatic ecosystems. The greatest contributors to toxic pollution are herbicides, pesticides and industrial compounds.

Organic Substance -- Organic pollution occurs when an excess of organic matter, such as manure or sewage, enters the water. When organic matter increases in a pond, the number of decomposers will increase. These decomposers grow rapidly and use a great deal of oxygen during their growth. This leads to a depletion of oxygen as the decomposition process occurs. A lack of oxygen can kill aquatic organisms. As the aquatic organisms die, they are broken down by decomposers which lead to further depletion of the oxygen levels. A type of organic pollution can occur when inorganic pollutants such as nitrogen and phosphates accumulate in aquatic ecosystems. High levels of these nutrients cause an overgrowth of plants and algae. As the plants and algae die, they become organic material in the water. The enormous decay of this plant matter, in turn, lowers the oxygen level. The process of rapid plant growth followed by increased activity by decomposers and a depletion of the oxygen level is called eutrophication.

Thermal Pollution -- Thermal pollution can occur when water is used as a coolant near a power or industrial plant and then is returned to the aquatic environment at a higher temperature than it was originally. Thermal pollution can lead to a decrease in the dissolved oxygen level in the water while also increasing the biological demand of aquatic organisms for oxygen.

Ecological Pollution -- Ecological pollution takes place when chemical pollution, organic pollution or thermal pollution are caused by nature rather than by human activity. An example of ecological pollution would be an increased rate of siltation of a waterway after a landslide which would increase the amount of sediments in runoff water. Another example would be when a large animal, such as a deer, drowns in a flood and a large amount of organic material is added to the water as a result. Major geological events such as a volcano eruption might also be sources of ecological pollution

Wastewater Treatment

Raw sewage includes waste from sinks, toilets, and industrial processes. Treatment of the sewage is required before it can be safely buried, used, or released back into local water systems. In a treatment plant, the waste is passed through a series of screens, chambers, and chemical processes to reduce its bulk and toxicity. The three general phases of treatment are primary, secondary, and tertiary. During primary treatment, a large percentage of the suspended solids and inorganic material is removed from the sewage. The focus of secondary treatment is reducing organic material by accelerating natural biological processes. Tertiary treatment is necessary when the water will be reused; 99 percent of solids are removed and various chemical processes are used to ensure the water is as free from impurity as possible. Agriculture, including commercial livestock and poultry farming, is the source of many organic and inorganic pollutants in surface waters and groundwater. These contaminants include both sediment from erosion cropland and compounds of phosphorus and nitrogen that partly originate in animal wastes and commercial fertilizers. Animal wastes are high in oxygen demanding material, nitrogen and phosphorus, and they often harbor pathogenic organisms. Wastes from commercial feeders are contained and disposed of on land; their main threat to natural waters, therefore, is from runoff and leaching. Control may involve settling basins for liquids, limited biological treatment in aerobic or anaerobic lagoons, and a variety of other methods.

GLOBAL WATER POLLUTION

Estimates suggest that nearly 1.5 billion people lack safe drinking water and that at least 5 million deaths per year can be attributed to waterborne diseases. With over 70 percent of the planet covered by oceans, people have long acted as if these very bodies of water could serve as a limitless dumping ground for wastes. Raw sewage, garbage, and oil spills have begun to overwhelm the diluting capabilities of the oceans, and most coastal waters are now polluted. Beaches around the world are closed regularly, often because of high amounts of bacteria from sewage disposal, and marine wildlife is beginning to suffer.

Perhaps the biggest reason for developing a worldwide effort to monitor and restrict global pollution is the fact that most forms of pollution do not respect national boundaries. The first major international conference on environmental issues was held in Stockholm, Sweden, in 1972 and was sponsored by the United Nations (UN). This meeting, at which the United States took a leading role, was controversial because many developing countries were fearful that a focus on environmental protection was a means for the developed world to keep the undeveloped world in an economically subservient position. The most important outcome of the conference was the creation of the United Nations Environmental Program (UNEP).

UNEP was designed to be “the environmental conscience of the United Nations,” and, in an attempt to allay fears of the developing world, it became the first UN agency to be headquartered in a developing country, with offices in Nairobi, Kenya. In addition to attempting to achieve scientific consensus about major environmental issues, a

major focus for UNEP has been the study of ways to encourage sustainable development increasing standards of living without destroying the environment. At the time of UNEP's creation in 1972, only 11 countries had environmental agencies. Ten years later that number had grown to 106, of which 70 were in developing countries.

CONCLUSION

Clearly, the problems associated with water pollution have the capabilities to disrupt life on our planet to a great extent. Congress has passed laws to try to combat water pollution thus acknowledging the fact that water pollution is, indeed, a serious issue. But the government alone cannot solve the entire problem. It is ultimately up to us, to be informed, responsible and involved when it comes to the problems we face with our water. We must become familiar with our local water resources and learn about ways for disposing harmful household wastes so they don't end up in sewage treatment plants that can't handle them or landfills not designed to receive hazardous materials. In our yards, we must determine whether additional nutrients are needed before fertilizers are applied, and look for alternatives where fertilizers might run off into surface waters. We have to preserve existing trees and plant new trees and shrubs to help prevent soil erosion and promote infiltration of water into the soil. Around our houses, we must keep litter, pet waste, leaves, and grass clippings out of gutters and Storm drains. These are just a few of the many ways in which we, as humans, have the ability to combat water pollution. As we head into the 21st century, awareness and education will most assuredly continue to be the two most important ways to prevent water pollution. If these measures are not taken and water pollution continues, life on earth will suffer severely. Global environmental collapse is not inevitable. But the developed world must work with the developing world to ensure that new industrialized economies do not add to the world's environmental problems. Politicians must think of sustainable development rather than economic expansion. Conservation strategies have to become more widely accepted, and people must learn that energy use can be dramatically diminished without sacrificing comfort. In short, with the technology that currently exists, the years of global environmental mistreatment can begin to be reversed.

Important Terms

Aquifers - natural rock formations, which contain ground water.
Eutrophication - The process of slowly filling in a water body with sediments and organic matter.
Non point source - delivers pollutants indirectly through environmental changes. One way in, which this occurs, is through run-off.
Pathogens - or disease producing organism.
Point source - occurs when harmful substances are emitted directly into a body of water. One way in which this occurs, is when someone throws a coke can into a body of water.
Pollution - to make foul or unclean; dirty.
Sediments - minerals or organic matter deposited by water, air, or ice...matter which settles to the bottom a liquid.

References

- Terry, LA Water Pollution ENVIRON. LAW PRACT., vol. 4, no. 1, pp. 19-29, 1996
- Poppe, Wayne; Hurst, Renee Water Pollution WATER QUAL INT, pp. 39-43, 1997
- Richman, M IND. Water Pollution WASTEWATER, vol. 5, no. 2, pp. 24-29, 1997
- Tibbetts, J Anon. Water ENVIRON. SOLUTIONS, vol. 9, no. 8, p. 26, 1996
- US EPA, WASHINGTON, D.C. 20460 (USA), 1996, v.p.
- Onsdorff, KA Pollution; Water ENVIRON. LAW PRACT., vol. 4, no. 1, pp. 14-18, 1996
- MacDonnell, LJ Water Quality LAND WATER LAW REV., vol. 31, no. 2, pp. 329-348, 1996
- Brassard, PG Wetlands and Water Pollution BOSTON COLL. ENVIRON. AFF. LAW REV., vol. 23, no. 4, pp. 885-919, 1996
- Ungate, CD Clean Water Initiative J. ENVIRON. PLANN. MANAGE., vol. 39, no. 1, pp. 113-122, 1996
- Lindsey, T; Neese, S; Thomas, D Pollutin Prevention WATER QUAL. INT., pp. 32-36, 1996
- Gannon, RW; Osmond, DL; Humenik, FJ; Gale, JA; Spooner, J Agricultural Water Quality WATER RESOUR BULL, vol. 32, no. 3, pp. 437-450, 1996
- U.S. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC (USA), 1996, 253 pp
- MacKenzie, SH The Ecosystem ISLAND PRESS, CA (USA), 1996, 240 pp