BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024,
Tamil Nadu, India

Programme

M.Sc., Environmental Science & Sustainable Management

Course Title:

Environmental Pollution & Toxicology(Core Choice)

Course Code: 25PGCC03

Unit-I

Water : Inorganic pollutants, POPs, and Radioactive substances

By Dr. N.D. Shrinithivihahshini
Assoc.Professor
Department of Environmental Science& Management

Introduction

Importance of Water :

Basis for understanding water quality and its impact on ecosystems

Key Topics Covered:

Physical, chemical, and biological properties

Water plays a crucial role in maintaining ecosystems, supporting agriculture, and sustaining human populations. Without water, biological processes would cease, and the planet's delicate balance would be disrupted.

Solids and Turbidity

Total Dissolved Solids (TDS):

Definition, acceptable limits, and sources (e.g.,soluble organics, minerals, salts)

Turbidity:

Impact on light penetration and aquatic ecosystems

Measurement using **nephelometric turbidity units** (NTU)

It refers to all inorganic and organic substances dissolved in water - Typically includes minerals, salts, metals, cations, and anions - Measured in parts per million (ppm) or milligrams per liter (mg/L)

Affects water taste, hardness, and corrosion potential.

Alkalinity& Acidity

Alkalinity:

Capacity to neutralize acid, measured in mg/L as $CaCO_3$

Importance in buffering pH changes

Sources: It originates from dissolved rocks, particularly limestone, and soil minerals.

Acidity:

Total acid content, impact on aquatic life

Waters are often classified based on their alkalinity levels:

Low: < 75 mg/L as $CaCO_3$

Moderate: 75-150 mg/L as $CaCO_3$

High: > 150 mg/L as $CaCO_3$

Understanding alkalinity is crucial for assessing water quality, managing aquatic ecosystems, and optimizing water treatment processes.

Ion Product: Kw=10−14 *Kw*=10−14 at 25°C, indicating equal concentrations of H^+ and OH^- ions(Blanco & Blanco, 2017).

Alkalinity& Acidity

Alkalinity is a measure of water's capacity to neutralize acids. It represents the total concentration of bases in water, primarily consisting of bicarbonate (HCO_3^-), carbonate (CO_3^{2-}), and hydroxide (OH^-) ions. Alkalinity is typically expressed in milligrams per liter (mg/L) or milliequivalents per liter (meq/L) as calcium carbonate ($CaCO_3$).

Alkalinity indicates the water's capacity to neutralize acids, pH are distinct measurements. **pH measures the actual acidity or basicity.**

Chemical Properties of water: Salinity

Definition and Measurement:

Salinity refers to the concentration of dissolved salts in water. It is typically expressed in parts per thousand (ppt) or practical salinity units (PSU).

Sources:

Natural (seawater intrusion); Anthropogenic (irrigation practices)

Impact:

Corrosion and stress on freshwater organisms

Waters are often categorized based on salinity levels: - Freshwater: < 0.5 ppt - Brackish water: 0.5-30 ppt - Saline water: 30-50 ppt - Brine: > 50 ppt

Measurement Method:

Electrical conductivity, Refractometry/Chemical analysis.

Hardness of Water

Hardness of water refers to the **concentration of dissolved minerals, primarily calcium and magnesium ions, in water.** These minerals are typically acquired **as water percolates through deposits of limestone, chalk, or gypsum.** Water hardness is usually expressed in terms of calcium carbonate (CaCO3) equivalents.

Definition:

- Presence of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions

Measurement:

- Expressed as mg/L of $CaCO_3$

Classification:

- Soft,
- moderately hard,
- Hard &
- very hard water

Soft water: 0-60 mg/L CaCO3
Moderately hard water: 61-120 mg/L CaCO3 -
Hard water: 121-180 mg/L CaCO3 –
Very hard water: >180 mg/L CaCO3

Treatment: - Ion exchange (water softeners) - Reverse osmosis - Distillation - Chemical precipitation

Nutrients in Water

Key Nutrients

Nitrogen and phosphorus compounds

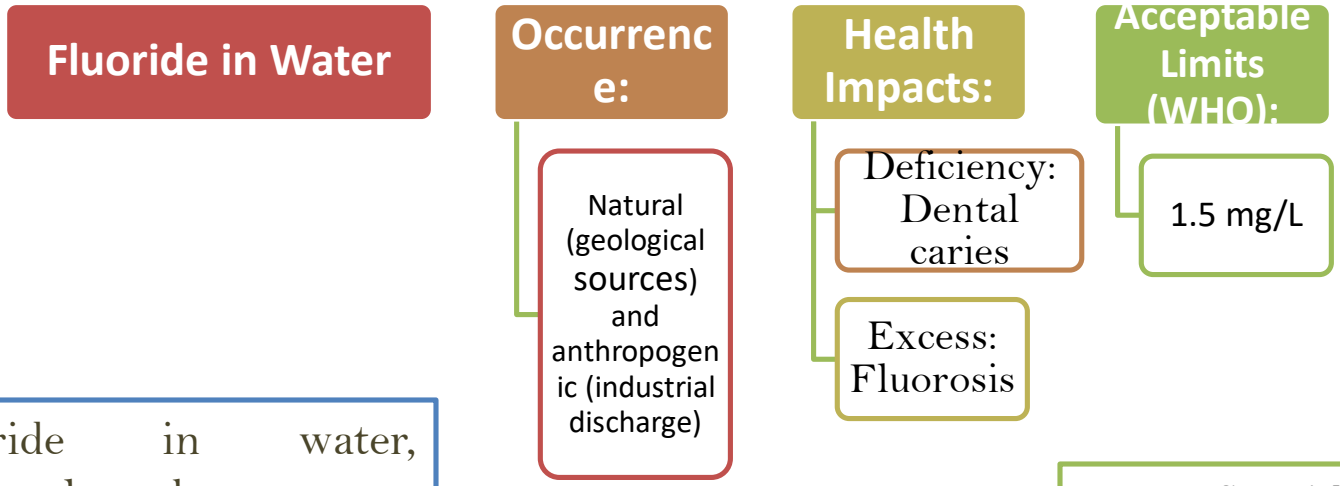
- **Pesticides, industrial solvents, oils**

Sources: Fertilizer runoff, wastewater discharge

Impact

Eutrophication and algal blooms

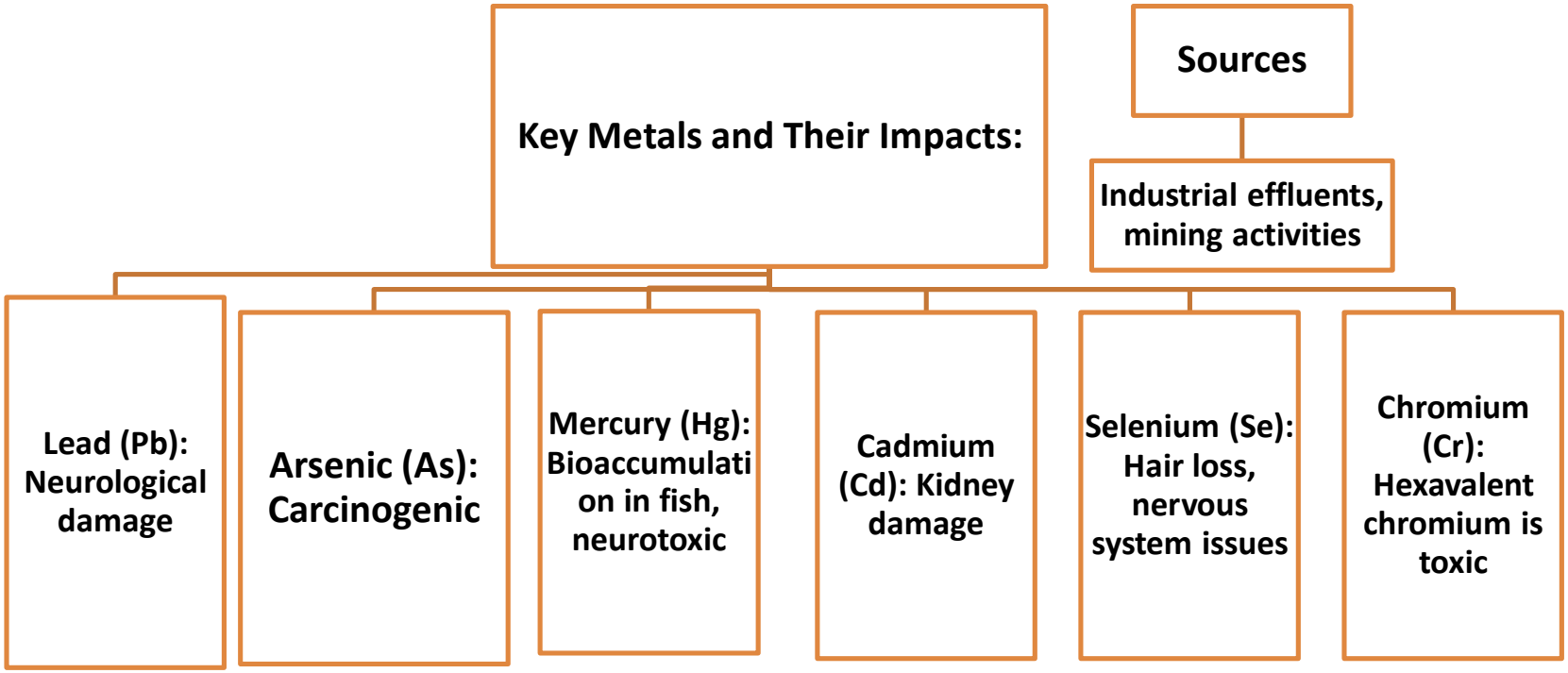
FLUORIDE IN WATER



Fluoride in water, commonly known as water fluoridation, is the controlled addition of fluoride to public water supplies.

Water fluoridation began in the United States in the 1940s and has since been adopted by many countries worldwide.

HEAVY METALS IN WATER



Interactive Question

Interactive Question 1

Q: How do heavy metals accumulate in aquatic organisms, and why is this a concern for human health?

ORGANIC POLLUTANTS –OXYGEN DEMANDING WASTES

Organic Pollutants – Oxygen Demanding Wastes

Biochemical Oxygen Demand (BOD):

Amount of oxygen needed by microbes to degrade organic matter

Chemical Oxygen Demand (COD):

Total oxygen required to oxidize both organic and inorganic substances

Impact:

Low dissolved oxygen levels, fish kills

PERSISTENT ORGANIC POLLUTANTS

Persistent Organic Pollutants (POPs)

Key Types:

- Endocrine Disrupting Chemicals (EDCs)
- Polychlorinated Biphenyls (PCBs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Dioxins

Sources:

- Industrial waste, pesticide runoff

Impact:

- Long-term persistence, bioaccumulation

PERSISTENT ORGANIC POLLUTANTS

PCBs
Synthetic organic chemicals consisting of chlorine atoms attached to biphenyl
-Historical use: Widely used in electrical equipment, hydraulic fluids, and plasticizers
-Current status: Production banned in many countries due to environmental persistence and toxicity
- Health effects: Potential carcinogen, impacts on immune, reproductive, and nervous systems

PERSISTENT ORGANIC POLLUTANTS

PCBs
Synthetic organic chemicals consisting of chlorine atoms attached to biphenyl
-Historical use: Widely used in electrical equipment, hydraulic fluids, and plasticizers
-Current status: Production banned in many countries due to environmental persistence and toxicity
- Health effects: Potential carcinogen, impacts on immune, reproductive, and nervous systems

PERSISTENT ORGANIC POLLUTANTS

Polycyclic Aromatic Hydrocarbons (PAHs): - Organic compounds containing multiple aromatic rings.
Sources: Incomplete combustion of organic matter (e.g., fossil fuels, wood)
Occurrence: Found in polluted air, grilled foods, and tobacco smoke
Health concerns: Some PAHs are carcinogenic and can cause respiratory issues

PERSISTENT ORGANIC POLLUTANTS

Dioxins:
A group of chemically-related compounds that are persistent environmental pollutants
Sources: Industrial processes, waste incineration, and some natural processes (e.g., volcanic eruptions) - Characteristics: Highly toxic, persistent in the environment, and bioaccumulative - Health effects: Can cause reproductive and developmental problems, damage the immune system, and interfere with hormones

PERSISTENT ORGANIC POLLUTANTS

POPs
These compounds share some common characteristics: -
Persistence in the environment
-Potential for bioaccumulation in food chains
-- Long-term health effects on humans and wildlife -
Regulatory focus for reduction and elimination are need of the hour.

Radioactive Substances in Water

Key Radio Nuclides

- Radon (Rn), Uranium (U), Cesium (Cs)

Sources

- Nuclear power plants, natural deposits

Impact

- Carcinogenic, impacts on aquatic ecosystems

Interactive Question

- **I Q 2**

Why are persistent organic pollutants (POPs) challenging to remove from water systems?

CASE STUDY II

Case Study – Fluoride Contamination in Rajasthan

Problem Statement:

- **Excess fluoride in groundwater**

Impact:

- High prevalence of skeletal fluorosis

Solutions:

- Defluoridation techniques (e.g., Nalgonda method)

CASE STUDY II

Case Study –Pollution of R.Ganga

Key Issues:

- Presence of heavy metals, high BOD levels

Sources:

- Industrial discharge, untreated sewage

Mitigation Measures:

- Namami Gange Project

STANDARDS& REGULATIONS

Standards and Regulations

WHO Guidelines:

Drinking water standards for contaminants

Indian Standards:

Bureau of Indian Standards (BIS)

Importance of Compliance:

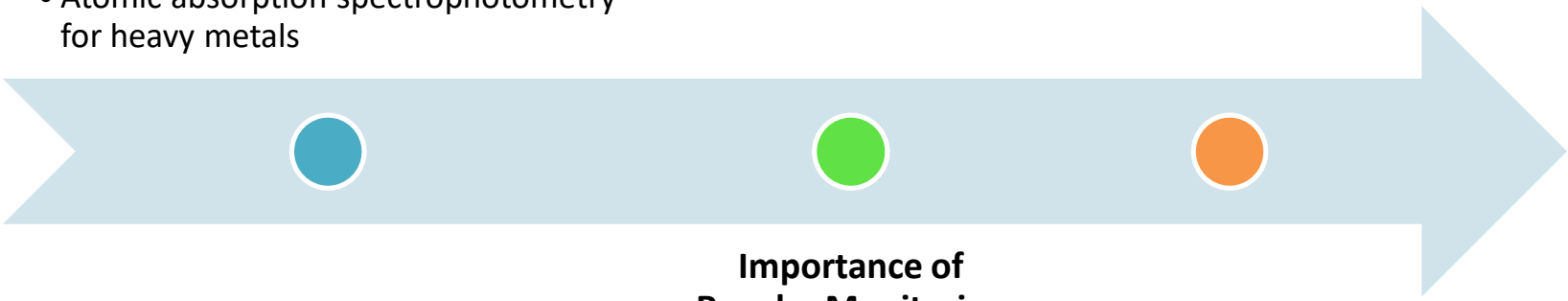
Protecting public health and ecosystems

https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/water-safety-and-quality/drinking-water-quality-regulation

TESTING AND MONITORING TECHNIQUES

Techniques for Water Analysis:

- Turbidity meters, spectrophotometry
- Atomic absorption spectrophotometry for heavy metals



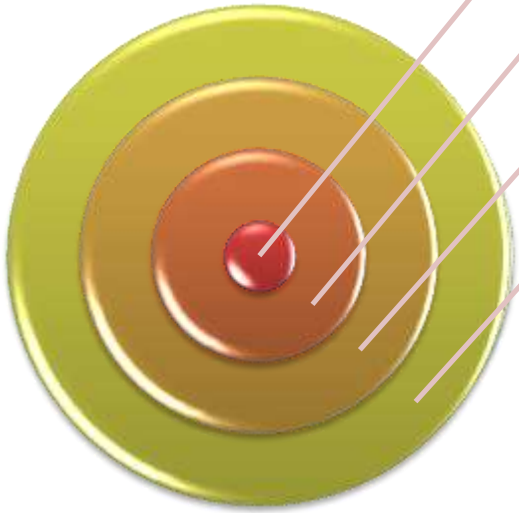
Importance of Regular Monitoring facilitates the Early detection of pollutants

Interactive Question

- **Interactive Final Question**

  How can advanced technologies be utilized for better water quality management?

Summary & Key Takeaways



- Properties of water: Physical, chemical, & biological
- Major pollutants & sources of water pollution.
- Strategies for pollution control & sustainable management.
- Case studies from India highlighting challenges and solutions.

Water is a fundamental resource essential for all life on Earth. It plays a crucial role in maintaining ecosystems, supporting agriculture, and sustaining human populations. In human societies, access to clean water is vital for drinking, sanitation, and hygiene, directly impacting public health and quality of life. Water also drives economic activities, from industrial processes to energy production. As climate change and population growth strain water resources, the importance of conservation, efficient management, and equitable distribution becomes increasingly apparent. Recognizing water's irreplaceable value is key to ensuring its availability for future generations and preserving the planet's biodiversity.

References

- **Books and Articles:**
  - "Water Quality: An Introduction" by Claude E. Boyd
  - "Environmental Pollution and Control" by C. S. Rao
- **Reports and Standards:**
  - WHO Guidelines for Drinking Water Quality
  - BIS Drinking Water Specifications (IS 10500:2012)
- **Websites:**
  - Ministry of Jal Shakti

Copyright Notice!

This presentation is for educational purposes only. All materials, including text, images, and references, are the intellectual property of their respective copyright holders.

- **Unauthorized reproduction, distribution, or use of this presentation is prohibited.**
- Proper attribution is required for any external sources or materials referenced in this work.
- **Disclaimer:**
  The creator of this presentation does not claim ownership of copyrighted material used herein