CLIMATE-RESILIENT DAMS AND
HYDROPOWER INFRASTRUCTURE
INTEGRATING
ENVIRONMENTAL SUSTAINABILITY
IN PLANNING AND DEVELOPMENT

Climate Change and Dam Safety in North East India

Ranendra Sarma, India

The Northeast Region

- The North Eastern Region comprises eight states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura.
- Brahmaputra Basin: 580,000 km^2 spanning China, Bhutan, India, Bangladesh.
- Large Dams: Approximately 25, oldest being Umtru Dam (1957).
- Many structures are now 40–60 years old, designed using historical data from a more predictable climate era.

Key Vulnerabilities

- Geo-ecological fragility and monsoon dependence.
- Massive deforestation and socio-economic instability.
- Frequent floods, landslides, earthquakes.
- Ageing infrastructure facing new climate realities.

Climate Change Impacts on Hydrology

- Less rain overall, but more intense when it occurs. This strains river capacities and overwhelms infrastructure
- Events exceeding 150mm/day rising by two per decade.
- 1,500+ glacial lakes in Arunachal Pradesh
- 29 classified as high-risk by NDMA
- Accelerating glacier melt poses serious GLOF risks
- Sharp descent from 3,000–5,000m to 155m at Pasighat generates high-velocity floodwaters.

The 2023 South Lhonak GLOF Disaster

- A massive moraine collapse into the glacial lake triggered catastrophic flooding down the Teesta Valley, Sikkim in Oct 2023.
- A 20-metre surge breached the lake's natural dam, sending floodwaters racing downstream.
- The flood overwhelmed and destroyed Teesta III project at Chungthang.
- This event serves as a stark reminder that climate change is rapidly transforming glacial hazards across the Himalayas.

Seismic Risks

- The entire Northeast region lies in Seismic Zone VI.
- Dams in this zone are continuously exposed to earthquake hazards throughout their service life.
- Seismic events can trigger cascading risks such as floods, landslides, and slope failures in reservoir areas.
- Steep, hilly terrain further amplifies vulnerability by complicating slope stability, access, and emergency response.

Topographical Risks

- Some Rivers in Northeast India often drain small, compact catchments (300–500 km²) yet receive exceptionally high rainfall, especially in Meghalaya, one of the wettest regions in the world.
- These conditions lead to rapid runoff concentration, with river levels rising sharply within 1–2 hours, leaving dam operators very limited response time.
- The combination of small basin size and extreme precipitation significantly increases the risk of reservoir filling and dam overtopping.

Myntdu Leshka HEP Stage-I (3 × 42 MW),

- Catchment area: ~350 km².
- Downstream Riverbanks support settlements, agriculture, and local livelihoods, heightening downstream risk.
- As a run-of-river project with limited storage, peak floods can reach ~10,440 m³/s.
- During intense rainfall, the reservoir can fill within minutes, making 24×7 real-time monitoring essential.

Transboundary Challenges

- India-China MOU on Hydrological Data-First signed 2002, renewed 2008, 2013, 2018
- India receives limited hydrological information from China regarding upstream flows, reservoir releases, and Tibetan rainfall patterns.
- 2017: China suspended data transfers during the Doklam standoff, revealing the fragility of cooperation.
- What's Needed: Strengthened bilateral mechanisms, Shared monitoring infrastructure, Real-time data protocols for all three rivers

Communication and Connectivity Gap

- Villages Without Mobile Connectivity: Arunachal Pradesh (29%), Nagaland (20%), Mizoram(13%)
- Flood warnings often arrive late or not at all in remote areas, giving residents little time to evacuate.
- Compounding Factors: Harsh terrain limits infrastructure development, Frequent power outages disrupt communications, Network failures common during extreme weather, Landslides routinely block arterial roads

Early Warning Systems

- NHPC Initiatives: Cloud-based EWS software application, Automatic water level recorders with telemetry, Master control room for all vulnerable projects
- NEEPCO Initiatives: 50 automatic weather stations across Northeast, Multiple telemetry systems for continuous monitoring, IMD R&D project on climate change impacts
- National Hydrology Project: Nagaland RTDAS-47 hydromet sites across 11 districts including AWS, ARG, and AWLR stations
- Meghalaya Infrastructure: Telemetry calibration and training by CWPRS team, March 2025

Dam Safety Act, 2021

- State Dam Safety Organizations: Must be adequately staffed and trained
- Inspection Schedules: Strict adherence to regular inspections
- Emergency Action Plans: Functional EAPs required for every dam
- All dams must undergo comprehensive reassessment including
  - ➢ PMF/SPF revision to reflect current and anticipated hydrological realities
  - ➢ Spillway capacity expansion where necessary
  - ➢ Emergency discharge upgrades for improved flood management

Community Participation

- Integration of Indigenous Knowledge with Modern Systems.
- Indigenous Flood Adaptation: The Mising Community of Assam.
- Local populations possess invaluable knowledge of river behaviour, terrain vulnerabilities, and historical flood patterns.
- Aapda Mitra Scheme: 1600 Community volunteers trained across Northeast states by NDMA.

Research and Capacity Building

- Strengthening Technical Expertise for the Future.
- Industry-Academia Collaboration.
- Focus Areas: Hydraulic engineering, hydropower technology, and climate adaptation strategies.
- Partnerships ensure skilled professionals to address dam safety challenges.

A Climate Adaptation Imperative

- Dam safety in Northeast India requires coordinated action now
- With millions inhabiting the floodplains below these structures, the urgency is beyond question. The 2023 South Lhonak GLOF is a stark reminder of what inaction costs.
- Investing now will always be cheaper than rebuilding after disaster strikes.


Thank You