International Journal for Research Trends in Social Science & Humanities
Volume 4, Issue 3
May-Jun 2026, PP 1-10

Dams and Disasters? Evaluating the Long-Term Viability of India's Hydroelectric Path

Sindhuja Sharma[1], Professor DD Sharma[2]
[1]Reasearch Scholar, Department of Geography, HPU Shimla
[2]Department of Geography, HPU Shimla

Abstract- India's journey into the hydroelectric era is a delicate balance of national decarbonization goals, environmental concerns, and regional geopolitics. With India's target of 500 GW of non-fossil fuel energy capacity by 2030, hydropower plays a pivotal role in the future. But the operation of mega-dams in areas of high geologic activity and climate sensitivity, such as the Himalayan belt, has significant second and third order effects. This paper evaluates the future of Indian hydroelectric program on a multi-faceted basis. It involves geographic potential changes, economic life cycles affected by sedimentation, transboundary hydro politics and hazards from the cryosphere such as Glacial Lake Outburst Floods (GLOFs). It also examines the domestic political economy of water and the need for decentralized, micro-hydropower systems that are connected to Traditional Ecological Knowledge (TEK). In the end, the paper calls for a paradigm shift from the conventional baseload mega-dams to Pumped Storage Hydropower (PSH) and resilient, community-owned micro-grids.

Keywords- India Energy Transition, Glacial Lake Outburst Floods (GLOFs), Pumped Storage Hydropower (PSH), Traditional Ecological Knowledge (TEK), Decarbonization.

I. Introduction

The academic debate regarding South Asian hydropower has shifted significantly from uncritical approval of centralized generation to a highly cautious, multifaceted critique. This evolution began with the recognition that top-down ecosystem management systematically marginalizes local communities and erases Traditional Ecological Knowledge (TEK), which is now recognized as a scientifically valid necessity for adaptive management and environmental monitoring. Traditional mega-dams cause severe socio-ecological disruption by fracturing vital river flows, degrading water quality, and wiping out downstream aquatic species (Gadgil et al., 1993; Berkes et al., 2000; Dudgeon et al., 2006; Kimmerer, 2016).

This socio-ecological vulnerability is heavily compounded by climate-induced cryosphere hazards in the highly unstable Himalayan region, where over two-thirds of planned and operational hydropower infrastructure sits directly in high-risk zones. Recent disasters—such as the Chamoli avalanche and the 2023 Sikkim Glacial Lake Outburst Flood (GLOF) that breached the Teesta-III dam—prove that these catastrophic events are highly probable, design-relevant threats that render current structural design standards obsolete. Furthermore, extreme high-altitude erosion yields rapid reservoir sedimentation, causing a continuous "economic haemorrhage" that destroys the validity of traditional cost-benefit models, which completely fail to account for rapid storage loss and the massive future costs of dam decommissioning (SANDRP, 2013; Annandale et al., 2016; Schwanghart et al., 2016; Shugar et al., 2021; Sattar et al., 2024; Dahal et al., 2025).

At the macro-level, these environmental threats are intensified by transboundary geopolitical friction, particularly in the un-treated Brahmaputra Basin. Driven by the legal doctrine of prior appropriation, competing riparian nations are rushing to build otherwise uneconomic dams simply to stake out "historic water use rights," highly securitizing regional water management. This regional vulnerability is worsened by the institutional decay of bilateral data-sharing agreements between India and China, which severely escalates flood risks during monsoon periods. To mitigate these compounding risks, contemporary literature increasingly advocates for a shift toward low-impact, decentralized alternatives—such as pairing traditional architectural forms with modern micro-grid turbines and community rainwater harvesting—to provide resilient energy access without causing mass displacement or environmental degradation (Rahaman & Varis, 2009; Kotoky & Bipindra, 2018; Joji & Jacob, 2023; Zhang, 2023).

India's future for hydroelectric development lies at the nexus of national decarbonization goals, ecological sensitivity, and geopolitical dynamics. Hydro is a key component of the energy transition with the country aiming to attain 500 GW of non-fossil energy power generation by 2030 and become a net zero by 2070 (The Energy and Resources Institute [TERI], 2023). India has made a step forward to meet these targets by hitting the 50% non-fossil fuel electricity capacity mark by July 2025 (Central Electricity Authority [CEA], 2026). This will include conventional mega-dams as well as growing pumped storage facilities and localized micro-hydroelectric systems, and is projected to deliver the necessary baseline stability and flexibility to the grid for the uptake of renewables. This does not mean that hydropower is necessarily an energy source that is without negative impact, though, as is suggested by the empirical evidence, it is not always the energy source lacking in impact.

Table 1: India's Power Generation Capacity Mix (As of Nov 2025)

Source Category	Installed Capacity (MW)	Percentage Share (%)	Capacity Visualization *(%)*
Fossil Fuels (Coal, Lignite, Gas)	246,942	48.4	48
Solar Power	132,848	26.1	26
Wind Power	53,986	10.6	11
Large Hydropower	50,415	9.9	10
Biomass & Waste to Energy	11,614	2.3	2
Small Hydropower	5,159	1.0	1
Nuclear Power	8,780	1.7	2

(Data Source: Central Electricity Authority, 2026. Total national capacity: 509.7GW)

*Visual representation of hydro's role in a grid crossing the 50% non-fossil milestone.

The links between India and the large dams came into being in post-Independence India when the large dams were called the "temples of modern India" by Prime Minister Jawaharlal Nehru. Most of this early development activity took place in the more stable peninsular regions and the fertile plains of the northern parts of the region and focused on multipurpose infrastructure to guarantee food security by irrigation and power generation. However, the high-altitude Himalayan and Northeastern frontiers were the inevitable targets for the geopolitical and infrastructural gaze once the prime peninsular and low-lying riverine areas were saturated, and the mighty economic push and mitigation of climate change was in full swing.

It has left an impact on the history of migration that has shifted the paradigm of a typical development process that was aligned with the national modernization into climate vulnerability, ecological degradation and intricate water disputes at home and abroad. Operational status of hydroelectric projects in climatically sensitive and geologically active areas like the Himalayan belt and Northeastern frontier poses a threat to the viability of the asset with respect to second and third order consequences. Assessing the hydroelectric path in India needs a multi-dimensional analytical approach. A study of geographical potentials, economic cycles like sedimentation, displacement of indigenous communities and trans-boundary hydro politics in shared river basins requires a study of Rahaman & Varis (2009).

Moreover, the rising number of climate-induced cryosphere disasters, including Glacial Lake Outburst Floods (GLOFs), has led to a transition towards structural resilience and national dam safety measures (NDMA, 2026). Meanwhile, the controversy over taxation of hydraulic resources in the internal domestic conflicts between host state and central governments highlight the political economy of water (NHPC Ltd. v State of Himachal Pradesh, 2024). This study explores these domains and current technological interventions like hydro-solar hybridization and the epistemological incorporation of Traditional Ecological Knowledge (TEK) in order to appraise the viability, structural hazards and policy shift that will shape the future of hydroelectric power in India. Although these intersecting dynamics are crucial, there is a significant lack of scholarly and policy research addressing these dynamics.

Past studies have been conducted from a single discipline viewpoint, such as engineering feasibility, economic rate of return, localized environmental impacts, and even regionally based security issues, of the hydroelectric development of India. There is no synthetic scholarship on the direct effects of geology on economic cycles or on socio-legal tensions and transboundary water insecurity on the financial risks of mega-projects. This paper is a multi-systemic and integrated analysis which attempts to close this research gap. The aim of this study is to develop a holistic framework for sustainable energy transition in India, exploring the interdependencies between the transboundary hydro politics, federal-state jurisprudence, economic lifecycles and the hazards of climate change.

II. Research Methodology and Objectives

The evaluation of India's hydroelectric trajectory requires a multidimensional analytical framework. This paper employs a qualitative policy analysis and secondary data synthesis methodology. It integrates geographic profiling, economic lifecycle assessment, and socio-legal review. Data is drawn from institutional reports (e.g., Central Electricity Authority, National Disaster Management Authority, Ministry of Power), judicial rulings (e.g., Himachal Pradesh High Court), and peer-reviewed scientific literature on cryosphere hazards and environmental flows. By analysing these intersecting domains alongside modern technological interventions like hydro-solar hybridization and the epistemological integration of Traditional Ecological Knowledge (TEK), this paper provides an evaluation of the viability, structural risks, and policy pivots that will shape India's hydroelectric future.

- Assess the natural and political hazards involved in dam construction in the Himalayan and Northeastern Regions of India.
- To discuss the viability of conventional mega dams versus smaller, decentralised renewable energy sources.
- To make policy recommendations based on informed needs of the community and sustainable hydropower development.

III. Thematic Analysis of India's Hydro-Trajectory

Geographic Profiling and the Strategic Shift to the Himalayan Frontier
The spatial distribution of India's hydroelectric potential is skewed, dictated by the topography of the Himalayan mountain range and the riverine networks of the Northeast. Reassessment studies conducted by the CEA estimate the identified installed capacity of large hydro potential in the country at approximately 133,410 MW (CEA, 2025). Approximately 67% of India's total hydroelectric potential remains untapped, with roughly 93% of this untapped potential concentrated in the northeastern region (Ministry of Power, 2024).

Regional Hydropower Density and Geopolitical Risk Matrix:
- **North-West Himalayas (Indus Basin):** Untapped Potential is 32.3GW$ (24% of National). Primary Risks is of high sedimentation rates, GLOFs.
- **North-East Himalayas (Brahmaputra Basin):** Untapped Potential is 62.7 GW (47% of National). Primary Risks are Transboundary water weaponization, massive infrastructure costs.
- **Central Himalayas (Ganga Basin):** Untapped Potential is 15.5 GW (12% of National). Primary Risks are Rock-ice avalanches, strict E-Flow mandates.
- **Peninsular Blocks:** Untapped Potential is 22.7 GW (17% of National). Primary Focus is transitioning to closed-loop Pumped Storage (PSH).

The Brahmaputra basin accounts for more than 80%of India's totally untapped hydroelectric capacity. To harness this, the CEA has published a $6.4trillion (approx. $77 billion USD) master transmission plan targeting 76GW of transmission from the basin by 2047 (CEA, 2024). This geographic pivot carries complex implications due to tectonic volatility, steep river gradients, and high rock friability.

The Sedimentation Crisis and Economic Lifecycle Re-evaluation
The economic viability of hydroelectric mega-projects is conventionally modelled over 40-to-100-year operational lifespan. In the context of the Himalayas, this financial modelling is severely undermined by extreme sedimentation rates, which act as an ongoing economic haemorrhage (Annandale, Morris, & Karki, 2016).

The Himalayan range features perennial streams that transport high sediment yields. Disruption of natural morpho dynamics accelerates the loss of live storage capacity.

Historical data indicates that reservoirs can lose nearly 30% of their gross capacity within a few decades due to sediment discharge.

Table 2: The Economic Haemorrhage of Sedimentation (Regional Analog: Tarbela Dam)

Capacity Metric	Volume (Billion Cubic Meters)	Capacity Degradation Bar
Original Gross Capacity (Year 0)	14.33 BCM	100%
Gross Capacity Remaining (Year 36)	10.105 BCM	70.5%
Capacity Lost to Sedimentation	4.225 BCM	29.5%

*Illustrating rapid capacity loss driven by Himalayan sediment loads.

Furthermore, the passage of suspended sediment causes extreme wear on electromechanical equipment (Giri, 2022). Crucially, there is a regulatory void regarding the end-of-life decommissioning phase of these mega-dams. Without integrating these expenditures into the initial Cost-Benefit Analysis (CBA), the long-term financial superiority of mega-dams is questionable.

IV. Hydro-Solar Hybridization and the Pumped Storage Paradigm

As the penetration of intermittent renewable energy accelerates, the primary utility of hydropower is shifting toward dispatchable energy storage and rapid grid balancing. Pumped Storage Hydropower (PSH) has emerged as a critical technological pivot (TERI, 2023).

The CEA's 2026 roadmap revised the estimated total PSP potential upward to approximately 267GW (CEA, 2026). Currently, the mandate targets the development of 100GW of Hydro Pumped Storage Projects by 2035-2036.

Table 3: Comparative Grid Storage Solutions Matrix

Feature	Pumped Storage Hydropower (PSH)	Battery Energy Storage Systems (BESS)
Duration of Supply	Long-duration (6+ hours)	Short-duration (Typically up to 4 hours)
Asset Lifespan	100 Years	10 to 15 Years
Grid Inertia	Provides physical rotating inertia	Synthetic inertia (Inverter-based)
Ecological Impact	Low (if off-river/closed-loop)	High (Mining for base metals)
LCOE Viability	Highly cost-effective at macro scale	Costly for long-duration stabilization

Operation of a Hydro-Solar Hybrid System

- **Daytime Phase:** Solar Arrays generate electricity ➔Excess energy powers PSH pumping stations ➔Water moved from Lower to Upper Reservoir.
- **Night Phase:** Grid demand peaks (zero solar) ➔Stored water released (Upper to Lower) ➔Turbines generate Round-The-Clock (RTC) dispatchable electricity.

The solar panels are coupled directly on the existing reservoirs, and operators are taking advantage of existing transmission infrastructure. During the daytime peak demand hours, solar energy is used, and the hydro reservoir stores the water for use at night. During peak hours in the day, solar energy is used with the hydro reservoir storing water for use at night (Silva et al., 2024).

V. Decentralized Mini-Grids: Micro-Hydropower in Remote Topographies

The national energy discourse is buzzed with the talk of multi-gigawatt Mega-dams, but the micro and mini-hydropower projects (MHP) offer a viable and socially just way of energy generation in remote areas. The potential for small and mini-hydel power in India is estimated to be 19,749 MW, with 6,474 identified sites (Ministry of New and Renewable Energy, 2024). There are 5,159 MW of small hydropower installed as of November 2025 (CEA, 2025).

These mega-dams are capital intensive and are inefficient to light up isolated tribal areas needing electricity. This is because central grids extend deep into rugged areas, incurring enormous transmission losses and the cost of infrastructure. Micro hydro schemes, which generate between a few kilo-watts and 100 kW, are run-of-the-river and run-of-the-river schemes are based on a local paradigm. They take some of a stream's flow to a small turbine and send it back downstream. This engineering means that there will be little or no disruption to the ecology and no displacement of local populations.

Table 4: Centralized vs. Decentralized Hydropower Architectures

Parameter	Centralized Mega-Hydro	Decentralized Micro-Hydro (MHP)
Primary Output Goal	National grid baseload / peak	Localized off-grid community access
Ecological Impact	High (Inundation, flow alteration)	Minimal (Run-of-the-river, no dams)
Social Displacement	High (Mass resettlement required)	None (Integrated into local landscape)
Projected Unit Cost	Lower at macro scale	₹4.56 to ₹8.31/kWh
Capital Cost/kW	Highly variable, prone to overruns	₹124,310 to ₹233,335

Environmental Footprints, Riverine Health, and Ecological Flow Mandates

A concrete dam completely changes the morphology, chemistry and biology of a river. Flow is regarded as the most significant riverine ecosystem variable (Dudgeon et al., 2006). The traditional paradigm of over-stimulating KWDs in India often resulted in dry riverbeds in the downstream portion, affecting aquatic life and riverbed habitats. The regulatory framework has changed to finally establish Ecological Flows (E-flows) as legally obligated minimum volumes of water released so that rivers have an ecological function. The National Green Tribunal (NGT) had previously issued a direction to states to keep the rivers with the E-flow of 15-20% of the average flow during lean season (MoEFCC, 2021). Moreover, the Ganga Notification 2018 also legally prescribes the E-flows for the main stream of the Ganga and its upper tributaries (MoWR, 2018) during the specific season.

Table 5: Mandated E-Flows (2018 Ganga Notification)

Season	Months	Mandated E-Flow (% of Average Flow)	Flow Retention Indicator
Dry Season	November to March	20%	
Lean Season	October, April, May	25%	
High Flow Season	June to September	30%	

Enforcing these norms remains contentious, as water released for ecological purposes represents a direct revenue loss for the operator. The institutionalization of E-flows is a step forward towards hydrological extraction, but it has limitations. The ideal E-flow regime should reflect the natural flow regime of the river, including flood pulses that stimulate fish spawning and the transport of sediment downstream (Arthington et al., 2018). Enforcement of these norms is still controversial because the water released to achieve these objectives is a direct loss of revenue to the hydroelectric company.

The concept of Cooperative Federalism and the judicial invalidation of the Water Cess.

The notion of Cooperative Federalism and the judicial invalidation of the Water Cess. Hydropower has been expanding in the Himalayan belt, leading to fiscal and constitutional conflicts between the Central Government and the states in the region where such infrastructure is being built. States like Himachal Pradesh, Uttarakhand, Sikkim and Jammu & Kashmir are saying that they are the ones to suffer from the adverse effects of dams, whereas the power produced and profits accrued are exported. In order to turn their topographical resources into cash, these states adopted legislative tools to impose a water cess on the use of river water for hydroelectric generation. The most prominent flash point was with the passing of Himachal Pradesh Water Cess on Hydropower Generation Act, 2023 (2023, Himachal Pradesh Legislative Assembly).

The legislation caused a stir from power generation companies and the Union ministry of power, both claiming that it is driving up the cost of renewable energy and is beyond the legislative powers of the state. In March 2024, the Himachal Pradesh High Court declared the 2023 Water Cess Act as unconstitutional, arguing that this tax was

International Journal for Research Trends in Social Science & Humanities
Volume 4, Issue 3
May-Jun 2026, PP 1-19

essentially a disguised levy on electricity generation, which is prohibited under Article 265 of the Co3: South Lhonak Lake (Sikkim), Moraine failure resulting in a massive displacement wave (GLOF) in minutes; 92+ confirmed deaths and cross-border flooding in Bangladesh.

Present Mitigation Phase (2025/2026): National Glacial Lake Outburst Floods Risk Mitigation Programme (NGRMP) is initiated by NDMA with a setup of satellite-based Early Warning Systems (EWS) and manual lake-lowering interventions in 189 high risk glacial lakes. The current hydroelectric infrastructure has proven to be unable to resist these hazards of high-energy. The inadequacy of current hydroelectric infrastructure to resist these hazards of high-energy has been shown over the last few years. Using a 27 million cubic meter (m3) rock and ice avalanche estimate by Shugar et al. (2021), the Chamoli disaster in the Uttarakhand state, India, in February 2021, killed the Tapovan Vishnugad hydroelectric power plant.

The worst case scenario was realized when the South Lhonak lake in Sikkim burst open on 4 October 2023, leading to the collapse of the 1200 mw Teesta-III hydropower dam (Sattar et al., 2024). More than 92 persons were found dead and 75 were reported missing in this event indicating its devastating potential as cryosphere events (Government of Sikkim, 2023). It is found that around 66% of the hydropower plants are in the potential GLOF tracks in the Himalayan states (Schwanghart et al., 2016).

The Dam Safety Act, 2021, on the other hand, is a new paradigm in infrastructure governance that will require dam owners to set aside funds specifically for maintenance, surveillance and emergency action plan (EAP) (Ministry of Law and Justice, 2021). Meanwhile, the NDMA is rolling out the National Glacial Lake Outburst Floods Risk Mitigation Programme (NDMA, 2026) to carry out lake-lowering activities and structural GLOF risk mitigation work for 189 high-risk glacial lakes. The NDMA, in an exciting recent pilot project, successfully tested an indigenously developed satellite-based early warning system (EWS) for GLOFs, integrating satellite-based data and ground-based sensors with automated warnings to enhance evacuation planning in the state of Himachal Pradesh (Talwar, 2026).

VI. Social Dislocation and the Integration of Traditional Ecological Knowledge

The development of hydropower projects imposes a cost on indigenous peoples. Mega-dams require the displacement of people from their ancestral territories, forcing communities to move to new places and forcing them to abandon new livelihoods. This displacement leads to the loss of the Traditional Ecological Knowledge (TEK) of the human generations which over many generations learned about the natural systems from direct experience with them, through their specific landscape (Gadgil et al., 1993; Berkes et al., 2000). Western Scientific Ecological Knowledge is the knowledge used in traditional EIAs which often does not account for the ecological interdependencies that have been passed down through generations that are inherent in TEK. Adopting TEK into the process of dam planning and Social Impact Assessments (SIAs) is scientifically required (Kimmerer, 2016).

Indigenous perspectives view rivers as the living, connected system of rivers in the biosphere. Moreover, TEK offers resilient templates for decentralized water management which can be alternatives to mega-dams. Community-managed drought mitigation and groundwater recharge mechanisms exist in traditional systems, such as the Ruza farming system in Nagaland and johads (earthen check dams) in Rajasthan (Joji & Jacob, 2023). These fundamental architectural principles combined with micro-grid technology can be used to provide energy security for rural communities without the social side effects that would be required with a centralized mega-dam, and therefore without violating Sustainable Development Goals.

VII. Conclusion & Policy Recommendations

India's hydroelectric trajectory is locked in a multidimensional transition. The pursuit of mega-dam potential in the Himalayan and Northeastern frontiers is colliding with geological volatility and climate-induced instability. The conventional economic models that justified these investments are invalidated by sedimentation, uncalculated decommissioning liabilities, and the physical destruction wrought by GLOFs. To ensure the viability of India's hydro-energy security, a systemic paradigm shift is required. At the macro-infrastructural level, policy focus must pivot away from traditional baseload mega-dams toward closed-loop Pumped Storage Hydropower (PSH) and hydro-solar hybrid configurations. At the same time, remote frontier areas should be electrified by implementing micro-hydropower systems owned and managed by communities, informed by TEK.

Based on the preceding analysis, the following structural pivots and research priorities are recommended:

1. **Transboundary Institutional Frameworks:** Research should focus on moving beyond the expired bilateral MoUs for data sharing. Future studies should design a multilateral Himalayan Water Commission to establish legally binding, cooperative basin management between India, China, and lower riparian states.
2. **Predictive AI for Sedimentation and Lifecycles**: As sedimentation cripples Himalayan dams, future policy must mandate the financial integration of end-of-life decommissioning costs directly into the Levelized Cost of Energy (LCOE). Academic research should investigate the integration of machine learning and real-time geospatial data to accurately predict these sediment loads.
3. **Expansion of Indigenous EWS Networks**: Building on the successful pilot of the NDMA's satellite-based Early Warning System in Himachal Pradesh, infrastructural policy must scale automated alert systems across all 189 high-risk glacial lakes to mitigate the cascading destruction of GLOFs.
4. **Decentralized Policy Subsidies**: State-level subsidies and standardized Power Purchase Agreements (PPAs) must be tailored specifically for community-owned micro-grids to make decentralized hydro financially viable for private sector investment.

References

1. Annandale, G. W., Morris, G. L., & Karki, P. (2016). Extending the Life of Reservoirs: Sustainable Sediment Management for Dams and Run-of-River Hydropower. The World Bank.
2. Arthington, A. H., et al. (2018). The Brisbane Declaration and Global Action Agenda on Environmental Flows. Frontiers in Environmental Science, 6, 45.
3. Central Electricity Authority. (2025). Status of Large Hydro Electric Potential Development - Basinwise. Ministry of Power, Government of India.
4. Central Electricity Authority. (2026). National Electricity Plan (Generation Vol. I) & Roadmap to 100 GW of Hydro Pumped Storage Projects. Ministry of Power, Government of India.
5. Dahal, K., et al. (2025). Sedimentation and reservoir sustainability in the Himalayas. Nature Scientific Reports.
6. Dam Safety Act, 2021. (2021). The Gazette of India, Ministry of Law and Justice.
7. Gadgil, M., Berkes, F., & Folke, C. (1993). Indigenous knowledge for biodiversity conservation. Ambio, 22(2/3), 151-156.
8. Giri, S. (2022). Cost and benefit analysis on sediment removal and recycling. Water-Energy-Food Nexus.
9. Ministry of Environment, Forest and Climate Change (MoEFCC). (2021). Status Paper on River Ganga. Government of India.
10. Ministry of Water Resources, River Development and Ganga Rejuvenation. (2018).
11. Notification S.O. 5195(E) on Ecological Flows in River Ganga. Government of India.
12. National Disaster Management Authority (NDMA). (2026). National Glacial Lake Outburst Floods Risk Mitigation Programme (NGRMP). Government of India.
13. NHPC Limited v. State of Himachal Pradesh & Ors. (2024). 2024 SCC Online HP 533. High Court of Himachal Pradesh.
14. Rahaman, M. M., & Varis, O. (2009). Integrated water management of the Brahmaputra basin: Perspectives and hope for regional development. Natural Resources Forum, 33(1), 60–75.
15. Sattar, A., et al. (2024). The Sikkim flood of October 2023: Drivers, causes, and impacts of a multi hazard cascade. Science, 384(6698), eadn1857.
16. Schwanghart, W., et al. (2016). Glacial lakes in the Indian Himalayas—From an area-wide glacial lake inventory to on-site and modelling based risk assessment. Science of the Total Environment, 468, S71-S84.
17. Shugar, D. H., et al. (2021). A massive rock and ice avalanche caused the 2021 disaster at Chamoli, Indian Himalaya. Science, 373(6552), 300-306.
18. The Energy and Resources Institute (TERI). (2023). Pumped Storage Plants: Essential for India's Energy Transition. TERI Discussion Paper.