BAJIRAO IAS ACADEMY

THE HINDU ANALYSIS

28 JULY 2025

INDIA's FIRST HYDROGEN TRAIN

Glacial Lake Outburst Floods

How is India preparing against GLOF events?

How many Glacial Lake Outburst Flood events has Nepal witnessed in recent times? What are the two most prominent types of glacial lakes found in the Indian Himalayan Region? How is the National Disaster Management Authority mitigating risks associated with GLOF events?

EXPLAINER

Safi Ahsan Rizvi

The story so far:

On July 8, Nepal experienced a catastrophic Glacial Lake Outburst Floods (GLOF) event which caused a flash flood along the Lende river, flowing from Tibet to Nepal, and washed away a China-built friendship bridge. The bridge had serviced the 10-year old inland container port at Rasuwagadhi in Rasuwa (north of Kathmandu). The catastrophe is also reported to have made four Nepalese hydro-power plants along the Bhote Koshi river unusable, obliterating 8% of the country's power supply. With rising temperatures and subsequent glacial melt, the increased risk of GLOFs is threatening life and property in the higher Himalayas.

Do trans-boundary watersheds diminish possibilities of early warning?

While Chinese authorities have as yet refrained from confirming the cause, most Nepalese scientists and officials confirmed a GLOF event in Tibet, where a supra-glacial lake had burst, diminishing its surface area to 43 hectares from 63 hectares a day before. Nepalese officials were quoted lamenting in local media that neither did the Chinese authorities provide an early warning, nor was there an established system of doing so, despite a recent increase in supra-glacial lakes on the Tibetan side.

Definite risk: The south-end of the Shako Cho lake (5,200 m) in north Sikkim. The south-end shows the weak debris that forms its moraine-dam. NDMA

Almost two-thirds of GLOF events are | casualties and billions in infrastructure | landslides is an identified gap that needs

THE GIST

As per India's National Remote Sensing Centre, the Indian Himalayan Region (IHR) is home to 11 river basins and 28,000 glacial lakes.

The National Disaster Management Authority (NDMA) has markedly accelerated its efforts to manage these increasing risks. With respect to mitigation, it has initiated a proactive shift from mere post-disaster response to risk reduction through its Committee on Disaster Risk Reduction (CoDRR).

One of the critical parameters in the exercise was to encourage Indian technology, systems and scientific expertise, one of which is the science of SAR interferometry.

CONTEXT

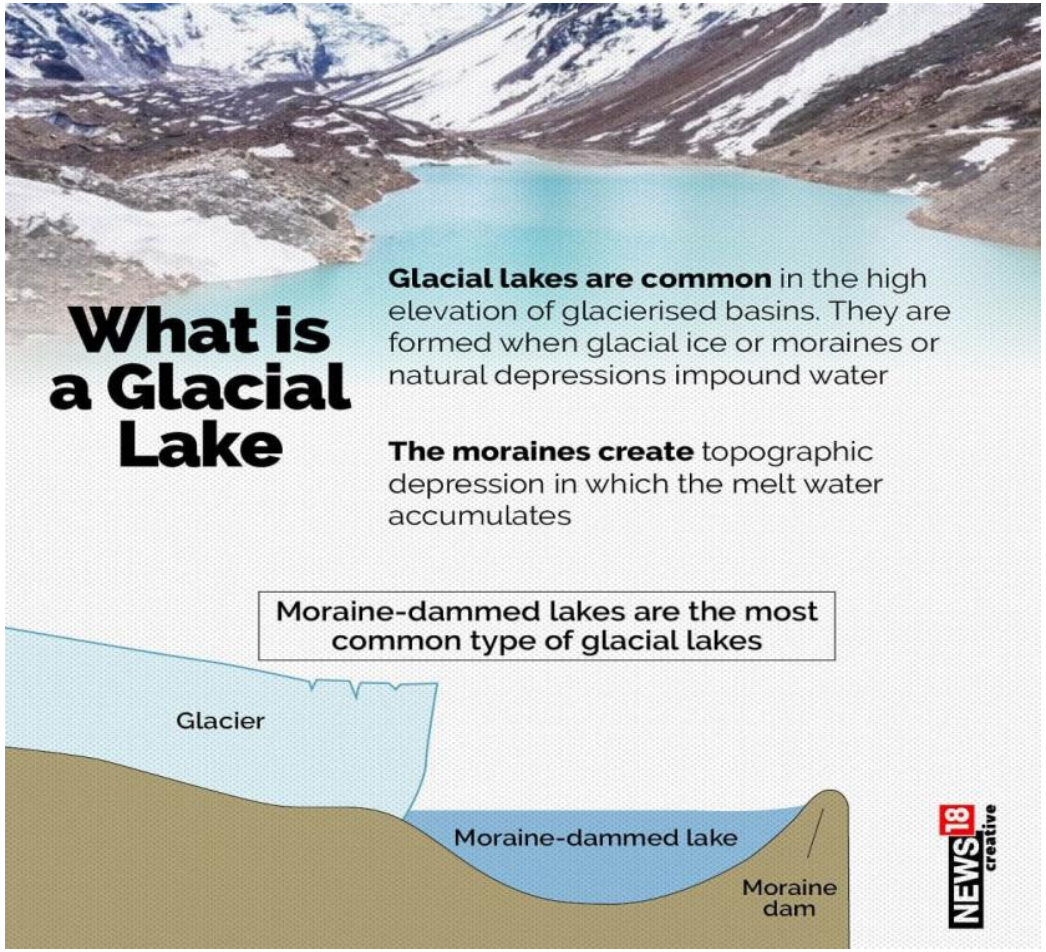
- India is intensifying efforts to counter **Glacial Lake Outburst Floods (GLOFs)**, also known as **glof** events, as such incidents have increased across the **Himalayan region**, especially in **Nepal**.
- The **NDMA** has launched a national programme to identify, monitor, and mitigate risks from **at-risk glacial lakes**.

Rising GLOF Threat Across the Himalayas

- Nepal recently faced **multiple glof events**, including in **Mustang**, **Humla**, and **Solukhumbu** districts.
- The July 2024 glacial lake outburst destroyed a **China-built bridge**, disrupted power supply, and highlighted a lack of **transboundary early warning systems**.
- Historical GLOFs like **Digi Tsho (1985)** and **Tama Pokhari (1998)** show the **recurring nature** of the glof threat.
- **Supraglacial** and **moraine-dammed lakes** are the two major types of glacier lakes in the **Indian Himalayan Region (IHR)**.
- India's IHR houses **28,000 glacial lakes**, with 7,500 in India, many above **4,500 m**, making monitoring **logistically challenging**.

What is a GLOF?

- A Glacial Lake Outburst Flood (GLOF) is a sudden release of water from a glacial lake due to dam failure, often leading to catastrophic downstream flooding.



India's Mitigation Strategy via NDMA

- The **NDMA**, through **CoDRR**, shifted focus to **risk reduction** and **early warning systems** for disaster preparedness, particularly for glof events.
- A **$20 million programme** was launched, now covering **195 glacial lakes**, prioritised by risk levels to prevent potential glacial lake outburst floods.
- Five-pronged approach: **glacial hazard assessment**, **AWWS**, **EWS**, **retention structures**, and **community engagement** for comprehensive disaster risk reduction.
- States deployed expeditions using **bathymetry**, **ERT**, **UAV surveys**, and **SAR interferometry** to study terrain changes and assess glof risks.
- **ITBP** supports **manual alerts**; permanent stations now installed at some glacier lakes for flood early warning.
- More expeditions planned post-monsoon to address critical **data and technology gaps** in the Himalayan cryosphere and improve glof prediction.

Understanding GLOFs and Risk Factors:

- **Glacial Lake Outburst Floods (GLOFs)** occur when dammed water bodies suddenly release due to **ice/landslides**, **melting**, or **earthquakes**.
- IHR has **11 river basins** prone to glacial lake outbursts.
- Factors include **rising global temperatures** due to climate change impacts, **inaccessible terrains**, and lack of **real-time weather stations**.
- Past disasters like the **Kedarnath (2013)** and **South Lhonak (2023)** floods underscore the high-impact risks of these mountain hazards and the need for effective glof mitigation strategies.

The increasing frequency of GLOFs highlights the urgent need for climate change adaptation and improved risk reduction strategies in the Himalayan region.

As global temperatures continue to rise, the threat of GLOFs and other climate-related disasters is expected to grow, necessitating robust disaster risk management approaches and enhanced early warning systems for glacial lake outbursts.

Age of Consent under POCSO Act

Not the way

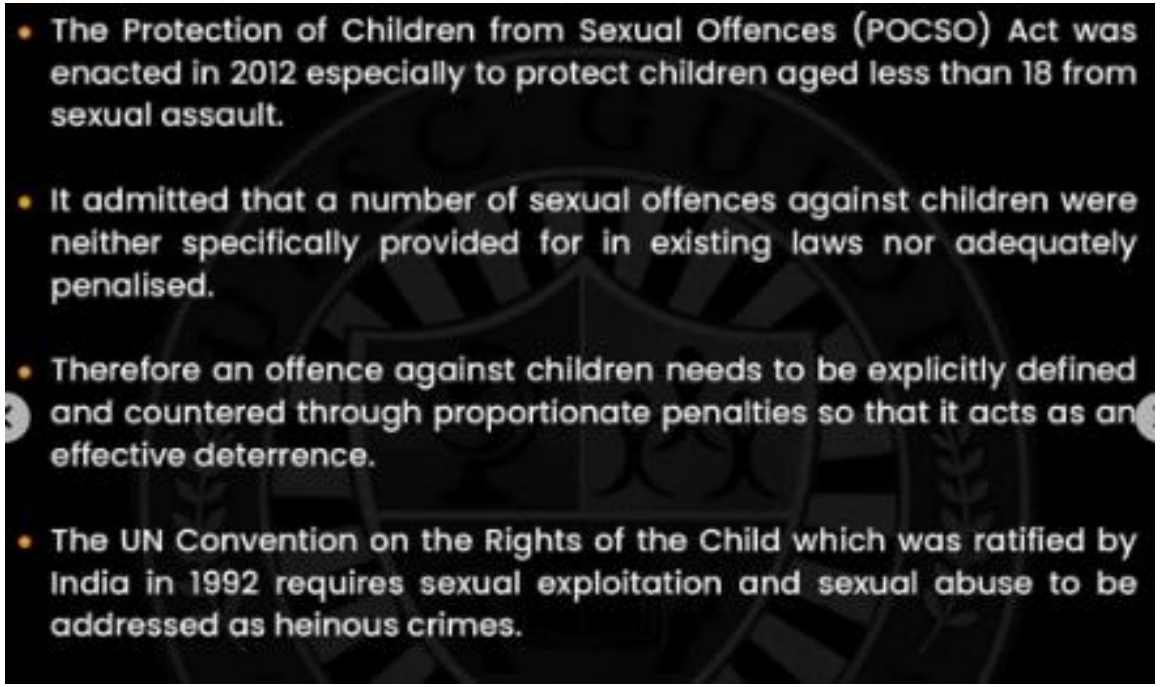
Criminalising adolescent sex will undermine the aim of the POCSO Act

The key objective of the Protection of Children from Sexual Offences (POCSO) Act, 2012 is the protection of children, but over the past few years, courts around the country and rights activists have called for some exemptions. Noticing a trend that adolescents, above 15 years but under 18, in voluntary relationships and having consensual sex were often being persecuted, the courts sought a review. In that backdrop, senior advocate Indira Jaising's written submission to the Supreme Court that consensual sex between teenagers aged 16-18 years must not be criminalised is a welcome move. She was appointed *amicus curiae* and her submissions are part of a petition filed by advocate Nipun Saxena. Her brief challenged the designation of 18 years as the age of consent. She said the only solution lies in declaring that sex between consenting adolescents between the age of 16, an almost universal age of sexual maturity, and 18, is not a form of 'abuse'. Ms. Jaising called for this exception to be read into the POCSO Act and Section 63 (sexual offences), of the Bharatiya Nyaya Sanhita (BNS). "Such an exception would preserve the protective intent of the statute while preventing its misuse against adolescent relationships that are not exploitative in nature," she said.

In a 2023 report, the Law Commission had said that it was against changing the age of consent. It advised "guided judicial discretion" instead, while sentencing in cases that involve children between 16 and 18 years in a voluntary, consensual relationship. Under the POCSO Act and under several provisions of the Indian Penal Code and the BNS, whoever commits a penetrative sexual assault on a child – who is anyone below 18 years – can face stringent punishment under Section 6 of the POCSO Act, Section 9 of the Prohibition of Child Marriage Act, 2006, and provisions of the IPC and BNS. A 16-year-old is considered a "child" under Section 2(d) of the POCSO Act and hence her consent does not matter. But caveats have to be put in place so that the broad intent of the law is adhered to, as the Madras High Court suggested in 2021, in *Vijayalakshmi vs State Rep*. The High Court said the age difference in consensual relationships should not be more than five years to ensure that a girl of an impressionable age is not taken advantage of by an older person. Educating adolescents about the law on sexual offences and its consequences is a must too. Criminalising normal adolescent behaviour is not the way to protect against non-consensual, exploitative sexual offences.

Context

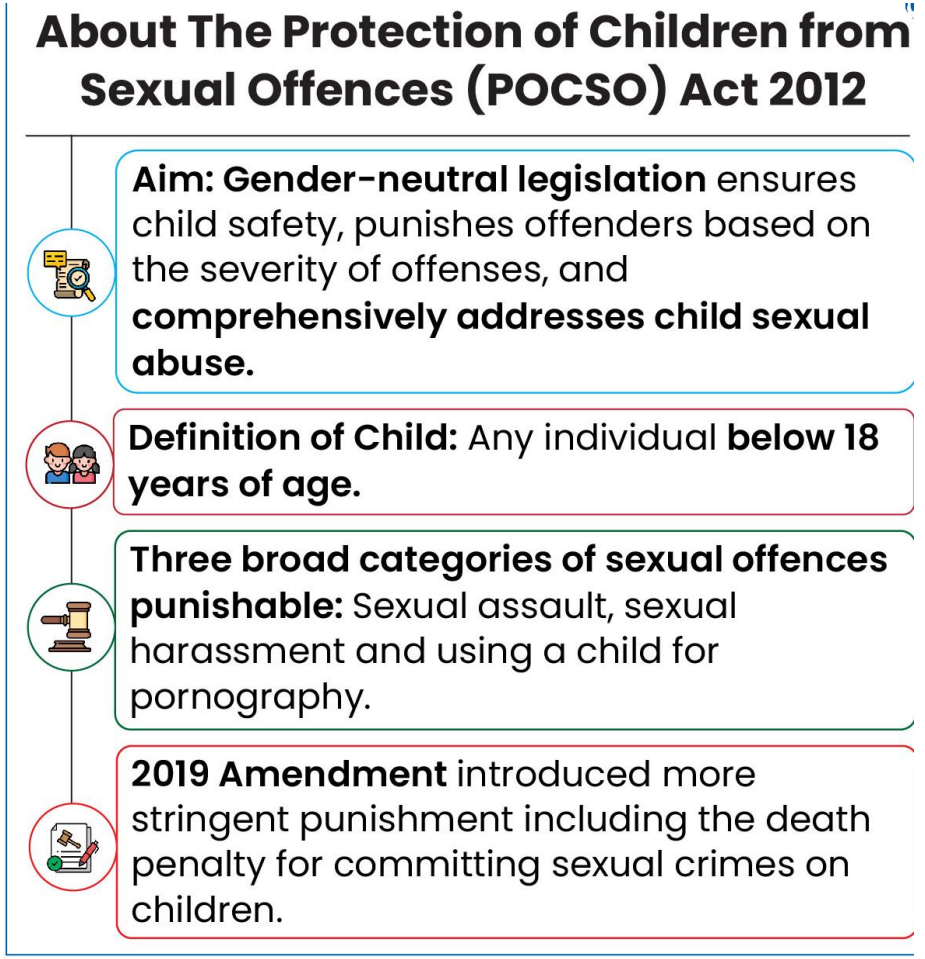
- Senior Advocate Indira Jaising, appointed *amicus curiae*, submitted to the Supreme Court that **consensual sexual relationships between adolescents aged 16–18** should not be criminalised under the POCSO Act, 2012, urging a nuanced interpretation to prevent misuse.



- **The Protection of Children from Sexual Offences (POCSO) Act, 2012** defines a "child" as anyone below the age of 18; hence, any sexual act with a person under 18 is considered non-consensual and criminal, regardless of mutual agreement.

- Judicial observations and rights-based critiques highlight that **criminalising consensual relationships** among adolescents aged 16–18 leads to unjust prosecutions and social stigma, despite absence of exploitative intent.

- Under **Section 6 of the POCSO Act** and aligned provisions in the IPC, BNS, and the **Prohibition of Child Marriage Act, 2006**, penetrative sexual assault on any minor attracts severe penalties, with no current legal scope for exceptions in consensual adolescent cases.

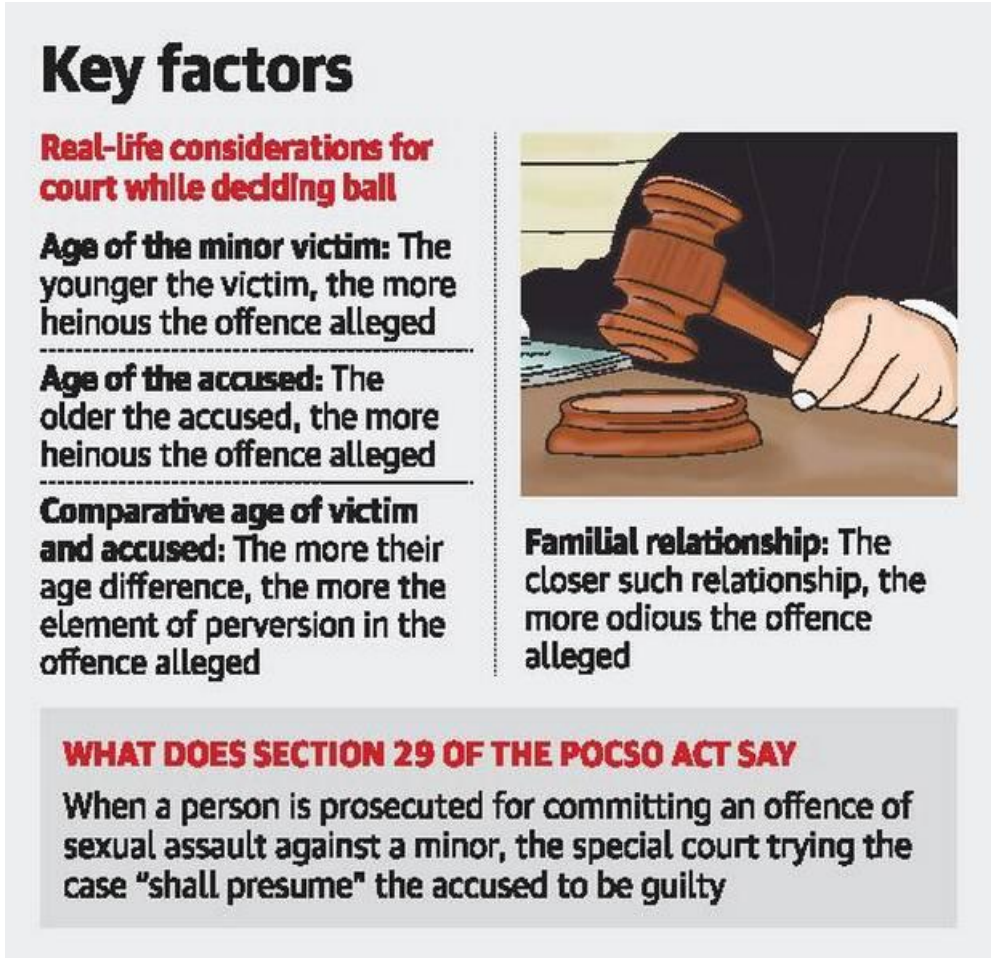


Judicial and Legal Interventions

- The petition by Advocate Nipun Saxena and the submissions by Indira Jaising call for an exception for **consensual sexual activity between 16–18-year-olds** to be read into POCSO and Section 63 of the BNS.
- In ***Vijayalakshmi v. State Rep.* (2021),** the Madras High Court proposed a safeguard by recommending that the age gap between the partners be no more than five years, to prevent predatory relationships disguised as consensual.
- The Law Commission opposed changing the age of consent but endorsed **"guided judicial discretion"** during sentencing to differentiate between exploitative conduct and non-exploitative adolescent intimacy.

Way Forward and Policy Concerns

- An **exception clause for consensual acts** between adolescents aged 16–18 would protect individual rights while upholding the protective objectives of POCSO, ensuring genuine cases of abuse are not diluted.
- **Comprehensive adolescent sex education** and legal awareness initiatives must be implemented to inform youth about the implications of the law and the concept of consent.
- **Blanket criminalisation** risks undermining judicial efficiency and harming young individuals emotionally and socially; hence, judicial discretion must be codified with safeguards to prevent arbitrary outcomes.



China's mega dam on Brahmaputra

China's mega dam on Brahmaputra, and concerns in India

DIVYA A
NEW DELHI, JULY 27

CHINA ON July 19 formally began the construction of a massive dam on the Brahmaputra river, close to the border with Arunachal Pradesh. The $167.8-billion hydropower project, with a generation capacity of 60,000 MW, will be the world's largest upon completion.

Since being announced in 2021, the project has raised concerns in India and Bangladesh about the impact it may have on the flow of the river.

EXPLAINED GLOBAL

Concerns in Arunachal

The dam on the Yarlung Zangbo, as the Brahmaputra is known in Tibet, is being built at the "Great Bend", where the river makes a U-turn in Medog county before entering India at Gelling in Arunachal Pradesh. The river is called Siang in Arunachal Pradesh.

A week before the dam's groundbreaking ceremony, Arunachal Pradesh Chief Minister Pema Khandu told *PTI* that it was a potential "water bomb" and an "existential threat".He said if China "suddenly release water, our entire Siang belt would be destroyed... In the long run... Siang and Brahmaputra rivers could dry up considerably".

Other experts too have flagged the risk of flooding due to the intentional or unintentional operation of reservoirs in Tibet, and unforeseen events such as dam failure, landslides, or earthquakes. Tibet is a seismically active zone, and the region where the dam is coming up is considered to be earthquake-prone and ecologically fragile.

View from Assam

The Brahmaputra is the lifeline of Assam, fundamental to its economy, and central to its history, culture, and ecology. Any significant disruption in the flow of the river in the state will have far-reaching consequences.

But Assam CM Himanta Biswa Sarma on July 21 said that he was "not immediately worried because Brahmaputra... is not dependent on a single source [of water]." It gets most of its waters from Bhutan, Arunachal Pradesh, and rainwater in Assam, Sarma said.

On June 2, he had posted on X that "the Brahmaputra is not a river India depends on upstream", and that "China contributes only ~30-35% of the Brahmaputra's total flow".

In the unlikely event of China reducing water flow, "it may actually help India mitigate the annual floods in Assam", he had said.

The Indian response

While it has issued no official reaction after the July 19 ceremony, New Delhi has long been monitoring Chinese infrastructure interventions on the river. In January, Ministry of External Affairs spokesperson Randhir Jaiswal said: "As a lower riparian state with established user rights to the waters of the river, we have consistently expressed... our views and concerns to the Chinese side over mega projects on rivers in their territory."

On July 23, Guo Jiakin, spokesperson for the Chinese Foreign Ministry, told reporters that the project was "fully within China's sovereignty". "China is engaged in cooperation with downstream countries on sharing hydrological data, flood prevention and disaster reduction," he said.

Ashok Kantha, a former Indian Ambassador to China, had previously told *The Indian Express* that the project, with its "very large reservoir, in a very difficult area" was "very risky, dangerous, and irresponsible". India, Kantha had said, needed to raise its concerns with China "forcefully".

India is engaged with China in a series of confidence-building measures after Foreign Secretary Vikram Misri announced last October that the two sides had reached an agreement "on patrolling arrangements along the Line of Actual Control, leading to disengagement and a resolution of the issues that had arisen in these areas in 2020".

Mitigation measures

At the heart of India's concerns, as articulated by CM Khandu, lies the fear that China may seek to weaponise the dam project at some stage, perhaps to build pressure on behalf of Pakistan during a future conflict.

India should make scientific calculations about the Chinese dam project and build its own capability to preempt any deliberate action in the future, said Uttam Sinha, senior fellow at the Manohar Parrikar Institute for Defence Studies and Analyses.

Water experts Naresh K Mathur and Debarshee Dasgupta had previously written in *The Indian Express* that as a mitigation strategy, India could plan storage on rivers of the Brahmaputra system to absorb potential variations in flows.

The storage of the Upper Siang project in Arunachal Pradesh, with its 300-metre-high dam, can serve as a buffer against variations in the flow of the river. But progress has been slowed by local resistance against the potential adverse environmental impact of the dam.

Sinha said there is a need to build more inland channels to carry the flow of excess water. The National Water Development Authority has proposed two links to connect the Brahmaputra and its tributaries to the Ganga basin with the aim of transferring surplus water to water-scarce regions.

Experts have also stressed on the need to utilise diplomatic channels to seek detailed hydrological and project-related data from China in order to assess downstream impact.

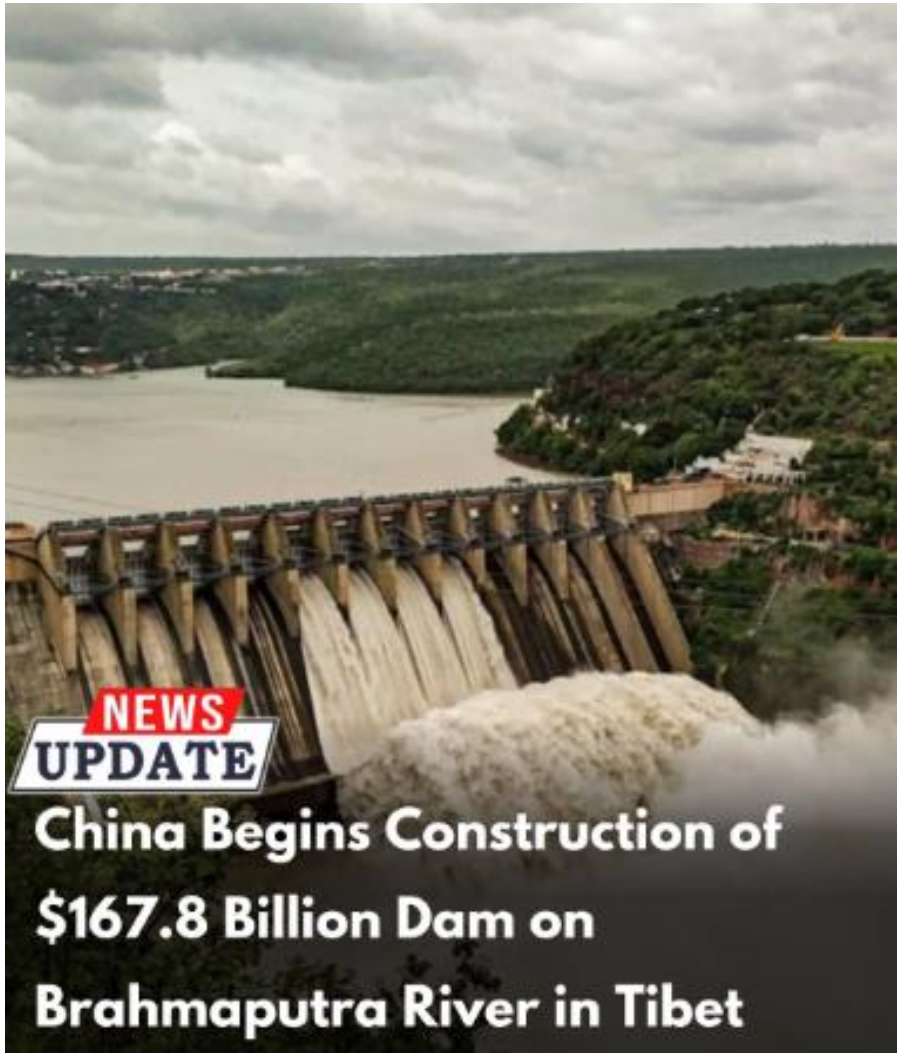
India should also have conversations with other low riparian neighbours — Bhutan, Bangladesh and even Myanmar — on developing a coordinated protocol for advance warning and disaster preparedness.

CONTEXT

- China has started building a **massive hydropower project** on the **Yarlung Zangbo River (Brahmaputra)** near Arunachal Pradesh.
- With a **60,000 MW capacity**, this **$167.8-billion mega dam** has triggered **concerns in India** over water flow, ecological impact, and strategic risks.

Strategic and Environmental Concerns for India

- The dam is located at the **“Great Bend” in Medog County**, near **Gelling in Arunachal Pradesh**, where the **Yarlung Zangbo becomes Siang/Brahmaputra**.
- Experts like **Ashok Kantha**, a strategic affairs analyst, warn the project is in a **seismically active zone and ecologically fragile area**, making it risky.
- India fears China may **weaponize the dam** during conflicts to pressure India or alter water flows.
- **Sudden water release** or reservoir mismanagement could cause **flooding or drought downstream**, especially in **Assam and Arunachal Pradesh**.
- **CM Pema Khandu** termed the project an **“existential threat”** and a **“potential water bomb.”**



India’s Response and Diplomatic Engagement

- India continues to express concerns about the **downstream impact** to China through diplomatic channels.
- Officials emphasize the need for **transparent hydrological data sharing** to assess **flow variations and flood risks**.
- India plans **buffer storage** like the **Upper Siang project** but faces **local opposition** due to environmental concerns.
- **Foreign Secretary-level agreements** have focused on **confidence-building measures** amid broader tensions.
- Experts urge India to **coordinate protocols** with **Bhutan, Bangladesh, and Myanmar** for **disaster preparedness**.
- The project’s potential adverse environmental impact on lower riparian states has led to calls for an international water treaty to address these concerns.

Significance of the Brahmaputra River:

- The **Brahmaputra** is a **lifeline for Assam**, crucial for its **agriculture, economy, and ecology**.
- It originates as **Yarlung Zangbo in Tibet**, enters India as **Siang**, and becomes Brahmaputra in Assam.
- Despite the dam, **70% of Brahmaputra's flow** comes from **rainfall and tributaries in India and Bhutan**.
- India is a **lower riparian state** with **established user rights** under international law.
- The **National Water Development Authority** has proposed **inland channel links** to redistribute surplus water effectively.

- ❑ The construction of this mega dam on the Yarlung Zangbo River, which could become the biggest dam in the world, has raised concerns not only in India but also among other low riparian neighbours.
- ❑ The project's formidable hydropower potential, while impressive, comes with significant risks due to its location in a seismically active zone.

1st Hydrogen powered Train

India's 1st hydrogen-powered train nears reality as Railways successfully tests coach

DHEERAJ MISHRA
NEW DELHI, JULY 27

India's first hydrogen-powered coach at ICF, Chennai.

INDIAN RAILWAYS has successfully tested the first hydrogen-powered coach or driving-power car earlier this week at its Integral Coach Factory (ICF) in Chennai, a key milestone in the its quest to build India's first hydrogen-powered train as only a few railways in the world have tried it, with a bulk of the projects still in the trial phase. Hydrogen is a cleaner fuel and will reduce dependence on fossil fuels with Railways one of the key players in India's mission to reduce greenhouse gas emissions. The ICF project will increase the share of renewable energy in its energy mix.

Officials said the project is in its final stage with tests of various equipment being conducted before the hydrogen-powered trains enter commercial service.

What's the project?

The Northern Railway zone undertook this project, costing around ₹136 crore, which began in 2020-21 and comprises two major components. First, the conversion of two conventional 1600-HP diesel power cars into hydrogen fuel cell-powered traction system, and second, setting up a hydrogen storage and fuelling facility at Jind in Haryana, with a storage capacity of 3,000 kg of the clean fuel.

The primary design, validation, and testing is being undertaken by Indian Railways' Research Design & Standards Organisation (RDSO). A senior Railway Ministry official said that the hydrogen train project was conceptualised for conversion of a 10-coach diesel-electric multiple unit (DEMU) into a hydrogen-powered multiple unit, with two 1600-HP cars. With a train length of 10 coaches, it can carry more than 2,600 passengers.

How will it work?

Hydrogen fuel technology is still an emerging field in the Railways. There are many challenges and safety concerns as hydrogen, the lightest element, is highly flammable, apart from being colourless, odourless and tasteless. As the project involves the retro-fitment of two diesel-powered cars into hydrogen fuel cell-powered cars, each power car will carry 220 kg of hydrogen, stored in specially designed cylinders at 350 bar pressure.

The mounting structure of hydrogen cylinders and fuel cells is critical and for that rounds of testing are ongoing.

Given the characteristics of the gas, officials said that to minimise the risk, Railways have done computational fluid dynamics (CFD) studies, wherein the worst cases of hydrogen leak and other failure modes are considered with continuous monitoring.

Fuelling facility

At the fuelling and storage facility in Jind, the storage capacity has been divided into two separate spaces — 2,320 kg at low pressure and 680 kg at high pressure.

The facility will be operated and maintained in accordance with the standards and specification of Petroleum Explosives Safety Organisation (PESO), a nodal agency under the Department for Promotion of Industry and Internal Trade (DPIIT).

CONTEXT

- Indian Railways has **successfully tested** the country's **first hydrogen-powered coach** at the **Integral Coach Factory (ICF)** in Chennai.
- This is a major step toward launching a **hydrogen-powered train**, enhancing **clean mobility** and reducing **greenhouse gas emissions**.

Project Overview and Technological Aspects

- The **Northern Railway zone** is executing the ₹**136 crore project**, initiated in **2020-21**.
- It involves converting a **10-coach DEMU train**, with **two 1600 HP cars**, into a **hydrogen-powered multiple unit**.
- Each **power car** carries **220 kg of hydrogen**, stored in **cylinders at 350 bar pressure**.
- The **Integral Coach Factory (ICF)** in Chennai is spearheading the coach design and trials.
- Hydrogen will be used via **fuel cell-powered traction systems**, replacing traditional diesel engines.

Thank you

Address

B-47, Main Road Shivalik Enclave, Block-B, Shivalik Colony, Malviya Nagar, New Delhi-110017

Phone Number +91 8178833167