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China's Yarlung Zangbo Mega-Dam Raises Strategic, Ecological and Water-Security Concerns for India and Bangladesh

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Recent Developments:

- A devastating **glacial collapse and flash flooding near the Nepal–China border** has renewed attention to the vulnerability of the Himalayan region to cascading hazards and raised fresh concerns regarding China's mega hydropower project on the **Yarlung Zangbo**, particularly for downstream countries such as India and Bangladesh.
- China is proceeding with a mega hydropower project near the **Great Bend of the Yarlung Zangbo** in southeastern Tibet, where the river makes a dramatic turn before flowing towards India. The project is expected to have an installed capacity of around **60 GW** and annual electricity generation of about **300 billion kWh**, making it one of the largest hydropower projects in the world.
- The project has gained additional significance after geological studies raised concerns about **active faults, earthquakes and landslides** in the project region, highlighting the difficulty of constructing very large infrastructure in the seismically active Himalayas.
- The project has also revived India's long-standing concerns regarding **hydrological data sharing, downstream ecological impacts, disaster preparedness and the absence of a comprehensive water-sharing treaty** with China.

Understanding the Yarlung Zangbo–Brahmaputra System:

River Course and Geography:

- The **Yarlung Zangbo** originates in the Tibetan Plateau and flows eastward through Tibet before making a sharp turn around the **Great Bend near Namcha Barwa**, after which it enters Arunachal Pradesh as the **Siang**.
- In Assam, the Siang combines with major tributaries such as the **Dibang and Lohit** and forms the **Brahmaputra**, which subsequently enters Bangladesh before reaching the Bay of Bengal.
- The river is therefore a **transboundary river system**, making its upstream management in China directly relevant to India and Bangladesh.
- The wider Brahmaputra basin extends across **China, India, Bangladesh and Bhutan**, creating shared interests in water security, agriculture, ecology, disaster management and hydropower.

Strategic Importance of the Great Bend:

- The Great Bend contains an exceptionally steep elevation gradient and deep gorges, creating enormous **hydropower potential**.
- The project seeks to exploit this geographical advantage through a large-scale hydropower system, reportedly involving multiple cascade power stations.

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Plot A P.127, AF block, 6 th street, 11th Main Rd, Shanthi Colony, Anna Nagar, Chennai, Tamil Nadu 600040

Phone: **044 4353 9988 / 98403 94477** / Whatsapp : **09710729833**

- The exact configuration of reservoirs, diversion structures and powerhouses has received limited independent verification, making **transparency and technical information sharing** particularly important.

Scale and Engineering Significance:

Mega Hydropower Project:

- The proposed project is estimated to have around **60 GW of installed capacity** and approximately **300 billion kWh of annual electricity generation**, substantially exceeding the annual generation associated with the Three Gorges project.
- The project is being developed in extremely difficult Himalayan terrain, where steep slopes, deep gorges, seismic activity and fragile geological conditions create major engineering challenges.
- China has described the development primarily as a major **hydropower and clean-energy project**, while downstream countries are concerned about its implications for river flows, sediment movement, ecosystems and disaster risks.
- Although the project has been described in some accounts as **run-of-the-river**, reports indicate associated reservoir and diversion infrastructure, making independent assessment of its actual hydrological effects essential.

Major Concerns for India and Downstream Countries:

Ecological and Environmental Concerns:

- The **Yarlung Zangbo Grand Canyon** is an ecologically sensitive Himalayan landscape with high biodiversity and complex mountain ecosystems.
- Large-scale infrastructure can alter **river flow, sediment transport, aquatic habitats and downstream ecological processes**, although the magnitude of these effects depends on the final project design and operating regime.
- Research on existing dams in the Yarlung Zangbo basin indicates that dams can modify **flow and sediment regimes**, demonstrating the need for cumulative-impact assessment rather than project-by-project evaluation.

Seismic and Geological Risks:

- The project lies in a **highly earthquake-prone Himalayan region**, where earthquakes, landslides and slope instability can pose risks to large infrastructure.
- Recent geological reporting has highlighted an **active fault zone** in the broader project area, reinforcing concerns regarding structural safety and construction in unstable terrain.
- The 2025 Tibet earthquake also demonstrated the broader vulnerability of Himalayan infrastructure to major seismic events.
- Climate change can further interact with geological hazards through **glacial retreat, extreme precipitation, glacial lake outburst floods and landslides**, creating cascading disaster risks.

Water-Security and Flow Regulation:

- As the **upper riparian state**, China possesses considerable geographical control over the upper reaches of the Yarlung Zangbo.
- A large hydropower system could potentially influence the **timing, seasonal pattern and sediment characteristics of downstream flows**, although this does not mean that China can completely control the Brahmaputra's total water availability in India.
- The Brahmaputra receives substantial additional flows from tributaries within India, particularly in Arunachal Pradesh and Assam, which reduces the extent to which an upstream project can determine the river's entire downstream discharge.

- Nevertheless, changes in **dry-season flows, sudden releases, sediment transport and flood timing** could have implications for downstream communities and ecosystems.

Geopolitical and Strategic Concerns:

- The project is located close to a **sensitive and disputed border region**, giving the infrastructure strategic significance beyond electricity generation.
- India's dependence on upstream hydrological information creates a degree of **information asymmetry**, particularly during floods and extreme weather events.
- The absence of a comprehensive **India–China transboundary river water-sharing treaty** remains a major institutional limitation.
- Water infrastructure on the upper reaches of a transboundary river can therefore become a component of broader **hydro-politics and regional strategic competition**.

India–China Cooperation on Transboundary Rivers:

Expert Level Mechanism:

- India and China established an **Expert Level Mechanism on Trans-border Rivers in 2006** to discuss hydrological information, emergency management and other transboundary river issues.
- The mechanism provides an institutional channel for discussing river-related concerns, but it is **not equivalent to a legally binding water-sharing treaty**.

Hydrological Data Sharing:

- India and China have arrangements for sharing **flood-season hydrological information** on the Brahmaputra and Sutlej.
- The broader cooperation framework has included arrangements covering hydrological data, emergency management and transboundary river concerns.
- India has repeatedly emphasised that timely hydrological information is important for **flood forecasting, disaster preparedness and mitigation**.
- Historical Government of India statements have also stressed that downstream interests should not be adversely affected by upstream activities.

Implications for India:

Economic and Social Dimensions:

- The Brahmaputra system supports **agriculture, fisheries, inland navigation, hydropower, wetlands and livelihoods** across northeastern India.
- Changes in river behaviour can therefore affect food security, local economies, infrastructure and the livelihoods of vulnerable communities.
- The issue is particularly significant for **Arunachal Pradesh and Assam**, where communities and ecosystems are closely connected with the river system.

Strategic Preparedness:

- India needs to treat the Brahmaputra not merely as a water resource but as a **strategic, ecological and disaster-management asset**.
- Greater hydrological monitoring, satellite observation and river-flow modelling can improve India's ability to anticipate changes in downstream conditions.

- Strengthening domestic hydropower and multipurpose projects may provide strategic resilience, but such projects must themselves satisfy rigorous **environmental and seismic safety standards**.

Way Forward for India:

Strengthen Bilateral Cooperation:

- India should pursue **real-time hydrological data sharing, joint disaster-warning mechanisms, regular expert-level consultations and transparent communication** on major upstream infrastructure.
- Existing institutional mechanisms should be strengthened rather than allowing transboundary water issues to become exclusively geopolitical disputes.

Demand Greater Transparency:

- India should seek access to **technical designs, environmental impact assessments, seismic studies, dam-safety assessments and operating protocols** relevant to the project.
- Independent scientific assessment and transparent exchange of information are essential because the project is located in an environmentally and geologically sensitive region.

Strengthen Regional and Domestic Capacity:

- India should cooperate with **Bangladesh and Bhutan** on downstream hydrology, disaster preparedness, ecological monitoring and climate-resilient river management.
- India should strengthen **early-warning systems, floodplain management, satellite monitoring, hydrological stations and community-based disaster preparedness**.
- Basin-level planning should integrate **water security, biodiversity conservation, disaster risk reduction, hydropower development and climate adaptation**.

Conclusion:

- China's Yarlung Zangbo mega-dam represents the intersection of **hydropower development, Himalayan ecology, disaster vulnerability, transboundary water governance and India–China geopolitics**.
- India's response should avoid both complacency and exaggerated assumptions about China's ability to completely control the Brahmaputra.
- The immediate priority should be **transparency, reliable hydrological data, scientific assessment, disaster preparedness and institutionalised transboundary cooperation**.
- A cooperative approach based on **equitable and reasonable utilisation, environmental sustainability, prior information sharing and downstream disaster protection** offers a more durable framework for managing the Brahmaputra basin.

Value Addition for UPSC:

Mains Enrichment:

- **Keywords:** Transboundary Rivers, Water Security, Hydro-politics, Upper Riparian, Lower Riparian, Yarlung Zangbo, Siang, Brahmaputra, Great Bend, Glacial Lake Outburst Flood, Environmental Impact Assessment, Hydrological Data Sharing, Disaster Risk Reduction, One Basin Approach.
- **Core argument:** “*Transboundary river management in the Himalayas requires a shift from unilateral infrastructure development towards transparency, scientific cooperation, ecological sustainability and shared disaster-risk management.*”
- **Institutional anchor:** The **2006 Expert Level Mechanism on Trans-border Rivers** provides an existing platform for India–China dialogue, but stronger and more predictable arrangements for data sharing and downstream protection remain necessary.

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