Chapter-2
Water Pollution

Vitrag .C. Dholakia
vitrag.dholakia @darshan.ac.in

Dedicated Faculty Committed Education
Darshan
Institute of Engineering & Technology

Topics to be covered

- Introduction
- Sources of water pollutant
- Classification of water pollutant
- Effects of water pollutants
- Control of water pollutants

Introduction

INTRODUCTION TO ENVIRONMENTAL POLLUTION

- **Environmental pollution** can be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (i.e. air, water and land) which can cause harmful effects on various forms of life or property.

Introduction

- **Pollutant**
- A pollutant may be defined as any substance present in the environment in such concentration that alter the quality of environment and affect the living things adversely.

Or

- Pollutant is defined as the substances that actually cause pollution.

TYPES OF ENVIRONMENTAL POLLUTION

- Water pollution
- Air pollution
- Land pollution

TYPES OF ENVIRONMENTAL POLLUTION

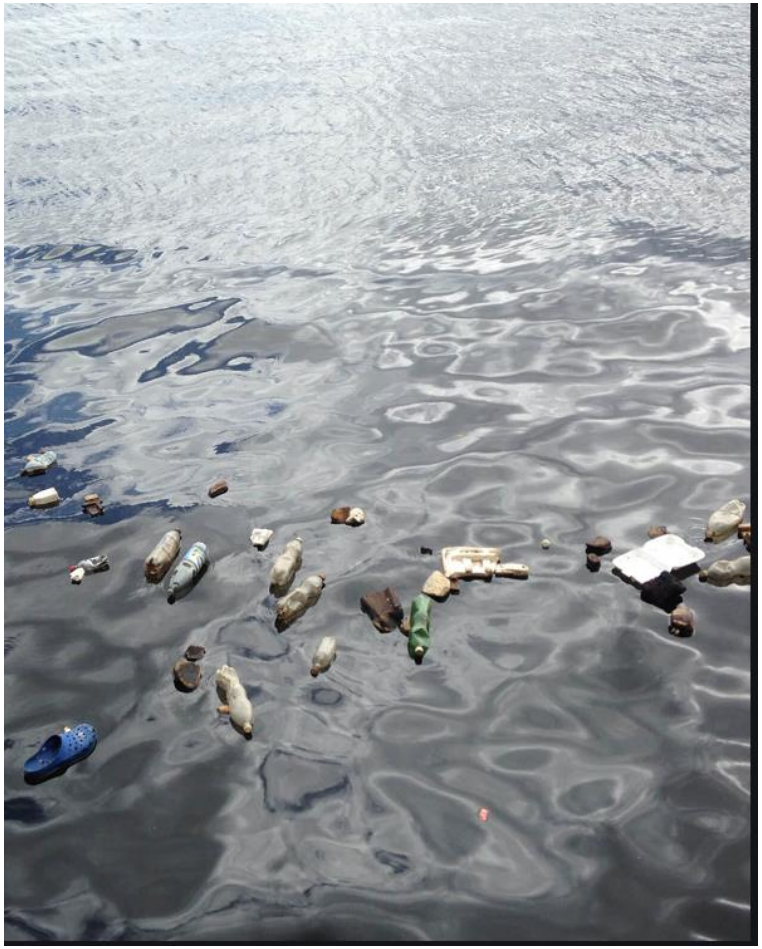
- Noise pollution
- Thermal pollution
- Marine pollution

Water Pollution

- **Water pollution** can be defined as alteration in physical, chemical or biological characteristics of water through natural or human activities making it unsuitable for its designated use.

Water Pollution

- Any physical, chemical or biological change in water quality that adversely affects living organisms or makes water unsuitable for certain uses is referred as **water pollution**.
- Fresh water present on the earth surface is put to many uses. It is used for drinking, domestic and municipal uses, agriculture, irrigation, industries, recreation etc.



Signs of polluted water

- Bad taste of drinking water.
- Offensive odours form rivers, lakes and oceans.
- Decrease in number of fish in fresh water and sea water.
- Oil and grease floating on the surface.
- Unchecked growth of aquatic weeds in water bodies.
- Presence of colour due to organic matter.

Types of water

- **Pure form of water:** In the form of H_2O, also known as distilled water.
- **Mineral water:** Water with acceptable limits of minerals specified by potable water standards.
- **Tap water:** Water supplied by the concerned authority available at homes.
- **Polluted water:** Water containing impurities not suitable for drinking.
- **Contaminated water:** Water containing harmful impurities, not suitable for any purpose nor even can be thrown in water bodies.

Water quality Standards:-

Main parameters which are required to be tested for determining the quality of water can be divided into.

(1) Physical (2) Chemical (3) Biological/Microbiological

(1) Physical parameters

- Turbidity
- Colour
- Odour
- Taste
- Temperature

Water quality standards

(2) Chemical Parameters

- Solids (suspended, dissolved, volatile)
- Hardness
- Chlorides
- pH
- Dissolved gases like Oxygen Carbon Dioxide, Hydrogen Sulphide
- Nitrogen compounds like Nitrites, Nitrates, Ammonical Nitrogen, Albuminiod Nitrogen
- Metals and other inorganic substances like Fluoride, Iron & Manganese, Lead, Arsenic, Iodides, Boron Cadmium

Water quality standards

(3) Biological parameters

- In Biological parameters includes various microorganisms like bacteria, virus, protozoa, worms present in water it may be pathogenic or non pathogenic.

- The agencies playing an important role in specifying the norms for various effluents to be discharged in the water bodies as well as for drinking water are:
- Indian Standards Institution (ISI)
- World Health Organization (WHO)
- United States Public Health Services (USPHS)
- Indian Council of Medical Research (ICMR)

Sources of water pollution

- Sources of water pollution can be classified as

  (1) Point Sources

  (2) Non Point Sources

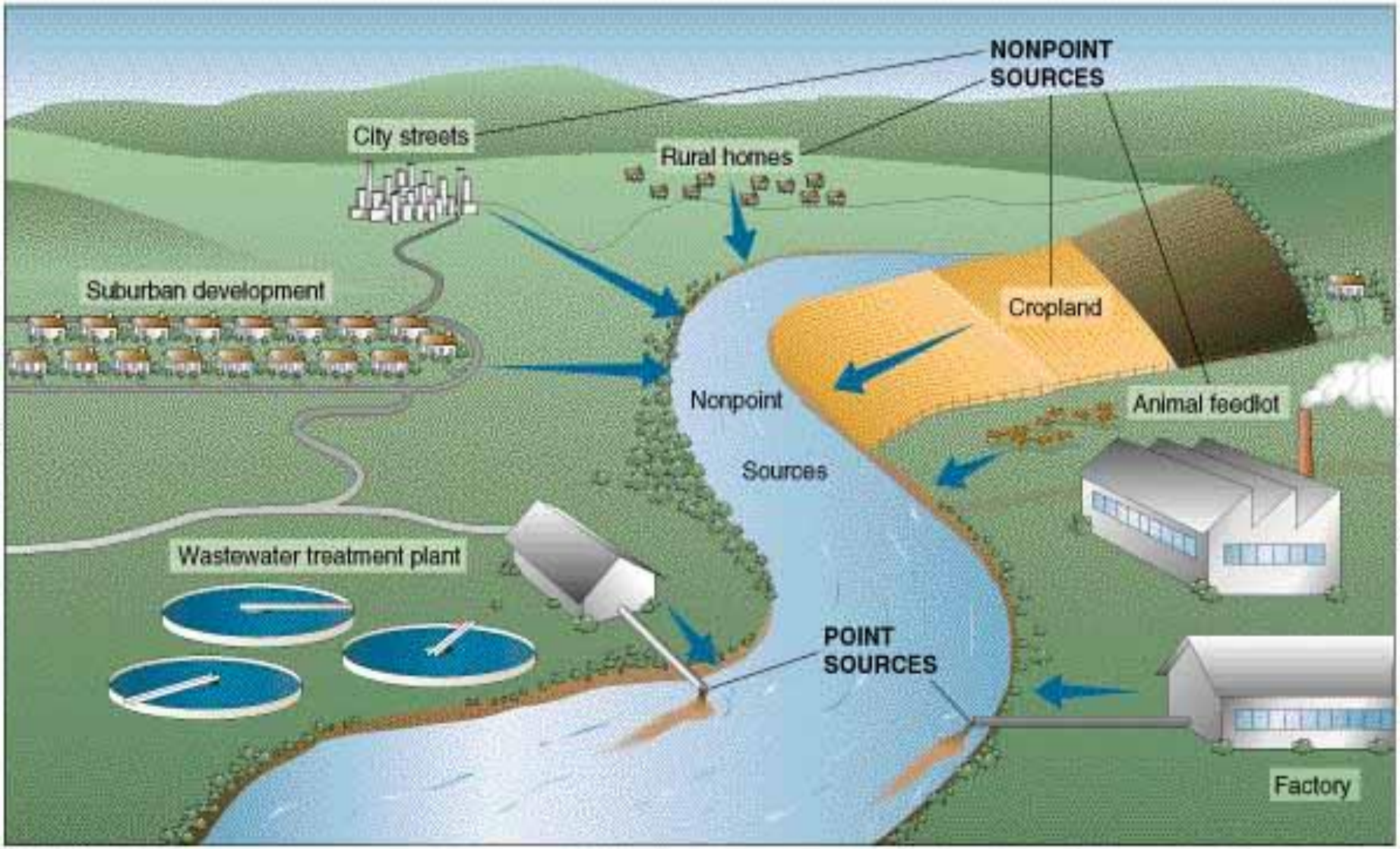
(1) Point Sources

- Those sources which can be identified as a single location are called point sources.
- Examples of point sources are industrial effluent, power plants, sewage discharge etc.
- It is possible to minimize the water pollution from the point sources if the waste water is collect and is given some treatment before it is discharged into a water body.

Sources of water pollution

(2) Non point sources

- Non point sources which are also called as area or diffused sources.
- Those sources whose location cannot be easily identified are called non point sources.
- The discharge from this sources is not at any particular site, rather these are scattered, which individually or collectively pollute the water.
- Example of non point sources are surface runoff from agricultural fields, overflowing small drains, rain water sweeping roads and fields etc


NONPOINT
SOURCES
City streets
Rural homes
Suburban development
Cropland
Nonpoint
Sources
Animal feedlot
Wastewater treatment plant
POINT
SOURCES
Factory

Sources of water pollution

- **Major sources of surface water pollution are:**
- Sewage: discharge of sewers and drains.
- Industrial effluents from different industries.
- Synthetic detergents used for washing and cleaning.

Sources of water pollution

- Agrochemicals like fertilizers containing nitrates and phosphates and pesticides used in agricultural fields which come in runoff from the agricultural land.
- Oil spillage during drilling and shipment.

Sources of water pollution

- Waste heat from industrial discharge increases the temperature of the water bodies.
- Major sources of ground water pollution are septic tanks, deep well injection of industrial effluents, mines etc.

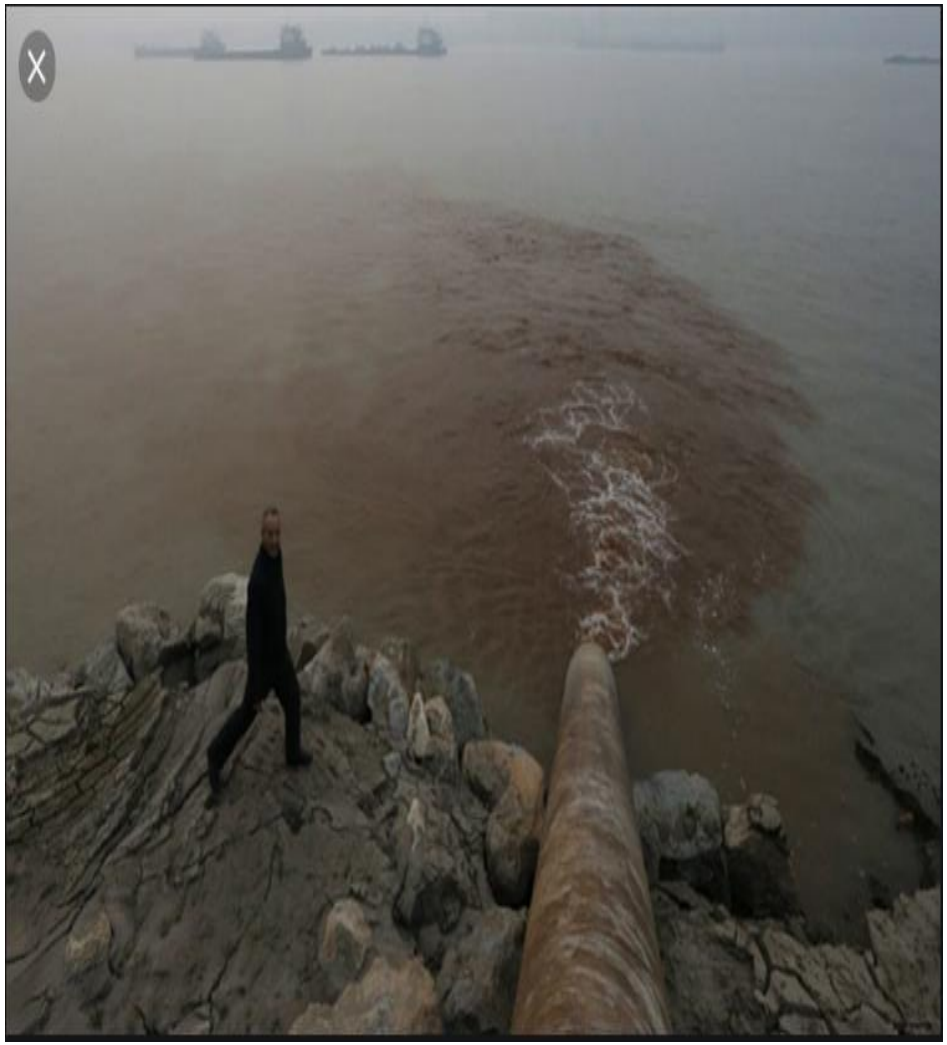
Classification of Water pollutants:

1. Inorganic Pollutant
2. Organic Pollutant
3. Suspended Matter
4. Radioactive Pollutant
5. Thermal Pollutant
6. Synthetic Organic Compound (Nutrient)
7. Pathogens (Bacteria, Virus, Protozoa, Worms)
8. Sediment

Classification of Water pollutants:

Organic pollutants:

- The organic pollutant means "**oxygen demanding pollutants"**.
- The organic pollutants are present in domestic sewage, plant nutrient, oil waste from food processing industries, dairy, pesticides waste etc.



Classification of Water pollutants:

- The most organic waste is biodegradable in nature hence it can be break down and used as food for micro organisms.
- The aerobic bacteria uses dissolved oxygen from the water and deplete the level of dissolve oxygen for the decomposition of organic matter.

Classification of Water pollutants:

Radioactive Compounds:

- The source of radio active compounds are nuclear power plants, medicated radioactive use in hospital and scientific use of radioactive material from laboratories, uranium and thorium mining etc.
- These wastes are highly toxic and cause birth defects, generic damage and cancer.

Classification of Water pollutants:

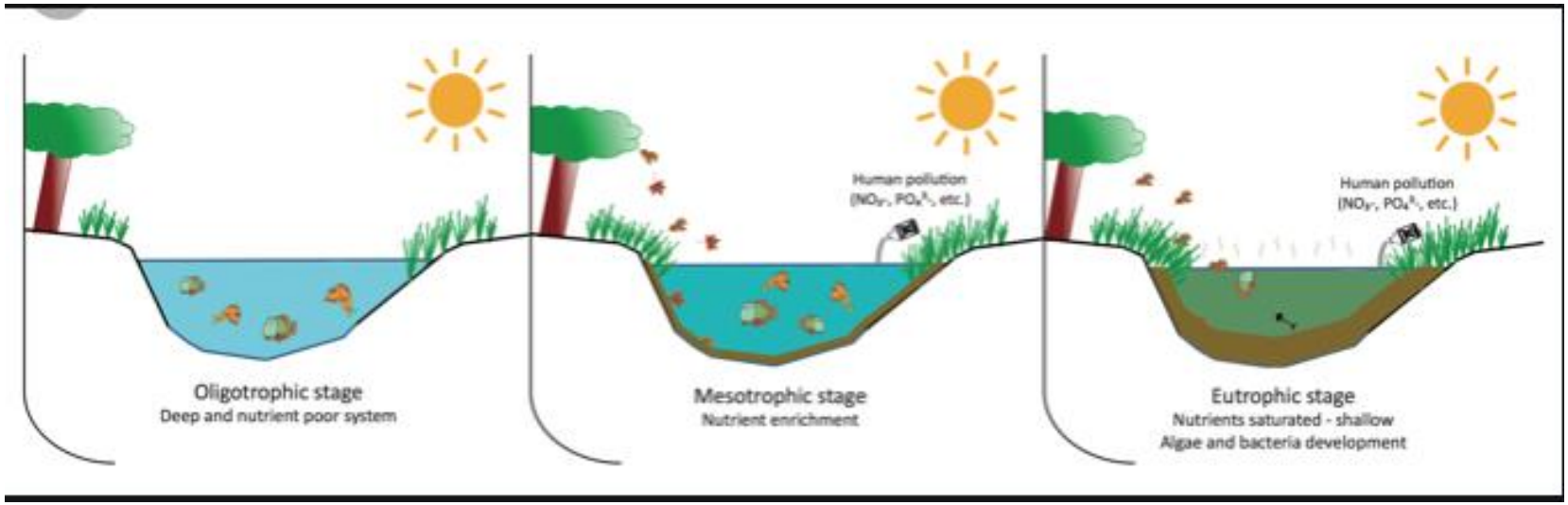
Thermal Pollutants:

- The thermal power plant based on coal fired or nuclear fuel fired is the major source of thermal pollution.
- These thermal plants release hot water and discharge into near by water body.
- The hot water discharge increase the temperature of water body and kills the aquatic creature.

Classification of Water pollutants:

Nutrients:

- The sewage and agriculture runoff waste from fertilizer and detergent industries contents phosphate and nitrogen in large quantity.
- Such runoff is discharge into water body then it results into over nutrition in water which is called eutrophication.
- The result is the formation of aquatic weeds and vegetable which again is the headache for public water supply.



Classification of Water pollutants:

Inorganic Pollutants:

- The inorganic pollutants are inorganic salts, mineral acids, toxic metals, some trace element etc.
- The inorganic pollutant makes water unfit for domestic purpose and cause danger of life for aquatic creature.

Classification of Water pollutants:

Suspended matter:

- The soil erosion is the main source for accumulation of sediments/suspended matter in water body.
- The other source is solids from domestic sewage and solids from construction activities.
- The suspended matter inhibits the penetration of sunlight in water body which results into decrease rate of photosynthesis process

Effects of Water pollutants:

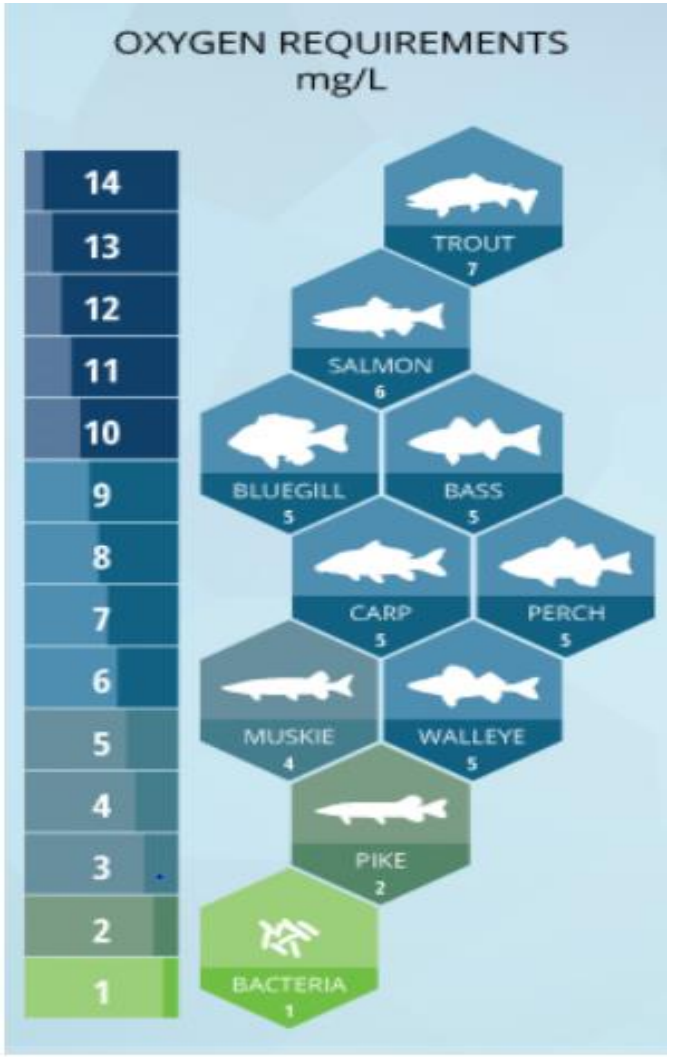
- Following are some important effects of various types of water pollutants:

Oxygen demanding waste (Biodegradable organic waste)

- Organic matter which reaches the water bodies is decomposed by microorganisms present in water. For this oxygen dissolved in water is used.
- ORGANIC MATTER + DO (O_2) + Bacteria $\longrightarrow$ $CO_2 + H_2O$
- **Biochemical Oxygen demand (BOD)** is used to as a measure to find out the amount of Biodegradable matter in the water.
- It is defined as amount of oxygen required by the bacteria to decompose the biodegradable organic matter under aerobic condition.
- The saturated value of DO in water is in the order of 8 to 10 mg/L.

Effects of Water pollutants:

- Optimum DO required for healthy fish and other aquatic life is about 5-8 mg/L.
- Due to degradation of waste DO levels gets reduced. If DO drops below 4 mg/L fish and other aquatic life is threatened and in extreme cases killed.
- Other effect of reduced DO is undesirable taste, odour and colour prohibiting its use for domestic and recreational purpose.



Effects of Water pollutants:

Pathogens

- Many wastes water especially sewage contains many pathogenic microorganisms which are usually contained if faces and urine of infected persons.
- Water borne dieses like cholera, dysentery, typhoid are caused due to pathogens present in water.

Effects of Water pollutants:

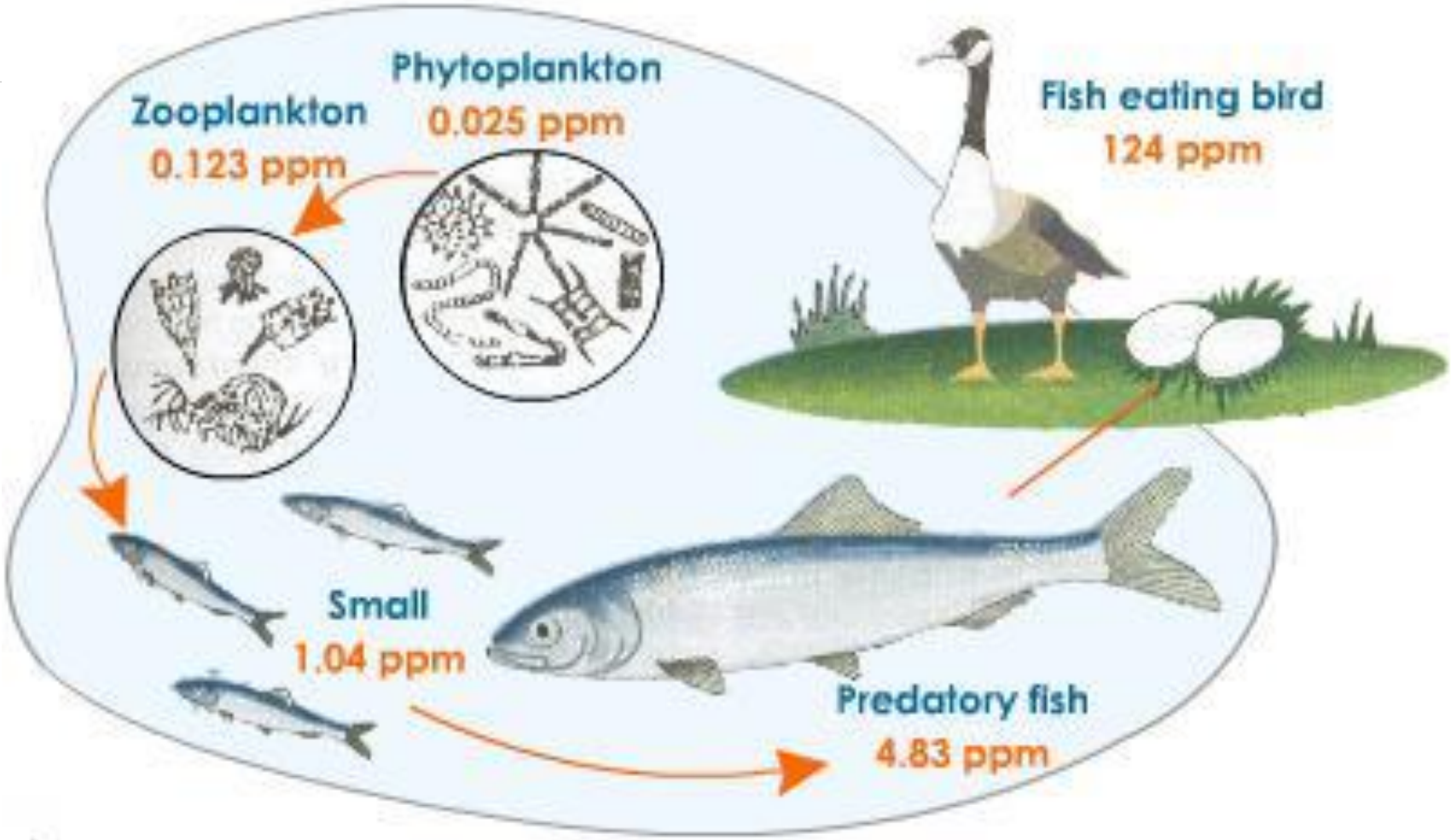
Nitrogen and phosphorus compounds (Nutrients)

- Additional of compounds containing nitrogen and phosphorus helps in growth of algae and other plants. These compounds are nutrient for growth.
- When these concentrations are high it causes rapid growth causing algal bloom. Also the growth of weeds increases.
- It covers up the water surface and prevents entry of sunlight into water bodies.
- Aquatic plants along with algae thus die; the bacteria present in water now decompose all these dead plants.
- The decayed organic matter adds unwanted colour, odour and taste to water.
- It also reduced DO of water and leads to death of fish and other aquatic animals.

Effects of Water pollutants:

Toxic Compounds

- Pollutants such as heavy metals, pesticides, cyanides and many other organic and inorganic compounds are harmful to aquatic organisms.
- Some of the substances like pesticides, methyl mercury etc moves in to the bodies of organisms from medium in which these organisms live.
- These substances tend to accumulate in the organisms body. This process is called **Bio accumulation**.
- The concentration of these toxic substances builds up at successive levels of food chain. This process is called **Biomagnification**



Process of Biological Magnification;
DDT concentrations increase in organisms along the food chain

Effects of Water pollutants:

- Following example of biomagnification of DDT in aquatic chain.

Components	DDT Concentration (ppm)
Birds	10.00
↑	↑↑
Needle fish	1.0
↑	↑↑
Minnows	0.1
↑	↑
Zooplankton	0.01
↑	↑
Water	0.000001

- **Mercury** dumped in water is converted to methyl mercury by bacterial action. A disease called Minimata dieses occurs due to consumption of methyl mercury contaminated fish.
- Concentration of **nitrate** more than 45 mg/L causes occurs blue baby diseases in infants.
- Excess fluoride causes fluorosis. It is effects the bones and teeth of the person.

Effects of Water pollutants:

Suspended matter

- Makes water aesthetically displeasing.
- Biodegradable suspended matter causes DO depletion.
- It reduced light penetration there by reducing photosynthesis and a corresponding loss in food production.
- Provides adsorption sites for harmful chemicals or biological organisms which can effect flora and fauna of stream.

Effects of Water pollutants:

Thermal Discharge

- Water is used for dissipation of waste heat in power plant and industries. This heated water is subsequently discharged into water bodies. Increased temperature of water has following effects:
- Increases biological activities.
- Cause death of some heat sensitive organisms.
- DO concentration decrease this together with increased biological activities at high temperature may result into anaerobic condition. Resulting in bad odour.
- Growth of algae increases.
- Toxicity of chemical pollutants increases with increases in temperature.

Eutrophication:-

- The word Eutrophication is originated from Greek words eu=well and trophes= food. Thus meaning is “well fed” or “nutrient rich”.

- Thus we can define eutrophication as excessive nutrient load in a water body or enrichment of water body by nutrients like phosphorus and nitrogen.

- Presence of nutrients is must for growth of organisms, bur if these nutrients are present in excessive amount then they act as pollutants because they allow excessive growth of aquatic plants like algae.

Eutrophication:-

- Depending upon the presence of nutrients, the water bodies (aquatic system) may be classified as under:

(1) Oligotrophic:

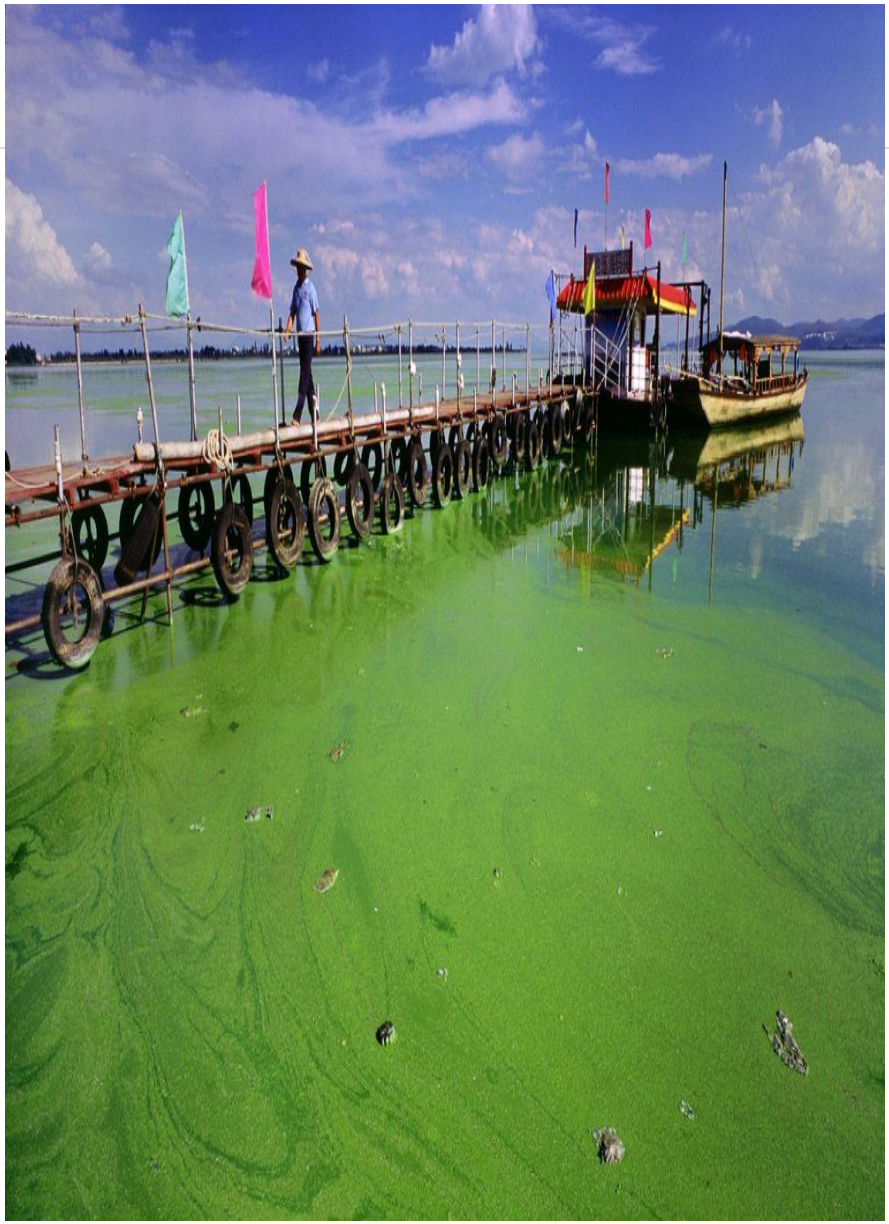
Water bodies with poor concentration of nutrients and very low productivity of aquatic plants.

(2) Mesotrophic:

Water bodies with moderate concentration of nutrients and average productivity of aquatic plants.

(3) Eutrophic:

Water bodies with high concentration of nutrients and very high productivity of aquatic plants.

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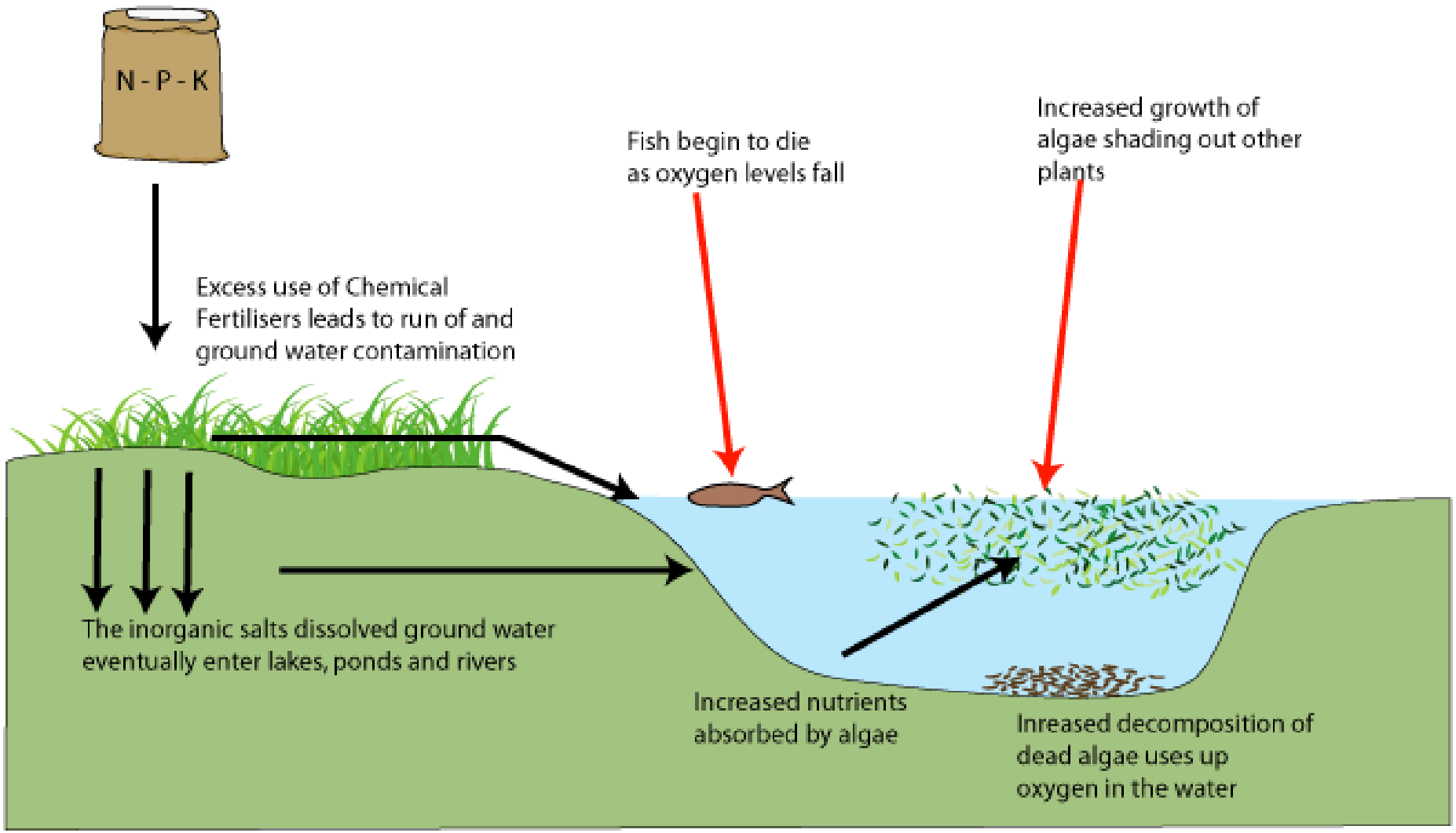
Eutrophication



Eutrophication:-

What causes eutrophication?

- Newly formed water bodies such as lakes, ponds and reservoirs, whether natural or man-made has low nutrient content and low plant productivity.
- Gradually, with the passage of time these water bodies become rich in nutrients through the deposit of domestic waste, agricultural residue (rich in nitrogen and phosphorus), and industrial waste etc which ultimately increase aquatic growth.
- In this way the oligotrophic water bodies turns gradually into Mesotrophic water body.
- Natural eutrophication is a very slow process, often taking more than 100 years. But artificial eutrophication is very fast as it depends on the input of organic waste matter.
- The aerobic decomposition of organic waste in the presence of oxygen by bacteria leads to eutrophication.

Eutrophication:-

- The nutrient rich water body supports the growth of algae and the entire water body becomes green.
- As more plants grow due to the additional supply of nutrients, more plants also die.
- Bacteria decompose these dead plants and organic waste using dissolved oxygen. As a results, BOD of water increases.
- Fish and other aquatic animals start dying due to the depletion of oxygen. Such a water body is said to be eutrophied.
- With an increase in BOD, water starts emitting an offensive smell and asthetic and recreational importance of the water body decreases.
- Generally, it is observed that concentration of nitrogen higher than 0.3 mg/L and phosphorus more than 0.15 mg/L cause eutrophication

Eutrophication:-

Effects of eutrophication:

- Higher growth rate of algae in the water body.
- Algae bloom restrict the penetration of sunlight in water body hence rate of photosynthesis process decreases.
- Decrease in dissolved oxygen (DO) and increase biological oxygen demand (BOD).
- Bad taste, bad odour is produced and also increases in turbidity of water.
- The decaying organic matter causes depletion of DO, destroying fish and other aquatic species.
- Asthetic and recreational importance of the water body decreases i.e. fishing, swimming, boating etc.

Eutrophication:-

Control of eutrophication

- The control at sources is the best practice to prevent eutrophication therefore waste water enrich with nutrient should be treated for removal of nitrogen, phosphorus and carbon before disposal.

- Recycling of nutrient should be adopted.

- Algae bloom should be removed the water body.

- Reducing the use of phosphate in detergents.

- Reducing the use of nitrate containing fertilizers.

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Control of water pollution

Water pollution can be checked or at least reduced by following measures:

- **By proper sewage treatment**:

The sewage should be properly treated before disposing it in any water bodies. Sewage should be given following treatment before discharging into water bodies

Primary treatment:

To remove floating impurities, girt, inorganic particles, settable solids etc. It mainly involves physical method for removal of impurities.

Secondary treatment:

Mostly aimed to remove organic impurities using mainly biological methods.

Tertiary treatment:

Mostly using strong oxidizing agents to remove impurities. Example chlorine gas. It is used to remove the impurities remaining after primary and secondary treatment.

Control of water pollution

- The industrial effluent should be properly treated before discharging it into water bodies.
- By enforcing stringent standards for disposal of sewage and industrial waste into water bodies.
- By prohibiting direct washing of clothes and animals in water bodies used for drinking water supply.
- Pesticides and fertilizers should be judiciously used to reduce chemical pollution due to surface runoff from farms. Less stable pesticides should be used.
- Increasing the vegetative cover to reduce water pollution due to soil erosion.
- Encouraging reuse of water.
- To avoid thermal pollution hot water should be cooled before releasing it into bodies.
- Advanced treatment for removal of nitrates and phosphates should be adopted to prevent eutrophication.