Tamralipta Mahavidyalaya

PG Department of Zoology

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Group A: Environmental pollution & management

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Eutrophication

The term eutrophication was introduced by German hydrologist C. A. Weber (1907) to describe nutrient rich condition. Eutrophication is the process by which lakes, rivers and coastal waters become increasingly rich in plant biomass as a result of the enhanced input of essential plant nutrients. This contrasts with oligotrophic water which is unproductive because restricted available of nutrients and mesotrophic water which is intermediate between these two states (Wetzel, 1975). The term eutrophication has also been used to describe the slow, natural process by which a geologically young and unproductive water body gradually increases in productivity as nutrients accumulated over time and as the water basin become shallow due to sedimentation (Wetzel, 1975). According to Urban waste water treatment Directive (1991) eutrophication may be defined as the enrichment of water by nutrients especially compounds of nitrogen and phosphorus causing an accelerated growth of algae and higher farms of plant life to produce an undesirable disturbance to the balance of organism and the quality of water concerned.

Types of eutrophication: Eutrophication are of two types-

The gradual accumulation for nutrients and organic biomass accompanied by increased level of production and a decrease in the average depth of the water column caused by sediment accumulation constitute the natural eutrophication process. Cultural eutrophication is simply the anthropogenic acceleration of eutrophication.

Cultural eutrophication may be beneficial to many aquatic systems Controlled fertilization of ponds or similar enclosed aquatic systems is a basic technique used in aquaculture to produce large crops of fishes and shellfishes. Cultural eutrophication may create problems if the system of interest is not properly managed.

Difference between natural and cultural eutrophication: -

Natural eutrophication	**Cultural eutrophication**
It is a natural process	It is a man made process
Natural eutrophication is a prolonged process	This is a rapid process
This type of eutrophication cannot be checked	Proper treatment and breakdown of sewage may check the eutrophication
Natural eutrophication associated with the aging of water bodies	Cultural eutrophication associated with the intensity of human interaction.

Factors responsible for eutrophication: -

The understanding of the factors of primary production has greatly helped understanding of eutrophication.

1. Vallentyne (1974) suggested that the demand for N and P usually is much larger than their natural supply.

2. In general, phosphorus in the form of organic and inorganic phosphates tends to be the element controlling the rate of plant growth and biomass formation in most temperate lakes (OECD, 1989).

3. In many tropical lakes, nitrogen is the controlling factor (UNEP, 1982).

4. In heavily loaded lakes with unnaturally high algal densities, light may finally become limiting (Lund, 1970).

Therefore out of several nutrients, P & N are the responsible elements or the presents day eutrophication.

Factors responsible for P-loading induced Algal growth:-

The intensified phosphate loading - leading to enhanced algal growth-is caused be several factors.

1. Increase in population density combined with urbanization. In urban areas, there is no possibility to re-use house hold waste, and it is released into the sewer system. Normal biological treatment of sewage oxidises organic matters and converts the P and N-compound into inorganic salts. These will be reconverted into organic matter i.e. algal biomass after their release into the aquatic environment.
2. Increased usages of phosphate in detergents.

What are the environmental impacts of eutrophication?

1) **Environmental Impact of Eutrophication -** The first and most undesirable effect of eutrophication is the shift in community structure of aquatic ecosystem. Phytoplankton population is dominated by blue green algae (cyanophyceae) in eutrophic water body. So food chain and food web is altered. The blue green algae are a less suitable source of food for higher trophic levels resulting in the variety and amount of zooplankton and thus of fish.
2) Several blue green algae excrete nuisance products giving the water an undesirable taste, colour and odour. These products can be toxic that inhibits the growth of other organisms.
3) When the algae decay aerobically by micro organisms, the dissolved oxygen level decrease and B.O.D. level increases. This causes an unhealthy situation for aquatic system.
4) Intensive blooms of algae reduce under water light penetration ultimately reduces productivity.
5) Eutrophication leads to increase in biomass and decrease in species diversity by the following ways-
   i. Nutrient enrichment of water body occur due to accumulation of nutrients like nitrogen, phosphorus etc.
   ii. This leads to algal bloom as well as increase the abundance of other aquatic plants which in turn results in higher biological productivity.
   iii. Amount of oxygen increases during the day time but during night there is a sharp decrease of oxygen leading to anoxia condition, and thereby resulted in the increase of CO_2 concentration.

iv. Water at this stage enjoys acidic condition (vis a vis) low pH.
v. Water also becomes turbid.
vi. The tolerant species can survive in such a condition but the sensitive species perishes.
vii. The anaerobic microorganisms increases in this stale and as a result degradation of the organic matter occur anaerobically.

Practical consequences of eutrophication effects are:

1. Changes in the population of aquatic ecosystem such as the replacement of the game fish by coarse fish
2. Decrease in amenity value for nature conservation, recreation and fishing
3. Problems in drinking water quality and treatment.

Schematic representation of different events which take place during eutrophication

1) Enrichment of water with nutrients

2) Algal bloom

3) Increased biological productivity

4) Increased O_2 depletion (during night)

5) Increased of CO_2 concentration

6) Increased acidity and lowering of pH

7) Decrease of species diversity

8) Increased biomass

9) Increased sedimentation and there by turbidity

10) Increased anoxic condition

11) Eutrophications.

Eutrophication of lake & river or eutrophication of marine system

A) Eutrophication of lakes and rivers:

Eutronhication in lakes have been observed all over the world. However, it is difficult to assess the qualitative and quantitative extent of eutrophication on a global scale. Vollenweider (1981) mentioned an EPA study which showed that out of 800 lakes in the USA-75% were eutrophic. Rast & Lee (1983) stated that eutrophication is one of the most significant causes of water deterioration of lakes and reservoirs in North America and Europe. There is relatively little literature dealing with eutrophication in rivers. However, eutrophication occurs in rivers whether they are exposed to natural or anthropogenic nutrient input. For example, the Amazon river forms flood plain lakes, where the sediment from water will settle. The resulting light penetration and the nutrient available in the sediment then allows the development of thick water blooms of blue green algae (Sioli, 1975). Eutrophication in rivers also encourage the development of macrophyts (Thomas, 1976).

B)Eutrophication in Marine system:

1) Occurance: Eutrophication in marine system occurs mainly in costal zones and enclosed water bodies e.g. Chespeake Bay, Potomac estuary, Tokyo bay, Baltic sea etc. The chlorophyll concentration in the open part of the North Sea, 70 Km off shore has remained fairly constant at 2 μgl^{-1}, but the concentration along the coast has increased from about 6 to about 9 ugl,but the concentration along the coast has increased from about 6 to about 9 μgl^{-1} over the past 10 years (Bennekom, et al. 1975).

Factors for marine eutrophication: The understanding of marine eutrophication processes is much limited due to the complex, open nature for these systems and to the lack of observations, both in time & space McErlean & Reed(1981) suggested that the concentration of chlorophyll 'a' may be useful as criterion to assess the trophic state of marine systems. A number of other indicators such as oxygen budgets, transparency and biological diversity have been evaluated but chlorophyll is emerging as an established criterion for estuarine eutrophication.

From the qualitative point of consideration, the flagellate *Phaeocystis pouchetii* begins to develop in the North Sea Ambio (Lancelot et al, 19870. The increase in nitrogen and phosphate, together with roughly constant silicon concentration favour the development of flagellates.

Nutrient sources for marine water: Rivers provide only part of the input to a marine area. The remainder is brought in by ocean water. There are differences in the relative importance of the nutrient processes that occur in fresh water as well as in marine water; Silicon usually controls the growth of diatoms. Silicon concentration correlated significantly with chlorophyll concentration phosphate nitrogen ratio is another important factor when the production takes place.

Are eutrophication both beneficial and detrimental? - Justify

Eutrophication is both beneficial and detrimental to fisheries:

Increasing the primary production of a water body will generally increase overall fish yield. However, changes in the quality of the fishery to favour those species that are generally less desirable in the North American culture may also be expected to accompany this increase in yield, especially at high trophic levels. One of the most dramatic effects of this type is the loss of cold water fish associated with deoxygenating of colder, hypolimnetic waters due to bacterial decomposition of algae. Literature also cites reduced grazing ability of carnivorous fish brought about by increased turbidity from increased amounts of phytoplankton as well as suspended sediment. Some highly eutrophic water bodies also tend to produce large populations of stunted pan fish, which may be the result of inadequate predation on these fish arising from the inability of predators to see then due to increased turbidity form planktonic algae and suspended sediment.

How can it be Avoided?

1. It can be avoided by the use of more organic fertilisers which are high in nutrients but are natural to the environment. Examples include manure which decomposes slowly so the nutrients are not readily leached away.
2. Proper treatment and breakdown of sewage before it is discharged into a river could prevent eutrophication taking place.
3. By biomanipulation of appropriate organism to eutrophic waterbody, the bloom of cyanophyceae could be checked.
4. By increasing the pH of eutrophic acidic water, the process could be prohibited.