

Causes of Eutrophication and its Impacts on Freshwater Ecosystem

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Abstract

Eutrophication is a process by which a water body became enriched in dissolved nutrients such as phosphates, nitrogen, etc. that stimulates the growth of aquatic plants usually resulting in the depletion of dissolved oxygen. The continuous depletion of dissolved oxygen in a water body hazardously affects aquatic life. The eutrophication impacts the biodiversity of an aquatic ecosystem through an increase of aquatic macrophytes, growth of algal blooms and rooted plants, and decrease the species richness. It also causes significant changes of the physicochemical properties of water such as turbidity, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), water pH, temperature, etc. Thus eutrophication is recognized as a major problem of the freshwater ecosystem globally. This study identified the major causes of eutrophication and its consequences in an aquatic ecosystem.

The freshwater ecosystems represent the terrestrial phases of the global hydrological cycle and include lakes, permanent rivers, streams, ponds, wetlands as well as groundwaters⁸. It plays a significant role in ecology as well as economy which provides ideal habitats for a large number of fishes, aquatic plants, reptiles, birds, and mammals. The freshwater ecosystem also provides several ecosystem services for humans such as flood control, climate regulation, food production etc. (Rao *et al.*, 2018). Some economic benefits like water for homes and farms, power generation and industrial development, etc. are facilitated by the freshwater ecosystem⁷. Freshwater constitutes only about 2.5% of all freely available water

on earth's surface, of which only 0.3% is readily accessible in lakes, rivers as well as reservoirs⁴. India has occupied 4% of the world's freshwater resources which includes 29,000 km of rivers, 3.15 million hectares of reservoirs, 2.35 million hectares of ponds and tanks, 0.2 million floodplains and 33 wetlands. But now a day, increasing the human population and their continuous pressures on the environment adversely impact on the freshwater ecosystem in the world. Thus the declining rate of biodiversity is far greater in freshwater than the most affected terrestrial ecosystems⁹. Different natural and anthropogenic causes are responsible for the degradation of a freshwater ecosystem. Among them, eutrophication is a major cause that seriously

impacts on freshwater ecosystem directly and indirectly.

Eutrophication is a serious environmental problem result from increasing nutrients such as Nitrogen (N) and Phosphorus (P) in an aquatic ecosystem³. Eutrophication of water bodies occurs due to nutrient over-enrichment, mainly phosphorus and followed by excessive growth of primary producers and oxygen depletion episodes due to algal organic matter decomposition⁵. The supplies of N and P to the aquatic ecosystem are derived from a wide variety of sources including groundwater, fluvial and atmospheric inputs¹¹. Nitrogen and phosphorous exports from the point and non-point sources can have a profound effect on the quality of receiving water². Excessive nutrients intake in an aquatic ecosystem is resulting in algal blooms which restrict the penetration of sunlight to deep water that led to the death of submerged macrophytes of that particular ecosystem. Thus the lower part of the water body suffers the lake of dissolved oxygen that causes a significant impact on other living organisms of the ecosystem.

Database and methodology :

In the present study, the data has been collected from both primary and secondary sources. The related primary data has been collected by field visits and observe the ecosystem of some selected water reservoirs. The amount of nitrogen (N) and phosphorus (P) is measured in some selected beels of the Sivasagar district of Assam. The available nitrogen and phosphorus were tested in the laboratory of Tocklai Tea Research Institute,

Jorhat, Assam. The secondary data has been collected from books, national and international journals, the environmental publications of both national and international levels.

Many works have been done on eutrophication in the aquatic ecosystem. Shinde and Gawande¹⁰ have studied the major causes of eutrophication and its effect on aquatic life. They also gave an idea of the types of eutrophication and identified the major point and non-point sources of nutrients. Rachel Leng⁶ examined the impact of cultural eutrophication on lakes in her research publication entitled “The impacts of cultural eutrophication on Lakes: A review of damages and nutrients control measures”. Ansari *et al.*,¹ also gave their contribution to the field of aquatic ecosystems. They studied how eutrophication affects water quality and threatens the aquatic ecosystem. Lei Zheng also has done notable work on the effect of eutrophication on stream ecosystems. Present work has studied the major causes of eutrophication and how it impacts the aquatic ecosystem.

Causes of Eutrophication :

Eutrophication is the result of excessive intake of N and P in a water body. These two nutrients are coming from two major sources *i.e.* point and non-point sources. In point sources, the nutrients are travel directly from sources to water. It includes sewage treatment plant discharges, industrial discharges, storm sewer discharges etc. On the other hand, non-point sources, waste comes

from ill-defined and diffuse sources such as atmospheric deposition, agricultural runoff, septic system etc.¹⁰. The major causes of eutrophication that occur in freshwater ecosystems are discussed below:

Chemical fertilizers :

Eutrophication is predominantly caused due to the use of chemical fertilizers for agricultural purposes. When these chemical fertilizers with a high concentration of Phosphorous and Nitrogen are washed by surface runoff into rivers, lakes, wetlands, and others water bodies due to rain, the algae, planktons, and other aquatic plants life well fed, and their photosynthesis activity is increased and it led the rapid growth of algal blooms and plants life in the aquatic ecosystems. According to an estimation between 1960 and 1990, the global use of synthetic nitrogen fertilizer increased more than sevenfold while phosphorous used more than tripled.

Concentrated animal feeding operation:

Eutrophication also results in concentrated animal feeding operations because it is a major contributor of P and N into a freshwater ecosystem. It normally discharged the nutrients that find a way into rivers, streams, lakes, wetlands as well as reservoirs where they accumulate in high concentration thereby plaguing the water bodies recurring cyanobacterial and algal blooms.

Sewage discharge and industrial waste :

In most developing countries, sewage water is directly discharged into water bodies such as rivers, lakes, ponds as well as wetlands

(fig. 1). It results in the concentration of a high amount of nutrients and therefore stimulating the dense growth of algal blooms and other macrophytes which threaten the other aquatic life in many ways. The direct discharge of industrial wastewater into water bodies also a major cause of eutrophication. Many industries use fossil fuel for power generation. The burning of fossil-fuelled to release harmful products into the environment. When it burned, it released nitrogen oxides into the atmosphere and that contributes to the formation of smog and acid rain. Fossil fuel combustion contributes approximately 22 trigrams of nitrogen pollution globally every year¹⁰.

Aquaculture :

It is another major source of nutrients that further contributes to eutrophication. About 47% of total aquaculture production comes from freshwater ecosystems such as lakes, streams, wetlands and man-made ponds. Such fish farms generate a concentrated amount of N and P from excrement, uneaten food and other organic waste. The nutrients came from unmanaged aquaculture discharged directly into the surrounding water and severe impact on the ecosystem. For every ton of fish, aquaculture operation produces 42 and 66 kg of nitrogen waste and between 7.2 and 10.5 kg of phosphate waste.

Natural events :

Eutrophication is a result of not only anthropogenic activities but some natural events also responsible for its occurrence. Different natural events such as floods, the natural flow of rivers and streams and storms can also



Fig 1: Discharge of wastewater into reservoirs

wash excess nutrients off the land into water bodies. In old lake or water bodies, they start to accumulate sediments as well as phosphorus and nitrogen naturally which help to the rapid growth of cyanobacterial growth and phytoplankton bloom.

Effect of Eutrophication :

The most remarkable effect of eutrophication is algal blooms. The phytoplankton and other photosynthetic plants grow explosively due to eutrophication which is known as algal blooms. It limits the amount of dissolved oxygen required for respiration by other aquatic life in a freshwater ecosystem. When the dissolved oxygen reaches a hypoxic level, the animal and plant species underwater such as fish, shrimp *etc.* suffocate to death. Algal blooms also prevent the penetration of sunlight to the lower part of the water body. Sunlight is necessary for plants and organisms like phytoplankton and algae, which makes their nutrients from sunlight, water and carbon dioxides¹⁰. Thus eutrophication finally affects the species diversity of the ecosystem. Algal

blooms are highly toxic and once the water reaches the anaerobic condition, the growth of more toxic bacterial is promoted which extensively deteriorate water quality and decline the availability of clean usable water (Figs 2,3).



Fig 2: Algal Bloom due to eutrophication



Fig 3: Fishes died due to Algal bloom.

Eutrophication has become a major cause of concern in developing as well as developed countries. The freshwater ecosystem of the densely populated nation like India, China, Bangladesh, Indonesia, Pakistan, and developed or industrialized countries of Europe, some states of the USA and Canada are suffering the threat of eutrophication. The scientific interest in eutrophication has consistently been significant during the last 25

years because the availability of freshwater for human consumption will become one of the great issues of the twenty-first century. The significance of the study on eutrophication has suddenly risen because environmentalists and ecologists predicted that eutrophication is likely to increase as a threat to freshwater resources and ecosystems.

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