Rapid Expansion of Himalayan Glacial Lakes

For Prelims: National Green Tribunal (NGT), glacial lake outburst floods (GLOFs), EWS, Hindu Kush Himalayas, Synthetic-Aperture Radar imagery,

For Mains: National Green Tribunal (NGT), glacial lake outburst floods (GLOFs), NDMA (National Disaster Management Authority), EWS, National Disaster Response Force (NDRF), ITBP

Source: TH

Why in News?

The **National Green Tribunal (NGT)**, taking suo motu cognisance of a news report, has recently issued a notice to the central government regarding the alarming increase in Himalayan **glacial lakes**, which have expanded by approximately 10.81% over the past 13 years due to rising temperatures.

What are Glacial Lakes?

- **About:** A glacial lake is a water body formed from a glacier, usually located at its base, but it can also develop on, within, or beneath the glacier.
- **Formation:** Glacial lakes form when glaciers erode the land, creating depressions that fill with meltwater as the glacier retreats.
    - Natural dams, made of ice or moraines, can also form glacial lakes, but these dams can be unstable and prone to bursting, leading to potential flooding.
- **Glacial Lake Expansion:** The NGT highlighted the report's finding that the surface area of glacial lakes in India has **increased by 33.7% from 2011 to 2024**, with **67 lakes identified as high-risk for GLOFs (glacial lake outburst floods)**.
    - This poses a significant threat to infrastructure and human lives in regions like **Ladakh, Himachal Pradesh, Uttarakhand, Sikkim**, and **Arunachal Pradesh**.
- **Causes of Glacial Lake Expansion:**
    - **Global warming** is raising temperatures in the Himalayas, which accelerates **glacier melting.**
    - **Retreating glaciers** contribute water to lakes and expose new land surfaces, facilitating the formation of new glacial lakes.
    - **Thawing permafrost** creates water-collecting depressions, expanding glacial lakes as it loses its natural drainage barrier.

What is a GLOF?

- A **glacial lake outburst flood (GLOF)** occurs when a glacial lake's dam fails, releasing large volumes of water, often due to rapid glacier melting or heavy precipitation.
- These floods can be triggered by glacier volume changes, lake water level fluctuations, and earthquakes.
    - According to the **National Disaster Management Authority**, climate change-induced

glacial retreat in the **Hindu Kush Himalayas** has created many new glacial lakes, leading to GLOFs.

- **Cases of GLOF in India**
  - In June 2013, Uttrakhand had received an unusual amount of rainfall leading to the melting of the Chorabari glacier and the eruption of the Mandakini river.
  - In August 2014, a glacial lake outburst flood hit the village of Gya in Ladakh.
  - In October 2023, the South Lhonak Lake, a glacial lake located at an altitude of 17,000 feet in the state's northwest, experienced a rupture as a result of continuous rainfall.

What are the Concerns of the Rapid Expansion of Glacial Lakes in the Himalayas?

- **Impact on Downstream Communities:** Communities downstream face **displacement, loss of life**, and **property damage**, with agriculture severely affected by floods.
  - Many high-risk lakes lack monitoring and early warning systems, leaving communities unprepared.
  - The **NGT highlighted** this issue for **67 lakes in Ladakh**, **Himachal Pradesh**, and **Uttarakhand**, pointing to weak enforcement of disaster preparedness laws.
- **Feedback Loop:** Rising global temperatures **accelerate glacial retreat**, expanding glacial lakes and increasing risks.
  - The **IPCC's 6th Assessment Report** highlights the unprecedented rate of Himalayan glacier retreat, worsening climate-induced hazards.
- **Infrastructure Vulnerability:** Critical infrastructure like **roads, bridges**, and **hydropower plants** are vulnerable to GLOF-induced floods, causing significant damage, economic losses, and delays in development.
- **Ecosystem and Biodiversity Disruption:** Floods from glacial lakes alter sedimentation and water flows, impacting aquatic biodiversity and disrupting habitats, as seen in the **2023 Sikkim floods** affecting downstream river ecosystems.
- **Triggering Secondary Disasters:** The destabilization of slopes due to melting ice and increased water pressure can trigger landslides. Apart from GLOFs and landslides, the rapid expansion of glacial lakes can also lead to:
  - **Debris Flows:** As glaciers retreat, they expose loose material that can be mobilized during heavy rainfall or seismic activity, causing debris flows that threaten settlements.
  - **Erosion:** Increased water levels in glacial lakes can accelerate bank erosion, leading to habitat destruction and loss of arable land.
- **Climate Change Impact:** The increase in glacial lakes is directly linked to climate change, particularly **rising temperatures** leading to accelerated glacier melting.
  - The Himalayan glaciers, crucial for rivers like the **Yangtze and Ganges**, support over a billion people, **highlighting significant environmental changes** affecting water resources and ecosystems.

What Risk Mitigation Strategies can be Adopted to Address Glacial Lake Expansion?

- **Enhanced Monitoring Systems:** Establishing comprehensive monitoring systems for glacial lakes is crucial. This includes **satellite surveillance** and **ground-based assessments** to track changes in lake volume and surface area, enabling timely responses to emerging threats.
  - Promoting use of **Synthetic-Aperture Radar imagery** (a form of radar that is used to create two-dimensional images) to automatically detect changes in water bodies, including new lake formations, during the monsoon months.
- **Early Warning Mechanisms:** Developing **early warning systems for GLOFs** can significantly reduce disaster risks. These systems should integrate **meteorological data with hydrological models** to predict potential outburst events and communicate risks effectively to local communities.
- **Transboundary Water Management:** Given that many Himalayan rivers cross national borders,

international cooperation is essential for effective management of water resources affected by glacial changes.
    - **Collaborative frameworks** can help share data, best practices, and resources among neighboring countries.
- **Funding and Resource Mobilisation:** Engaging with international organizations for funding can support infrastructure development aimed at mitigating disaster risks associated with glacial lake expansion.
    - This includes investments in resilient infrastructure and sustainable practices that align with global climate goals. One such example is **Coalition for Disaster Resilient Infrastructure (CDRI).**
- **Training Local Manpower:** Apart from pressing specialised forces such as **National Disaster Response Force (NDRF)**, the NDMA emphasises the need for trained local manpower.

Drishti Mains Question

Discuss the implications of rapid expansion of Himalayan glacial lakes on natural disaster risks in India. What measures should be taken to mitigate these risks while ensuring compliance with environmental regulations?

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. When you travel in Himalayas, you will see the following: (2012)

1. Deep gorges
2. U-turn river courses
3. Parallel mountain ranges
4. Steep gradients causing land sliding

Which of the above can be said to be the evidence for Himalayas being young fold mountains?

(a) 1 and 2 only

(b) 1, 2 and 4 only

(c) 3 and 4 only

(d) 1, 2, 3 and 4

Ans: (d)

Mains

Q. Dam failures are always catastrophic, especially on the downstream side, resulting in a colossal loss of life and property. Analyze the various causes of dam failures. Give two examples of large dam failures. (2023)

Q. Bring out the causes for more frequent landslides in the Himalayas than in Western Ghats. (2013)