Water Pollution

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Water Pollution

- **Water pollution** is any chemical, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.

The source of it all

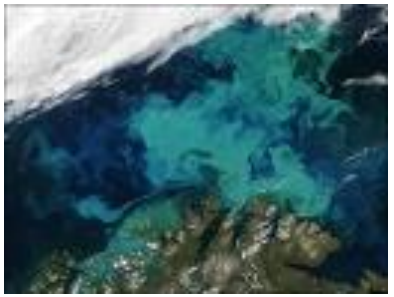
- Point source: pollution that comes from a specific location

Sludge from a copper mine.

Industrial discharge

Other Sources

- Non-point source: pollution that occurs from multiple sources with no single polluter identified.



Who are the polluters?

- **The major source** of 41-48% water pollution is agriculture according to the **Connect** the dots from population growth, food production, water use and water pollution.
- Industrial Facilities
- Municipal
- Mining

What is water polluted with?

- Disease-causing agents
- Oxygen demanding waste
- Plant nutrients (NO_3^-, PO_4^{3-})
- Organic chemicals (solvents, petroleum)
- Inorganic chemicals (Fe, Pb, NH_3)
- Sediment
- Heat

What are they polluting?

Types	Examples	Sources
• Infectious agents	• Bacteria, viruses, parasites	• Human and animal waste
• Oxygen-demanding waste	• Biodegradable animal waste & plant debris	• Sewage, animal feedlots, food processing plants, pulp mills
• Plant nutrients	• NO_3, PO_4, SO_4	• Sewage, animal waste, fertilizers
• Organic chemicals	• Petroleum products, plastics, cleaners, etc.	• Industry, farms, households

What else are they polluting?

Types	Examples	Sources
• Inorganic chemicals	• Acids, salts, metal compounds	• Industry, households, surface runoff
• Sediment	• Clay, sand, silt	• Erosion, farms, industry
• Thermal	• Heat	• Power plants, nuclear facilities, industry

Water borne Diseases

Type of Organism	Disease	Effects
Bacteria	• Typhoid fever • Enteritis	• diarrhea, vomiting, inflammation • stomach pain, nausea, vomiting
Virus	• Hepatitis B	• fever, severe headache, jaundice, enlarged liver
Parasites	• Dysentery • Giardiasis	• diarrhea, abdominal pain • diarrhea, cramps, fatigue
Parasitic worms	• Schistoso-miasis	• Abdominal pain, rash, anemia, chronic fatigue

Water Quality

- There are two classes of water quality standards:
  - biological
  - chemical

Chemical Water Quality

- Water Quality Index (WQI) is a set of standard test parameters used to compare water quality all around the country.
  - An numerical WQI is assigned based on the results of nine (9) separate parameters

WQI Parameters

- Dissolved Oxygen (DO)
- pH
- Temperature Change (ΔT)
- Biochemical Oxygen Demand (BOD)
- Nitrates
- Total Phosphates
- Total Dissolved Solids (TDS)
- Turbidity or Total Suspended Solids (TSS)

Q Value

- Measurements of each parameter are taken and recorded and then are converted into a “Q value”

Water Quality Factor Weights

- **The "Q" value for each parameter is determined and multiplied by a weighting factor:**
  - Dissolved oxygen 0.17
  - pH 0.11
  - Biochemical oxygen demand 0.11
  - Temperature change 0.10
  - Total phosphate 0.10
  - Nitrates 0.10
  - Turbidity 0.08
  - Total solids 0.07

Dissolved Oxygen

- Oxygen gas is not very soluble in water.
- As the temperature of a liquid increases, the solubilities of gases in that liquid decrease.
  - T↑, Solubility↓

Gas Solubility

- Heating a solution of a gas enables the particles of gas to move more freely between the solution and the gas phase.
- shift to the more disordered, more highly dispersed, and therefore, more probably gas state.

DO Test

- The test for DO determines the availability of oxygen for aquatic life
- A high concentration of DO indicates high water quality

Farming and Dissolved Oxygen

- A significant ingredient in urban and agricultural are fertilizers that stimulate the growth of algae and other aquatic plants.
- As plants die, aerobic bacteria consume oxygen in the process of decomposition.
- Many kinds of bacteria also consume oxygen while decomposing sewage and other organic material in the river.

pH

- Water contains both H+ (hydrogen) ions and OH- (hydroxyl) ions. The pH test measures the H+ ion concentration of liquids and substances.

Human-Caused Changes in pH

- In the U.S., the pH of natural water is usually between 6.5 and 8.5, although wide variations can occur.
- Increased amounts of nitrogen oxide (NOx) and sulfur dioxide (SO_2), primarily from automobile and coal-fired power plant emissions, are converted to nitric acid and sulfuric acid in the atmosphere.

Changes in Aquatic Life

- Changes in the pH value of water are important to many organisms. Most organisms have adapted to life in water of a specific pH and may die if it changes even slightly.

pH Extremes

- At extremely high or low pH values (e.g., 9.6 or 4.5) the water becomes unsuitable for most organisms. For **example**, immature stages of aquatic insects and young fish are extremely sensitive to pH values below 5.
  - Very acidic waters can also cause heavy metals, such as **copper and aluminum, to be released into the water**.

Nitrates

- Nitrogen is a much more abundant nutrient than phosphorus in nature.

- the primary algae of algal, are able to use N_2 and convert it into forms of nitrogen that plants can take up through their roots and use for growth: **ammonia (NH_3) and nitrate (NO_3)**.

Nitrates

- As aquatic plants and animals die, bacteria break down large protein molecules into ammonia.
  - Ammonia is then oxidized (combined with oxygen) by specialized bacteria to form **nitrites (NO_2) and nitrates (NO_3^-).** These bacteria get energy for metabolism from oxidation.

Sources of Nitrates

- Sewage is the main source of nitrates added by humans to rivers and lakes.
- Septic systems are common in rural areas.

Problems with Nitrate Contaminated Water

- Water containing high **nitrate** levels can cause a serious condition called methemoglobinemia
  - This condition prevents the blood from carrying oxygen;

Water Temperature

- The water temperature of a river is very important for water quality.
  - Many of the physical, biological, and chemical characteristics of a river are directly affected by temperature.

Temperature Influences

- the amount of oxygen that can be dissolved in water;
- the rate of photosynthesis by algae and larger aquatic plants;
- the metabolic rates of aquatic organisms;
- the sensitivity of organisms to toxic wastes, parasites, and diseases.

- Remember, cool water can hold more oxygen than warm water, because gases are more easily dissolved in cool water.

Turbidity

- Turbidity is a measure of the relative clarity of water:
  - Turbidity increases as a result of suspended solids in the water that reduce the transmission of light.
  - Suspended solids are varied, ranging from clay, silt, and plankton, to industrial wastes and sewage.

Sources of Turbidity

- **H**igh turbidity may be caused by soil erosion, waste discharge, urban runoff, abundant bottom feeders (such as carp) that stir up bottom sediments, or algae growth.
- The presence of suspended solids may cause color changes in water, from nearly white to red-brown, or to green from algal blooms.

Suspended Solids

- Suspended solids can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development.

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Municipal Monitoring

- Sanitary wastes (from toilets, washers, and sinks) flow through sanitary sewers and are treated at the wastewater treatment plant.
  - Storm sewers carry rain and snow melt from streets, and discharge untreated water directly into rivers.

Phosphorus

- Phosphorus is usually present in natural waters as phosphate .
  - Organic phosphate is a part of living plants and animals, their by-products, and their remains.
  - Inorganic phosphates are ions and are bonded to soil particles; there are some phosphates present in laundry detergents.

Sources of Phosphorus

- Phosphorus comes from several sources: human wastes, animal wastes, industrial wastes, and human disturbance of the land and its vegetation.

Sources of P

- Storm sewers sometimes contain illegal connections to sanitary sewers. Sewage from these connections can be carried into waterways by rainfall and melting snow.
- Phosphorus-containing animal wastes sometimes find their way into rivers

Groundwater Clean-up

- The EPA decides who is responsible for the clean-up process and monitors progress.
  - Containment
  - Removal
  - Bioremediation
  - Treatment