Groundwater Pollution in India.

Mains: GS III – *Conservation, Environmental Pollution and Degradation*

Why in News?

Recently, the 2024 Annual Groundwater Quality Report by the Central Ground Water Board (CGWB) reveals more than 20% of samples from 440 districts were contaminated with nitrates and identified groundwater death zones.

What is groundwater pollution?

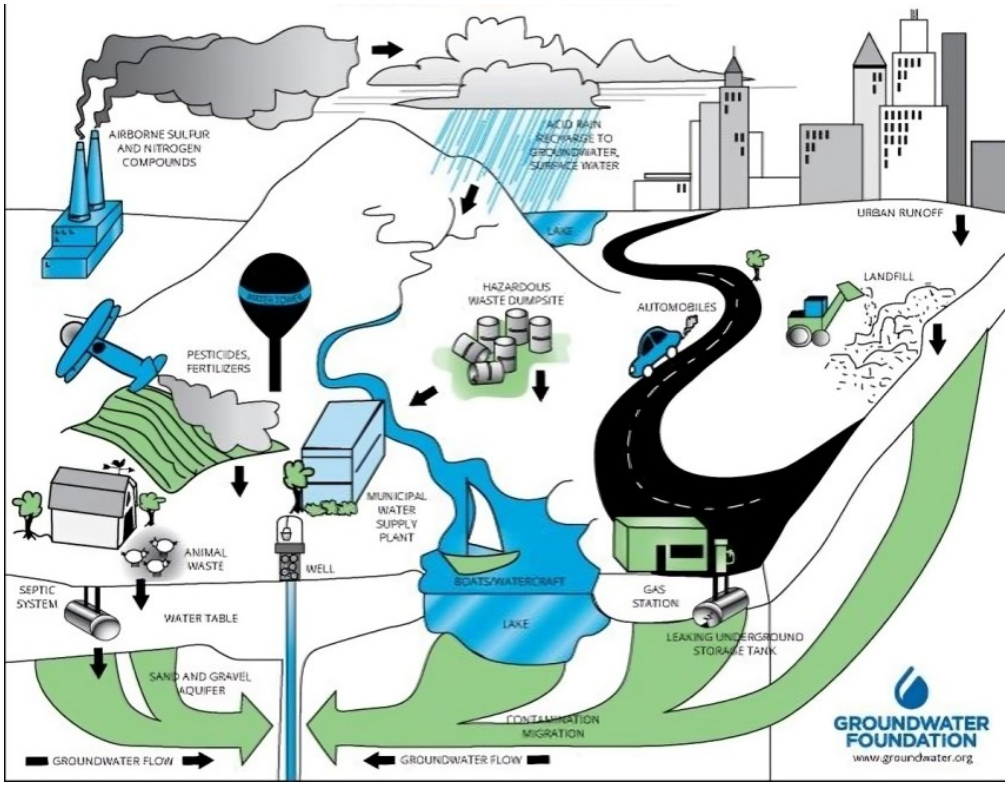
- **Groundwater** – It exists beneath the Earth's surface, filling the spaces within soil and rocks in a saturated zone.
- It's a vital source of freshwater, often accessed through wells and springs.
- **Groundwater pollution** – It is also known as groundwater contamination, occurs when harmful substances contaminate underground water sources.
- **Causes** – This can happen due to natural occurrences or human activities.
- Pollutants can enter groundwater through various pathways, including *surface contamination, industrial waste, and agricultural runoff.*
- It is largely due to the *overuse of chemical fertilisers and leaching from septic systems.*
- **Groundwater death zones** – These are areas in groundwater systems where *dissolved oxygen levels are significantly depleted, making it difficult or impossible for life to survive*.
    - ***For example**, In Budhpur, Baghpat (Uttar Pradesh), 13 people died within a fortnight this year, from kidney failure and related complications.*
    - It is allegedly linked to toxic discharges from nearby paper and sugar mills contaminating local borewells.

What are the major contaminants and associated diseases?

- **Fluoride** – The 2024 CGWB report found that 9.04% of 15,259 samples groundwater samples exceeded the *WHO's 1.5 mg/L fluoride limit.*
- Around 66 million people suffer from *skeletal fluorosis* caused by fluoride contamination.

***Skeletal fluorosis** is a debilitating condition that causes joint pain, bone deformities, and stunted growth, particularly in children.*

    - In Rajasthan, over 11,000 villages have reported cases.



    - In Jhabua (Madhya Pradesh), fluoride levels exceed 5 mg/L, with 40% of tribal children affected.
- **Arsenic** – Its exposure is concentrated in the Gangetic belt—including *West Bengal, Bihar, Uttar Pradesh, Jharkhand, and Assam.*
- It leads to *skin lesions, gangrene, respiratory problems*, and various internal cancers.

> ***Gangrene** is a serious medical condition where body tissues die due to a lack of blood supply.*

- Elevated blood arsenic levels make 1 in 100 individuals highly vulnerable to cancer, *including cancers of the skin, kidney, liver, bladder, and lungs, as well as other secondary cancer types*.
    - In Ballia (U.P.), arsenic concentrations reached 200 µg/L—20 times the WHO limit— linked to over 10,000 cases of cancer and other diseases.
- In Bihar's Bhojpur and Buxar districts, similar impacts have been observed.
- While arsenic is geogenic, its mobilisation is worsened by groundwater over-extraction, mining, and irrigation.

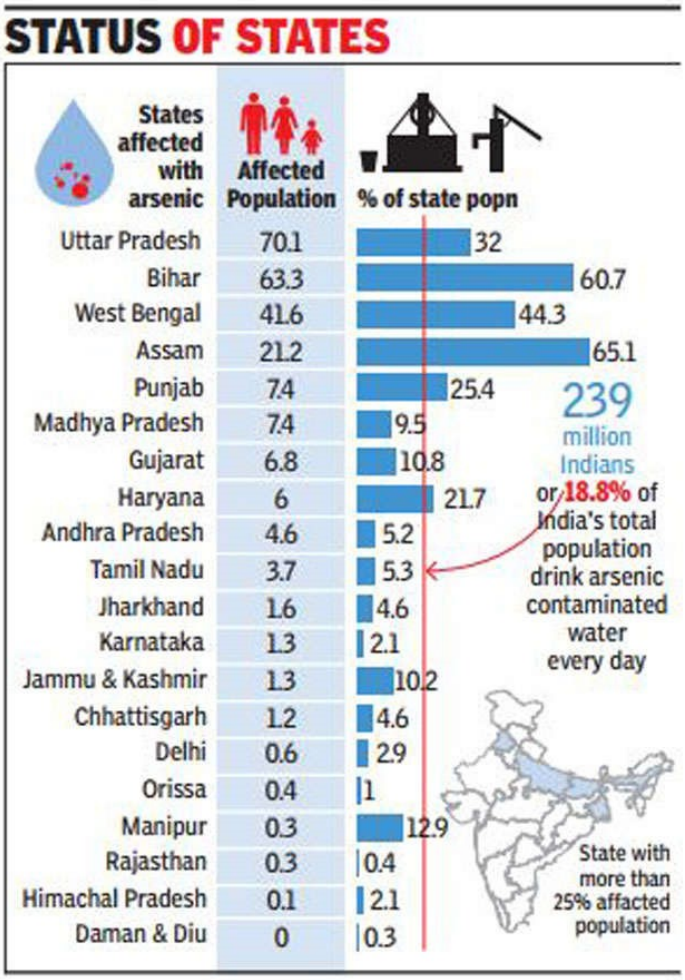
> ***Geogenic** refers to something originating in or caused by geological processes, especially those occurring naturally within the Earth.*

Nitrate contamination – It is rampant in northern India and poses a severe threat to infants.

- When baby formula is mixed with nitrate-laced water, it can cause blue baby syndrome.

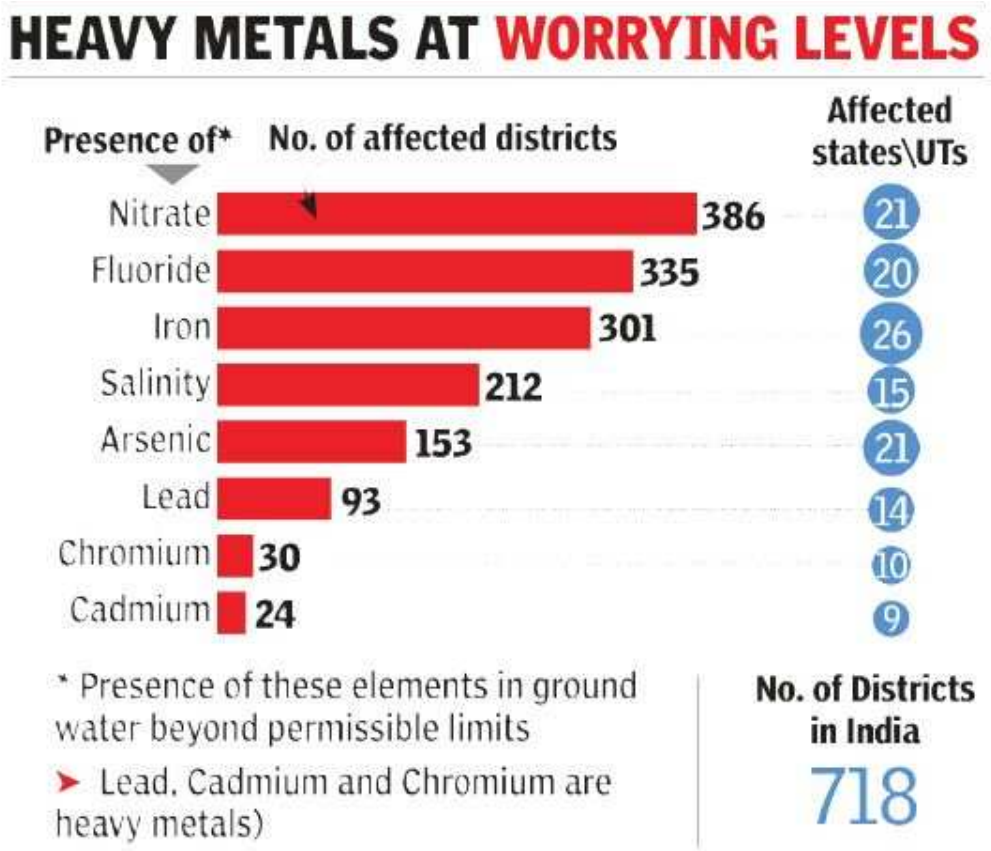
***Blue baby syndrome**, also known as cyanosis or infant methemoglobinemia, is a condition where a new born baby's skin appears bluish due to low oxygen levels in the blood.*

- The 2023 National Health Profile recorded a 28% rise in hospital admissions from acute nitrate toxicity over five years, particularly in Punjab, Haryana, and Karnataka.



- Today, 56% of Indian districts exceed safe nitrate levels.
- **Uranium contamination** – It is increasingly detected due to *excessive groundwater extraction and fertiliser use*.
- A study by the Central University of Punjab in the Malwa region found increased uranium levels in groundwater.
- It is *exceeding the WHO threshold of 30 µg/L*, posing serious risks of *chronic organ damage and nephrotoxicity.*
- The results showed that 66% of samples posed health risks for children and 44% for adults.

***Nephrotoxicity** refers to kidney damage caused by exposure to toxic substances, including certain medications and chemicals.*



- **Heavy metals** — *Lead, cadmium, chromium, mercury* enter groundwater from unchecked industrial discharges.
- They cause *developmental delays, anaemia, immune system issues, and neurological damage.*
    - The ICMR-National Institute for Research in Environmental Health (NIREH) found dangerously high blood lead levels among children near industrial clusters in Kanpur (U.P.) and Vapi (Gujarat).
- Contamination from *leaking septic systems and sewage infiltration* has triggered repeated outbreaks of cholera, dysentery, and hepatitis A and E.
    - In Paikarapur, Bhubaneswar, over 500 residents were recently affected by a *waterborne disease outbreak tied to sewage-contaminated groundwater*.

Why the crisis persists?

- **Ineffective policies** – The Water (Prevention and Control of Pollution) Act, 1974, *scarcely addresses groundwater pollution*.
- The CGWB lacks statutory authority, and State Pollution Control Boards (SPCBs) are under-resourced and technically constrained.
- **Inadequate industrial regulation** – Industries operate with *minimal oversight, and sanitation infrastructure*, especially in rural and peri-urban India, remains deficient.
- **Institutional fragmentation** – Agencies such as *CGWB, CPCB, SPCBs, and the Ministry of Jal Shakti operate in silos*, often duplicating efforts and lacking coordination for integrated, science-based interventions.

CPCP *– Central pollution control board.*

SPCB *– State pollution control board.*

- **Weak legal enforcement** – While the Water Act exists, its enforcement on groundwater discharge is inadequate.
- *Regulatory loopholes* and *negligent compliance* encourage polluters.
- **Lack of real-rime data** – Monitoring is infrequent and poorly disseminated.
- Without early warning systems or integration with public health surveillance, *contamination often goes undetected until after serious health outcomes emerge.*
- **Over extraction** – Excessive pumping lowers water tables and concentrates pollutants, *making aquifers more vulnerable to geogenic toxins and salinity intrusion*.

What are the acceptable limits of contaminants?

Indian Bureau of Standards guidelines for contaminants levels in drinking water

Analyte	Unit	Limits		Health effects
		Acceptable	Permissible*	
Chloride (Cl)	mg/L	250	1000	Eye/nose irritation; stomach discomfort
Fluoride (F)	mg/L	1	1.5	Bone disease; children may get mottled teeth
Iron (Fe)	mg/L	1	None	Anesthetic effect; promotes iron bacteria
Nitrate (NO_3)	mg/L	45	None	Blue baby syndrome
Arsenic (As)	µg/L	10	No relaxation	Skin damage; increased risk of cancer
Uranium (U)	µg/L	30	No relaxation	Increased risk of cancer; kidney toxicity
Electrical Conductivity (EC)	µS/cm at 25°C	750	3000	Anesthetic effect; cardiovascular complications

What changes to be done?

- **Unified framework –** *A National Groundwater Pollution Control Framework* can clearly define responsibilities across agencies and empower the CGWB with regulatory authority.
- **Modernized monitoring infrastructure** – Use of *real-time sensors, remote sensing, and open-access platforms.*
- Integrating water quality data with health surveillance systems like *Health Management Information System (HMIS) for early detection.*
- **Targeted remediation and health interventions** – Installing *community-level arsenic and fluoride removal systems*, especially in high-risk regions.
- *Expand piped water access and awareness campaigns* in water stressed areas.
- **Urban and industrial waste reforms** – *Mandating Zero Liquid Discharge (ZLD), regulate landfills strictly*, and enforce penalties for illegal discharges.
- **Agrochemical reform** *– Promoting organic farming, regulate fertiliser and pesticide use*, and encourage balanced nutrient management.
- **Citizen-Centric groundwater governance** – *Strengthening the role of panchayats, water user groups, and school programmes* in water testing, monitoring, and advocacy.

What lies ahead?

- *Effective interventions* could be taken including defluoridation, improved nutrition, and provision of safe drinking water.
- India's groundwater crisis calls for a *bold, coordinated, and multi-dimensional strategy* that integrates regulation, technology, health, and public participation.

Reference

The Hindu| Groundwater Pollution in India