



Water Pollution

Water pollution

- Water pollution is defined as the addition or presence of undesirable substances in water.
- It is one of the most serious environmental problems caused mainly by various industrial, agricultural and domestic activities.

Sources of water pollution

- Water pollution sources can be **either point sources or nonpoint sources**.
 - **Point sources:** Pollutants are discharged directly from the source to the water. e.g. a drain pipe carrying industrial effluents into a water body.
 - **Non-point sources:** Pollutants come from diffused sources or from a larger area. e.g. runoff from agricultural fields, grazing lands, construction sites etc.

Agricultural sources:

1. Agricultural runoff has fertilizers and pesticides that contain many nutrients.
2. These chemicals can get leached and seep into the groundwater polluting it.
3. Further these nutrients can cause eutrophication in the water bodies.
4. Aquatic organisms take and incorporate these nutrients into the food chain.
(bioaccumulation)
5. At higher trophic levels, the concentration of these pollutants magnify
(Biomagnification).

Domestic and industrial waste:

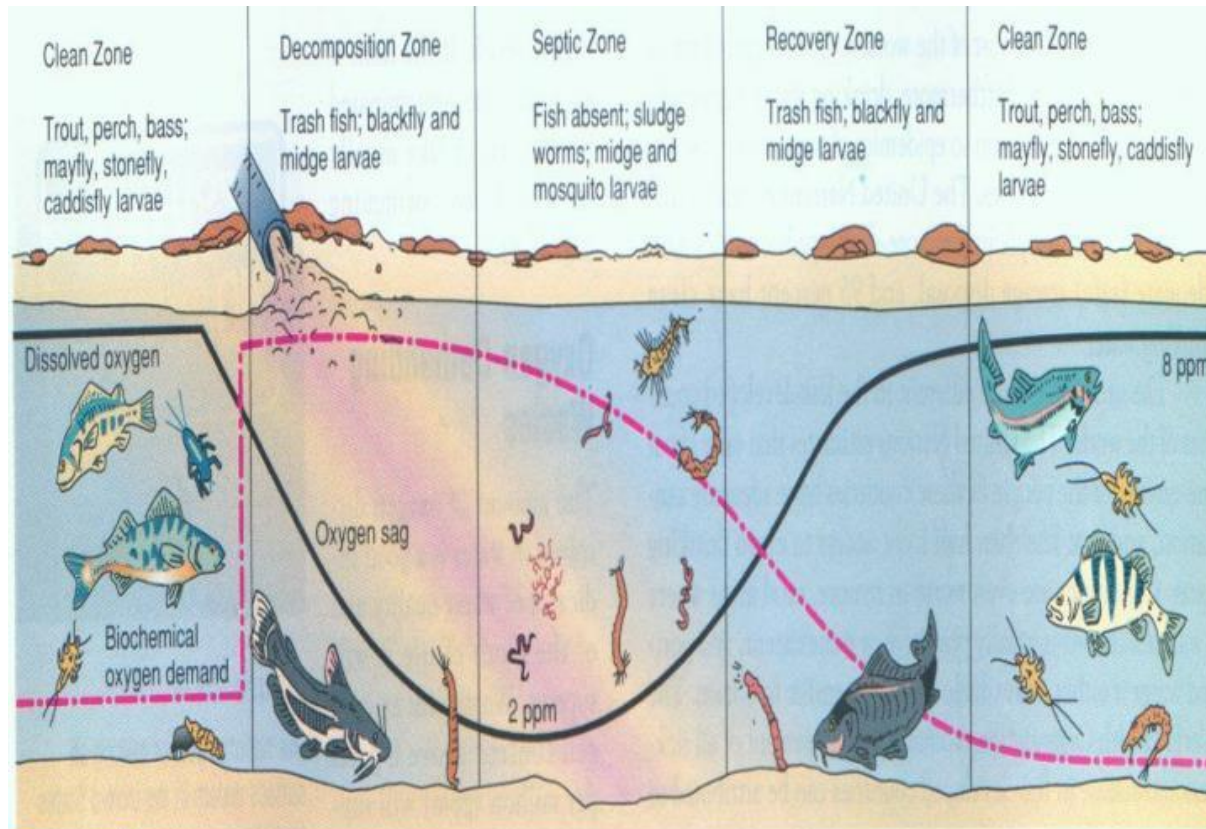
1. Domestic sewage contains human and animal excreta, food residues, detergents and other wastes.
2. Untreated sewage and industrial effluents contain toxic inorganic and organic pollutants.

- **Sewage Water**

- Sewage water includes discharges from houses and other establishments.
- The sewage contains human and animal excreta, food residues, cleaning agents, detergents, etc.
- Domestic and hospital sewage contain many undesirable pathogenic microorganisms.

- **Dissolved Oxygen (DO)**

- Presence of organic and inorganic wastes in water decreases the dissolved oxygen content of the water.
- Water having DO content below 8.0 mg/L may be considered as contaminated.
- Water having DO content below 4.0 mg/L is considered to be highly polluted.
- A number of factors like surface turbulence, photosynthetic activity, O_2 consumption by organisms and decomposition of organic matter are the factors which determine the amount of DO present in water.
- The **higher amounts of waste increase the rates of decomposition and O_2 consumption** thereby **decreases the DO content of water.**



Dissolved Oxygen Depletion

- **Biological Oxygen Demand (BOD)**

- Water pollution by organic wastes is measured in terms of Biochemical Oxygen Demand (BOD).
- *BOD is the **amount of dissolved oxygen needed by bacteria in decomposing the organic wastes** present in water. It is expressed in milligrams of oxygen per litre of water.*
- The ***higher value of BOD indicates low DO content of water.***

- **Industrial Wastes**

- Discharge of wastewater from industries like petroleum, paper manufacturing, metal extraction and processing, chemical manufacturing, etc., that often contain toxic substances, notably, **heavy metals (defined as elements with density > 5 g/cm³** such as **mercury, cadmium, copper, lead, arsenic**) and a variety of organic compounds.

Marine and coastal pollution

- Oceans and coastal waters receive a large percentage of their waste and pollutants – including plastic debris, nutrients, oil, heavy metals and radioactive waste – from land-based sources.
- The rest comes from the shipping industry, fisheries and other sea-based sources.

- **Agricultural sources**

- Agricultural runoff contains dissolved salts such as **nitrates, phosphates, ammonia** and other nutrients, and toxic metal ions and organic compounds.
- Fertilizers contain major plant nutrients such as **nitrogen, phosphorus** and **potassium**.
- Excess fertilisers may reach the groundwater by leaching or may be mixed with surface water.
- Pesticides include insecticides, fungicides, herbicides, etc. They contain a wide range of chemicals such as **chlorinated hydrocarbons (CHCs. E.g. DDT, Endosulfan etc.)**,

Dichlorodiphenyltrichloroethane

- **Thermal and Radiation Pollution**

- Power plants – thermal and nuclear, chemical and other industries use a lot of water for cooling purposes, and the used hot water is discharged into rivers, streams or oceans.
- Discharge of hot water may increase the temperature of the receiving water by 10 to 15 °C above the ambient water temperature. This is **thermal pollution**.
- Increase in water temperature **decreases dissolved oxygen** in the water.
- Nuclear accidents near water bodies or during natural calamities like tsunami and earthquakes pose the risk of radiation leakage (radiation exposure) into water bodies. E.g. **Fukushima Daiichi nuclear disaster**.
- **Radioactive iodine** tends to be absorbed by the thyroid gland and can cause thyroid cancer.

- Aquatic organisms in the hot tropical water bodies live dangerously close to their upper limit of temperature, particularly during the warm summer months.
- A slight increase in temperature affects aquatic organisms in following ways:
 1. Affects feeding in fishes
 2. Affects their growth
 3. Decreases their swimming efficiency
 4. Decreases their resistance to diseases and parasites
 5. Also reduces the biological diversity of aquatic ecosystem

- **Underground water pollution**

- In India at many places, the groundwater is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewage channels and agricultural runoff.
- Pollutants like **fluorides, uranium, heavy metals and nutrients like nitrates and phosphates** are common in many parts of India.

- **Nitrates**

- Dissolved nitrates commonly contaminate groundwater.
- Excess nitrate in drinking water reacts with **haemoglobin** to form non-functional **methaemoglobin** and **impairs oxygen transport**. This condition is called **methemoglobinemia** or **blue baby syndrome**. children may also have trouble breathing as well as vomiting and diarrhoea

- **Trace metals**

- Include **lead, mercury, cadmium, copper, chromium** and **nickel**.
- These metals can be toxic and carcinogenic.

- **Arsenic**

- Seepage of industrial and mine discharges, fly ash ponds of thermal power plants can lead to arsenic in groundwater.
- In India and Bangladesh (Ganges Delta)
- Chronic exposure to arsenic causes **black foot disease**. It also causes diarrhoea and also lung and skin cancer.

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- **Fluoride**

- Excess fluoride in drinking water causes **neuromuscular disorders, gastrointestinal problems, teeth deformity, hardening of bones and stiff and painful joints (skeletal fluorosis).**
- Pain in bones and joint and outward bending of legs from the knees is called **Knock-Knee syndrome.**
- Fluorosis is a common problem in several states of the country due to the intake of high fluoride content water

- Pollution of water bodies by **mercury** causes **Minamata** (neurological syndrome) disease in humans.

Mercury compounds in wastewater are converted by bacterial action into extremely toxic **methyl mercury** mental derangement

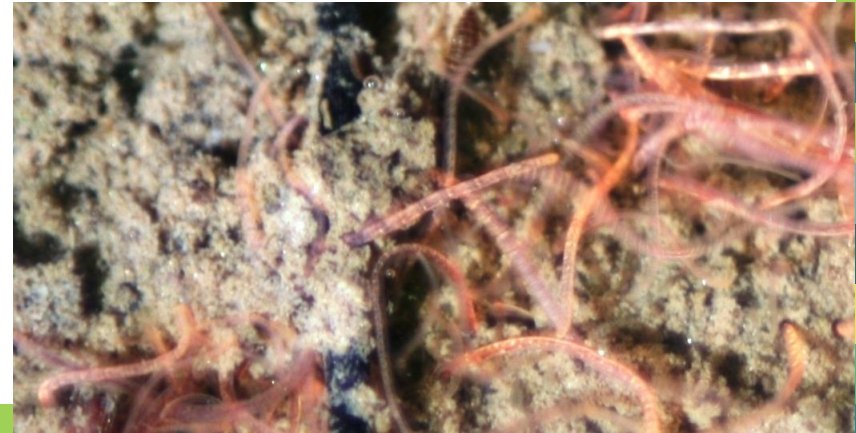
- Lead causes **lead poisoning** (Lead interferes with a variety of body processes and is toxic to many organs and tissues).
- The compounds of lead cause anaemia, headache, loss of muscle power and bluish line around the gum.
- Water contaminated with **cadmium** can cause **itai itai** disease also called **ouch-ouch disease** (a painful disease of bones and joints) and cancer of lungs and liver.

• **Effects of Water Pollution on the Environment**

- Presence of large amounts of nutrients in water results in **algal bloom** (excessive growth of planktonic algae. This leads to **ageing of lakes**.
- A few toxic substances, often present in industrial wastewaters, can undergo biological magnification (Biomagnification) in the aquatic food chain. This phenomenon is well-known for mercury and DDT.
- High concentrations of DDT disturb calcium metabolism in birds, which causes thinning of eggshell and their premature breaking, eventually causing a decline in bird populations.

- **Effects of Water Pollution on Aquatic Ecosystem**

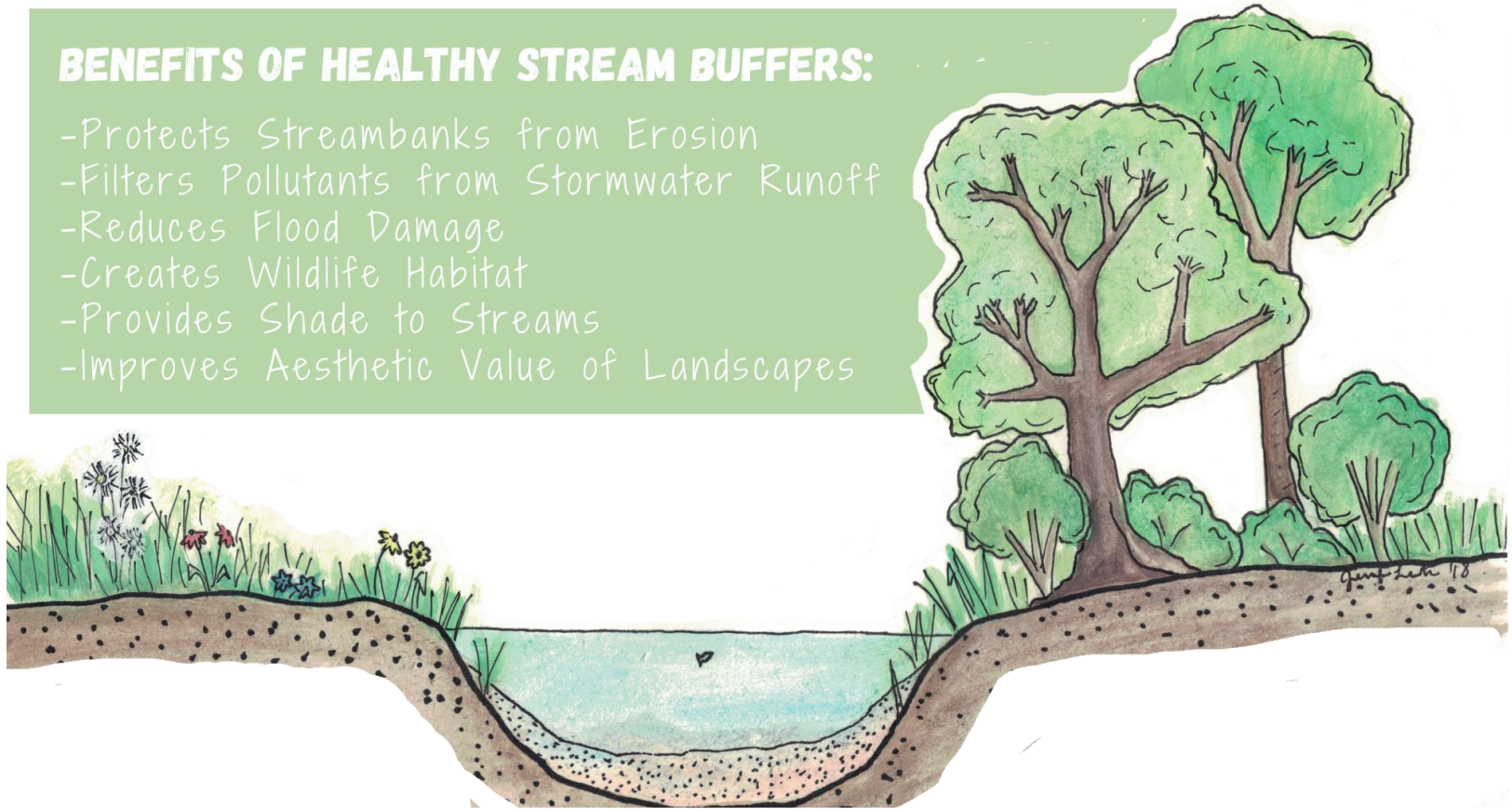
- Polluted water reduces Dissolved Oxygen (DO) content, thereby, eliminates sensitive organisms like plankton, molluscs and fish etc.
- However, a few tolerant species like **Tubifex (annelid worm)** and some insect larvae may survive in highly polluted water with low DO content. Such species are recognized as **indicator species** for polluted water.
- **Biocides, polychlorinated biphenyls (PCBs)** (organic chemicals consisting of carbon, hydrogen and chlorine atoms) and **heavy metals** directly eliminate sensitive aquatic organisms.
- Hot waters discharged from industries, when added to water bodies, lowers its DO content.



- **Riparian buffers:** A riparian buffer is a vegetated area (a "buffer strip") near a stream, usually forested, which helps shade and partially protect a stream from the impact of adjacent land uses.
- Treatment of sewage water and the industrial effluents before releasing it into water bodies. Hot water should be cooled before release from the power plants.
- Excessive use of fertilisers and pesticides should be avoided. Organic farming and efficient use of animal residues as fertilisers can replace chemical fertilizers.
- **Water hyacinth** (an **aquatic weed, invasive species**) can purify water by taking some toxic materials and a number of heavy metals from water.

BENEFITS OF HEALTHY STREAM BUFFERS:

- Protects Streambanks from Erosion
- Filters Pollutants from Stormwater Runoff
- Reduces Flood Damage
- Creates Wildlife Habitat
- Provides Shade to Streams
- Improves Aesthetic Value of Landscapes





- Oil spills in water can be cleaned with the help of oil zapper, microorganisms.
- It has been suggested that we should plant **eucalyptus** trees all along sewage ponds. These trees absorb all surplus wastewater rapidly and release pure water vapour into the atmosphere.

Bioremediation

Bioremediation is the use of microorganisms (bacteria and fungi) to degrade the environmental contaminants into less toxic forms.

Microorganisms can be specifically designed for bioremediation using **genetic engineering techniques**.

In situ bioremediation

In situ — It involves treatment of the contaminated material at the site.

Bioventing: supply of air and nutrients through wells to contaminated soil to stimulate the growth of indigenous bacteria.

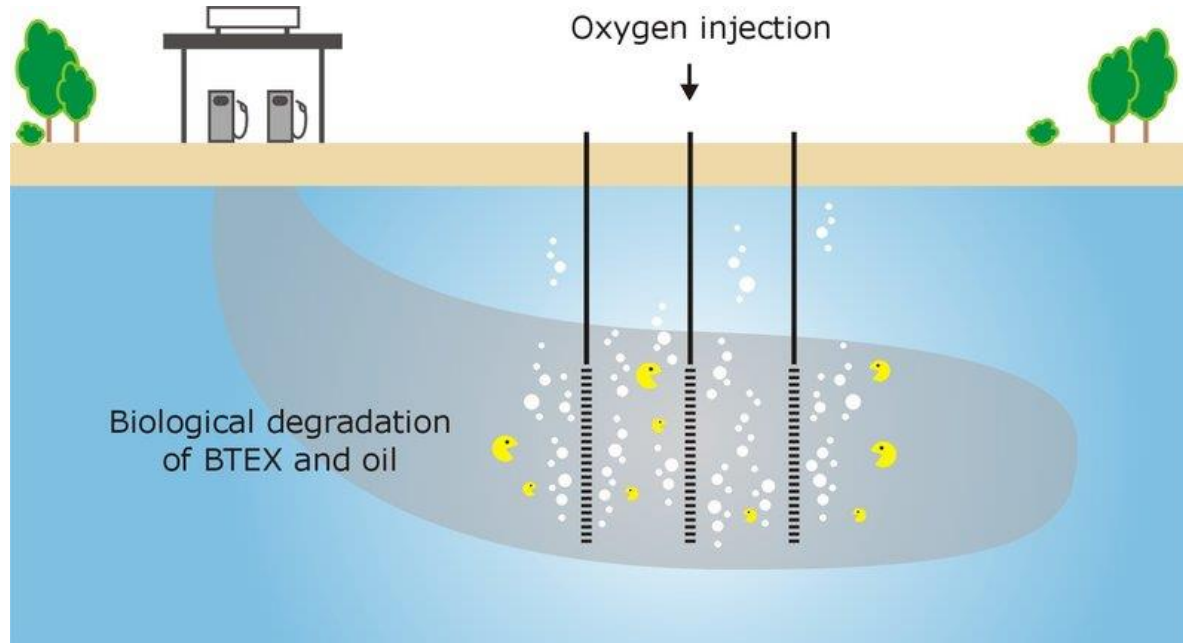
Biosparging: Injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria.

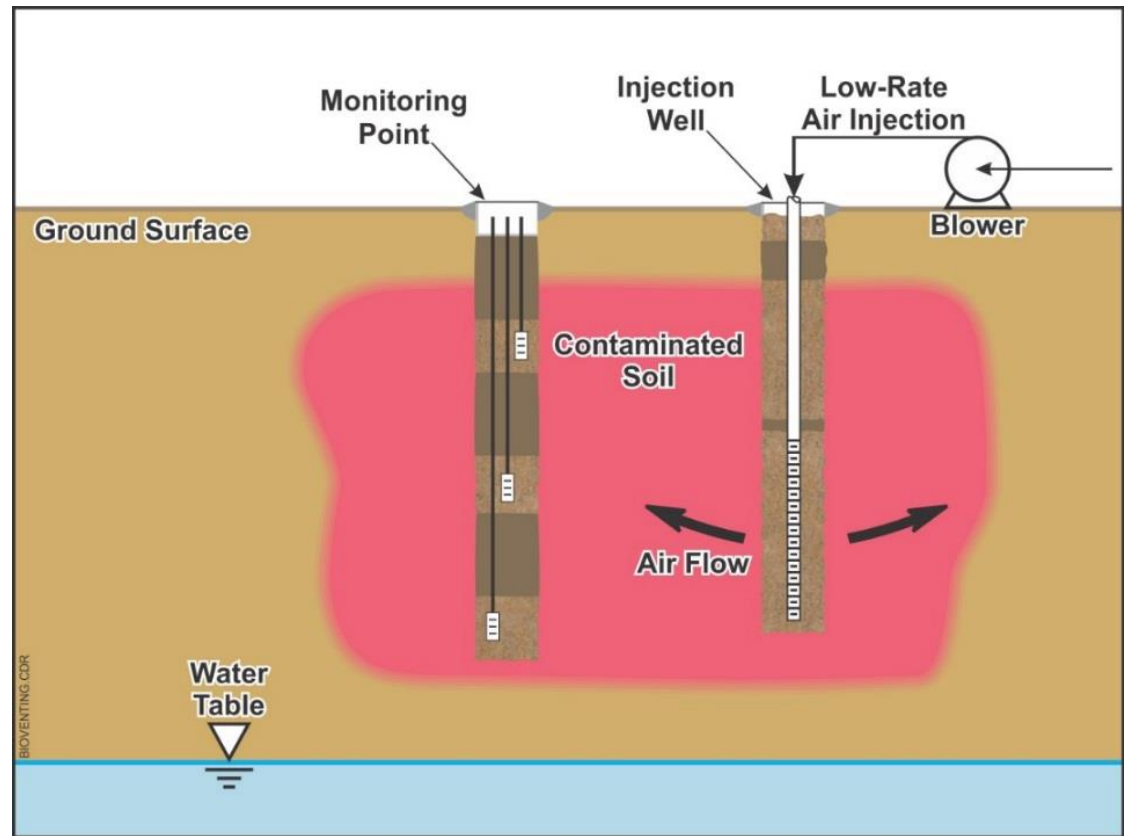
Bioaugmentation: Microorganisms are imported to a contaminated site to enhance the degradation process.

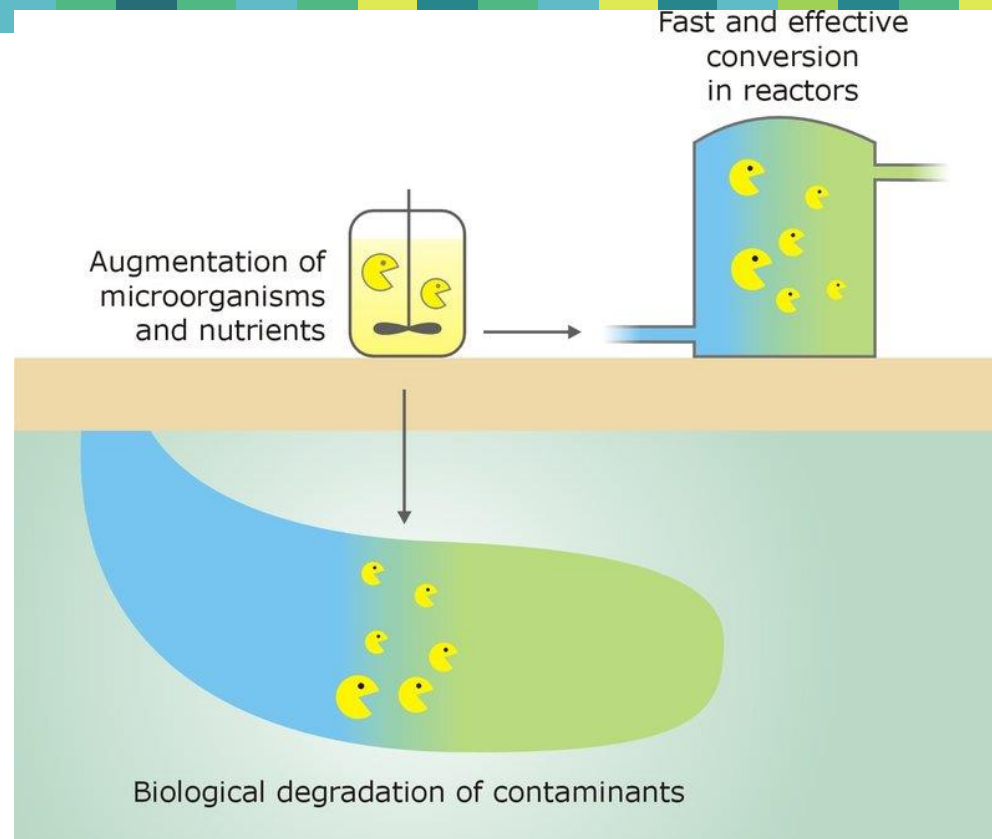
Using bioremediation techniques, TERI has developed a mixture of bacteria called '**Oilzapper and Oilivorous-S'** which degrades the pollutants of oil-contaminated sites, leaving behind no harmful residues..

Oilzapper is essentially a cocktail of five different bacterial strains

benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN), these pollutants can be removed via a biological approach we call biosparging.









Pre-bioremediation: a site
in Mehsana, Gujarat



Post-bioremediation: the
same site after 2 months

Ex situ bioremediation

Ex situ — involves the removal of the contaminated material to be treated elsewhere.

Landfarming: contaminated soil is excavated and spread over a prepared bed and periodically tilled until pollutants are degraded. The goal is to stimulate indigenous biodegradative microorganisms and facilitate their aerobic degradation of contaminants.

Bioreactors: it involves the processing of contaminated solid material (soil, sediment, sludge) or water through an engineered containment system.

Composting: Composting is nature's process of recycling decomposed organic materials into a rich soil known as compost.

Phytoremediation

- Phytoremediation is the use of **plants** to remove contaminants from soil and water.
- Natural phytoremediation is carried out by mangroves, estuarine vegetation and other wetland vegetation.

TOP 5 phytoremediators...

Indian mustard *Brassica juncea*



White Willow



Poplar tree *Populus deltoides*



Indian grass *Sorghastrum nutans*



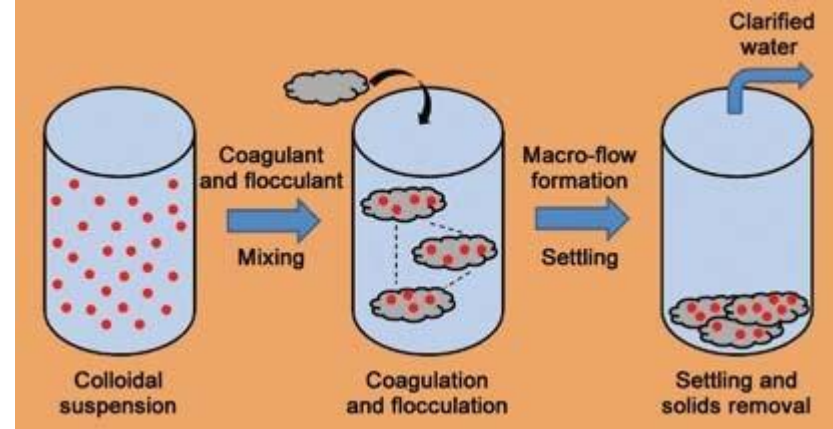
Sunflower *Helianthus annuus*



Flocculation ऊर्णन

Aluminium sulphate (alum) is the most common coagulant used for water purification.

Other chemicals, such as ferric sulphate or sodium aluminate, may also be used.



Chlorine is used because it is a very effective disinfectant, and residual concentrations can be maintained to guard against possible biological contamination in the water distribution system.

The addition of chlorine or chlorine compounds to drinking water is called **chlorination**.

Fluoridation

Water fluoridation is the **treatment of community water supplies** for the purpose of adjusting the concentration of the free **fluoride ion** to the optimum level sufficient **to reduce dental caries**.

Fluoride is generally present in all natural water. Its concentration up to a certain level is not harmful. Beyond that level, the bones start disintegrating. This disease is called **fluorosis**.

We have fluoride problem in many parts of our country. Bureau of Indian Standards prescribes 1.0 mg/l as desirable and 1.5 mg/l as a maximum permissible limit for drinking water.

Defluoridation at domestic level can be carried out by mixing water for treatment with an adequate amount of **aluminium sulphate (alum) solution, lime or sodium carbonate and bleaching powder** depending upon its alkalinity (concentration of bicarbonates and carbonates in water) and fluoride contents.

Legal measures to control water pollution:

- The Water Act (1974), the Water Cess Act (1977 and 1988), and the Environment (Protection) Act or EPA (1986) are the main acts to tackle water pollution.
- The Water Cess Act deals with revenue-generation.
- Pollution control boards at the central and state levels are empowered to prevent, control, and abate water pollution, and to advise governments on matters pertaining to such pollution.

- CPCB coordinates the activities of the state boards and also prepares a list of polluting industries in India.
- The acts mainly deal with industrial units and do not cover the regulation of water pollution originating from the household and agriculture sectors.

The Water (Prevention and Control of Pollution) Act, 1974

- The Act targets prevention and control of water pollution
- It provides for the establishment of Boards for the prevention and control of water pollution (CPCB and SPCBs)
- It prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance.

- CPCB and SPCBs lay down standards and implement them for the prevention and control of water pollution.
- The Water (Prevention and Control of Pollution) Cess Act, 1977 provides for levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

- AMRUT aims to transform 500 cities and towns into efficient urban living spaces.
- It is a centrally sponsored scheme with 80% budgetary support from the Centre.
- Ministry of Housing and Urban Affairs,
Government of India

Thrust Areas of AMRUT:

- (i) Water Supply,
- (ii) Sewerage facilities and septage management,
- (iii) Storm Water drains to reduce flooding,
- (iv) Pedestrian, non-motorized and public transport facilities, parking spaces etc

Smart cities mission:

- City rejuvenation mission for 100 chosen cities.
- Aims to provide core infrastructure in the city: housing, water and electricity supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity and digitalization, etc.
- Holistic approach for all round development of city.
- Three pronged strategy: city improvement (retrofitting), city renewal (redevelopment) and city extension (green-field development).

National River Conservation Plan (NRCP)

Ministry of Jal Shakti

- Centrally sponsored plan launched in 1995.
- Presently covers 38 rivers in 178 towns spread over 20 States.
- Interception and diversion of sewage and setting up of Sewage Treatment Plants are the main strategies under the National River Conservation Plan (NRCP).
- River conservation activities such as creation of civic infrastructure for sewage management and disposal are also being implemented under other central schemes.

- The **Ganga Action Plan (GAP)** was launched by the Government in 1985, for pollution abatement activities in identified polluted stretches of river Ganga. But it did not succeed in cleaning Ganga.
- **National Mission for clean Ganga 2011** was then established as a society and as an implementation arm of National Ganga River Basin Authority (NGRBA).
- NRGBA was constituted under the provisions of the Environment (Protection) Act (EPA), 1986.
- But, it was dissolved in 2016 and replaced with **National Council for Rejuvenation, Protection and Management of River Ganga** (referred as National Ganga Council).

The National Ganga Council is chaired by Prime Minister.

- The EPA Act, 1986 envisages **five tier structure at national, state and district level** to take measures for prevention, control and abatement of environmental pollution in river Ganga and to ensure continuous adequate flow of water so as to rejuvenate the river Ganga.

Namami Gange Programme

- **Namami Gange Programme** is an **Integrated Conservation Mission**, approved as a 'Flagship Programme' by the Union Government in **June 2014** to accomplish the twin objectives of effective abatement of pollution and conservation and rejuvenation of National River Ganga.
- It is being operated under the Department of Water Resources, River Development and Ganga Rejuvenation, **Ministry of Jal Shakti**.
- The program is being implemented by the **National Mission for Clean Ganga (NMCG)**, and its state counterpart organizations i.e., State Program Management Groups (SPMGs).
 - NMCG is the implementation wing of **National Ganga Council** (set in 2016; which replaced the National Ganga River Basin Authority (NRGBA)).
- It has a **Rs. 20,000-crore, centrally-funded**, non-lapsable corpus and consists of nearly 288 projects.

- Main pillars of the programme are
 - Sewerage Treatment Infrastructure
 - River-Surface Cleaning
 - Afforestation
 - Industrial Effluent Monitoring
 - River-Front Development
 - Biodiversity conservation
 - Public Awareness
 - Ganga Gram
- Marking a major shift in implementation, the Government is focusing on **involving people** living on the banks of the river to attain sustainable results.
- The government is also **involving the States and grassroots levels institutions** such as Urban Local Bodies and Panchayati Raj Institutions.