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Eutrophication is a phenomena caused by abnormal growth of algae in a water body. What are the reasons of algal bloom and how this phenomenon controlled.
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1) - Introduction

2) - Reasons of algal bloom

- a) Increase in concentration of Phosphates and Nitrates
- b) Natural eutrophication
- c) Cultural eutrophication
- d) Population explosion of photosynthetic bacteria
- e) Causes of accelerated eutrophication

3) - Classification of Aquatic System

- a) Oligotrophic system
- b) Mesotrophic system
- c) Eutrophic system

4) - Effects of Eutrophication

- a) Growth of eutrophication phytoplankton
- b) Water pollution (Effect on aquatic systems)
- c) Effects on economy (e.g by recreation)
- d) Effects on Human Society
- e) Effects on water bodies

5) Control

- a) by Leibig's Law of Minimum
- b) General awareness about eutrophication

1) Introduction of concept

The term "eutrophic" means well nourished; thus, eutrophication refers to natural and artificial addition of nutrients to the body of water and to the effect of the added nutrients. When the effect of the added nutrients are undesirable, eutrophication may be considered as pollution.

Richard Nixon, 37th president of United States and also known as the environmental president who signed the National Environmental Policy Act on January 1, 1970 defined it as an increase in the rate of supply of organic matter to the ecosystem. It is a process by which water body acquire high concentrations of nutrients, especially Nitrates and Phosphates. These nutrients are the basic reason of algal bloom.

2) Reasons of algal bloom

Eutrophication basically is the excessive growth of phytoplankton. It is often the result of natural processes, anthropogenic pollution with nutrients and agricultural run-off carrying fertilizers in the water bodies.

Sometimes it occurs naturally and sometime it occurs culturally.

a) Natural eutrophication

It is a phenomenon in which basin is filled gradually in the form of nutrients and sediments inputs occurs over long time periods.

b) Cultural eutrophication

Human induced or cultural eutrophication, occur on a much shorter time scale (decades) as a result of human disturbance and nutrient inputs.

Both natural and cultural eutrophication increase the concentration of nitrates and phosphates which then promote the growth of algal bloom in a water body.

c) Population explosion of photosynthetic bacteria

Eutrophication of water is a natural or human induced increase in the concentration of nutrients, such that phosphorus and nitrogen, required for living things. A high concentration of such nutrients may cause a population explosion of photosynthetic bacteria. As the bacteria die and decay, the concentration of the dissolved oxygen in the water is lowered, leading to the death of fish.

d) Cause of Accelerated Eutrophication

There are main causes of eutrophication are, anthropogenic including

- i) Sewage effluents
- ii) Organic wastes
- iii) Agricultural run-offs

- iv) Excreta and exudates of living beings
- v) Direct discharge of municipal and agricultural waste in water reservoir
- vi) Run off of agricultural fertilizers and pesticides are the basic causes.

3) Classification of Aquatic System

Fresh formed body of water has a very low concentration of plant and animal nutrients, so little plants develop in such water.

Nutrients contents increase gradually by

- Surface runoff
- Wind Borne dust
- Organic debris
- Excreta and exudates of animals

Bacteria and blue green algae fix atmospheric nitrogen. Thus, nutrient status of water improves resulting in moderate development of plants, animals and microbes in plants. With the passage of time; further nutrient enrichment occurs thus dense population of plants, phytoplankton and animal occurs.

Aquatic Systems

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Oligotrophic

is a system with poor nutrients and poor productivity

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Mesotrophic

is a system with moderate nutrient status and moderate productivity

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Eutrophic

is a system with rich nutrients and rich productivity

4) - Effects of Eutrophication of Water

- Eutrophication generally promotes excessive plant growth and decay, favours simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality.

a) Rapid Growth of Phytoplankton

In aquatic environments, enhanced growth of choking aquatic vegetation or phytoplankton (e.g. algal bloom) disrupts normal functioning of the ecosystem, causing a variety of problems such as lack of oxygen in the water, needed for fish and shellfish to survive. The water then becomes cloudy, coloured a shade of green, yellow, brown or red.

b) Effect on Aquatic System

Due to the addition of nutrients, Oligotrophic Aquatic system converts into Mesotrophic Aquatic System and Mesotrophic Aquatic System converts into Eutrophic Aquatic System. Water loses its aesthetic and economic value.

Organic debris and silt settles at the bottom.

Margins or aquatic body turn into a marsh with a small shallow pond at the centre.

c) Effects on Human Society

Human Society is impacted as well; eutrophication decreases the resources value of rivers lakes and

estuaries such that respiration recreation, fishing, hunting, and aesthetic enjoyment are hindered. Health-related problems can occur where eutrophic conditions interfere with drinking water treatment.

d) Effects on water bodies

When the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish. Similarities include subsequent negative environmental effects such as anoxia, and severe reductions in water quality. Fish and other animal populations may occur. Other species may experience an increase in population that negatively affects other species in the direct ecosystem.

Control

a) In order to control the growth of algae we should take some necessary steps.

- 1) Reduce the use of agrochemicals.
- 2) Use appropriate ditches for water runoff.
- 3) Spread awareness about the effects of eutrophication.
- 4) Use sustainable development goals (SDGs) to reduce its effects.

b) Liebig's Law of Minimum

Growth of plant primarily depends upon availability of controlling nutrients. According to Liebig, continuation of growth depends upon availability of minimum quantity of anyone of the controlling nutrients are called limiting nutrients. Eutrophication can be controlled by controlling the concentration of limiting nutrients.

Law states:

Nitrogen (N) / Phosphorous (P): e.g if $\frac{N}{P} = 10$, phosphorus is limiting nutrient and its content should be increased otherwise of nitrogen.

