

Marine Pollution

The ocean plays a key role in cycles of carbon, nitrogen, phosphorus and a variety of other important chemicals. Ocean chemistry has been changing due to human activities, both regionally in coastal waters and in the open ocean. Some of the greatest impacts are on carbon, nitrogen, and dissolved oxygen, which affect biological productivity. The rate of primary production is determined primarily by light and nutrients. Decades of pollution of marine waters, along with coastal habitat destruction, overfishing and bottom trawling have had devastating impacts on biodiversity and habitats. The increasing demand for seafood worldwide has depleted fish populations and devastated the economic well-being of coastal communities. At the same time, climate change is altering the oceans in major ways that we are only beginning to understand.

Land-based sources pollute estuaries and coastal waters with nutrients, sediments, pathogens as well as many thousands of toxic chemicals, including metals, pesticides, industrial products, pharmaceuticals and more. Following the industrial revolution, increasing amounts of materials have been discharged into the environment from chemical industries, sewage treatment plants, and agriculture, eventually reaching marine ecosystems. There is growing scientific evidence demonstrating serious, sometimes disastrous, impacts of pollution in the marine environment. Pollutants of major concern are those that are widespread and persistent in the environment, accumulate in biota, and induce effects at low concentrations. Toxic chemicals are varied and often difficult to detect.

The term marine pollution was defined as :

"The introduction by man, directly, or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as: hazards to human health, hindrance to marine activities, impairment of the quality of seawater for various uses and reduction of amenities".

The main sources of marine pollution are:

- Eutrophication * Thermal pollution * Pollution by heavy metals
- Pollution by ships * Oil pollution * Radioactivity
- Domestic effluents

Thermal pollution

Thermal pollution is defined as the addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life.

Thermal pollution is defined also as the change in the water temperatures of lakes, rivers, and oceans caused by man-made industries and practices. These temperature changes may adversely affect aquatic ecosystems especially by contributing to the decline of wildlife populations and habitat destruction.

Thermal pollution is defined also as sudden increase or decrease in temperature of a natural body of water which may be ocean, lake, river or pond by human influence.

The industries like iron and steel plants, petroleum refineries, nuclear reactors, electric power plants etc. use large amount of water for cooling purposes. The water discharged from such installations carries a lot of heat which when released into nearby bodies leads to thermal pollution.

Such an increase in temperature of the aquatic bodies by 8 to 10 degrees Celsius becomes injurious to the aquatic life. When an increase in temperature of the aquatic body affects and disrupts the normal activities of the aquatic living organisms, the process is known as thermal pollution.

Thermal pollution occurs when power plants and factories discharge hot or cold water into nearby rivers, lakes, streams, oceans or bays, causing rapidly changing water temperatures. Most marine organisms have specific temperature needs and are unable to survive sudden changes. Even small temperature changes may result in thermal shock to aquatic life, cause reproduction difficulties and lower disease resistance.

Sources of Thermal Pollution:

The following sources contribute to thermal pollution.

1. Nuclear power plants
2. Coal fired plants
3. Industrial effluents
4. Domestic sewage
5. Hydro-electric power

1. **Nuclear power plants:** Nuclear power plants including drainage from hospitals, research institutions, nuclear experiments and explosions, discharge a lot of heat that is not utilized along with traces of toxic radio nuclides into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing the temperatures of water bodies. The

operations of power reactors and nuclear fuel processing units constitute the major contributor of heat in the aquatic environment. Heated effluents from power plants are discharged at 10 C higher than the receiving waters that affect the aquatic flora and fauna.

2. **Coal-fired power plants:** Coal fired power plants constitute a major source of thermal pollution. The condenser coils in such plants are cooled with water from nearby lakes or rivers. The resulting heated water is discharged into streams thereby raising the water temperature by 15C. Heated effluent decreases the dissolved content of water resulting in death of fish and other aquatic organisms. The sudden fluctuation of temperature also leads to "thermal shock" killing aquatic life that has become acclimatized to living in a steady temperature.
3. **Industrial effluents:** Industries like textile, paper, pulp and sugar manufacturing release huge amounts of cooling water along with effluents into nearby natural water bodies. The waters polluted by sudden and heavy organic loads result in severe drop in levels of dissolved oxygen leading to death of several aquatic organisms.
4. **Domestic Sewage:** Domestic sewage is discharged into rivers, lakes, canals or streams with minimal treatment or without any treatment. These wastes have a higher organic temperature and organic load. This leads to decrease in dissolved oxygen content in the receiving waters resulting in the set-up of anaerobic conditions causing release of foul and offensive gases in water. Eventually, this leads to development of anoxic conditions resulting in rapid death of aquatic organisms.
5. **Hydro-electric power:** Generation of hydroelectric power sometimes leads to negative thermal loading in water systems.

Apart from electric power industries, various factories with cooling requirement contribute to thermal loading.

Thermal pollution in streams by human activities

1. Industries and power plants use water to cool machinery and discharge the warm water into a stream
2. Stream temperature rises when trees and tall vegetation providing shade are cut.
3. Soil erosion caused due to construction also leads to thermal pollution
4. Removal of stream side vegetation
5. Poor farming Practices also lead to thermal pollution

Effects of Thermal pollution

1. Reduction in dissolved oxygen: Concentration of Dissolved Oxygen (DO) decreases with increase in temperature.
2. Increase in toxicity: The rising temperature increases the toxicity of the poison present in water. A 10C increase in temperature of water doubles the toxicity effect of potassium cyanide, while 80C rise in temperature triples the toxic effects of o-xylene causing massive mortality to fish.
3. Interference in biological activity: Temperature is considered to be of vital significance to physiology, metabolism and biochemical processes that control respiratory rates, digestion, excretion, and overall development of aquatic organisms. Temperature changes cause total disruption to the entire ecosystem.
4. Interference in reproduction: In fishes, several activities like nest building, spawning, hatching, migration and reproduction depend on optimum temperature.

5. **Direct mortality:** Thermal pollution is directly responsible for mortality of aquatic organisms. Increase in temperature of water leads to exhaustion of microorganisms thereby shortening the life span of fish. Above a certain temperature, fish die due to failure of respiratory system and nervous system failure.
6. **Food storage for fish:** Abrupt changes in temperature alter the seasonal variation in the type and abundance of lower organisms leading to shortage of right food for fish at the right time.

Control measures for thermal pollution

The following methods can be adapted to control high temperature caused by thermal discharges:

1. **Cooling towers:** Use of water from water systems for cooling systems for cooling purposes, with subsequent return to the water way after passage through a condenser, is called cooling process. Cooling towers transfer heat from hot water to the atmosphere by evaporation. Cooling towers are of two types:
 - (i) **Wet cooling tower:** Hot water coming out from the condenser (reactor) is allowed to spray over baffles. Cool air, with high velocity, is passed from sides, which takes away the heat and cools the water.
 - (ii) **Dry cooling tower:** Here, hot water is allowed to flow in long spiral pipes. Cool air with the help of a fan is passed over these hot pipes, which cools down hot water. This cool water can be recycled.
2. **Cooling ponds:** Cooling ponds are the best way to cool thermal discharges. Heated effluents on the surface of the water in cooling ponds maximize dissipation of heat to the atmosphere and

minimize the water area and volume. The warm water wedge acts like a cooling pond.

3. **Spray ponds:** The water coming out from condensers is allowed to pass into the ponds through sprayers. Here water is sprayed through nozzles as fine droplets. Heat from the fine droplets gets dissipated to the atmosphere.
4. **Artificial lakes:** Artificial lakes are man-made water bodies that offer once-through cooling. The heated effluents can be discharged into the lake at one end and water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.

Effects of Thermal Pollution

Among recognized scientists and scholars, there are generally two schools of thought when it comes to the effects of thermal pollution. Some lean on the side of the negatives of this pollution on marine ecosystems and how it is detrimental to positive environmental practices. However, some lean towards the side that without these industries operating the way they do, then some of the most basic parts of human life would be completely obsolete. Waste water would not be able to be properly maintained, we would have no industries that could produce the goods we need, and so on. The effects of thermal pollution on ecosystems, however, greatly outweigh the benefits that industries have by participating in the act.

1. **Decrease in DO (Dissolved Oxygen) Levels:** The warm temperature reduces the levels of DO (Dissolved Oxygen) in water. The warm water holds relatively less oxygen than cold water. The decrease in DO can create suffocation for plants and animals such as fish, amphibians and

copepods, which may give rise to anaerobic conditions. Warmer water allows algae to flourish on surface of water and over the long term growing algae can decrease oxygen levels in the water.

2. Increase in Toxins: With the constant flow of high temperature discharge from industries, there is a huge increase in toxins that are being regurgitated into the natural body of water. These toxins may contain chemicals or radiation that may have harsh impact on the local ecology and make them susceptible to various diseases.

3. Loss of Biodiversity: A dent in the biological activity in the water may cause significant loss of biodiversity. Changes in the environment may cause certain species of organisms to shift their base to some other place while there could be significant number of species that may shift in because of warmer waters. Organisms that can adapt easily may have an advantage over organisms that are not used to the warmer temperatures.

4. Ecological Impact: A sudden thermal shock can result in mass killings of fish, insects, plants or amphibians. Hotter water may prove favorable for some species while it could be lethal for other species. Small water temperature increases the level of activity while higher temperature decreases the level of activity. Many aquatic species are sensitive to small temperature changes such as one degree Celsius that can cause significant changes in organism metabolism and other adverse cellular biology effects.

5. Affects Reproductive Systems: A significant halt in the reproduction of marine wildlife (although this may be true, reproduction can still occur between fish – but the likelihood of defects in newborns is significantly higher) can happen due to increasing temperatures as reproduction can happen within certain range of temperature. Excessive temperature can

cause the release of immature eggs or can prevent normal development of certain eggs.

6. Increases Metabolic Rate: Thermal pollution increases the metabolic rate of organisms as increasing enzyme activity occurs that causes organisms to consume more food than what is normally required, if their environment were not changed. It disrupts the stability of food chain and alters the balance of species composition.

7. Migration: The warm water can also cause particular species of organisms to migrate to suitable environment that would cater to its requirements for survival. This can result in loss for those species that depend on them for their daily food as their food chain is interrupted. Above all else, the most important thing to consider is that the effects of thermal pollution greatly outweighs the human need for it to be done. Plants and industries have been able to find successful ways around thermal pollution, but many of them are not practicing it because it's simply easier to work from the traditional model. If we want to promote the thriving environment that surrounds marine biology, then the attitude around thermal pollution needs to take a drastic turn. By being aware of the causes and effects, you can have a significant impact on how these plants choose to operate and you can opt to make change.