# 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**

**Ground water pollution**

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# INTRODUCTION

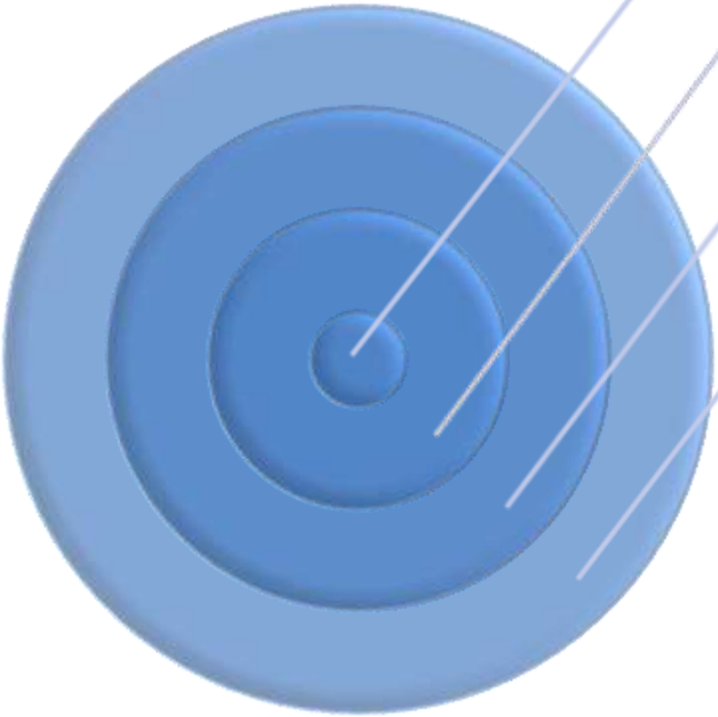
## What is Groundwater?

- Definition: Groundwater pollution refers to the contamination of aquifer resources by various pollutants, rendering the water unsuitable for diverse purposes and posing significant threats to human health, life, and vegetation (Taloor et al., 2024). This issue is particularly critical in India, where groundwater serves as a crucial source of drinking water larger number of people.
- Importance of groundwater in India (e.g., agriculture, drinking water)

## Groundwater Pollution:

- Overview and relevance…

# OVERVIEW



GWP is characterized by the presence of both geogenic and anthropogenic pollutants.

Common contaminants :**1.Inorganic & 2. Organic**
1.Fluoride, nitrate, and uranium,

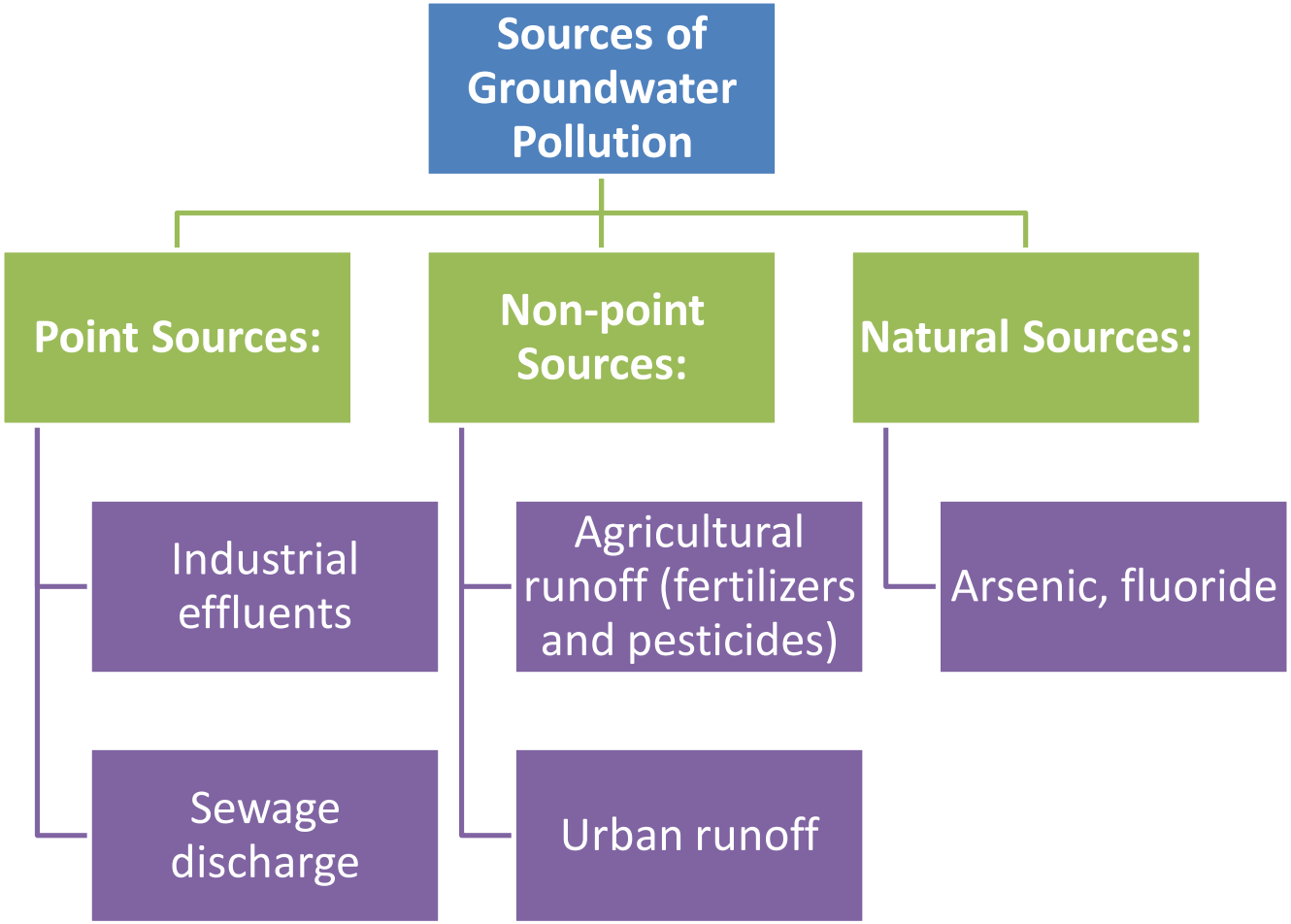
2. Pharmaceuticals, endocrine disrupting compounds, and pesticides (Coyte et al., 2019; Sackaria & Elango, 2019).

In India,some areas are experiencing contamination levels that exceed both Indian and World Health Organization (WHO) drinking water guidelines (Coyte et al., 2019).

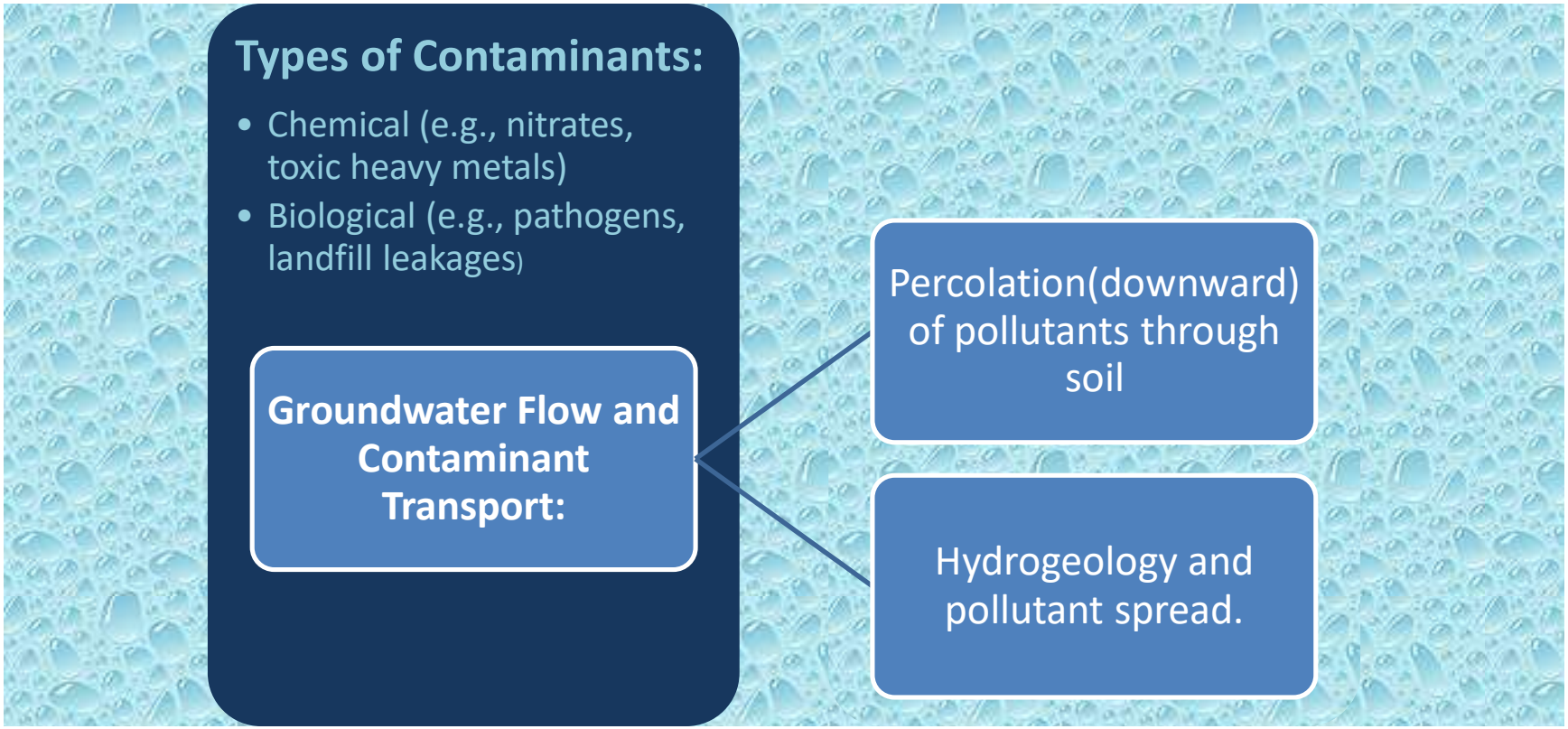
# ROLE OF GEOGENIC & ANTHROPOGENIC FACTORS

- The interplay between natural and human-induced factors makes groundwater pollution in India a complex issue requiring comprehensive assessment and management strategies.

# GWP: SOURCES


Sources of Groundwater Pollution
Point Sources:
Non-point Sources:
Natural Sources:
Industrial effluents
Sewage discharge
Agricultural runoff (fertilizers and pesticides)
Urban runoff
Arsenic, fluoride

# MECHANISMS OF POLLUTION



# GWP:Case Study(s)

**Case Study 1– Arsenic Contamination in West Bengal**

| | |
|---|---|
| **Problem Statement:** | • High arsenic levels in groundwater<br>• Health impacts: Skin lesions, cancer,pigmentation |
| **Causes:** | • Natural geological conditions<br>• **Over-extraction of groundwater** |

**Case Study II-inorganic contaminants in Groundwater of Rajasthan**

**Prob.stmt: High levels of Fluoride,nitrate &Uranium**

**Causes: Water scarcity& over exploitation**

Rajasthan is India's largest state by area, and has a significant groundwater reliant population due to a general lack of surface water accessibility.
Groundwater, including water that is used for drinking without any treatment, contains multiple inorganic contaminants in levels that exceed both Indian and World Health Organization (WHO) drinking water guidelines. The most egregious of these violations were for **fluoride, nitrate, and uranium**; 76% of all water samples in this study had contaminants levels that exceed the WHO guidelines for at least one of these species.

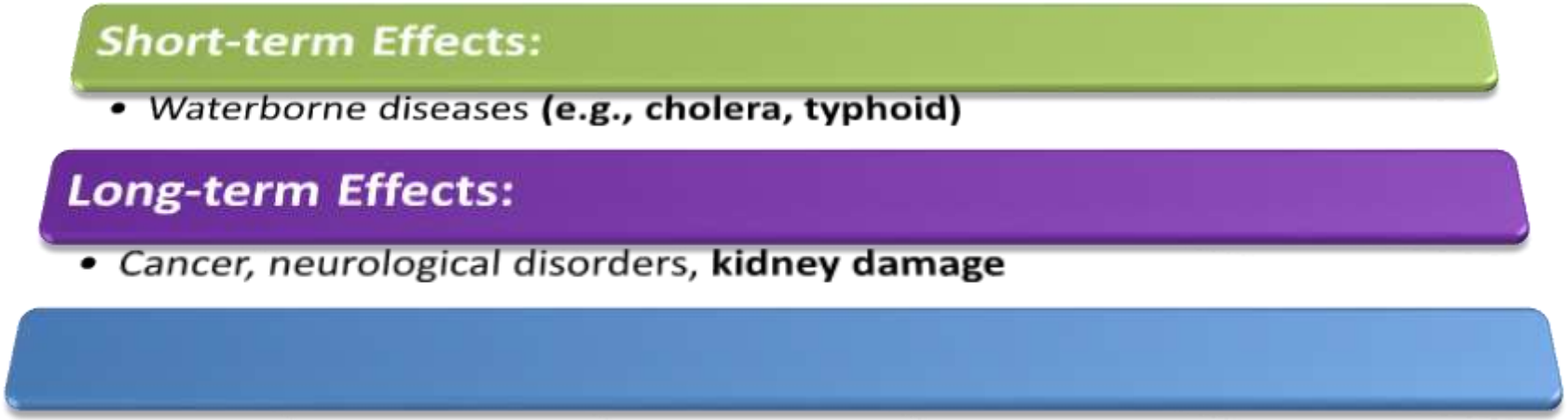
Source: Coyte, R. M., Singh, A., Furst, K. E., Mitch, W. A., & Vengosh, A. (2019). Co-occurrence of geogenic and anthropogenic contaminants in groundwater from Rajasthan, India. *Science of The Total Environment*, *688*, 1216–1227.

# Interactive Question

**I Q 1:**

What are the two main categories of groundwater pollution sources? State few examples for each.

# GROUNDWATER POLLUTION: IMPACTS ON HEALTH



# GWP :CASE STUDY-AGRICULTURE

**Case Study – Nitrate Contamination in Punjab**

**Problem Statement:**

- Excess nitrate levels from fertilizer use.

**Impact:**

- ***Blue Baby Syndrome (Methemoglobinemia)***

**Solutions:**

- **Promoting organic farming**
- Reducing fertilizer use

# GWP: **Policy and Regulations**

## Key Indian Regulations:

- Water (Prevention and Control of Pollution) Act, 1974.
- Groundwater Management Guidelines by Central Ground Water Board (CGWB)

## International Examples:

- Safe Drinking Water Act (USA)

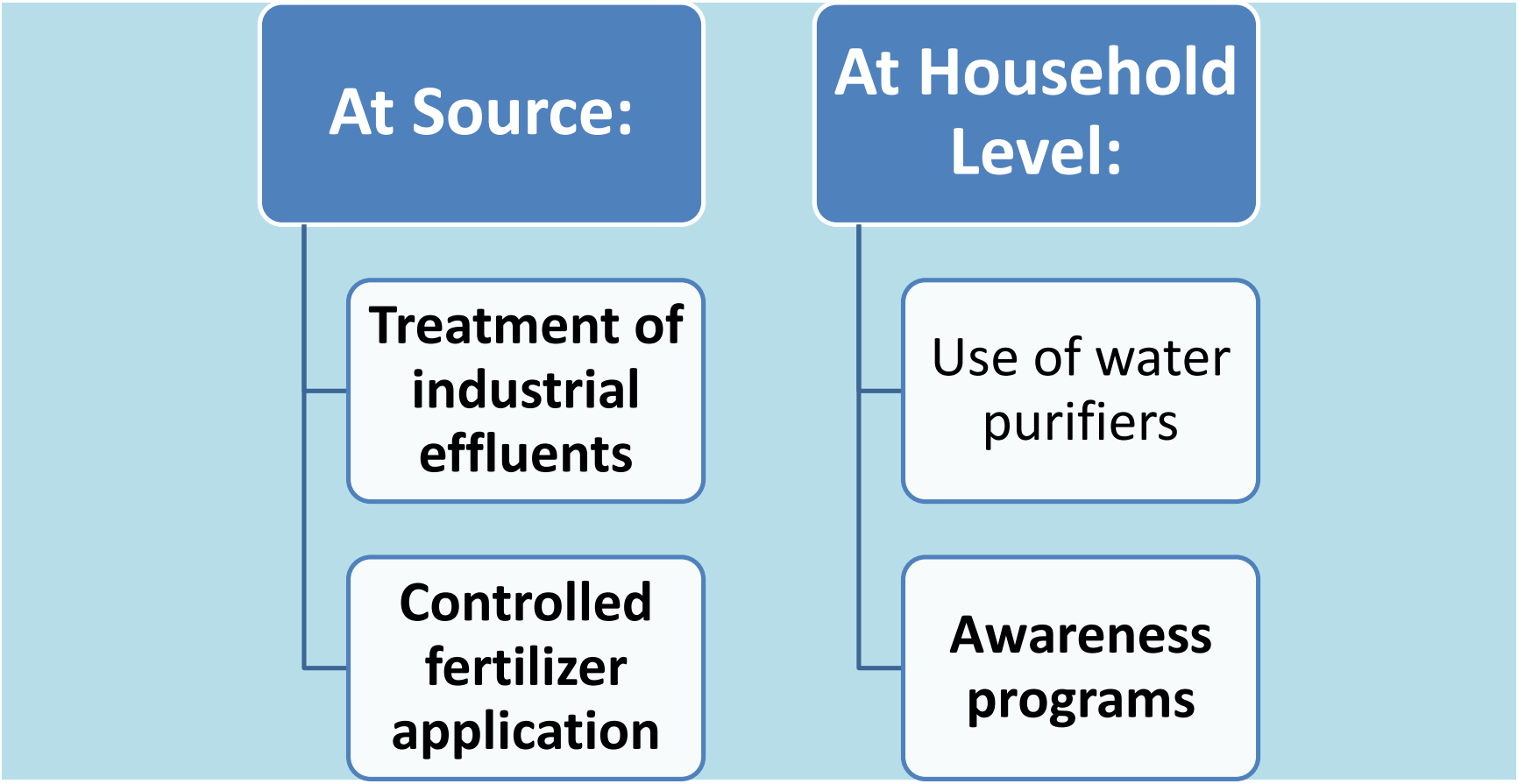
CGWB:All projects extracting/proposing to extract ground water in excess of 100 $m^3$ /day in Over-exploited, Critical and Semi-critical areas and in excess of 500 $m^3$ /day in areas underlain by non-alluvium and 2000 $m^3$ /day in areas underlain by alluvium in Safe assessment units shall have to mandatorily submit impact assessment report and ground water modeling study of existing/ proposed ground water withdrawal on the ground water regime covering 5 KM radius area around the project site prepared by accredited consultants.

# Interactive Question

**I Q 2:**

Name two major health effects of groundwater pollution caused by chemical contaminants.

# GWP: PREVENTION OF HEALTH PROBLEMS AND MITIGATION STRATEGIES



# CASE STUDY III

## Case Study – Uranium Contamination in Punjab

- **Problem Statement:**
  - Presence of **uranium in groundwater**
- **Health Risks:**
  - **Bone and kidney damage**

## Government Actions:

- Installation of Reverse Osmosis (RO) plants

# GWP: Impact on Agriculture

- **Impact on Agriculture**
- **Contaminated Irrigation Water:**
  - Crop yield reduction
  - **Bioaccumulation of heavy metals in food**

Studies have shown that irrigation with contaminated water leads to the accumulation of heavy metals in soil and subsequent uptake by crops (Khan et al., 2007; Rahman et al., 2023).

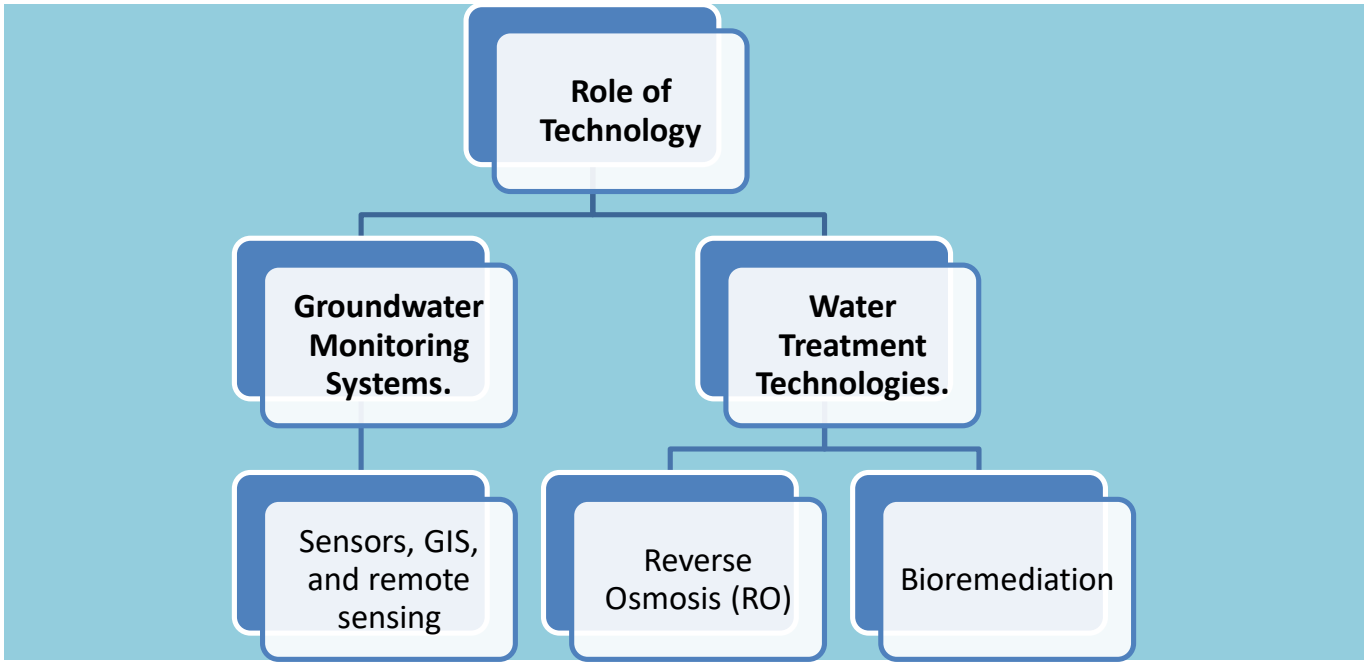
In Bangladesh, long-term irrigation with arsenic-contaminated groundwater has resulted in **increased arsenic content** in soil and rice plants (Rahman et al., 2023). The concentration of arsenic was found to be highest in rice roots, followed by straws and grains, with 0.8-1% of arsenic translocating to the edible parts of the rice (Rahman et al., 2023).

# Interactive Question

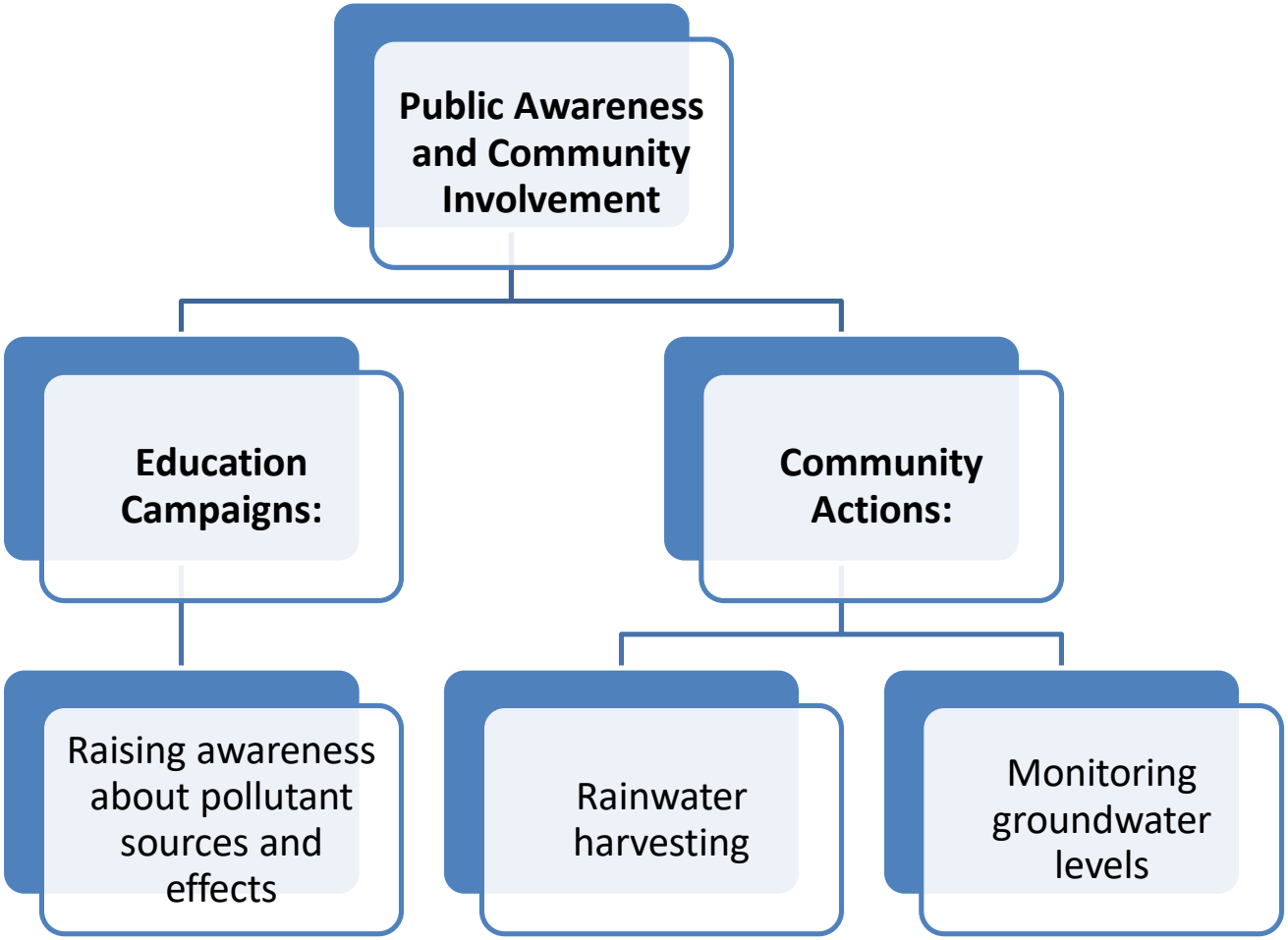
**I Q 3:**

How does groundwater pollution impact agricultural productivity and food safety?

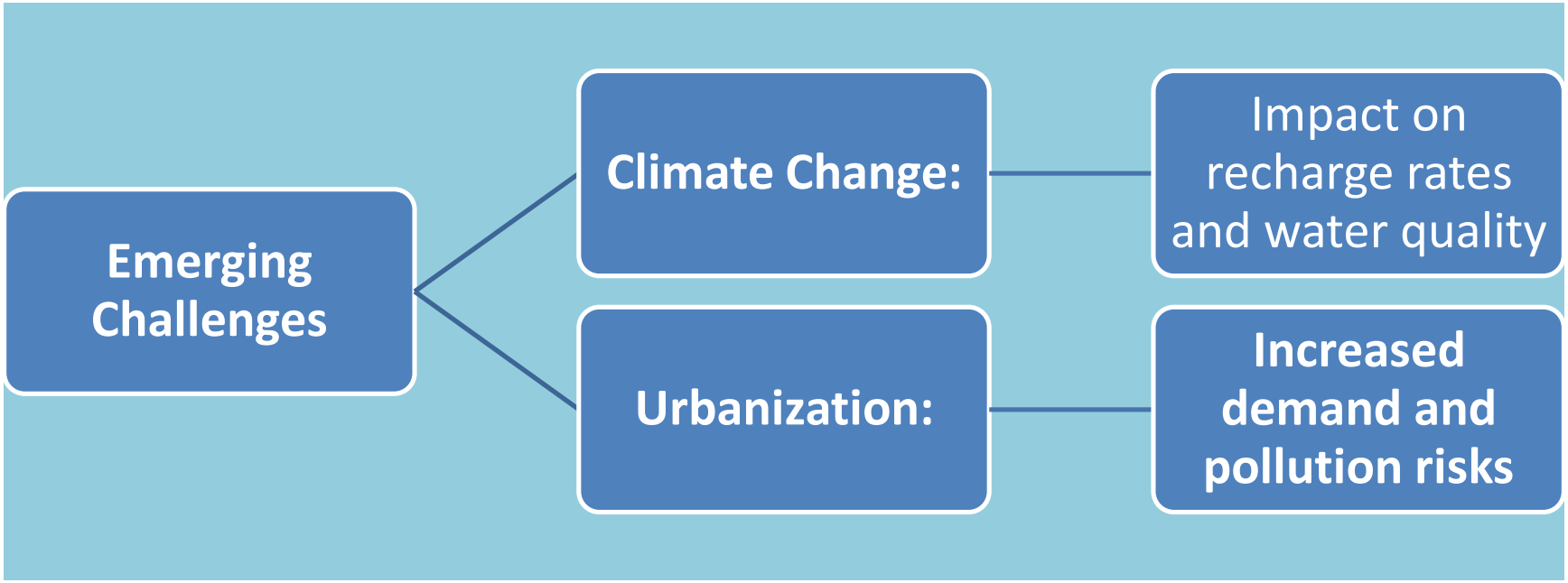
# GWP-MANAGEMENT



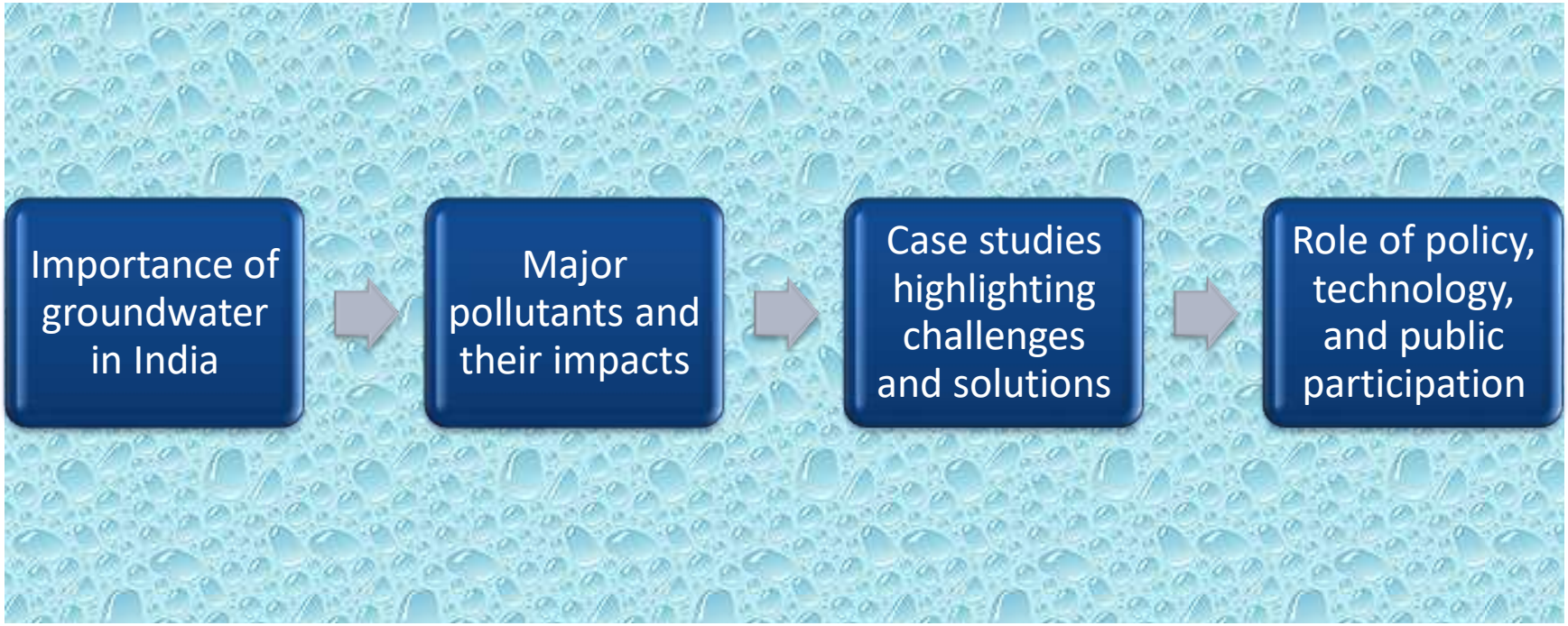
# GWP_MANAGEMENT



# GWP_MGMT.:EMERGING CHALLENGES



# SUMMARY & KEY TAKEAWAYS



# Final Interactive Question

**I Q 4:**

Suggest one innovative solution to mitigate groundwater pollution present in your region(local context).

# References


- **Books and Articles:**
  - "Groundwater Hydrology" by David Keith Todd
  - "Environmental Pollution and Control" by C. S. Rao
- **Reports:**
  - Central Ground Water Board Reports
  - WHO Guidelines for Drinking-Water Quality
- **Websites:**
  - Ministry of Jal Shakti
  - National Institute of Hydrology

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