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Climate Resilience Across Borders

Insights from India-Bhutan Relations

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Geopolitics & Geoeconomics

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Abstract

Climate change is increasingly recognised as one of the most pressing global challenges in contemporary times. In South Asia, the region is experiencing significant repercussions including extreme rainfall, flooding, etc. As natural phenomena don't pay attention to manmade political borders, these issues often span across the region. Nevertheless, it simultaneously presents a distinctive opportunity for regional collaboration as it can't be handled in isolation. The climate cooperation between India and its Himalayan neighbour Bhutan seems visible on this front. Hence, this study explores the various facets of bilateral cooperation between India and Bhutan over climate change. The study aims to analyse the existing climate cooperation between India and Bhutan along with the case study on hydropower trade. As per the study, mutually beneficial hydropower cooperation between these two countries seems instrumental in strengthening India's commitment for renewables. However, the emerging challenges in Bhutan, including escalating hydropower debt, youth unemployment, and delays in project completion, pose significant obstacles to climate cooperation efforts. In conclusion, the study advocates for the diversification of climate cooperation, which currently relies heavily on hydropower, to encompass non-hydropower sectors, collaborative research, and information exchange, thereby enhancing the capacity to address common climate challenges effectively.

Keywords: Climate Change, Hydropower, South Asia, China, Regional Cooperation.

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List of Abbreviations

IPCC	Intergovernmental Panel on Climate Change
ADB	Asian Development Bank
GDP	Gross Domestic Product
MoU	Memorandum of Understanding
LDC	Least Developed Country
UN	United Nations
GNH	Gross National Happiness
CEA	Central Electricity Authority
CWC	Central Water Commission
MW	Megawatt
CHP	Chhukha Hydropower Project
HEP	Hydroelectric plant
COP	Conference of the Parties
PM	Particulate Matter
WHO	World Health Organization
SDGs	Sustainable Development Goals
GLOFs	Glacial Lake Outburst Floods
KW	Kilowatts
UNFCCC	United Nations Framework Convention on Climate Change
GW	Gigawatts
CDM	Clean Development Mechanism
CBET	Cross Border Electricity Trade
MU	Million Units
JET	Joint Experts Team
JGE	Joint Group of Expert
JTT	Joint Technical Team
EWS	Early Warning System
SAARC	South Asian Association for Regional Cooperation
BBIN	Bangladesh, Bhutan, India, and Nepal

1. Introduction

South Asia is one of the regions in the world that is most likely to be affected by climate change (Abeysekara et al., 2024). As per the Intergovernmental Panel on Climate Change (IPCC), South Asia is likely to warm up more than the rest of the world as the climate changes. In addition, it is anticipated that monsoon rainfall will rise, accompanied by a higher frequency of extreme precipitation events (Ahmed, 2014). According to a 2015 Asian Development Bank (ADB) report, the total costs of climate change in South Asia are expected to rise over time and eventually reach unsustainable heights. Without a global shift away from reliance on fossil fuels, South Asia may lose 1.8% of its Gross Domestic Product (GDP) annually by 2050, and by 2100, that percentage could average 8.8% (ADB, 2015). According to the report, by 2050, the Maldives is predicted to suffer the largest GDP loss, while Bangladesh, Bhutan, India, Nepal, and Sri Lanka are predicted to suffer yearly GDP losses of 2.0%, 1.4%, 1.8%, 2.2%, and 1.2%, respectively.

Nonetheless, climate change is a factor that both divides and unites countries. Scholars have studied these two aspects of environmental issues, emphasising the possibility of international cooperation as well as conflict. Scholars and policymakers have shown a great deal of interest in the interactions among environmental problems like climate change, the depletion of renewable resources, water distribution, and natural disasters (McDonald, 2013). On the other hand, Ide (2019) offers a thorough examination of the scholarly literature pertaining to environmental issues and the possibility of interstate cooperation. The existing body of literature on environmental peace-making suggests that nations in conflict have the potential to transcend their disputes and collaborate on shared environmental issues.

In South Asia, the bilateral relations between India and Bhutan reflect these aspects. Both the South Asian countries seem to be cooperating on environmental challenges like climate change. Bisht (2019) has discussed a case study of the India-Bhutan Cooperation on the river Saralbhanga. The article argues that a combination of both formal organisations and informal networks has played critical role in fostering cooperation on transboundary rivers between these two neighbours. Both the countries

have signed a Memorandum of Understanding (MoU) for cooperation in the environmental sector, including climate change (PTI, 2021, June 18).

1.1. Basic Profile of Bhutan

Bhutan, a small, landlocked nation situated in the Himalayas, shares its borders with the Tibetan region of China and the Indian states of Sikkim, Assam, West Bengal, and Arunachal Pradesh (Ueda, 2003). This highly mountainous and rugged area spans roughly 38,394 km^2, comparable in size to Switzerland, and is inhabited by approximately 0.7 million individuals (National Statistics Bureau, Bhutan, 2023).

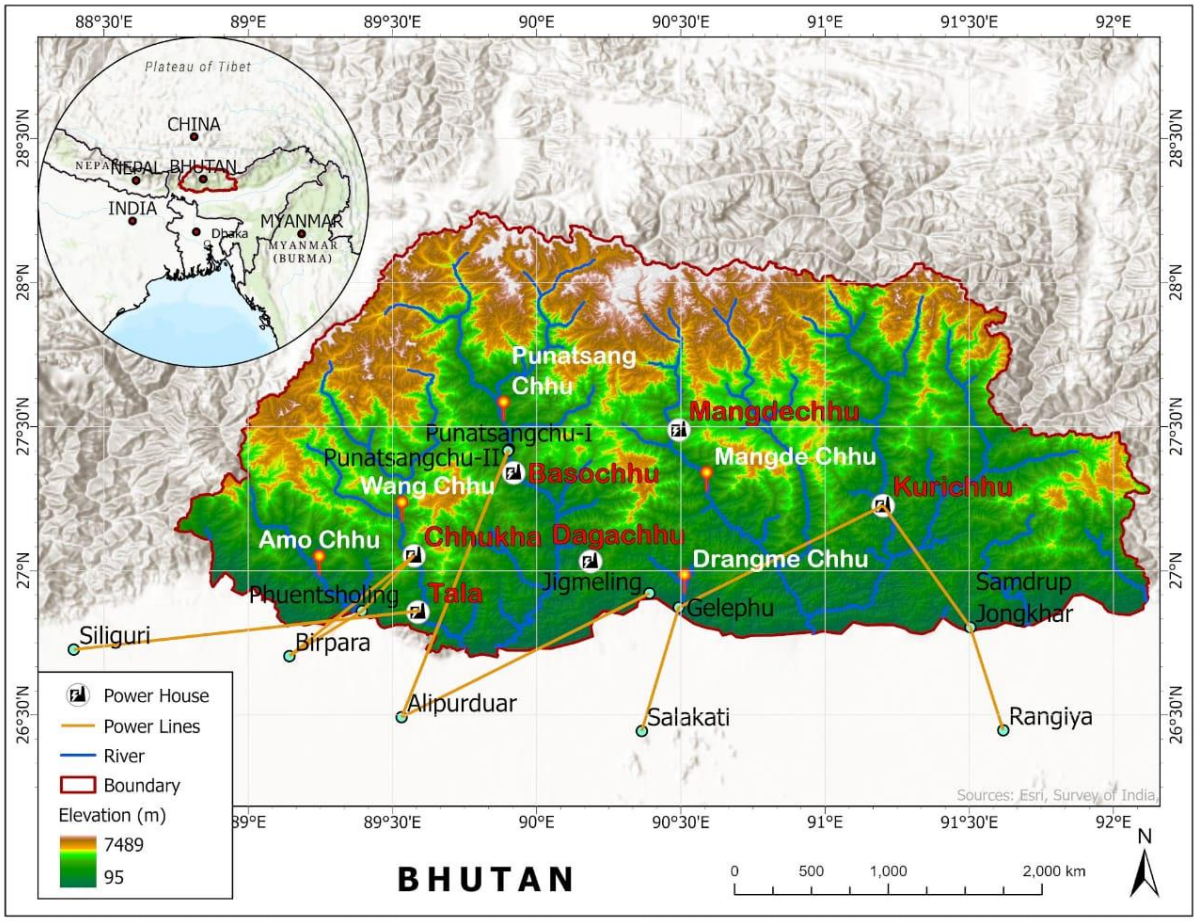


Fig. 1. Location Map of Bhutan (with major hydropower projects and power transmissions lines)[1]

[1] Prepared by the author using a Bhutan shapefile digitised from Google Earth.

The country exhibits a low population density of 20 people/km^2, with merely 45.8% of its population living in urban regions. Geographically, it is situated between longitudes 88° E and 93° E, and latitudes 26° N and 29° N (Tariq et al., 2021). The Kingdom of Bhutan, which is separated by the states of Sikkim (32 km), West Bengal (183 km), Arunachal Pradesh (160 km), and Assam (264 km), shares a border with India of about 699 km (km) (Government of India, 2023). Of these, Assam has the longest border segment, making up 37.77% of the entire boundary, while Sikkim has the shortest, making up 4.58%.

Bhutan holds a unique distinction of being the lone carbon negative country globally, with over 71% of its land covered by forests. Additionally, in terms of water resources, it also ranks among the highest in per capita water availability (Norten, 2021). The glaciers, glacial lakes, wetlands, and monsoon rainfall are the major sources of the nation's freshwater. In topography, the northern region is marked by steep mountains that reach heights of around 7,500 metres (m), while the southern region features elevations that drop to as low as 100m (Tariq et al., 2021). This diverse topography of the region leads to the creation of profound valleys, through which four major rivers flow: Amochhu, Wangchhu, Punatsangchhu, and Manas (Figure 1). While the majority of these rivers originate within Bhutan, the headwaters of the Kurichhu, Gongri, and Amochhu are located in Tibet (World Bank Group, 2016). All rivers in Bhutan eventually empty into India. These rivers are essential in shaping Bhutan's landscape and fulfilling various water-related purposes.

Throughout its geographically diverse landscape, with the north experiencing bitterly cold winters and the south being warm and humid tropical, quite a few ethnic groups have settled. Bhutan is essentially divided into two main cultural groups, reflecting the Drukpas and the Lhotshampas. The Drukpas include a number of sub-ethnic groups such as the Ngalopas, Mongolpas, Khenpas, Bumthangpas, Kurtoepas, and Sharchopas, all of them following the Drukpa school of Mahayana Buddhism. On the one hand, Lhotshampas, mostly of Nepalese descent, are Hindus in terms of religion and represent the predominant ethnic group in Bhutan. They live in the Southern part of Bhutan and make up almost one-third of the country's total population (Herison, 2024).

On the economic landscape, recently, Bhutan changed its status from a 'Least Developed Country' (LDC) to a developing middle-income country in the United Nations (UN) list (December 2023). The country has a $3,718 GDP per capita, but its development plan is still based on the concept of Gross National Happiness (GNH) (World Bank, 2024). Bhutan has deep economic and strategic ties with India, which is its largest trading partner, a major source of foreign assistance, and a buyer of surplus hydroelectric power. Hydropower has turned into a steady income source for the country, accounting on average for 13% of Bhutan's GDP (MoF, Bhutan, 2024). As per the Macroeconomic Situation Report of the Government of Bhutan (2023), hydropower is the largest source of foreign currency earnings, accounting for almost 36% of total exports over the years and about 27% of domestic revenue.

1.2. Data and Methodology

This research has employed a qualitative methodology, incorporating the following methods:

Literature Review/Document Analysis: A literature review was performed by examining the present context and evaluating the existing frameworks, which encompass legal agreements, policy frameworks, environmental accords, and bilateral strategies aimed at enhancing climate resilience between India and Bhutan.

The secondary data collection was done from the different official government sites in India and Bhutan, including the Central Electricity Authority (CEA), India, Central Water Commission (CWC), India, Department of Water Resources, River Development and Ganga Rejuvenation, India, Ministry of Finance, Royal Government of Bhutan, Department of Labour, Ministry of Labour and Human Resources, Royal Government of Bhutan, among others.

The collected data was studied, analysed, and finally concluded.

Case Study: An investigation of specific climate resilience initiative, such as Bhutan's hydropower trade with India.

The benefits and challenges for climate cooperation between India and Bhutan were identified and based on the study, policy recommendations were made.

2. Historical Perspective on India-Bhutan Environmental Cooperation

After India's independence, India-Bhutan relations have been mainly guided by the Treaty of Perpetual Peace and Friendship, 1949 (Malik & Sheikh, 2016). Both the countries signed a mutually agreed treaty to ensure perpetual cooperation in various sectors. It specially incorporated the areas for cooperation, like trade and commerce, national security including import export of arms and ammunitions, cultural exchanges, etc. The treaty underwent a revision in 2007, incorporating provisions that grant Bhutan greater autonomy in its external affairs, independent of Indian influence. This revision aims to align with the national interests of both countries (Nga et al., 2019). Although the draft of both the treaties did not incorporate environmental cooperation, it influenced the future environmental and resource-sharing collaboration.

After the friendship agreement, the major environmental sector that began with bilateral cooperation between the two countries was hydropower trade. This shows how countries can choose to cooperate on environmentally sensitive issues like clean energy. Both nations have benefited from the hydropower trade, with Bhutan receiving export revenue from India and India receiving clean energy (Royal Bhutanese Embassy, New Delhi, India, 2025).

The hydropower cooperation between these two countries started mainly in 1961, with the Jaldhaka agreement. After this agreement, a series of cooperative initiatives began between India and Bhutan. In the 1970s, three power import connections were set up in southwestern Bhutan to provide electricity to villages and towns near the Indian border (Premkumar, 2016). The contract for the execution of the 336 MW Chhukha run-of-the-

river hydropower project was formalised in 1974. The breakthrough was achieved in 1987, when the Chhukha Hydropower Project (CHP) of 336 MW was commissioned (Royal Bhutanese Embassy, New Delhi, India, 2025). In February 1994 and March 1996, agreements were struck to implement the 60 MW Kurichhu reservoir hydroelectric plant (HEP) and the 1020 MW Tala run-of-the-river HEP. Hence, the 1990's witnessed both the countries emphasising more on environmental issues and engaging in bilateral discussions to balance hydropower development with ecological concerns (Premkumar, 2016).

During the 2000's, the growing urgency of climate change encouraged India and Bhutan to strengthen their bilateral cooperation through formal agreements. A significant milestone was the 2006 Agreement on Cooperation in the Field of Hydroelectric Power, which focused on the sustainable development of hydropower resources to meet Bhutan's clean energy goals while addressing regional energy demands (MoEA, India, 2016). In 2009, Bhutan further solidified its environmental commitment by pledging to remain a carbon-neutral country at the Conference of the Parties 15 (COP) Summit in Copenhagen (Daksh, 2024). India has played a pivotal role in supporting Bhutan's ambitious goals by investing in clean hydropower projects that not only bolster Bhutan's economy but also help offset carbon emissions across the region.

Beyond clean energy collaboration, India and Bhutan have also actively worked on biodiversity conservation in the ecologically sensitive Himalayan region. A notable example is their joint efforts, alongside Nepal, to conserve the Kanchenjunga Landscape, an expansive area of approximately 16,000 km^2, which serves as a vital ecological corridor for biodiversity preservation and climate adaptation in the Eastern Himalayas (PTI, 2014).

3. Climate Change Impacts and Vulnerabilities of India and Bhutan

South Asia is a global hotspot for climate change (Afzal & Nishtar, 2023). Since the South Asian countries share common rivers, ecosystems, and weather systems, the subcontinent becomes more vulnerable to the impact of climate change. Five out of eight countries in South Asia, i.e. Pakistan, Maldives, India, Sri Lanka, and Bangladesh, are littoral states and, hence, vulnerable to sea-level rise. A country like Maldives, with lower average altitude, faces an existential crisis (Walshe & Stancioff, 2018). In the northern side of the region, there are the mighty Himalayas, Hindu Kush and Karakoram Mountain ranges, shared by Afghanistan, Pakistan, India, Nepal, and Bhutan (Sharma et al., 2022a). Weather and climate hazards do not respect political boundaries and, hence, cannot be tackled effectively without common efforts.

Climate response in South Asia requires immediate attention as approximately 800 million individuals reside in regions identified as climate vulnerable hotspots. These areas are expected to face the consequences of increasing temperatures and severe weather phenomena by 2050, if high levels of carbon emissions persist (Fruman and Huq, 2022). As entire South Asian countries are prone to climate-induced hazards, India and Bhutan also have reason for concern.

While India and Bhutan share a few issues, the escalating threat of climate change is emerging as a critical concern for both nations. The rise in temperatures, frequency of natural disasters, glacial melt, insufficient early warning system, transboundary water issues, and air pollution are increasingly affecting the livelihood in both the countries. Addressing these challenges requires a collective effort, as the climatic issues impacting the region transcend national boundaries. Therefore, effective solutions should entail cooperation that extends beyond the limits of individual nations (Madhavan, 2024).

Among the significant environmental issues, air pollution has increasingly become a visible concern in both India and Bhutan. Despite Bhutan's commitment to eco-friendly policies and sustainable development, the country still faces challenges from cross-

border pollution. Bhutan's geographic location in the eastern Himalayas and its dependence on natural air flows mean that pollution from neighbouring countries can significantly impact its air quality. As a landlocked nation with limited industrial activity, much of Bhutan's air pollution is attributed to transboundary sources, primarily from emissions originating in its neighbouring countries including India (Sharma et al., 2022b). The research additionally reveals that the Particulate Matter 2.5 **(**PM) levels in Thimphu, Bhutan, from 2018 to 2020 were three times higher than the thresholds established by the World Health Organization (WHO). By examining the transboundary characteristics of this air pollution, the study identifies India and Bangladesh as major contributors.

As the country cannot effectively tackle these environmental issues in isolation, Bhutan's Prime Minister Tshering Tobgay has highlighted the importance of India's advancement in addressing regional air pollution. According to Tobgay, as India becomes a more advanced country, its efforts to curb pollution will likely lead to significant reductions in emissions, which would have a positive downstream impact on Bhutan's air quality (PTI, 2024a). Tobgay's statement underscores the interdependence of air quality management in the region and suggests that India's progression towards cleaner technologies and sustainable development would yield regional environmental benefits. Additionally, the aim is to supply India with green renewable hydrogen, which would aid in reducing carbon footprints and facilitate the achievement of India's Sustainable Development Goals (SDGs).

Along with air quality, the agricultural sector has also been affected by climate change, with projections indicating that more severe and adverse effects are likely in the future. As per estimates, South Asia may lose around 1.8% and 8.8% of its GDP by 2050 and 2100, respectively, in the absence of adaptive measures to tackle climate change. The average loss in South Asia is higher compared to the global average (7%). This might be because of the overreliance of South Asian economies on agriculture. Out of the eight South Asian countries, Bhutan is predicted to be the worst hit, with around 18% agricultural loss by 2099, whereas India ranks 3rd in the list, with a projected 10% loss (Kapoor et al., 2024).

The above-mentioned issues, especially air pollution, highlight that climate change presents a collective challenge for both India and Bhutan, necessitating collaborative efforts to address it effectively.

4. Climate Resilience in Transboundary Cooperation

Climate resilience, which refers to the ability of social, ecological, and institutional systems to anticipate, absorb, adapt to, and recover from shocks caused by climate change while retaining essential functions, has become a key analytical framework in the literature on climate governance (IPCC, 2022). Especially important for climate-vulnerable areas like the Himalayan belt, climate resilience emphasises on adaptation, institutional preparedness, transboundary cooperation, and enduring sustainability in contrast to mitigation, which focuses on reducing emissions.

In India-Bhutan bilateral relations, climate resilience is referred to as a transboundary strategy that includes shared river basin management, hydropower cooperation, disaster risk reduction, and institutional coordination to work together to address climate-related changes in water flows, glacial melt, and severe weather events. Since Bhutan and the northeastern states of India are more susceptible to various climatic and geological hazards, such as irregular monsoon patterns, glacial lake outburst floods (GLOFs), landslides, etc., it creates a compelling situation for collaborative resilience-building efforts (Mukherji et al., 2015).

4.1. Climate Resilience and Hydropower Cooperation

Hydropower is central to economic and environmental cooperation between India and Bhutan. It is often seen as an energy-security arrangement, but hydropower cooperation also acts as a measure for climate resilience between these two nations. In addition to bringing revenue, essential to employ climate adaptation and conservation policies, Bhutan's run-of-the-river hydropower projects, developed largely with Indian technical and financial assistance, generate low-carbon electricity, and enhance adaptive capacity through regulated river flows (CRF India, 2025).

From a resilience perspective, hydropower cooperation facilitates shared risk management. Climate change-induced hydrological volatility affects both upstream (Bhutan) and downstream (India) regions; hence, coordinated dam operation, data-sharing on rainfall and glacier dynamics, and early warning systems become essential components of transboundary climate resilience. For instance, data from the Manas River basin in eastern Bhutan are transmitted directly to the CWC office in Barpeta, Assam, while western basins such as the Amochhu, Wangchu, and Punatsangchhu share information with CWC offices in Cooch Behar and Jalpaiguri, West Bengal. Agreed transmission schedules during monsoon and non-monsoon periods ensure that Indian agencies receive timely and accurate information for flood forecasting and preparedness (Choden, 2025).

In addition, most of Bhutan's hydropower plants are run-of-the-river type, which indicates the dependency on availability of water in the river. However, water availability significantly decreases in the dry winter season, typically from November to April (SARI/EI and IRADe, 2016). Since domestic energy demand in Bhutan is rising, it necessitates import of energy from outside to fulfil the need. Hence, Bhutan imports energy from India to cater to the energy demands, specifically in water scarcity scenarios (ETE, 2023). It means, for Bhutan, which derives over 90% of its electricity from hydropower and relies on exports to India for substantial revenue, this partnership builds economic and institutional resilience against climate-induced variability—such as erratic monsoons, accelerated glacier retreat, and increased flood risks—while providing India with reliable, low-carbon baseload power to support its grid stability and renewable energy targets (Palit, 2025; Future Water, 2021).

4.2. Hydropower and Gross National Happiness (GNH)

Since 1971, Bhutan has dismissed GDP as the sole metric for assessing progress. Instead, it has advocated for an alternative development framework that evaluates prosperity based on established principles of GNH, alongside the spiritual, physical, social, and environmental well-being of both its populace and the natural surroundings. The concept of GNH enjoys the support and validation from the highest authorities in

Bhutan. The present king, Jigme Khesar Namgyel Wangchuck, has also said that "GNH measures the quality of a country in a more holistic way and believes that the beneficial development of human society takes place when material and spiritual development occurs side by side to complement and reinforce each other" (Ura, 2015). Even the Constitution of Bhutan, under its Article 9, emphasises that "The State shall strive to promote those conditions that will enable the pursuit of GNH."

The pursuit of GNH is also reflected in Bhutan's obsession to harness the potential of hydropower in the country. Tshering Tobgay, the Prime Minister of Bhutan, had said in an interview that although hydropower is bound to create environmental concerns, the advantages accrued from it surpasses the disadvantages (Yasuda et al., 2017). This not only supports making Bhutan a carbon negative country but also gives its neighbour India green energy (Martin, 2016).

Apart from being a clean energy, hydropower has been proven for its significance in realising other socio-economic development targets enshrined in the GNH. First is to provide safe, reliable, sufficient, and affordable electricity for domestic consumption and industrial use. The other is providing the much-needed capital gained from export of hydroelectricity to finance social projects and achieve economic self-reliance (Tshering and Tamang, 2004). Because of the increased hydropower generation, Bhutan has achieved a high rate of electrification, with over 99.5 per cent of households connected to the grid (DoE, Bhutan, 2023).

Although hydropower stimulates the various socio-economic and material benefits, it is also not immune to environmental losses (Berga, 2016). The construction of hydropower dams triggers variation in hydrology and river morphology, which significantly impacts aquatic biota and their habitats (Agostinho et al., 2008). Due to accumulation of water in the reservoir, often terrestrial floral and faunal habitats are permanently lost to submergence (Rai et al., 2024).

In Bhutan, the construction of hydropower plants was highlighted as one of the key drivers of deforestation and forest degradation (MoAF, 2017). Hence, to lessen the

negative impacts, Bhutan has established comprehensive frameworks through various rules and regulations aimed at mitigating environmental degradation. Notable examples include the Environmental Assessment Act of 2000, Environmental Assessment Guideline for Power Transmission Lines from 2012, and the Environmental Assessment Guideline for Hydropower Development (2012) (World Bank Group, 2016). In addition to these legal provisions, the benefit-sharing mechanisms implemented by the Bhutanese government not only facilitate the attainment of poverty alleviation objectives but also foster social acceptance for large-scale infrastructure initiatives that might otherwise lead to social upheaval.

5. The China Factor and Incentivised Cooperation

Chinese engagement in Bhutan, particularly infrastructure development near disputed border areas, has introduced a new strategic variable in Bhutan's foreign relations. While China's involvement is often framed in geopolitical terms, it indirectly incentivises India to deepen its climate and hydropower cooperation with Bhutan as a counterbalancing strategy.

Instead of reacting with strong security measures, India has focused more on developmental diplomacy and climate cooperation (Chakrabarty, 2022). By building climate-resilient infrastructure, helping Bhutan with its renewable energy goals, and supporting Bhutan's GNH sustainability model, India presents itself as a trustworthy and environmentally responsible partner, unlike China's focus on large infrastructure projects.

Additionally, Beijing's presence in Bhutan's northern border areas and its own upstream dam cascade on the River Yarlung Tsangpo (Brahmaputra) raise strategic concerns for India regarding water flow regulation and regional influence (Manhas and Lad, 2024). By intensifying hydropower and climate partnerships and support for projects like Punatsangchhu-II, India effectively counters this influence, positioning climate cooperation as a form of strategic reassurance (PIB, 2025; IMPRI, 2025). This

reassurance is manifested through concessional financing, technology transfer, and joint monitoring, which signal India's commitment to Bhutan's sovereignty and sustainable development while securing its own energy and security interests in the eastern Himalayas.

6. Bhutan's Small State Dilemma

Bhutan, a small Himalayan country, is strategically located between Asia's regional powers China and India (Sherpa, 2013). Apart from being sandwiched between two political and economic powers, Bhutan, in terms of its geographical extent, is a small state. As per the international relations theories, the small state formulates their foreign policy essentially maintaining neutrality (Simpson, 2018). However, in the case of Bhutan, though it seems inclined towards India, it has systematically managed to balance relations between both India and China (Shivamurthy, 2022).

With India, it shares unique relations. In comparison to other South Asian countries, both countries remain committed to smooth and trouble-free bilateral relations (Sarkar, 2012). The Friendship Treaty of 1949, which was amended in 2007, has proven instrumental in shaping the overall bilateral engagement between them. The bilateral relations between these two Himalayan neighbours span not only economic engagements but also cultural, strategic, political, and other engagements (Rajput, 2014). The strategic location of Bhutan, especially close to the narrow strip (also known as 'Chicken's Neck'), which connects India's north-eastern states to mainland India, enhances its geopolitical value for India (Mitra & Thaliyakkattil, 2018). Bhutan shares these security concerns and has employed its foreign policy considering India's strategic vulnerability. As a small, landlocked state, Bhutan has established good economic ties with India to ensure its financial security. As Bhutan has huge hydropower potential, India has helped it to exploit hydropower and has acted as a reliable importer of the excess hydroelectricity produced in Bhutan.

On the other hand, China employed a relatively aggressive stance against Bhutan until the 1960's (Gambhir, 2021). However, Beijing has demonstrated a degree of strategic

foresight in recognising Bhutan as a small yet significant component of its policy framework in South Asia. Similar to its approach with Nepal, Beijing has utilised a combination of persuasive tactics and coercive measures in its dealings with Bhutan, reminding it of the potential consequences of aligning with India (Jha, 2013).

Bhutan, on the other hand, employed balancing policies after India's defeat to India in the 1962 war. In 1974, the then King of Bhutan invited the Chinese representative to his coronation, and in his public statements expressed a desire for friendly relations with China (Mitra & Thaliyakkattil, 2018). Most recently, both the countries have strived to enhance cooperation in the fields of economy and tourism, hydroelectricity and infrastructure, and resource exploitation (Jha, 2013). Along with these non-traditional security issues, both countries have shown interest in resolving the contested boundary issue through continued bilateral engagement.

Being a small, landlocked state with restricted foreign policy options, Bhutan has been balancing its position between the two major powers, India and China. In other words, Bhutan's most significant achievement in foreign policy can be characterised by its ability to avoid being perceived as either a taken-for-granted entity or as entirely untrustworthy by India or China. Along with this, as a proponent of the concept of GNH, Bhutan has successfully established its separate identity at the international forum (Kaul, 2022).

6.1. Bhutan's Small State Strategy and Hydropower as Climate Resilience Tool

Climate resilience is strategically applied in the context of India-Bhutan transboundary cooperation through shared hydropower initiatives that serve as adaptive infrastructure against climate-induced vulnerabilities, while Bhutan's small-state agency balances relations with its larger neighbours. Bhutan is a small country that manages its geopolitical situation between India and China by using climate cooperation to build trust and resilience (Kaul, 2021). Due to its small size and limited resources, Bhutan

seeks to strengthen its bilateral relationship with India, its main development partner, to boost climate resilience while steering clear of regional competition.

Hydropower cooperation shows this approach in action. Bhutan's hydropower projects receive project investigation, design, engineering services, construction supervision, and highly concessional financing from its trusted partner India, which also commits to buy all surplus electricity after meeting Bhutan's domestic needs (Government of India & Royal Government of Bhutan, 2006). This mutually beneficial partnership elevates Bhutan's preparedness to build resilience against impeding climate crisis (Druk Journal, 2025). Hence, by treating hydropower as climate adaptation infrastructure, Bhutan alleviates glacial melt impacts through controlled storage and energy diversification, while India also secures renewable energy and strengthens its regional influence (CRF India, 2025).

As a small state, Bhutan strategically chooses this deepened cooperation with India to counterbalance China's growing regional presence, using climate resilience as a low-risk domain for economic and security gains without direct confrontation (Kaul, 2021).

7. India-Bhutan Climate Cooperation Initiatives

7.1. Hydropower Trade

7.1.1. Hydropower Potential in Bhutan

Bhutan, a small, landlocked nation located in the eastern Himalayas, has abundant water resources due to the presence of immense river networks (Katel et al., 2015). Amo Chu, Wang Chu, Punatsang Chu, and Drangme Chu are the major river basins among them. Additionally, several smaller rivers, including Aiechhu, Jaldhaka, Jomori, Nyera Amari, and Merak-Sakteng, contribute to the hydrological landscape (Ranjan, 2020).

Bhutan ranks among the highest in the world in per capita freshwater availability, approximately around 100,000 cubic metres (Dorji & Choden, 2021). This exceptionally high-water availability can be attributed to Bhutan's smaller population, combined with substantial annual rainfall. The continuous mountain boundary with the southward inclination of the Himalayas is the primary reason for the critical and minor shared river

basins between India and Bhutan. Estimates indicate that approximately 56 smaller rivers traverse the political border, flowing into Indian territory to converge with the Brahmaputra River (Ranjan, 2020).

Along with enabling hydropower generation, the rivers of Bhutan play a critical role in shaping the social, cultural, and economic landscape of the country. The river valleys in the Greater Himalayas, located at higher altitudes, are notably wider compared to those found in the inner Himalayas and the southern foothills. As the rivers traverse through the Inner Himalayas towards the southern foothills, the valleys become narrower and steeper. This topographical setting suits hydropower generation, if harnessed properly (Katel et al., 2015).

Bhutan's hydroelectric potential is estimated at 30 GW, with 23.8 GW deemed techno-economically viable for development (Lad & Jaybhaye, 2025). However, the current installed hydropower capacity stands at a mere 1606 MW, representing only 5.35 per cent of the projected potential, indicating a significant gap in harnessing this resource (Department of Hydropower & Power Systems, Ministry of Economic Affairs, Royal Government of Bhutan, 2018).

Although Bhutan's hydropower sector has not achieved the expected growth, its salience for the country's overall development remains indispensable. As per the 12th Fiver Year Plan (2018-2023), the hydropower sector has contributed an average 16 per cent to Bhutan's GDP between 2007 to 2016. This figure is projected to increase to as much as 30 per cent after accounting for the upcoming construction of HEP.

7.1.2. Hydropower Collaboration Between India and Bhutan

The Jaldhaka Agreement, 1961, marks the beginning of hydropower collaboration between India and Bhutan. This agreement enabled the provision of 250 kilowatts (KW) of complimentary electricity to Bhutan from the project located in West Bengal, India (Ranjan, 2020). A significant advancement in this bilateral cooperation occurred in 1988 with the commissioning of the Chhukha Hydropower Project (CHP), which boasts a

capacity of 336 MW. This project marked the first large-scale hydropower endeavour in Bhutan, receiving substantial support from the Indian government, comprising 60 per cent in grants and 40 per cent in loans (Ranjan, 2018).

Since then, Bhutan has established five hydropower projects, such as the Chhukha hydropower project, with an installed capacity of 336 MW, the Basochu hydropower project at 64 MW, the Kurichu hydropower project at 60 MW, the Dagachhu hydropower project at 126 MW, and the Tala hydropower project, with a capacity of 1,020 MW. Additionally, the Mangdechhu hydropower project, which commenced operations in 2019, has an installed capacity of 720 MW (BSYB, 2020). As per the Department of Hydropower & Power Systems, Bhutan (2018), a comprehensive agreement was formalised in March 2009 between Bhutan and India to develop 10,000 MW of hydropower projects, with the intention of exporting surplus electricity to India by 2020.

India has pledged to transition 50 per cent of its electricity generation capacity from fossil fuels to renewable sources by the year 2030, in alignment with its Intended Nationally Determined Contributions (INDCs) under the United Nations Framework Convention on Climate Change (UNFCCC) (Chateau et al., 2023). To meet this ambitious goal, India must incorporate an additional 196 to 276 gigawatts (GW) of renewable energy capacity, which is a significant challenge (Pulla, 2015). Considering the substantial opposition to the construction of hydropower dams within its own borders, it is prudent for India to explore investments in hydropower projects in Bhutan as a strategic means to diversify its domestic energy portfolio (Yasuda et al., 2017).

The patterns observed in India's hydropower imports from Bhutan indicate a trend of stability over recent years. Since April 2018, India has expanded its import capacity from Bhutan, reflecting a prioritisation of clean energy sources (Figure 2). Conversely, Bhutan benefits from this trade by generating increased foreign currency revenue, thereby reinforcing its dedication to maintaining carbon neutrality and advancing its SDGs.

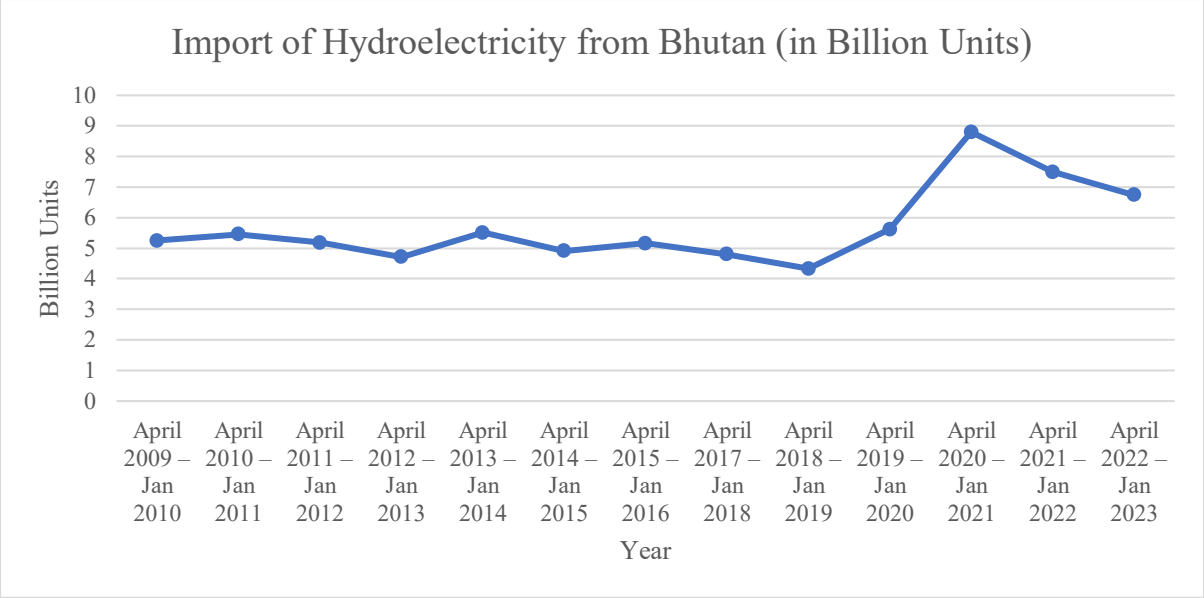


Fig. 2. Hydroelectricity Import by India from Bhutan (April 2009-Jan 2010 to April 2022-Jan 2023) (*Source:* Central Electricity Authority, India)

In addition to the conventional cooperation over hydropower, both the countries are exploring opportunities to diversify clean energy cooperation. Therefore, the recently concluded roundtable on the theme "Securing Sustainable Future: India-Bhutan Renewable Energy Partnership" on 28 October 2024 emphasised on further strengthening bilateral clean energy partnership, including through development of new energy projects in the fields of solar and green hydrogen (ANI, 2023). As a result, Tata Power, India, and Bhutan's Druk Green Power Corporation have established a collaboration aimed at developing 5,000 MW of clean energy initiatives (PTI, 2024b). Considering that Bhutan has the capacity to produce 12,000 MW of solar energy and 700 MW of wind energy, it would significantly contribute to diversifying the power generation source in Bhutan (Lhaden & Lhaden, 2024). This diversification attempt further reaffirms their commitment towards clean energy initiatives.

7.1.3. Reducing Carbon Footprints Through Hydropower Trade

More than half of India's total installed energy capacity is sourced from coal (Nagamani, 2015). Consequently, there exists an opportunity to decrease CO_2 emissions in the nation by substituting fuels and enhancing the utilisation of renewable energy sources (IRADe & NTPC School of Business, 2022). To achieve this goal, India has systematically

upheld its renewable energy contributions in the power sector. To ensure this, India has significantly increased its installed capacity of renewable energy from 15521 MW in 2010 to 125160 MW in 2023 (Government of India, 2024). Along with this tremendous growth in renewables, India also employs a policy to import hydropower from its two neighbouring countries known for hydropower generation, Bhutan and Nepal. By importing from these two countries, India ensures its commitment towards carbon neutrality along with indirectly supporting economies of these two Himalayan neighbours (Borge-Diez et al., 2024).

A formula based on the Clean Development Mechanism (CDM) and derived from the methodological tool established by the UNFCCC has indicated that India's anticipated carbon emission reductions from Cross Border Electricity Trade (CBET) during the period from 2016-17 to 2020-21 amount to 3.65 million tons of CO2 per year. Furthermore, it has been determined that CBET, particularly in relation to hydropower, with neighbouring countries like Bhutan and Nepal contributes to a significant annual reduction in carbon emissions (IRADe & NTPC School of Business, 2022). For Example, from the year 2016-17 to 2020-21, the total hydropower import by India from the above-mentioned countries was recorded at 23123.7 million units (MU), of which a whopping 22,932 MU was imported only from Bhutan (Ministry of Power, GOI, 2021). This fact confirms that the role of Bhutan in reducing India’s carbon footprints is crucial.

7.2. Gelephu Zero Carbon City

In recent times, Gelephu, a zero-carbon city located on the border between Bhutan and India, exemplifies effective climate cooperation between the two nations (Haider, 2024). This expansive city, part of a collaborative project covering over 2,500 km^2, significantly surpasses the size of Thimphu, the capital, which spans only 26 km^2 (North East News, 2024). Focusing on areas such as hydroelectricity generation, wildlife conservation, waste management, agriculture, forestry, and the establishment of wildlife corridors, this initiative has the potential to be a transformative factor in climate cooperation between India and Bhutan. Such projects serve as a prime example for developing countries, demonstrating how one nation can assist another in addressing climate

change challenges. This innovative climate financing model enhances India's commitment to its environmental responsibilities by engaging its South Asian neighbours. The importance of India's role in this project was emphasised by Bhutanese Prime Minister Tshering Tobgay, who stated, "If we chose any other place, then such a project may succeed, it may have its challenges, but if we plan this along the border with India, the concept itself will drive it to success, because Bhutan's future is intrinsically linked with India" (North East News, 2024, November 1).

This environmentally friendly project emphasises the preservation of farmlands, wildlife sanctuaries, and heritage sites while incorporating Bhutanese cultural elements into its architectural design. India has pledged financial support of ₹10,000 crore over the next five years to ensure its successful implementation (Laskar, 2024).

8. Climate Cooperation Other Than Hydropower

Apart from cooperating in hydropower, India and Bhutan extend their climate cooperation to addressing shared contemporary issues such as flood management, non-hydropower energy, air pollution, etc. (Table 1).

Table 1. Existing Climate Cooperation Mechanism in Non-hydropower Sector

Sr. No.	Cooperation Mechanism	Purpose
1	Joint Expert Team (JET) on Flood Forecasting	Evaluates the advancements and additional necessities of a network comprising 32 hydro-meteorological stations situated within the catchments of transboundary rivers.
2	Joint Group of Experts (JGE) on Flood Management	Examines and evaluates the likely causes and consequences of the persistent flooding and erosion occurring in the southern foothills of Bhutan and the adjacent plains in India. Additionally, proposes suitable and mutually

		agreeable remedial actions for both governments.
3	Joint Technical Team (JTT) on Flood Management	Evaluates the on-site conditions and offers technical assistance to JGE regarding flood management.
4	Memorandum of Understanding (MoU), 2021	Measures to mitigate air pollution, waste disposal strategies, chemical oversight, climate change mitigation, and related concerns.
M	Memorandum of Understanding (MoU), 2024	Renewable energy, environment and forestry
6	Joint Vision Statement on India-Bhutan Energy Partnership, March 2024	Engages in the development of hydro-power, solar and green hydrogen Enhances collaboration in the areas of energy efficiency and energy conservation.

(Source: DoWR, RD & GR, Government of India).

9. How Hydropower Model is Building Resilience in India-Bhutan Climate Cooperation

The existing hydropower model itself builds multi-dimensional resilience in the India-Bhutan relationship. It increases hydrological resilience by addressing seasonality and glacial melt through storage and run-of-river schemes, economic resilience by providing export earnings for Bhutan and clean power for India, and institutional resilience through arrangements such as the Joint Technical Committee on Hydropower, which facilitates data sharing and prevents disputes (Palit, 2025). Nevertheless, cost overruns in schemes such as Punatsangchhu-I and II, partly because of geological difficulties and climate-related delays, could impact the debt sustainability of Bhutan and future cooperation, possibly affecting the 30:70 grant-loan ratio formula (changed from the original 60:40 formula) and necessitating more Indian concessions or other sources of funding (CRF India, 2025). Despite the presence of asymmetries (with a larger partner, India), this model remains a successful case of environmental cooperation in an asymmetrical

relationship, as it proves the possibility of a successful long-term collaboration based on mutual benefits, trust-building, and adaptive governance in the face of geopolitical pressures from China (Palit, 2025; FutureWater, 2021).

This conceptual framing of climate resilience in India–Bhutan cooperation highlights its dual role as both a technical adaptation strategy and a geopolitical tool for strategic reassurance, offering lessons for other asymmetrical transboundary partnerships in South Asia.

10. Challenges to India-Bhutan Climate Resilience Cooperation

Although hydropower trade has become a critical part of India-Bhutan bilateral relations over the past few years, a few concerns have emerged in this trade in recent times. Rising hydropower debt, rising unemployment in Bhutan due to skilled labour from India, and delays in completing hydropower projects are some of the significant ones.

10.1. Mounting Hydropower Debt Pressure on Bhutan

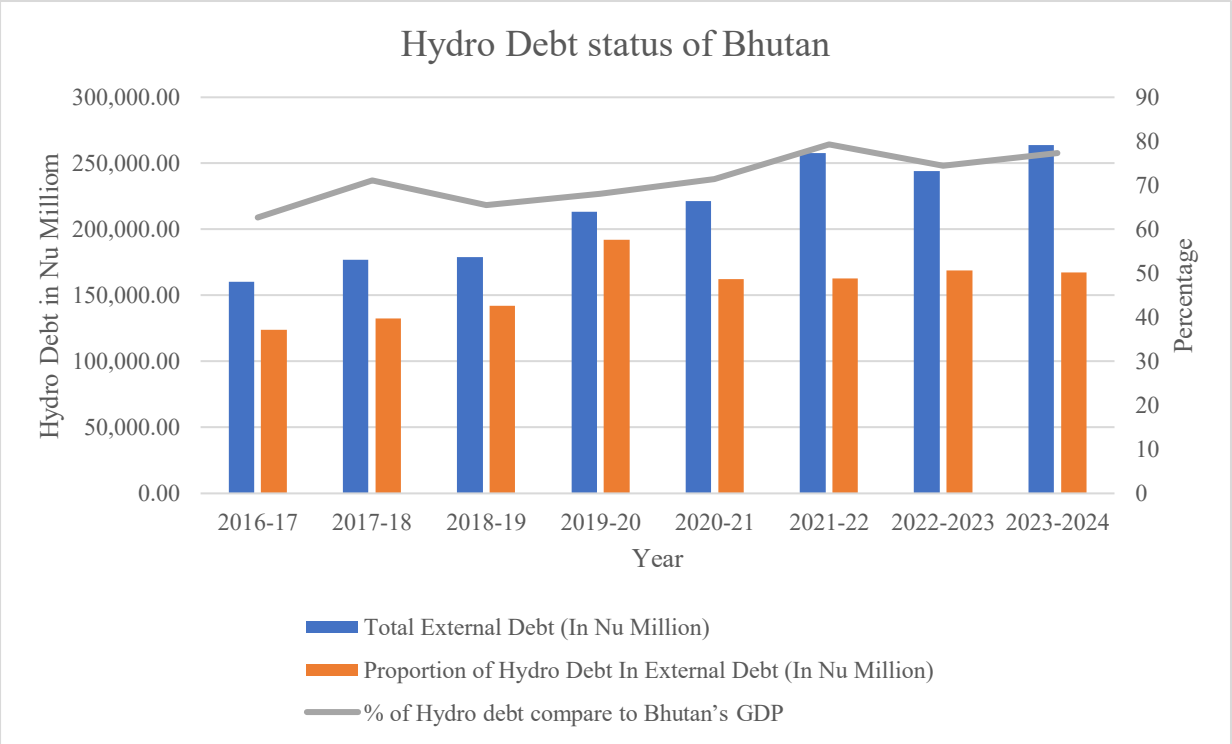
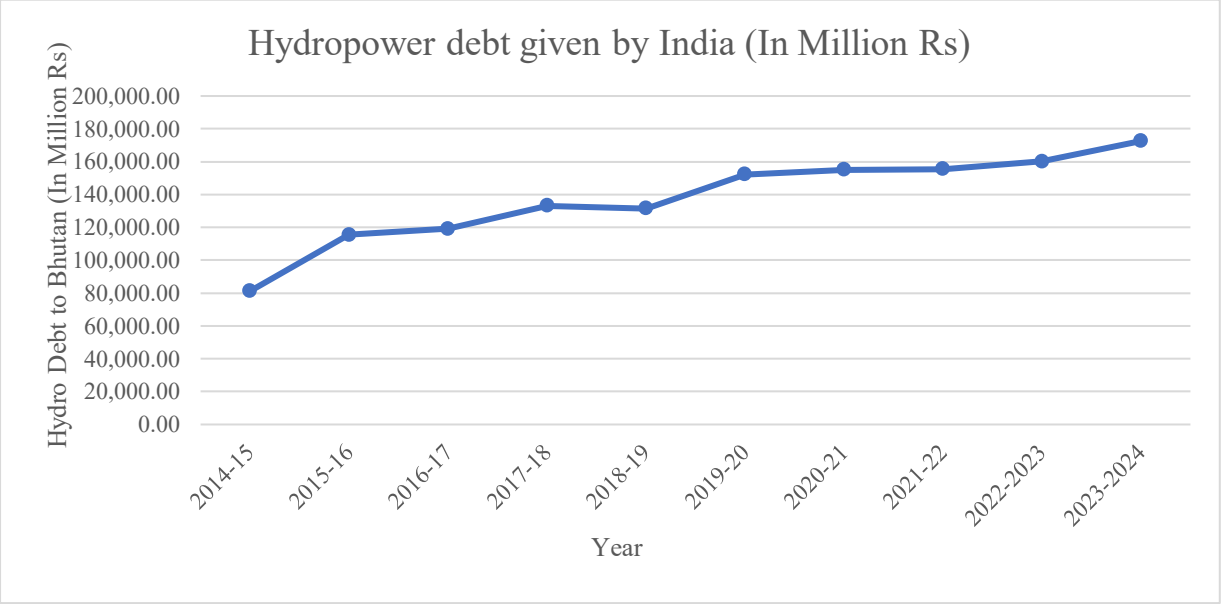


Fig. 3 Hydro Debt Status of Bhutan (2016-17 to 2023-24)

Source: Public debt situation report, Ministry of Finance, Royal Government of Bhutan.

Although hydropower export contributes heavily to Bhutan's GDP, concerns of debt taken for the sustenance of hydropower projects and related infrastructure has been piling up in Bhutan. As per the data, the proportion of hydropwer debt in the overall external debt shows continuous rise over the last few years (Figure 3). During 2016-17 to 2023-24, this ratio was the highest, 90.08%, in 2019-20, while the lowest was around 63.30%, in 2021-22. In addition, the proportion of hydropower debt in the GDP of Bhutan recorded a significant increasing trend during 2016-17 to 2023-24. This hydropower debt-to-GDP ratio rose from 62.29% in 2016-17 to 77.3% in 2023-24, an increase of 19.41%.



(Fig.4 Total Hydropower Debt Given by India to Bhutan (2014-15 to 2023-24)
Source: Public debt situation report, Ministry of Finance, Royal Government of Bhutan).

The hydropower debt given by India to Bhutan has been steadily in upward trend since the last decade (Figure 4). It has increased from around $81,183 million in 2014-15 to around $1,72,565 million in 2023-24, which accounts for more than double in just a decade. This trend underscores the critical role of India in hydropower production in Bhutan. However, the increasing debt has also created the burden of interest payment, which further strains Bhutan's economy. In addition, since 2010, India has changed its 'loan to grant' policy to finance hydropower projects in Bhutan from 60:40 to 70:30 (Bhonsale, 2023). Consequently, the proportion of hydropower debt in the overall financial assistance by India to Bhutan seems to be increasing as compared to grants.

The reduction is clearly illustrated by the decline in grants from 10,721 million Nu in 2015-16 to 6,773 million Nu in 2023-24. (Figure 5). This changing policy indicates that India's financial assistance to Bhutan to support its hydropower infrastructure continues to increase but its nature has shown Indian inclination to provide more loans instead of grants.

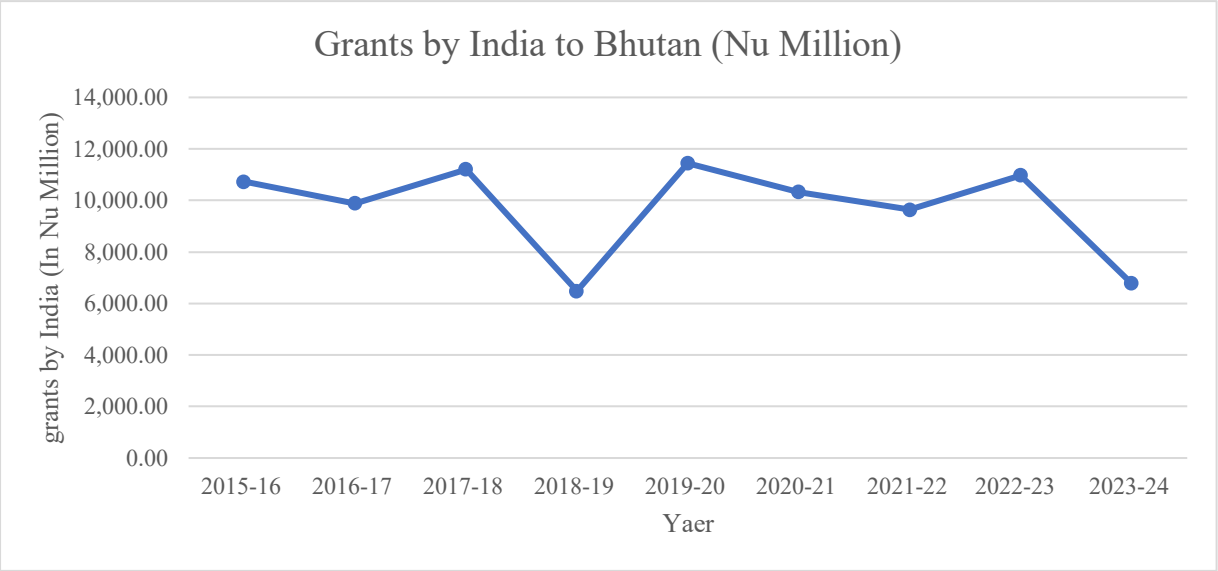


Fig. 5 Financial Grants Given by India to Bhutan (2015-16 to 2023-24)
(Source: Public debt situation report, Ministry of Finance, Royal Government of Bhutan).

10.2. Unemployment Issue

Apart from the hydro debt, the emerging challenge of local youth unemployment has started to become visible in Bhutan. A significant proportion of foreign workers receiving work permits in Bhutan are employed in the hydropower sector. For instance, during 2020–2021, approximately 13,821 labourers, out of a total of 18,509 foreign workers, were employed solely in the hydropower industry (Table 2). This heavy reliance on foreign labour is primarily due to the availability of affordable and easily accessible skilled and unskilled workers, predominantly from India.

India's proximity facilitates the influx of workers, who often possess the expertise required for large-scale hydropower projects. While this arrangement supports Bhutan's economic growth and energy goals, it also impacts local employment opportunities, as reliance on foreign labour limits the engagement of the domestic workforce in this key

sector. Consequently, India consistently dominates the tally of foreign labourers receiving work permits in Bhutan, further underscoring its significant role in the country's labour market dynamics.

Table 2. Work Permits Issued to Foreign Workers in Bhutan (2017-18 to 2023-24)

Year	Total Number of Foreign Labour Issued Permit	Number of Indian Labour Issued Permit	Percentage of Indian Labours
2023-2024	127340	126258	99.15
2022-2023	140830	139543	99.10
2021-2022	36178	35889	99.20
2020-2021	18,688	18,509	99.04
2019–20	16,417	NA	-
2018–19	50,057	49,677	99.24
2017–18	54,972	54,533	99.20

(Source: Annual Reports of the year 2017-18, 2018–19, 2019–20, 2020-2021, 2021-2022, 2022-2023 and 2023-24, Department of Labour, Ministry of Labour and Human Resources, Royal Government of Bhutan).

As per the Statistical Yearbook 2023, the unemployment rate of both males and females has increased from 2.7 per cent to 5.9 per cent during the short period from 2019 to 2022. The increase in unemployment during the given period is roughly double, indicating the severity of the issue. Additionally, the rate of unemployment among the youths is a more concerning issue for Bhutan. The rate of unemployment among the youth has increased from 11.9 per cent to 28.6 per cent, more rapidly as compared to the overall rate.

10.3. Delay in Completion of Hydropower Projects

In 2009, India and Bhutan entered into a commitment to collaboratively achieve the goal of generating 10,000 MW of electricity by the year 2020, recognising the mutual advantages of this endeavour and the opportunity to strengthen their historical ties and relations (Saklani & Tortajada, 2019). India pledged to offer support and financial resources, as well as to acquire Bhutan's excess electricity following the year 2020.

However, the delays in the completion of hydropower projects have become a major issue, considering the financial sustainability. Although the cost overrun due to delays in projects seem pervasive in most of the sub regions in the world (Latin America 53%, and Central Asia 108%), South Asia leads the table with 138% cost overrun (BEA, 2017). With significant jump in the overall cost, Bhutan is also not an exception to this. For example, the hydro project Punatsangchhu-1 was supposed to cost Rs 3,400 crore, and has cost Rs 9,700 crore (more than 2.5 times) (Table 3).

Table 3. Cost Overrun for Major Hydro Projects in Bhutan

Project Name	Capacity (MW)	Original Cost (Rs Cr.)	Escalated Cost (Rs Cr.)	Escalation Percentage (%)	Grant : Loan Ratio
Projects financed by the Indian Government					
Chhukha	336	83	246	**197**	60:40
Tala	1,020	1,400	4,126	**193**	60:40
Punatsangchhu I	1,200	3,400	9,700	**170**	40:60
Punatsangchhu II	1,020	3,778	7,435	**97**	30:70
Kurichhu	60	313	564	**79**	60:40
Mangdechhu	720	2,896	4,500	**29**	30:70
Projects financed by the Austrian Government and the ADB					
Dagachhu I	126	820	1,296	**48**	-
Basochhu II	40	142	182	**28**	-
Basochhu I	24	145	144	**None**	-

Source: Review of the Sustainable Hydropower Development Policy 2008. 27 May 2014. National Council of Bhutan

These examples explicitly illustrate that the cost overruns due to delays have the potential to hamper the economic health of the country. Because of this, the hydropower debt is in the upward trend, which is the major concern.

In the possible reasons for delays, apart from the bureaucratic hurdles, the fragile geology and climate change also plays a critical role. The recurring landslides and slope

destabilisation at the project site, due to the poor geological condition, resulted in delays of several projects in Bhutan, including both the Punatsangchhu projects (Dema, 2023). Climate change is another factor that could further escalate the cost due to design changes in the projects.

11. Conclusion and Policy Recommendations

India and Bhutan, two South Asian neighbours, not only share physiographical features like rivers, mountains, political boundaries, etc., but also cultural aspects, including shared traditions and religion. In recent times, a new addition to this shared culture has been climate change. Due to their geographical proximity, both the countries share emerging climatic concerns. However, both the countries have established bilateral mechanisms, underscoring the importance of cross-border initiatives to tackle boundary-defying environmental challenges like climate change by enhancing resilience capacity. The hydropower trade demonstrates the integrity and commitment of India and Bhutan towards reduced carbon emissions. In addition, both the countries explore ways to diversify climate initiatives beyond the non-hydropower sector. However, these efforts need to be expediated to ensure enhanced climate cooperation mechanisms.

Additionally, these cooperative mechanisms, including hydropower trade, seem to face challenges in the near future. This includes the piling hydropower debt in Bhutan due to reasons like delay in project completion, unemployment among youths, climate change, the fragile geology of Himalayas, among others. These issues may escalate to create hurdles in the climate cooperation between both the countries, if not handled properly. Hence, the study attempts to suggest feasible policy interventions to tackle climate-borne issues in the region.

1) Bhutan currently relies heavily on hydropower export for its foreign currency reserves and domestic electricity requirements. In other words, hydropower has become a backbone of the Bhutanese GDP. However, this ‘all eggs in one nest’ policy ultimately would face challenges as hydropower generation is subject to geological disasters and projected impacts on river water availability due to

climate change. Consequently, this may hamper hydropower generation in Bhutan, which would eventually disturb India's carbon emission targets as well. Hence, addressing this insecurity, both the countries should prioritise the non-hydropower renewable energy sector, such as solar, wind, and geothermal power, for continued cooperation. This diversification of the energy basket would ultimately benefit both the nations.

2) The anticipated effects of climate change on Bhutan are expected to result in both temporal and spatial fluctuations in river flow, characterised by elevated flows during the monsoon season and significantly reduced flows during the dry season. This variability may complicate the management of the hydropower system. Such changes will have a considerable impact on hydro electricity generation and export to India. Furthermore, the rise in temperatures is leading to the formation of supra-glacial lakes, alongside the presence of numerous potentially hazardous glacier lakes upstream, which pose risks associated with Glacial Lake Outburst Floods (GLOFs) and the potential failure of hydropower dams. Given the implications of these for hydropower generation, it is imperative for both nations to prioritise collaborative research and the establishment of information-sharing mechanisms to effectively monitor glacial dynamics.
3) GLOF due to climate change is emerging as a major potential disaster and this concern is shared by both India and Bhutan. To effectively combat GLOF, it requires timely information sharing, well in advance, with the downstream localities. Currently, community-level information sharing regarding extreme rainfall, river water levels, etc., is being circulated by villagers across the borders. Government-to-government information sharing mechanism is also in place but it takes too much time to reach the receivers. Therefore, the transboundary Early Warning System (EWS) needs to be strengthened to combat flash floods/GLOF in the region.
4) Both the countries should actively explore ways to elevate their existing bilateral climatic cooperation efforts to multilateral scale to include other SAARC nations such as Nepal and Bangladesh. The integrated efforts of Bangladesh, Bhutan, India, and Nepal (BBIN) group in areas like collaborative glacial monitoring, climate data analysis, transboundary water data sharing, hydropower generation

and its regional trade, etc. would surely strengthen the region's capacity to counter climate change.

5) Although the hydropower sector is a major employment provider, the rising unemployment, especially amongst youth, has emerged as a major challenge in Bhutan. However, the major reason cited for this is the unavailability of local skilled manpower in Bhutan. Due to this, foreign skilled labours, mainly from India, are employed in Bhutan's hydropower projects. This may create widespread dissatisfaction against India among the local Bhutanese. Hence, both India and Bhutan should take efforts to increase the availability of skilled local Bhutanese manpower through joint training and capacity enhancement programmes.
6) Cross border efforts pertaining to the shared disaster risk reduction should be further strengthened and diversified to include contemporary challenges beyond flood management. This may include joint efforts to mitigate air pollution, climate resilient agricultural practices, etc.
7) Environmental and social impacts of hydropower infrastructure need increased attention because the push for its quick development, with narrow focus on improving technical capacity, may end up leading to public criticism and unrest.
8) For a country like Bhutan, where utilising the hydropower potential and addressing environmental concerns both are prioritised, comprehensive guidelines to ensure sustainability during preparation, construction, and operation of hydropower need to be enacted.

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