International Journal of Biology Research
ISSN: 2455-6548; Impact Factor: RJIF 5.22
Received: 07-10-2020; Accepted: 22-10-2020; Published 10-11-2020
www.biologyjournal.in
Volume 5; Issue 3; 2020; Page No. 12-14

Study the effects of eutrophication a algal bioom in marine water

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Abstract
Eutrophication, dystrophication or hypertrophication, is when a body of water becomes overly enriched with minerals and nutrients which induce excessive growth of algae. This process may result in oxygen depletion of the water body after the bacterial degradation of the algae. One example is an "algal bloom" or great increase of phytoplankton in a pond, lake, river or coastal zone as a response to increased levels of nutrients. Eutrophication is often induced by the discharge of nitrate or phosphate-containing detergents, fertilizers, or sewage into an aquatic system. Lake Eutrophication has become a global problem of water pollution. Chlorophyll-a, total nitrogen, total phosphorus, biological or chemical oxygen demand and secchi depth are the main indicators to evaluate Lake Eutrophication level. Target 14.1 of Sustainable development goal 14 preventing every form of marine pollution including nutrient pollution which is eutrophication.

Keywords: algal bloom, chlorophyll-a, marine pollution etc

Introduction

Eutrophication most commonly arises from the oversupply of nutrients, most commonly as nitrogen or phosphorus, which leads to overgrowth of plants and algae in aquatic ecosystems. After such organisms die, bacterial degradation of their biomass results in oxygen consumption, thereby creating the state of hypoxia.

According to Ullmann's Encyclopedia, "the primary limiting factor for eutrophication is phosphate." The availability of phosphorus generally promotes excessive plant growth and decay, favouring simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality. Phosphorus is a necessary nutrient for plants to live, and is the limiting factor for plant growth in many freshwater ecosystems. Phosphate adheres tightly to soil, so it is mainly transported by erosion. Once translocated to lakes, the extraction of phosphate into water is slow, hence the difficulty of reversing the effects of eutrophication. However, numerous literature reports that nitrogen is the primary limiting nutrient for the accumulation of algal biomass.

The sources of these excess phosphates are phosphates in detergent, industrial/domestic run-offs, and fertilizers. With the phasing out of phosphate-containing detergents in the 1970s, industrial/domestic run-off and agriculture have emerged as the dominant contributors to eutrophication.

Fig 1: Eutrophication of the Potomac River evident from the bright green water, caused by a dense bloom of cyanobacteria

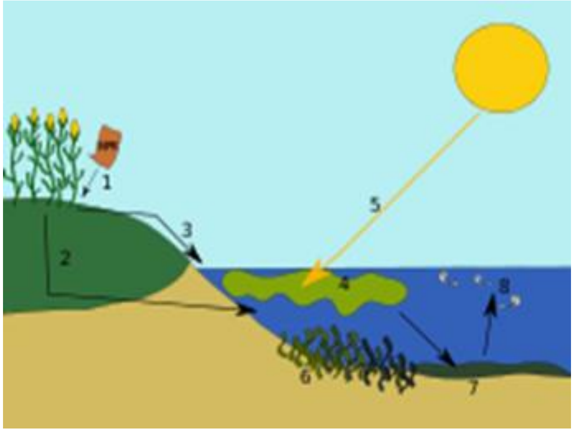

Fig 2

1. Excess nutrients are applied to the soil. 2. Some nutrients leach into the soil and later drain into surface water. 3. Some nutrients run off over the ground into the body of water. 4. The excess nutrients cause an algal bloom. 5. The algal bloom reduces light penetration. 6. The plants beneath the algal bloom die because they cannot get sunlight to photosynthesize. 7. Eventually, the algal bloom dies and sinks to the bottom of the lake. Bacteria begins to decompose the remains, using up oxygen for respiration. 8. The decomposition causes the water to become depleted of oxygen. Larger life forms, such as fish die.

Review of literature

Human activities can accelerate the rate at which nutrients enter ecosystems. Runoff from agriculture and development, pollution from septic systems and sewers, sewage sludge spreading, and other human-related activities increase the flow of both inorganic nutrients and organic substances into ecosystems. Elevated levels of atmospheric compounds of nitrogen can increase nitrogen availability. Phosphorus is often regarded as the main culprit in cases of eutrophication in lakes subjected to "point source" pollution from sewage pipes. The concentration of algae and the trophic state of lakes correspond well to phosphorus levels in water. Studies conducted in the Experimental Lakes Area in Ontario have shown a relationship between the addition of phosphorus and the rate of eutrophication. This is because the growth of nitrogen-fixing cyanobacteria is reliant on phosphorus concentration levels in lakes. Humankind has increased the rate of phosphorus cycling on Earth by four times, mainly due to agricultural fertilizer production and application. Between 1950 and 1995, an estimated 600,000,000 tonnes of phosphorus was applied to Earth's surface, primarily on croplands.

Material and method

Eutrophication is a common phenomenon in coastal waters. In contrast to freshwater systems where phosphorus is often the limiting nutrient, nitrogen is more commonly the key limiting nutrient of marine waters; thus, nitrogen levels have greater importance to understanding eutrophication problems in salt water. Estuaries, as the interface between freshwater and saltwater, can be both phosphorus and nitrogen limited and commonly exhibit symptoms of eutrophication. Eutrophication in estuaries often results in bottom water hypoxia/anoxia, leading to fish kills and habitat degradation. Upwelling in coastal systems also promotes increased productivity by conveying deep, nutrient-rich waters to the surface, where the nutrients can be assimilated by algae. Examples of anthropogenic sources of nitrogen-rich pollution to coastal waters include seacage fish farming and discharges of ammonia from the production of coke from coal.

The World Resources Institute has identified 375 hypoxic coastal zones in the world, concentrated in coastal areas in Western Europe, the Eastern and Southern coasts of the US, and East Asia, particularly Japan.

In addition to runoff from land, fish farming wastes and industrial ammonia discharges, atmospheric fixed nitrogen can be an important nutrient source in the open ocean. A study in 2008 found that this could account for around one third of the ocean's external (non-recycled) nitrogen supply, and up to 3% of the annual new marine biological production. It has been suggested that accumulating reactive nitrogen in the environment may prove as serious as putting carbon dioxide in the atmosphere. Terrestrial ecosystems are subject to similarly adverse impacts from eutrophication. Increased nitrates in soil are frequently undesirable for plants. Many terrestrial plant species are endangered as a result of soil eutrophication, such as the majority of orchid species in Europe. Meadows, forests, and bogs are characterized by low nutrient content and slowly growing species adapted to those levels, so they can be overgrown by faster growing and more competitive species. In meadows, tall grasses that can take advantage of higher nitrogen levels may change the area so that natural species may be lost. Species-rich fens can be overtaken by reed or reedgrass species. Forest undergrowth affected by run-off from a nearby fertilized field can be turned into a nettle and bramble thicket.

Chemical forms of nitrogen are most often of concern with regard to eutrophication, because plants have high nitrogen requirements so that additions of nitrogen compounds will stimulate plant growth. Nitrogen is not readily available in soil because N_2, a gaseous form of nitrogen, is very stable and unavailable directly to higher plants. Terrestrial ecosystems rely on microbial nitrogen fixation to convert N_2 into other forms such as nitrates. However, there is a limit to how much nitrogen can be utilized. Ecosystems receiving more nitrogen than the plants require are called nitrogen-saturated. Saturated terrestrial ecosystems then can contribute both inorganic and organic nitrogen to freshwater, coastal, and marine eutrophication, where nitrogen is also typically a limiting nutrient. This is also the case with increased levels of phosphorus. However, because phosphorus is generally much less soluble than nitrogen, it is leached from the soil at a much slower rate than nitrogen. Consequently, phosphorus is much more important as a limiting nutrient in aquatic systems.

Conclusion

Eutrophication was recognized as a water pollution problem in European and North American lakes and reservoirs in the mid-20th century. Since then, it has become more widespread. Surveys showed that 54% of lakes in Asia are eutrophic; in Europe, 53%; in North America, 48%; in South America, 41%; and in Africa, 28%. In South Africa, a study by the CSIR using remote sensing has shown more than 60% of the dams surveyed were eutrophic. Some South African scientists believe that this figure might be higher with the main source being dysfunctional sewage works that produce more than 4 billion liters a day of untreated, or at best partially treated, sewage effluent that discharges into rivers and dams.

Many ecological effects can arise from stimulating primary production, but there are three particularly troubling ecological impacts: decreased biodiversity, changes in species composition and dominance, and toxicity effects.

1. Increased biomass of phytoplankton
2. Toxic or inedible phytoplankton species
3. Increases in blooms of gelatinous zooplankton
4. Increased biomass of benthic and epiphytic algae
5. Changes in macrophyte species composition and biomass
6. Decreases in water transparency (increased turbidity)
7. Colour, smell, and water treatment problems
8. Dissolved oxygen depletion
9. Increased incidences of fish kills
10. Loss of desirable fish species
11. Reductions in harvestable fish and shellfish
12. Decreases in perceived aesthetic value of the water body

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