# River Water Quality

Section **3a**: Anthropogenic Influence on Running water Hydromorphology & Water Quality

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# Anthropogenic Influence on Running water Hydromorphology & Water Quality

Types & Sources of Pollution –

Organic Pollution

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2. Nutrients
3. Sources of Organic Pollution
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5. Fate of organic material released to freshwater
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# Section Goals

- Show the different types of pollution, the effects of toxic chemicals and how planktic organisms play a major role in pollutant fluxes and fate of freshwater ecosystems as well as the use of biomarkers and finally how dams influence the river continuum concept.

# Section Outcomes

- A student should consider how anthropogenic stresses may influence or/and alter the synthesis of a biocommunity or integrity at tissue or cellular level of an organism and to understand how contaminant fluxes and transfer is done through freshwater ecosystems plankton

# Introduction

- Running waters are the most impacted ecosystems due to anthropogenic influence (settlement & activities).
- Most activities affect river ecosystems by interfering with Discharge, Salinity, Conductivity, TDS, TSS
- Pollution is “the direct or indirect introduction of substances, vibrations, heat or noise into the air, water or land which may be harmful to human health or the quality of the environment, as a result of human activity” (European Community Water Policy 1996)

# Introduction

**Eutrophication**

can be natural from rock weathering and soils or human caused:

- Accumulation of nutrients in water and associated sediments, which lead to an excessive growth of algae (phytoplankton & periphyton) & higher plants (macrophytes) with multiple effects. The source of nutrients may be a variety of point & diffuse sources.

Effects:

- ✓ increase in plant & animal biomass, in growth of rooted plants
- ✓ increase in turbidity of water & in rate of sedimentation,
- ✓ development of anoxic conditions,
- ✓ decrease in species diversity,
- ✓ change in dominant biota & increase in the frequency of algal blooms
  - ➢ Anaerobic bacteria under anoxic conditions produce hydrogen sulphide ($H_2S$), thioalcolohs (RSH) & ammonia ($NH_3$)

# Introduction

Constituents, Sources & effects in a water system that can derive of a Sewage from a City Sewage System (Manahan, 1994)

| Constituent | Potential Sources | Effects in Water |
|---|---|---|
| Oxygen-demanding substances | Mostly organic materials, particularly human faeces | Consume dissolved oxygen |
| Refractory organics | Industrial wastes, household products | Toxic to aquatic life |
| Viruses | Human wastes | Cause disease major deterrent to sewage recycle through water systems |
| Detergents | Household detergents | Aesthetics, prevent grease and oil removal, toxic to aquatic life |
| Phosphates | Detergents, human waste | Algal nutrients |
| Grease and oil | Cooking, food processing, industrial wastes | Aesthetics, harmful to some aquatic life |
| Salts | Human wastes, water softeners, industrial wastes | Increase water salinity |
| Heavy metals | Industrial wastes, chemical laboratories | Toxicity |
| Chelating agents | Some detergents, industrial wastes | Heavy metal ion very soluble in water and is transported around the system |
| Solids | All sources | Aesthetics, harmful to aquatic life |

# Nutrients

- Even though necessary for healthy waters, in high levels cause a variety of problems
- Nutrient pollution (sewage & fertilizers) causes eutrophication => reducing oxygen content =>growth of anaerobic decomposers
- The chemistry of decomposition is different when it occurs in water containing oxygen & in water characterised by anoxic conditions
- In anaerobic Decomposition, $H_2S$ & $NH_3$ produce poisonous gases in high concentrations. $CH_4$ & $CO_2$ gases leave water & pass into the air
- Drinking water high in nutrients ($NO_3^-$) get converted into toxic nitrites (reduces blood capacity to carry $O_2$)
- Phosphorus introduced to aquatic systems by detergents & fertilizers can rise, may cause aquatic plants grow rapidly, then their death & then productivity is limited when $PO_4^-$ is used up

# Sources of Organic Pollution

Sewage & domestic wastes: sewage effluents unprocessed have BOD about 300-400 mg/L whereas after treatment 20-60mg/L . The amount of oxygen required to break down the faeces and other organic waste varies and has risen progressively with changes in life style and increasing affluence

Urban run-off: is rich in organic matter including faeces & vegetable matter. Has rapid flushing & run-off due to the nature of the urban substrate & provides the neighbouring aquatic systems with water high in nutrients (BOD = hundreds up to thousands mg/L depending on treatment)

Industries: manufacturing textiles, leather goods & paper involve the processing of organic material along with chemical agents & large amounts of water => produce much effluent containing high concentration of dissolved and particulate organic matter rich in carbohydrates and protein

# Sources of Organic Pollution

- Agriculture: a major source of organic pollution from plant cultivation and farming. Slurry from intensive livestock farming in untreated can be 100 times more polluting than untreated sewage. Fertilizers & detergents wash-off along with inadequately stored fodder crops can run-off and enter surrounding watercourses
- Food processing & manufacture: abattoirs, dairies, canneries, breweries produce large amounts of organic waste with increased BOD

# Nature & Composition of pollutants

- Organic effluent typically contains both particulate & soluble organic & inorganic material
- Sewage & other organic contaminants of freshwater are characterised by high concentrations of largely organic particulate material & large amounts of dissolved organic and inorganic material.
- The particulate & dissolved organic component of sewage consists of around 30% lipid, 25% protein, 10% lignin & cellulose & smaller amounts of amino acid, starch & glycoprotein's

# Fate of organic material released to freshwater

- Organic component of sewage increases the activity of aerobic decomposing organisms. High BOD results in deoxygenation of the water column & surrounding sediments
- Organisms can increase their abundance by several orders of magnitude in response to inputs of sewage
- In waters receiving severe organic pollution, the benthic community (mostly bacteria) grows & may form a slime (mucilage) over the substrate (sewage fungus)
- In Aerobic conditions the organic component through the pyruvic acid is broken down to $NH_3$, $CO_2$ & $H_2O$.
- Proteins are catabolised by hydrolysis to amino-acids which in turn is oxidized to pyruvic acid & $NH_3$

# Fate of organic material released to freshwater

- When $O_2$ is used up, aerobic decomposers get replaced by anaerobic ones. Anaerobic bacteria break down amino-acids using different metabolic ways & produce additionally to $NH_3$, $CO_2$ & $H_2O$, acetic acid, $H_2S$ & $CH_4$
- The fate of the ammonia produced by the breakdown of organic pollutants largely depends on the water oxygen level.
- Aerobic bacteria decompose $NH_3$ to $NO_3^-$ & $NO_2^-$, whereas in anaerobic conditions $NH_3$ accumulates. Some can transform $NO_3^-$ to $N_2$ releasing oxygen.
- $P_2$ from organic material is broken down to $PO_4^-$ by microbial action
- Through organic waste, water gets enriched with $Ca^{2+}$, $Mg^{2+}$, $K^+$, $Cl^-$

# Pathogens

- Freshwater bodies polluted by faecal discharges from man, pets, farm animals & wild animals may transport a variety of pathogens such as bacteria, viruses & protozoans. Waterborne diseases account for millions of deaths annually.
- Bacterial counts (total & faecal coliforms) are expressed in colonies/100 ml. Upstream & downstream water counts differ. When a water body receives untreated wastes, the count could be a million times bigger.
- Potable water produces 1/100ml, & suitable for swim is 200/100ml (EPA). In rivers relatively free of faecal discharges, total faecal counts (colonies) are less than 100/100 ml

# Hormone Pollution

- Source of pollution that cannot undergo treatment
- The source of the hormone (mostly steroids) is thought to be the urine of people under treatment or women taking contraceptive pills and domestic detergents
- Such substances contain compounds that imitate the effects of otherwise naturally produced hormones

(e.g. estradiol made male fish to produce egg yolk proteins, normally found in female, in trout & eels in Britain & in France)