Gangotri Glacier Study Reveals Earlier Snowmelt Trends

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Gangotri Glacier Snowmelt Latest News

- A recent study has reconstructed the long-term discharge flow of the Gangotri Glacier System (GGS), the source of the upper Ganga basin feeding the Bhagirathi River in the central Himalayas.
- With climate change driving faster glacier melt globally, glaciologists are closely examining how changes in Gangotri's discharge patterns could affect water availability, river flow, and long-term sustainability of the region's ecosystems and livelihoods.

Composition of the Gangotri Glacier System (GGS)

- The GGS comprises four glaciers — **Meru** (7 km²), **Raktavaran** (30 km²), **Chaturangi** (75 km²), and the largest, **Gangotri** (140 km²).
- Together, the system spans **549 km²**, with about **48% glacierised area**, across elevations from **3,767 m to 7,072 m**.
- The GGS receives precipitation from **western disturbances in winter (October–April)** and the **Indian summer monsoon in summer (May–September)**.

- Seasonal rainfall (May–October) averages **260 mm**, with a mean temperature of **9.4°C** recorded between 2000–2003.

New Study on Gangotri Glacier System (GGS)

- The **Hindu Kush Himalaya (HKH)** holds vital snow and ice reserves that feed major rivers like the Indus, Ganga, and Brahmaputra, sustaining millions of lives.
- In recent decades, climatic changes have **altered the cryosphere and hydrological cycles**, leading to faster glacial retreat and shifting seasonal discharge patterns.
- While most modelling studies focus on large river catchments, it is difficult to separate the impacts of snowmelt and precipitation there.
- Smaller systems like the GGS allow for more precise assessments, making it a preferred choice for hydrologists and climate scientists.
- However, long-term discharge analysis and understanding climatic drivers have remained limited.
- To address this, a new study titled *"**Hydrological Contributions of Snow and Glacier Melt from the Gangotri Glacier System and Their Climatic Controls Since 1980**"* was conducted.
- The study, published in the *Journal of the Indian Society of Remote Sensing*, provides deeper insights into GGS's meltwater contributions and climate influences.

Key Findings of the Study

- The study combined the **Spatial Processes in Hydrology (SPHY) glacio-hydrological model** with the **Indian Monsoon Data Assimilation and Analysis (IMDAA) dataset (1980–2020)** to reconstruct GGS discharge trends.
    - SPHY model is **a hydrological modelling tool** suitable for a wide range of water resource management applications.
- It found that maximum discharge occurs in **summer**, peaking in **July (129 m^3/s)**.
- The **mean annual discharge** was estimated at **28±1.9 m^3/s**, primarily from **snow melt (64%)**, followed by **glacier melt (21%)**, **rainfall-runoff (11%)**, and **base flow (4%)**.
- A decadal analysis revealed a **shift in discharge peaks from August to July after 1990**, linked to **reduced winter precipitation** and **enhanced early summer melting**.
- The highest volumetric increase (7.8%) occurred between **1991–2000 and 2001–2010**.
- While mean annual temperatures rose, there was **no significant trend in precipitation or glacier melt**.
- Snow melt declined due to shrinking snow cover, whereas **rainfall-runoff and base flow increased**.
- The analysis highlighted that **summer precipitation** was the main driver of annual discharge, followed by **winter temperature**.

Implications of the Study on GGS

- The findings highlight **warming-induced hydrological changes** in the Gangotri Glacier System (GGS), with increasing rainfall run-off and base flow.
- This aligns with the **25% excess rainfall** observed in North India's summer monsoon (June–August), which has caused frequent floods in Uttarakhand, Jammu, and Himachal Pradesh.

- While such events are often hastily termed “cloudbursts” without scientific evidence, climate change does raise the risk of extreme rainfall.
- The study stresses the **need for sustained field monitoring and advanced modelling** to improve **water resource management** in glacier-fed river basins, ensuring resilience against future hydrological and climatic shifts.

Source: TH | DTE
