Water Pollution in India: Critical Analysis
(30 November, 2021)
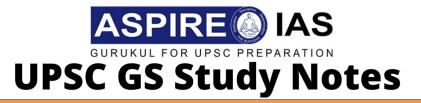
What is Water pollution?

Water Pollution Definition: Water Pollution is the **addition/presence of undesirable substances to/in water such as organic, inorganic, biological, radiological, heat, which degrades the quality of water** so that it becomes unfit for use.

What are the Sources of Water Pollution?

Sources of Water Pollution in India: Natural sources of water pollution are soil erosion, leaching of minerals from rocks (due to natural solubility and solubility triggered by acid rain), and **decaying of organic matter.**

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- When pollutants are discharged from a specific location such as a drain pipe carrying industrial effluents discharged directly into a water body it represents point source pollution.
- In contrast, non-point sources include discharge of pollutants from diffused sources or from a larger area such as runoff from agricultural fields, grazing lands, construction sites, abandoned mines and pits, etc.

What are the Causes of Water Pollution?

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1. **Sewage Water-** Sewage water include 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.

2. **Dissolved Oxygen (DO)**

   - The Presence of **organic and inorganic wastes in water decreases the dissolved oxygen content** of the water.
   - Water **having DO content below 0 mg/L** may be considered **contaminated**.
   - Water having **DO content below. 4.0 mg/L** is considered t **highly polluted.**
   - DO content of water is **important for the survival of aquatic organisms.**
   - A number of factors like **urface turbulence, photosynthetic activity, O_2 consumption by organisms, and decomposition of organic matter** are the factors that 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.

3. **Biological Oxygen Demand (BOD)**

   - Water **pollution by organic waste** is measured in terms of Biochemical Oxygen Demand (BOD).
   - BOD is th **amount of dissolved oxygen needed by bacteria in decomposing the organic wastes present in water**. It is expressed in **milligrams of oxygen per liter of water.**
   - The **higher value of BOD indicates a low DO content** of water.
   - Since BOD is limited to biodegradable materials, it is not a reliable method of measuring water pollution.

Biological Oxygen Demand (BOD) is a standard criterion for ?(2017)

   a. Measuring oxygen levels in blood
   b. Computing oxygen levels in forest ecosystems
   c. Pollution assay in aquatic ecosystems
   d. Assessing oxygen levels in high altitude regions

Ans:c

4. **Chemical oxygen demand (COD)**

   - Chemical oxygen demand (COD) is a **slightly better mode** used to measure pollution load in the water.

- COD measures the **amount of oxygen in parts per million required to oxidize organic (biodegradable and non-biodegradable) and oxidizable inorganic compounds in the water sample.**

5. 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.

6. Agricultural sources

- **Agricultural runoff** conta **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.), organophosphates, metallic salts, carbonates, etc.**
- Many of the **pesticides are non-degradable,** and their residues have a long life.
- Wastes from **poultry farms, piggeries, and slaughterhouse** etc. reach the water through runoff.
- Not only is the agricultural sector the **biggest consumer** of global freshwater resources, with farming and livestock production using **about 70 percent of the earth's surface water supplies**, but it's also a serious water polluter.

- The River pollution in India, Agricultural pollution is **top source of contamination** and streams, the **second-biggest source in wetlands, and the third main source in lakes**. Nutrient pollution, caused by excess nitrogen and phosphorus in water or air, is the number-one threat to water quality worldwide and can cause algal blooms.

7. Thermal Pollution

- **Power plants, thermal and nuclear, chemical, and other industries use a**

lot of water for cooling purposes, and then used hot water is discharged into rivers(that causes river water pollution in India), 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.
- An increase in **water temperature decreases dissolved oxygen** in the water.
- Unlike terrestrial organisms, aquatic organisms are adapted to a uniform steady temperature of the environment. A sudden rise in temperature kills fishes and other aquatic animals.
- One of the best methods of reducing thermal pollution is to store the hot water in **cooling ponds**, allow the water to cool before releasing into any receiving water body
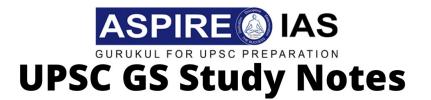
8. Radiation Pollution

- **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.
- Radiation exposure **causes mutations in the DNA of marine organisms**. If those mutations are not repaired, the cell may turn **cancerous**.
- Radioactive iodine tends to be absorbed by the thyroid gland and can cause thyroid cancer.

9. Marine pollution

- Oceans are the **ultimate sink of all-natural and manmade pollutants**.
- The **sewerage and garbage of coastal cities** are also dumped into the sea.
- The other sources of oceanic pollution are **navigational discharge of oil, grease, detergents, sewage, garbage, and radioactive wastes, offshore oil mining, oil spills.**

10. Oil Spills

- The most common cause of oil spills is **leakage during marine transport and leakage from underground storage tanks**.
- An oil spill could occur during **offshore oil production as well**.

Impact of oil spill on marine life

- Oil being lighter than water covers the water surface as a **thin film cutting off oxygen to floating plants** and other producers.
- **Within hours of an oil spill, the fishes, shellfish, plankton die due to suffocation and metabolic disorders.**
- **Birds and sea mammals that consume dead fishes** and plankton **die due to poisoning.**

11. Invasive species

- Plants **of water hyacint** are the world's most problematic aquatic weed, also called **'Terror of Bengal'.**
- They grow **abundantly in eutrophic water** bodies and lead to an imbalance in the ecosystem.
- They cause havoc by their excessive growth **leading to stagn ion** of polluted water.

12. 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

- Excess nitrate in drinking water **reacts with hemogl** to form non-functional **methemoglobin** and impairs oxygen transport. This condition is called **methemoglobinemia** or blue baby syndrome.
- High levels of nitrates may form **nogens** and can accelerate **eutrophication** in surface waters.

Trace metals

- Include a **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),** millions of people are exposed to groundwater contaminated with high levels **of arsenic, a highly toxic and dangerous pollutant.**
- Chronic exposure to arsenic **causes black foot se.** It also

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causes **diarrhoea** and also **lung and skin cancer.**

Fluoride

- Excess fluoride in drinking **neuromuscular disorders**, **gastrointestinal problems, teeth deformity, hardening of bones, and stiff and painful joints (skeletal fluorosis)**.
- **Pain in bones and joints** and **outward bending of leg** 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.

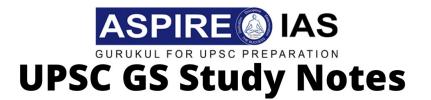**Q. Which of the following can be found as pollutants in the drinking water in some parts of India?**

1. **Arsenic**
2. **Sorbitol**
3. **Fluoride**
4. **Formaldehyde**
5. **Uranium**

Select the correct answer using the codes given below.

a. **1 and 3 only**
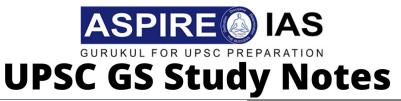b. **2, 4 and 5 only**
c. **1, 3 and 5 only**
d. **1, 2, 3, 4 and 5**

Ans. c

Effects of Water Pollution in India

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Effects of Water Pollution on Human Health

- **Domestic and hospital sewage** contain many undesira pathogenic **microorganisms,** and its disposal into the water without proper treatment may cause an outbreak of serious diseases caused by water pollution, such as **typhoid, cholera**, etc.
- Metals like lead **zinc, arsenic, copper, mercury, and cadmium in industrial wastewaters adversely affect humans and other animals**
- Consumption of such **arsenic** polluted water leads to **accumula on** of arsenic in the **body parts like blood, nails, and hairs causing skin lesions, rough skin, dry and thickening of the skin, and ultimately skin cancer**
- **Mercury compounds in wastewater are converted by bacterial action into extremely toxic methyl mercury,** which can cause numbness of limbs, lips, and **tongue, deafness, blurring of vision, and mental derangement**
- Pollution of water bodies by **mercury causes Mina** (neurological syndrome) disease in humans.
- Lead causes **lead poisoni** (Lead interferes with a variety of body processes and is toxic to many organs and tissues).
- The compounds of lead cause **anemia, headache, loss of muscle power, and bluish line around the gum**.
- Water contaminated with **cadmium can cause itai itai diseas** also called ouch-ouch disease (a painful disease of bones and joints) and cancer of the lungs and liver.

Effects of Water Pollution on the Environment

- Micro-organisms involved in the biodegradation of organic matter in sewage waste consume a lot of oxygen and make water oxygen-deficient killing fish and other aquatic creatures.
- 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 wastev s**, can undergo biological magnification (**Biomagnification)** in the aquatic food chain. Eg., **mercury and DDT.**
- High concentrations of **l** disturb calcium metabolism in birds, which **causes thinning of eggshells** and their premature breaking, eventually causing a **decline in bird populations**.

Effects of Water Pollution on Aquatic Ecosystem

- Polluted water **reduces Dissolved O (DO)** content, thereby, **eliminates sensitive organisms like plankton, molluscs, and fish.** etc.
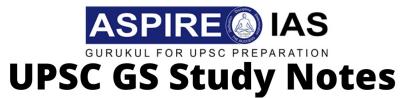- However, a few **tolerant species** like **Tubifex** (annelid worm) **some**

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), and heavy metals** directly **eliminate sensitive aquatic** organisms.

Eutrophication

- The **nutrient-enrichment of the lakes promotes the growth of algae, aquatic plants, and various fauna**. This process is known as **natural eutrophication.**
- Similar nutrient enrichment of lakes at a **accelerated rate is caused by human activities** and the consequent ageing phenomenon is known as **cultural eutrophication**.
- On the basis of their nutrient content, lakes are categorized as **Oligotrophic** (very low nutrients), **Mesotrophic** (moderate nutrients), and **Eutrophic** (highly nutrient-rich).
- A vast **majority of lakes in India are either eutrophic or mesotrophic** because of the nutrients derived from their surroundings or organic wastes entering them.

Algal Bloom

- **Phytoplankton (algae and blue-green bacteria) thrive on** excess **nutrients** and their population explosion **covers almost the entire surface layer**. This condition is known as an algal bloom.
- Phytoplankton is **photosynthetic during the daytime adding oxygen** to the aquatic ecosystem. But **during nights, they consume far more oxygen as they respire** aggressively. i.e. **Algal blooms accentuate the rate of oxygen depletion** as the population of phytoplankton is very high.

- The primary consumer **like small fish are killed due to oxygen deprivation caused by algal blooms.**
- **The death of primary consumers** adversely **affects the food chain.**
- Further, more oxygen is taken up by microorganisms during the decomposition process of dead algae, plants, and fishes.
- The new **anaerobic condition** (absence of oxygen) were created to promote the growth of bacteria such as **Clostridium botulinum** which produces toxins deadly to aquatic organisms, birds, and mammals.
- **Water temperature has also been related to the occurrence of algal blooms**, with unusually warm water being conducive to blooms.
- **Algal blooms can be any color**, but the most common ones **red or brown.** These blooms are commonly referred to as **red or brown tides**.
- **Loss of coral reefs**: Occurs **decrease in water transparency** (increased **turbidity**).
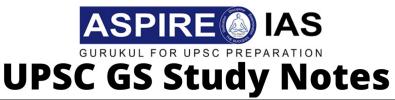
Harmful Algal Blooms

Most algal blooms are not harmful, but some produce **toxins**. These are known as Harmful Algal Blooms (HABs). E.g. **Shellfish poisoning**.

Significantly impact on **local economies and the livelihood** of coastal residents.

Dead zones (biological deserts)

- Dead zones are areas in the ocean wit **very low oxygen concentration (hypoxic conditions).**
- Eg., the Gulf of Mexico every spring (farmers fertilize their crops and rain washes fertilizer off the land and into streams and rivers).
- Gulf of Oman and it's growing.

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- Marine Pollution

Marine pollution-

Refers to the **emptying of chemicals into the ocean** and its harmful effects.

World efforts to control Marine Pollution:

Convention on the Dumping of Wastes at Sea/London Convention

- The Protocol states that "the polluter should, in principle, bear the cost of pollution".
- The International Maritime Organization (IMO) is responsible for the Secretariat
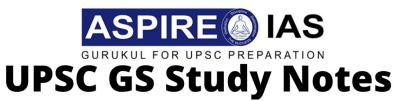
The United Nations Convention on Law of the Sea

- UNCLOS establishes general obligations for safeguarding the marine environment and protecting freedom of scientific research on the high seas.
- It also creates an innovative legal regime for controlling mineral resource exploitation in deep seabed areas beyond national jurisdiction, through an International Seabed Authority.
- UNCLOS can hold states liable for damage caused by violation of their international obligations to combat pollution of the seas.

Marpol Convention/ International Convention for the Prevention of Water Pollution from Ships

- Adopted in response to the number of tanker accidents in 1976-1977.
- The Convention includes regulations aimed at preventing and minimizing water pollution from ships - both accidental pollution and that from routine operations.

Case Studies of Indigenous technologies by Indians to purify water which won Innovation Awards.

- Using **artificial intelligence and robotic** , Asim Bhalerao and Nidhi Jain have been instrumental **in diverting 600 MLD (Million Liters a Day) of raw sewage from entering water bodies** and prevented over 5,600 hours of manual scavenging.
- **Nikhilesh Das** from Assam came up with an indigenous way to use **human hair to clean oil spills** in water.
- Anjan Mukherjee, a former marine chief engineer, has developed the **Taraltec Disinfection Reactor.**
- **Using Floating Wetlands** to Make Water Bodies Pollutant- . **Tarun Sebastian Nanda**, an ecological engineer, is using a natural way to clean water bodies in Delhi through his '**Adopt an Island'** initiative.

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Water Pollution Control Measures

I. Realizing the importance of maintaining the cleanliness of the water bodies, the Government of India has passed the **Water Prevention and Control of Pollution Act. 1974** to safeguard our water resources.

II. An ambitious plan to save the river called the **Ganga Action   n** was launched in 1985.

III. In India, the **Central Pollution Control Board (CPCB),** an **apex body in the field of water quality management,** has developed a concept of "**designated best use".**

Accordingly, the water body is designated **as A, B, C, D, E** on the basis of

- **pH.**
- **dissolved oxygen, mg/l**
- **BOD. (200C) mg/l**
- **total coliform (MPN/100ml)**
- **free ammonia mg/l.**
- **electrical conductivity etc.**

The CPCB, in collaboration with the concerned State Pollution Control Boards, has **classified all the water bodies** including coastal waters in the country **according to their "designated best uses".**

IV. **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.

V. **Excessive use of fertilizers and pesticides should be avoided. Organic farming and the efficient use of animal residues** as fertilizers can replace chemical fertilizers.

VI. **Water hyacinth** (an aquatic weed, invasive species) can purify water by taking some toxic materials and a number of heavy metals from water.

VII. Oil spills in water can be cleaned with the help of **bregol** — a by-product of the paper industry resembling **sawdust, oil zapper, microorganisms.**

VIII. It has been suggested that we should pla **eucalyptus trees all along sewage pond**s. These trees absorb all surplus wastewater rapidly and release pure water vapor into the atmosphere.

IX. **Bioremediation**

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

XI. **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.

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and oil spills.
  b. It is the latest technology developed for under-sea oil exploration.
  c. It is a genetically engineered high biofuel yielding maize variety.
  d. It is the latest technology to control the accidentally caused flames from oil wells.

Ans: a

XII. **Coagulation / Flocculation**- **Aluminium sulphate (a)** is the most common coagulant used for water purification.

XIII. **Chlorine** is used because it is a very effective disinfectant, and residual concentrations can be maintained to guard against possible biological contamination

XIV. **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.

XV. **pH Correction** - Lime is added to the filtered water to adjust the pH and stabilise the naturally soft water in order to minimise corrosion

XVI. **National Environmental Engineering Research Institute (NEE)** is in Nagpur.

XVII. **EcoSan** toilets-,Ecological sanitation is a sustainable system for handling human excreta, using dry composting toilets.

XVIII. **Bio-Toilets- D**esigned by Railways along with DRDO.

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