Global Decline in Freshwater Reserves

For Prelims: National Aeronautics and Space Administration, World Meteorological Organization, El Niño, Wetlands, Waterborne diseases, Artificial Intelligence, World Water Day , Atal Bhujal Yojana, Jal Shakti Abhiyan, Pradhan Mantri Krishi Sinchai Yojana, Desalination

For Mains: Climate Change and Water Scarcity, India's Water Crisis, Freshwater Ecosystems and Biodiversity, Impact of Water Stress on Global Food Security.

Source: BS

Why in News?

Recent data from **National Aeronautics and Space Administration (NASA)- German GRACE (Gravity Recovery and Climate Experiment)** satellites reveal a significant **decline in Earth's total freshwater levels** since 2014.

Note:

The GRACE is a joint mission by NASA and Germany, its goal is to measure Earth's **gravity field,** using two identical satellites that orbit Earth about 220 km apart. These satellites track **gravitational changes** due to various geophysical processes like **ocean currents**, **groundwater storage, ice sheet dynamics,** and solid Earth movements such as **earthquakes.**

What is the Status of Decline in Freshwater Reserves?

- **Global:** Between 2015 and 2023, freshwater stored on land, including lakes, rivers, and groundwater, **fell by 1,200 cubic kilometres**.
    - Half of the world's countries have **degraded freshwater systems,** with over **400 river basins** experiencing declining water flows, including iconic watersheds like the **Congo Basin.**
    - The **World Meteorological Organization** reports that **2023 marked the driest year in over three decades** for rivers globally, exacerbating the freshwater crisis.
- **India:** Home to **18% of the global population**, India has just **4% of the world's freshwater resources** and occupies only **2.4% of Earth's surface**. Nearly half of its **rivers are polluted**, and over **150 primary reservoirs are at just 38% of their storage capacity,** exacerbating the country's severe water crisis.
    - The 2018 Composite Water Management Index by **NITI Aayog (National Institution for Transforming India)** indicates that a significant portion of India's population faces high to extreme water stress, with approximately **600 million Indians experiencing water scarcity**..
    - **Groundwater depletion** is a major concern, especially in **agrarian states** like Punjab

and Haryana, where **overexploitation for irrigation and domestic use** has caused water tables to drop significantly.
    - Areas in central and western India, including Rajasthan, Maharashtra, and Gujarat, are frequently hit by **droughts,** further depleting already strained water reserves.

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Water on the Earth's surface

Reservoir	*Volume (Million Cubic km)*	*Percentage of the Total*
Oceans	1,370	97.25
Ice Caps and Glaciers	29	2.05
Groundwater	9.5	0.68
Lakes	0.125	0.01
Soil Moisture	0.065	0.005
Atmosphere	0.013	0.001
Streams and Rivers	0.0017	0.0001
Biosphere	0.0006	0.00004

Water covers about 71% of the earth's surface. 97% of the earth's water is found in the oceans (too salty for drinking, growing crops, and most industrial uses except cooling). 3% of the earth's water is fresh.

What are the Causes for the Decline in Freshwater Levels?

- **Role of El Niño Events:** The **2014-2016 El Niño event,** one of the most significant since 1950, disrupted rainfall patterns globally.
    - **Warmer Pacific Ocean temperatures** shifted atmospheric jet streams, intensifying drought conditions worldwide.
- **Effects of Climate Change:** Climate change has caused **irregular and uneven rainfall patterns,** resulting in **prolonged dry spells,** droughts, and erratic monsoon seasons.
    - Intense precipitation events caused **surface runoff** instead of **groundwater replenishment.** Prolonged dry periods compact soil, reducing its **water absorption capacity.**
    - Climate change **amplifies evaporation** and increases **atmospheric water-holding capacity,** worsening drought conditions.
        - Droughts have significantly affected regions such as Brazil, Australasia, North America, Europe, and Africa.
- **Over-extraction of Groundwater:** Over-reliance on groundwater for irrigation, particularly in areas with inadequate rainfall, has led to its depletion, **as extraction often exceeds natural replenishment.**

    - Additionally, industries and urban centres that depend on groundwater further exacerbate the depletion.
- **Loss of Ecosystems:** Destruction of natural ecosystems, such as **wetlands** and forests, **reduces the ability of the land to retain water.**
    - The loss of forest cover leads to **soil erosion,** which reduces the ability of the land to absorb rainwater, further decreasing the replenishment of water bodies.
- **Agricultural Practices and Pollution:** Agriculture consumes **70% of the world's accessible freshwater,** but inefficient irrigation methods and the cultivation of water-intensive crops lead to **significant water waste.**
    - **Industrial waste and untreated wastewater** also contribute to the pollution of water bodies, with long-term impacts on water quality and availability.

What are the Implications of Freshwater Decline?

- **Impact on Biodiversity:** The **World Wildlife Fund (WWF)** reports an **84% decline in freshwater species since 1970,** driven by habitat loss, pollution, and migration barriers like dams.
    - These factors destabilise ecosystems, threatening biodiversity and their essential services.
- **Impact on Human Communities:** The **2024 UN report on water stress** highlights that reduced water availability strains farmers and communities, leading to **famine, conflicts, poverty, and a higher risk of waterborne diseases.**
    - Water scarcity also hampers industries, affecting economic development and job creation. By 2025, **1.8 billion people may experience "absolute water scarcity,"** a crisis worsened by **rapid population growth**, inefficient water use, and poor governance.
    - **Urban areas are not immune to water stress.** Many cities in India including Chennai, and Bengaluru, have faced severe water shortages in recent years, disrupting daily life and leading to **increased costs for water transportation and management.**
- **Ecosystem Services:** Freshwater ecosystems **support nutrient cycling,** boosting agricultural productivity. Wetlands also help **mitigate flooding and enhance climate resilience.**
    - Their degradation threatens these vital services, reducing both environmental and community stability.
- **Geopolitical Conflicts:** Over **60% of global freshwater is shared by two or more countries.** The decline in these resources, whether due to droughts, over-extraction, or pollution, can lead to **disputes over water rights and usage.**
    - Water scarcity can worsen political tensions, as seen in the **Nile River dispute between Egypt, Sudan, and Ethiopia.**
        - Ethiopia's construction of the Grand Ethiopian Renaissance Dam has raised concerns in Egypt over its water supply, potentially escalating into broader conflicts.
    - Similarly, in **India, disputes over river water sharing**, such as those involving the **Indus Water Treaty (IWT) with Pakistan** and the inter-state conflicts over the **Cauvery** and **Krishna rivers,** have led to ongoing conflicts between states.
- **Science and Technology:** The decline in freshwater resources impacts **Artificial Intelligence (AI)** systems, which **rely on water for cooling data centres.**
    - By 2027, AI is estimated to consume **4.2 to 6.6 billion cubic metres of water annually,** increasing pressure on already limited water supplies.

What are the Initiatives Related to Water Conservation?

- **Global:**
    - **World Water Day**
    - **Water Credit**
    - **Water Action Agenda:** Launched at the **United Nations 2023 Water Conference,** includes over 830 voluntary commitments from the global water community to fast-track progress towards **Sustainable Development Goal 6(ensuring universal access to water and sanitation by 2030).**
- **India:**
    - **National Water Policy (2012)**
    - **Atal Bhujal Yojana**

- **Jal Shakti Abhiyan**
- **Pradhan Mantri Krishi Sinchai Yojana**
- **Mission Amrit Sarovar**
- **National Aquifer Mapping (NAQUIM)**
- **Bhu-Neer Portal:** It aims to improve groundwater regulation across India. It provides a centralised platform for accessing information on groundwater laws, regulations, and sustainable practices.

Way Forward

- **Policy Reorientation:** Countries need to treat water as a common good, reorienting public policies on **water pricing, subsidies, and procurement** to encourage conservation, especially among heavy water users.
  - Ensuring **vulnerable communities have access to clean water** and sanitation is critical to addressing water-related inequalities.
- **Rainwater Harvesting:** Rainwater harvesting systems, both large and small, offer a practical solution to **supplement freshwater supplies**, particularly in water-scarce regions.
- **Optimise Desalination:** **Desalination,** though **energy-intensive and costly,** provides a solution to **water scarcity in coastal areas.**
  - Energy-efficient technologies like **reverse osmosis** should be optimized to reduce costs and environmental impacts. Additionally, **nanotechnology-based devices** can be developed for efficient water purification with less energy-intensive processes.
- **Infrastructure Development:** Optimising infrastructure like dams, stepwells, reservoirs, and aqueducts can improve water storage and distribution, but careful planning is needed to avoid environmental and social issues.
  - New dam projects should **prioritise ecological restoration, sediment management,** and equitable water distribution.
- **Bottled Water Alternatives:** Sustainable alternatives like **water filters and refillable containers** should be promoted to reduce bottled water demand and encourage eco-friendly consumption.

Drishti Mains Question:

Examine how climate change contributes to freshwater scarcity and suggest measures society should adopt to mitigate its impact on water resources.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q.1 Which one of the following ancient towns is well known for its elaborate system of water harvesting and management by building a series of dams and channelizing water into connected reservoirs? (2021)

(a) Dholavira
(b) Kalibangan
(c) Rakhigarhi
(d) Ropar

Ans: (a)

Q.2 With reference to 'Water Credit', consider the following statements: (2021)

1. It puts microfinance tools to work in the water and sanitation sector.
2. It is a global initiative launched under the aegis of the World Health Organization and the World

Bank.
3. It aims to enable the poor people to meet their water needs without depending on subsidies.

Which of the statements given above are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans: (c)

Mains

Q.1 What are the salient features of the Jal Shakti Abhiyan launched by the Government of India for water conservation and water security? **(2020)**

Q.2 Suggest measures to improve water storage and irrigation system to make its judicious use under the depleting scenario. **(2020)**