

2. Effect of water pollution on plants

The following are the effects of water pollution on plants:

- i. *Effects of acid deposition:* Many of the gases from acid, aerosols and other acidic substances released into the atmosphere from industrial or domestic sources of combustion from fossil fuels finally fall down to ground and reach the water bodies along with run-off rainwater from polluted soil surfaces thereby causing acidification of water bodies by lowering its pH . In many countries chemical substances like sulphates, nitrates and chloride have been reported to make water bodies such as lakes, river and ponds acidic.
- ii. *Nutrient deficiency in aquatic ecosystem:* Population of decomposing microorganisms like bacteria and fungi decline in acidified water which in turn reduces the rate of decomposition of organic matter affecting the nutrient cycling. The critical pH for most of the aquatic species is 6.0. The diversity of species decline below this pH whereas the number and abundance of acid tolerant species increases. Proliferation of filamentous algae rapidly forms a thick mat at the initial phase of the acidification of water. Diatoms and green algae disappear below pH 5.8. *Cladophora* is highly acid tolerant species and is

abundant in acidic freshwater bodies. Macrophytes are generally absent in acidic water as their roots are generally affected in such water resulting in poor plant growth. *Potamogeton pectinalis* is found in acidified water. It is observed that plants with deep roots and rhizomes are less affected while plants with short root systems are severely affected in acidic water.

- iii. *Effects of organic matter deposition:* Organic matter from dead and decaying materials of plants and animals is deposited directly from sewage discharges and washed along with rainwater into water bodies causing increase in decomposers / microbes such as aerobic and anaerobic bacteria. Rapid decomposition of organic matter increase nutrient availability in water favouring the luxuriant growth of planktonic green and blue-green algal bloom. In addition many of the macrophytes like *Salvinia*, *Azolla*, *Eicchornia* etc. grow rapidly causing reduced penetration of light into deeper layer of water body with gradual decline of the submerged flora . This condition results in reducing the dissolved Oxygen and increase in the biological oxygen demand (B.O.D). The B.O.D of unpolluted fresh water is usually below 1 mg/l while that of organic matter polluted water is more than 400 mg/l.
- iv. *Effects of detergent deposition:* Detergents from domestic and industrial uses wash down into water bodies causing serious effects on plants. Detergents contain high phosphates which results in phosphate-enrichment of water. Phosphates enter the plants through roots or surface absorption causing retarded growth of plants, elongation of roots, carbon dioxide fixation, photosynthesis, cation uptake, pollen germination and growth of pollen tubes, destruction of chlorophylls and cell membranes and denaturation of proteins causing enzyme inhibition in various metabolic processes.
- v. *Effects of agricultural chemicals:* Chemicals from fertilizers, pesticides, insecticides, herbicides etc. applied to crops in excess are washed away with rainwater as runoff, then enter into soil and finally arrive at the water bodies. Chemicals from fertilizers result in eutrophication by enrichments of nutrients. Ammonium from fertilizers is acidic in nature causing acidification of water. Similarly pesticides, herbicides and insecticides also cause change in pH of the water bodies. Most common effect of these substances is the reduction in photosynthetic rate. Some may uncouple oxidative phosphorylation or inhibit

nitrate reductase enzyme. The uptake and bioaccumulation capacities of these substances are great in macrophytic plants due to their low solubility in water.

- vi. *Effects of industrial wastes:* Effluents from industries contain various organic and inorganic waste products. Fly ash form thick floating cover over the water thereby reducing the penetration of light into deeper layers of water bodies. Fly ash increases the alkalinity of water and cause reduced uptake of essential bases leading to death of aquatic plants. Liquid organic effluents change the pH of water and the specific toxicity effects on the aquatic plants vary depending on their chemical composition. There may be synergistic, additive or antagonistic interactions between metals with respect to their effects on plants however these effects are reduced in hard and buffered freshwater bodies.
- vii. *Effects of silt deposition:* Deposition of silt in water bodies occurs as a result of erosion carrying silt laden water and due to flood. It increases the turbidity of water and reduces light penetration in deep water causing decline in abundance of submerged plants. Siltation inhibits the growth of aquatic plants. Abundance of phytoplankton is affected due to reduction in surface exchange of gases and nutrients. Plants that are tolerant to turbidity are abundant followed by those that are intermediate and the least tolerant species. Plants such as *Polygonum*, *Sagittaria* etc. are found to grow in dominance.
- viii. *Effects of oil spillage:* Oil pollution due to spillage of oil tankers and storage containers prevents oxygenation of water and depletes the oxygen content of the water body by reducing light transmission inhibiting the growth of planktons and photosynthesis in macrophytes.
- ix. *Effects of thermal pollution:* The release of heated water into water bodies from the thermal power plants has an adverse effect on the aquatic life. It reduces the activity of aerobic decomposers due to oxygen depletion because of high temperature. With decreased organic matter decomposition, the availability of nutrients in the water bodies is jeopardised. Aquatic plants show reduced photosynthesis rate due to inhibition of enzyme activity with increased temperature. Primary productivity and diversity of aquatic plant species decline because of increased temperature of water bodies as a result of thermal pollution.

- x. *Effect of nutrient enrichment*: Nutrient enrichment in aquatic water bodies leads to eutrophication which is a process whereby water bodies receive excess inorganic nutrients, especially N and P, stimulating excessive growth of plants and algae. Eutrophication can happen naturally in the course of normal succession of some freshwater ecosystems. However, when the nutrient enrichment is due to the activities of humans, it is referred to as “*cultural eutrophication*”, where the rate of nutrient enrichment is greatly intensified. Eutrophication was recognized as a pollution problem in North American lakes and reservoirs in the mid 20th century (Rohde, 1969). Plants must take in nutrients from the surrounding environment in order to grow. Nitrogen and phosphorous, in particular, encourage growth because they stimulate photosynthesis. This is why they are common ingredients in plant fertilizers. When agricultural runoff pollutes waterways with nitrogen and phosphorous rich fertilizers, the nutrient-enriched waters often pave way to algal bloom leading to eutrophication. The result is oxygen depletion and dying of fishes due to suffocation.
- xi. *Phytotoxicity effects on plants*: When chemical pollutants build up in aquatic or terrestrial environments, plants can absorb these chemicals through their roots. Phytotoxicity occurs when toxic chemicals poison plants. The symptoms of phytotoxicity on plants include poor growth, dying seedlings and dead spots on leaves. For example, mercury poisoning which many people associate with fish can also affect aquatic plants, as mercury compounds build up in plant roots and bodies result in bioaccumulation. As animals feed on polluted food the increasing levels of mercury is built up through food chain.

Control of Water Pollution

The key challenges to better management of the water quality in India comprise of temporal and spatial variation of rainfall, uneven geographic distribution of surface water resources, persistent droughts, overuse of ground water and contamination, drainage and salinisation and water quality problems due to treated, partially treated and untreated wastewater from urban settlements, industrial establishments and runoff from irrigation sector besides poor management of municipal solid waste and animal dung in rural areas (CPCB Report, 2013). Some of the control measures are given below:

1. The Ganga Action Plan and the National River Action Plan are being implemented for addressing the task of trapping, diversion and treatment of municipal wastewater.
2. In most parts of the country, waste water from domestic sources is hardly treated, due to inadequate sanitation facilities. This waste water, containing highly organic pollutant load, finds its way into surface and groundwater courses near the vicinity of human habitation from where further water is drawn for use. Considerable investments should be done to install the treatment systems.
3. With rapid industrialization and urbanization, the water requirement for energy and industrial use is estimated to rise to about 18 per cent (191 bcm) of the total requirements in 2025 (CPCB Report, 2013). Poor environmental management systems, especially in industries such as thermal power stations, chemicals, metals and minerals, leather processing and sugar mills, have led to discharge of highly toxic and organic wastewater. This has resulted in pollution of the surface and groundwater sources from which water is also drawn for irrigation and domestic purpose. The enforcement of regulations regarding discharge of industrial wastewater and limits to extraction of groundwater needs to be considerably strengthened, while more incentives are required for promoting waste water reuse and recycling.
4. For the agricultural sector, water and electricity for irrigation are subsidized for political reasons. This leads to wasteful flood irrigation rather than adoption of more optimal practices such as sprinkler and drip irrigation. Optimized irrigation, cropping patterns and farming practices should be encouraged for judicious use of water.
5. The water quality management in India is accomplished under the provision of Water (Prevention and Control of Pollution) Act, 1974 that was amended in 1988. The basic objective of this Act is to maintain and restore the wholesomeness of national aquatic resources by prevention and control of pollution. The Water (Prevention and Control of Pollution) Cess Act was enacted in 1977, to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities.
6. The Central Pollution Control Board (CPCB) has established a network of monitoring stations on aquatic resources across the country. The water quality monitoring and its management are governed at state/union territory level in India. The network covers 28 states

and 6 Union Territories (CPCB Report, 2013). Water quality monitoring is therefore an imperative prerequisite in order to assess the extent of maintenance and restoration of water bodies.

7. There should be ban on washing of clothes and laundry alongside the river bank.
8. Industries should install Effluent Treatment Plant (ETP) to control the pollution at source.
9. All towns and cities must have Sewage Treatment Plants (STPs) that clean up the sewage effluents.
10. Improper use of fertilizers, herbicides and pesticides in farming should be stopped and organic methods of farming should be adopted. Cropping practices in riparian zone should be banned to protect the riparian vegetation growing there.
11. Religious practices that pollute river water by dumping colourful paints of idols containing harmful synthetic chemicals should be stopped.
12. Rain water harvesting should be practiced to prevent the depletion of water table.
13. Making people aware of the problem is the first step to prevent water pollution. Hence, importance of water and pollution prevention measures should be a part of awareness and education programme.
14. *Polluter pays principle* should be adopted so that the polluters will be the first people to suffer by way of paying the cost for the pollution. Ultimately, the *polluter pays principle* should be designed to prevent people from polluting and making them behave in an environmentally responsible manner.
15. As riparian vegetation helps in making the river water clean because of the multiple functions, to prevent people from felling and clearing down of riparian forest zones for road construction, agricultural practices, recreational and tourism, sand mining, quarrying and clay mining etc. community should play a regulatory role.