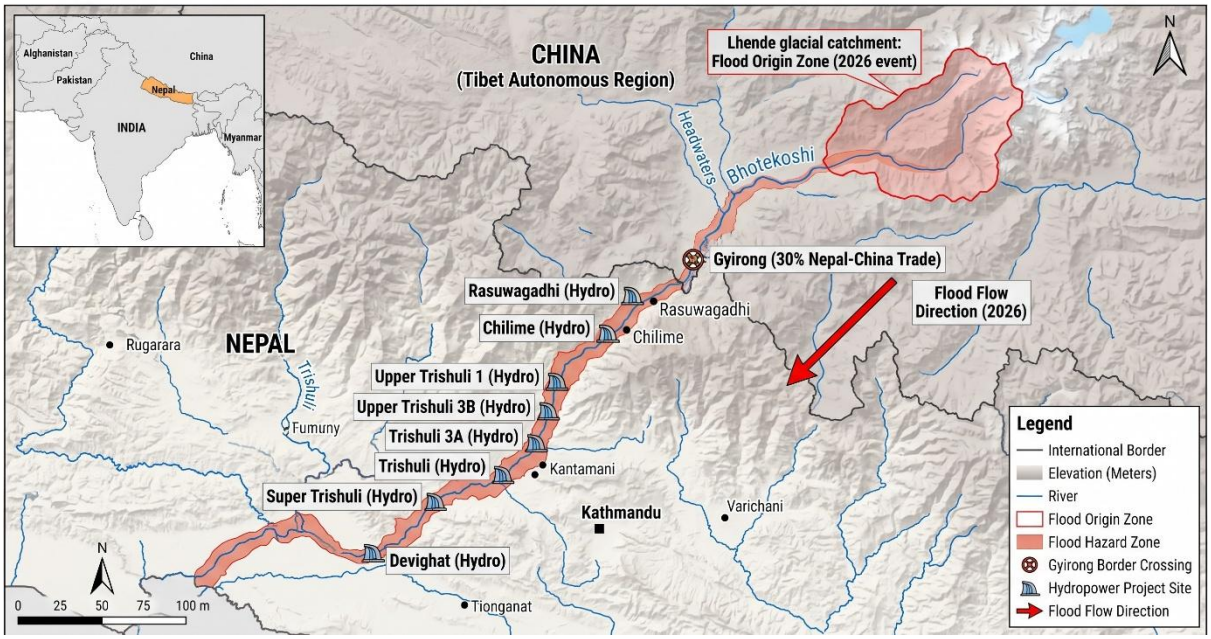
Techno-Economic Climate Risk in Nepal: Study for Risk-Rated River Basin Finance

By Samyog Dhungel
Economist
October 2026

I. The Wake-Up Event: Rasuwa and the Anatomy of a Recurring Disaster

On the morning of August 26, 2026 at 8:37 AM NST, a glacial collapse above the Bhotekoshi River in the Lhende catchment straddling the Nepal-Tibet border sent a debris torrent downstream (ICIMOD, 2026a). Within minutes, communications towers were destroyed and emergency responders were issuing door to door warnings. By 9:00 AM NST, the Department of Hydrology and Meteorology had been formally notified by which point the flood had already overwhelmed infrastructure built and reinforced specifically to resist such events (ICIMOD, 2026a).

GEOPOLITICAL MAP OF THE NEPAL-TIBET BORDER REGION: TRISHULI AND BHOTEKOSHI RIVER BASIN AND THE 2026 FLOOD EVENT.



The consequences of this disaster were severe. Eight hydropower projects in the Trishuli sub-basin of the Narayani system were damaged or disrupted which included: operational plants at Rasuwagadhi (111 MW), Chilime (22 MW), Trishuli 3A (60 MW), Trishuli (25.25 MW), and Devighat (14 MW), alongside the under construction Upper Trishuli 3b (37 MW), Upper Trishuli 1 (216 MW), and Super Trishuli (100 MW) (ICIMOD, 2026a; International Water Power, 2026). Nepal's Ministry of Energy reported roughly 430 MW of supply affected which is approximately one-eighth of the country's installed capacity (Down to Earth, 2026a). The Roads Department estimated NPR 30 billion in damage to road and bridge infrastructure, with 68 suspension bridges of which 33 bridges were deemed beyond repair, 33 driveable bridges, and 69 km of highway impaired. The Government of Nepal's Rapid Damage and Needs Assessment, published on September 10, 2026, estimated total recovery needs at NPR 723 billion

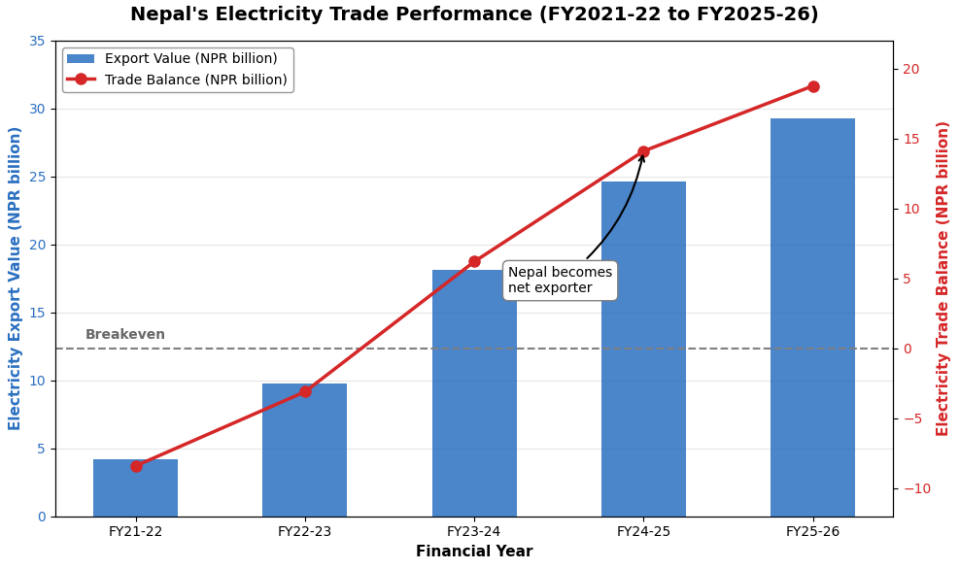
including NPR 391 billion for energy and grid rehabilitation and NPR 73 bullion for transport infrastructure (Government of Nepal, 2026). Combined casualties in Nepal and Tibet exceeded 1,250 lives, a toll that was still rising days later (Japan Times, 2026). The Gyirong border crossing through which 30% of all Nepal-China trade previously flowed was completely disrupted.

This event was not a statistical outlier. It followed an almost identical flood on July 8, 2025, which also originated in Tibet's Purepu glacier, that struck the same Bhotekoshi corridor and swept away the Miteri Bridge, and damaged the Rasuwagadhi dry port (Khabarhub, 2025). The ICIMOD-led assessment noted a clear pattern, the same site devastated by the previous year's Rasuwa flood was once again under threat (ICIMOD, 2026b). Since 1900, dozens of floods have occurred near the Nepal-Tibet border and the pattern is repeating while the cost is compounding.

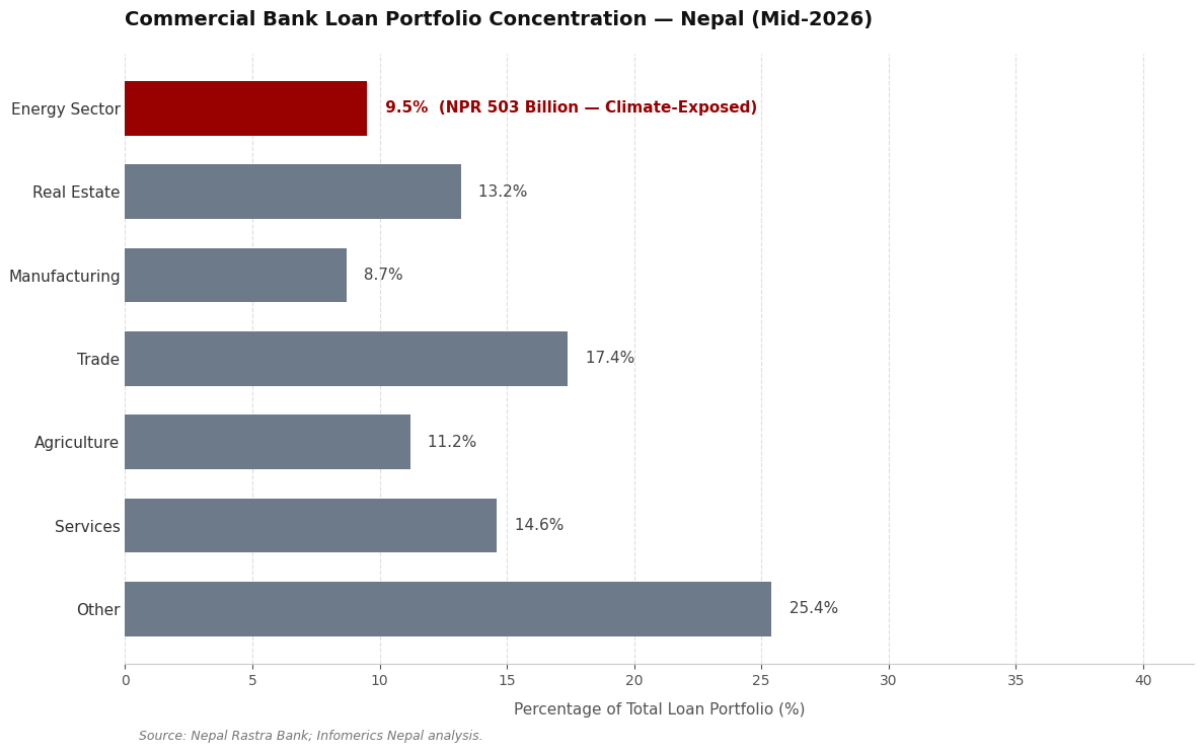
What this disaster exposed in not just a simple hydrology issue but also a deeper financial architecture problem.

II. Nepal's Hydropower Economy: The Stake Is Now Too Large to Ignore

Hydropower in Nepal is no longer just a infrastructure, it is rather the macroeconomic thesis. With approximately 83,000 MW of theoretical potential and 43,000 MW technically and economically feasible, Nepal aims to multiply the installed capacity nearly sixfold to 30 GW by 2035, with more than half meant for export (Urjakhabar, 2026; Japan Times, 2026). In fiscal year 2025-26, Nepal exported electricity worth NPR 29.32 billion to India and Bangladesh, recording an NPR 18.76 billion electricity trade surplus which is the first sustained net-exporter position in nearly a decade (Kathmandu Post, 2026c). India has committed to an inter-governmental 10,000 MW purchase agreement and Bangladesh has become a direct buyer under the tripartite arrangement with the NEA (SAARC Chamber, n.d.). Even conservative projections indicate that power exports could bring in over USD 500 million annually by 2030, if sustained (Urjakhabar, 2026).



Against this backdrop, Nepal's banking sector has made a proportional bet. According to Nepal Rastra Bank, commercial banks had disbursed over NPR 503 billion to the energy sector by mid-2026 which exceeded 9.5% of total loan investment (Kathmandu Post, 2026b; Insurance Khabar, 2026). There also are some individual banks that carry energy-sector concentrations above 17% (Insurance Khabar, 2026). Similarly, Employees Provident Fund (EPF), Citizens Investment Trust (CIT), and institutional capital have followed. The sector's NEPSE-listed hydropower stocks have historically ranked among the highest in market turnover (Parajuli, 2026). The significance of the energy sector's share lies not in its size relative to other sectors but in its geographic concentration, unlike trade or manufacturing loans which are distributed across thousands of independent borrows while energy sector loans are clustered in the same river basins, exposed to the same glacial hazards, and subject to simultaneous crystallisation from a single upstream event.

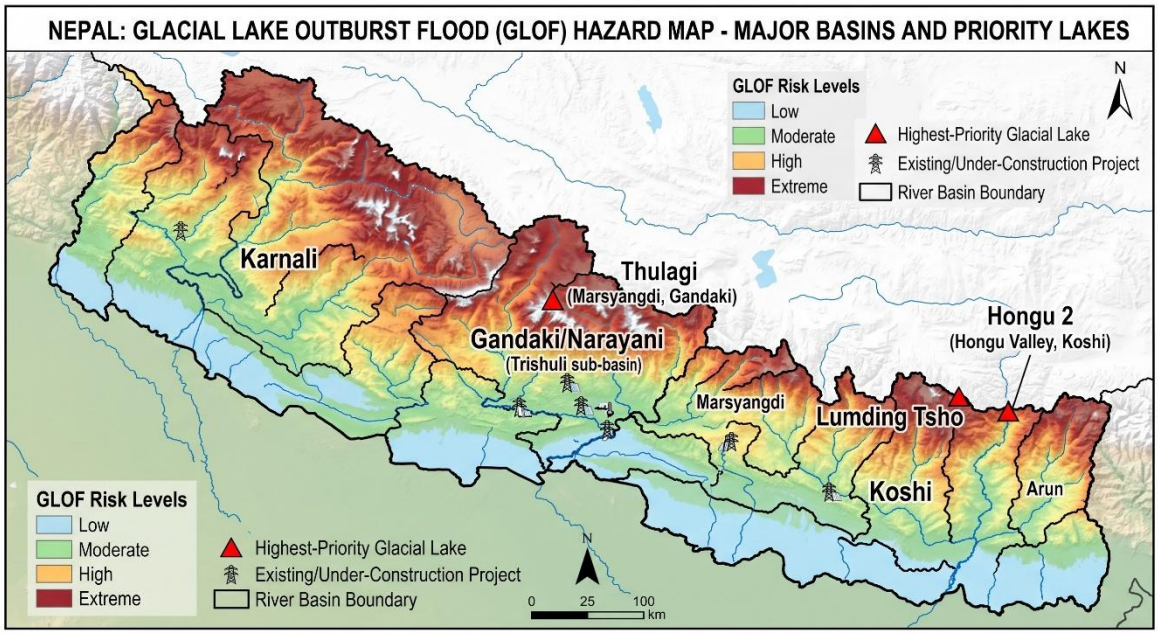


Loan Portfolio Breakdown — Nepal Commercial Banks (Mid-2026): Correlation, Not Concentration, Is the Risk

As stated plainly by analysts and industry practitioners, the problem is that almost all of the capital was committed under project assessments that treat climate induced river basin hazards, including GLOF risks, as qualitative footnotes rather than quantified pricing variables (Scroll.in, 2024). Projects are, by and large, financed on personal and corporate guarantees rather than on rigorous techno-climatic risk analysis (Cadmus Group, 2026; Scroll.in, 2024). When floods damage those projects, the loan book carries unaccounted climate risk. When enough projects are damaged or disrupted simultaneously, that unpriced risk crystallised across the system at once, as seen in August 2026.

III. The GLOF Dimension: Quantifying Nepal's Glacial Time Bomb

Nepal sits at the epicentre of Himalayan glacial lake formation. Sustained glacier melts which are being driven by warming that is running at two to three times the global average at high Himalayan elevations has generated more than 5,000 glacial lakes across the Hindu Kush-Himalaya (HKH) region, dammed by loosely consolidated moraines that are inherently unstable (Veh et al., 2020). Nepal has experienced at least 26 GLOF events since the 1970s, and 47 glacial lakes are currently classified as potentially dangerous by national authorities out of which four, Thulagi, Lower Barun, Lumding Tsho, and Hongu 2 have been identified as immediate priorities for intervention under a USD 36 million Green Climate Fund project managed by UNDP (UNDP, n.d.a.).

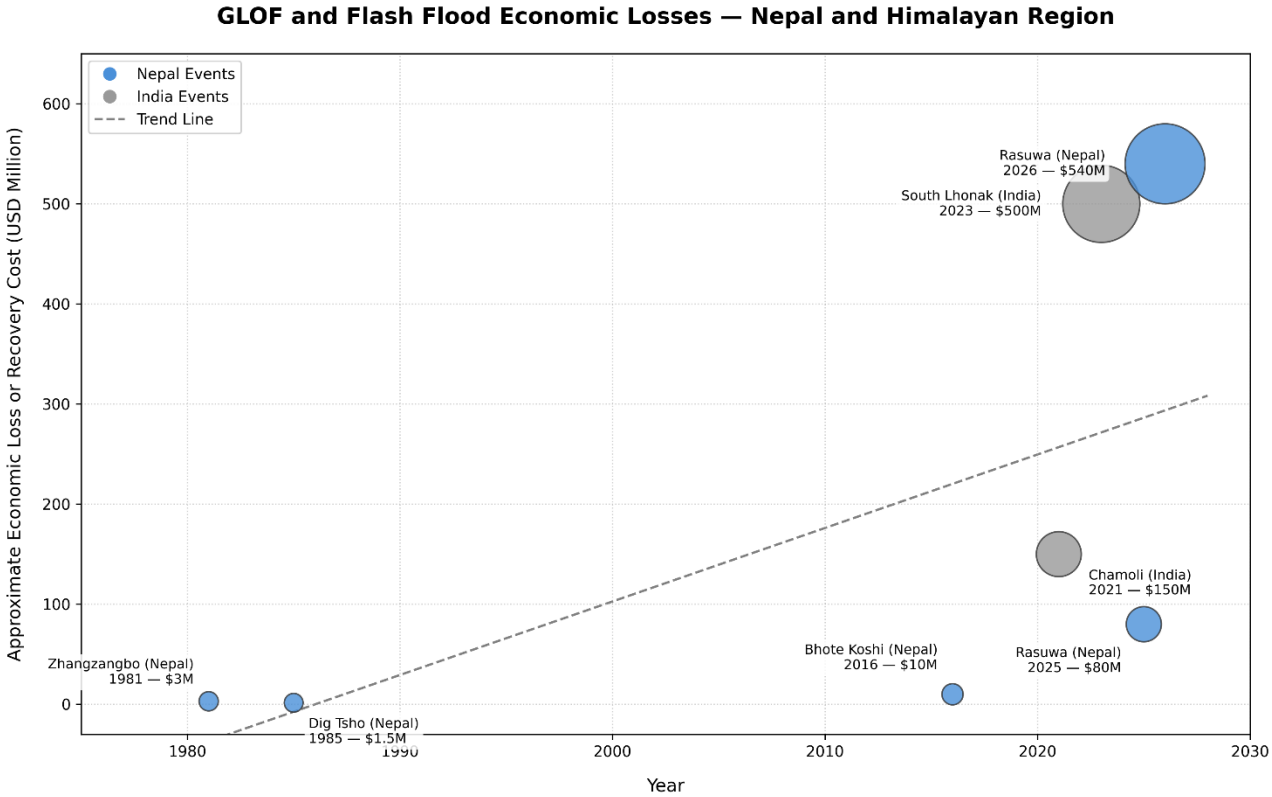


The potential of damage is not simply academic. Research modelling worst-case breaches of priority lakes estimated hydropower project losses of USD 8.98 billion for Imja Tsho, USD 2.4 billion for Tsho Rolpa, and USD 2.2 billion for Thulagi along (npj Natural Hazard, 2026). A single GLOF event can cause economic losses exceeding USD 100 million (UNDP, n.d.a). Research on Himalayan GLOF hazard estimates the 100-year outburst flood in the Eastern Himalayas has an average volume of 33.5 million cubic metres and a peak discharge of approximately 15,600 m^3/s which is at least an order of magnitude higher than comparable figures from the Hindu Kush or Karakoram (Veh et al., 2020).

A 2025 study specifically modelling the Poiqu-Bhotekoshi and Gyirong-Trishuli transboundary basins, which are the precise corridors that produced the 2025 and 2026 disasters and has identified 28 glacial lakes as highly susceptible to outburst (Sattar et al., 2025). In extreme scenarios, modelled peak discharges range from 7,532 to 38,220 m^3/s, flood depths can reach 60 meters surpassing seasonal high-flow floods by up to ten times, and at risk are over 3,000 buildings, approximately 50 bridges, nine hydropower sites, and around 50 km of road (Sattar et al., 2025). These are not tail end scenarios in a probabilistic sense but

they rather represent the upper end of the probability distribution whose lower end has already been realised twice in thirteen months.

Historically, GLOF events in Nepal document a track record of infrastructure destruction. The 1981 Zhangzangbo GLOF damaged the Sun Koshi Hydropower Plant and caused USD 3 million in losses. The 1985 Dig Tsho GLOF destroyed the Namche hydropower station and cost USD 1.5 million (Sattar et al., 2019). Today, the scale has changed as projects now at risk are at orders of larger magnitude, the capital employed is correspondingly greater and the downstream financial exposures is system level moving through bank balance sheets, equity markets, and sovereign fiscal commitments.

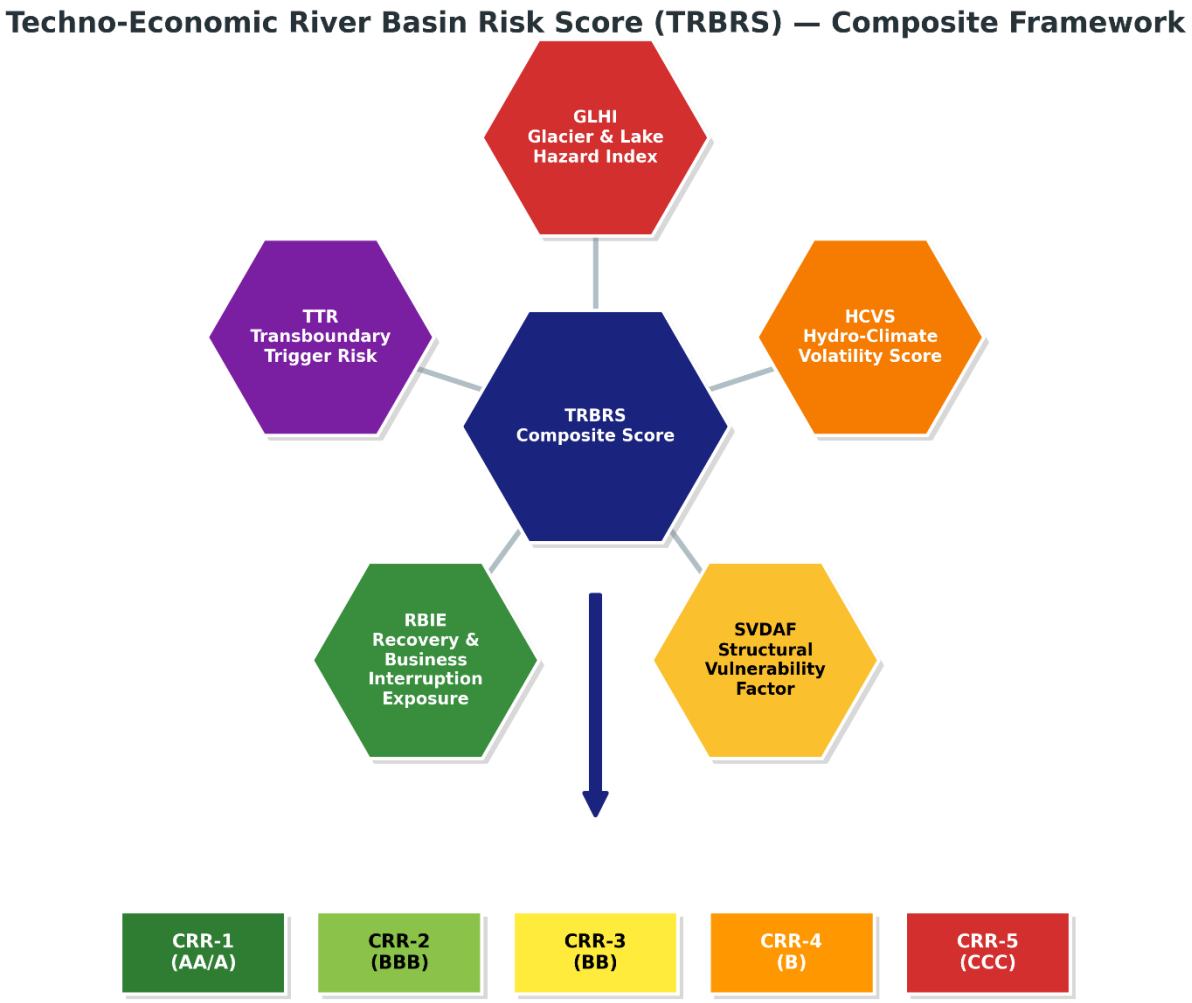


Sources: Sattar et al. (2019); Government of Nepal RDNA (2026); ICIMOD (2026). Figures represent economic loss or recovery cost estimates. India events shown for regional comparability.

IV. A Techno-Economic Risk Framework for River Basin Projects: What Should Exist

Nepal's regulatory environment for hydropower is said to acknowledge the problem without resolving it. The Department of Electricity Development (DoED) Guidelines for Study of Hydropower Projects (2018) require climate risk consideration but it does not provide any methodology. There seems to be lack of guidance on climate models, standardised GLOF quantification protocol, benchmark for what constitutes adequate screening (Department of Electricity Development, 2018; Kathmandu Post, 2026b). The asymmetry is telling, as multilateral-financed projects (IFC, ADB, World Bank) typically meet rigorous

climate risk standards because their lenders impose them as a disbursement conditions. But domestically financed private-sector projects, which make up the bulk of the development pipeline, do not (Cadmus Group, 2026; Scroll.in, 2024; Department of Electricity Development, 2018). This explains the disproportionate concentration of damage among privately financed projects in the 2021, 2023, 2024, 2025, and 2026 events. ICIMOD and the Water and Energy Commission Secretariat (WECS), supported by Norway, are currently developing Nepal's first Climate-Resilient Hydropower Guideline but it does not yet exist in operational form (Kathmandu Post, 2026b).



What is needed is a **Techno-Economic River Basin Risk Score (TRBRS)**, which is a composite quantitative rating framework that can be applied at the project appraisal stage and updated through the project life. Its architecture would integrate five dimensions:

1. **Glacier and Lake Hazard Index (GLHI):** The first component quantifies the physical likelihood and severity of a GLOF event. It draws on a satellite-based inventory of glacial lakes within the project's upstream catchment which records each lake's area, volume, and rate of growth over time. Because the type of dam containing a lake strongly influences its failure risk, the index also

distinguishes between moraine-dammed lakes which are composed of loose glacial debris and are comparatively unstable and bedrock-dammed lakes, which are more resistant to breach. Each lake's distance to the project's water intake is also recorded, since proximity tells both the speed and force with which a flood wave would arrive. These physical characteristics are combined with surge wave modelling under high, medium, and low breach scenarios, and with a frequency analysis of historical GLOF events using Bayesian regression, following the methodology Lützow et al. (2025) applied to 21 Nepalese lakes in the HESS (Hydrology and Earth System Sciences) framework. The result is a probability of exceedance curve, which expresses the flood magnitude and its return period (e.g.: a 1 in 25 year or 1 in 100-year event), which is reported as peak discharge in cubic meters per second at the project intake.

2. **Hydro-Climate Volatility Score (HCVS):** This second component captures the broader climatic and hydrological instability of the river basin, independent of any single glacial lake. It is built from historical streamflow records, with particular attention to the seasonal imbalance between monsoon and dry season runoff, and from climate projection under two Representative Concentration Pathways (RCP): a moderate warming scenario (RCP 4.5) and a high warming scenario (RCP 8.5), for precipitation and temperature trends in the basin. A further consideration is the extent to which glacier melt currently sustains dry season baseflow, and the projected trajectory of that contribution's decline as glaciers retreat. This component draws on the World Meteorological Organization's (WMO) Global Energy Resilience Atlas Hydro-Climate Risk Indices (Paranunez & Alvarado, 2024) and on basin-specific hydrological modelling using Soil and Water Assessment Tool (SWAT), calibrated for Nepali Himalayan conditions as demonstrated for the Madi River Basin (Shrestha et al., 2024).

3. **Structural Vulnerability and Design Adequacy Factor (SVDAF)**
   The third component evaluates how well a project's physical infrastructure is positioned to withstand a GLOF, if one occurs. The key inputs include:
   - The elevation of the water intake relative to the modelled GLOF flood envelope,
   - Whether the diversion weir was engineered to withstand a flood of the scale a GLOF could produce, or only a lesser design flood,
   - The depth of the diversion tunnel and whether it incorporated sediment bypass provisions,
   - The distance of the powerhouse from the main river channel and,
   - The presence and reliability of early-warning systems, including the time allowed to operators to shut the project down safely (FutureWater, 2021).

4. **Recover and Business Interruption Exposure (RBIE)**
   The fourth component translates physical risk into financial terms. It considers the estimated time required to restore generation following a design-basis GLOF event, the revenue lost per day of outage, and the project's debt service coverage ratio during that interruption. It also accounts for whether the project holds business interruption coverage and whether it is adequate, as well as the

degree to which the project is concentrated within the lender's broader energy-sector portfolio. The final factor determines how much a single GLOF event could affect the lender's overall exposure.

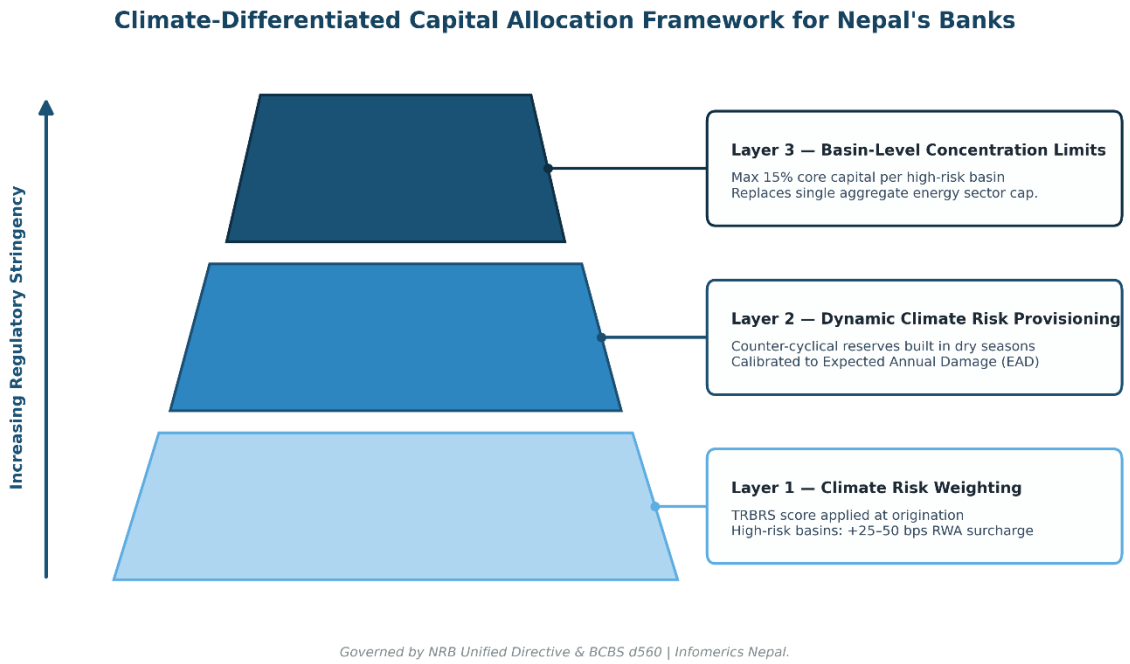
5. **Transboundary Trigger Risk (TTR)**
   The fifth and final component addresses risk arising from the fact that glacial lake catchments often span international borders. It considers the proportion of the upper basin lying outside Nepal's jurisdiction, the availability and reliability of cross-border data sharing and early warning arrangement (with Tibet/China) and the presence or absence of treaty-level mechanisms for sharing risk between countries. The relevance of this dimension is underscored by the August 2026 events, in which the triggering collapse occurred in a catchment partly situated in Gyirong Country and warning is said to have reached to Nepalese authorities only after critical infrastructure had already been destroyed (ICIMOD, 2026a).

These five sub-scores which is weighted by materiality, can generate a composite TRBRS on a scale that maps directly onto credit rating terminology where projects scoring the lowest risk quartile might carry a TRBRS of A/AA, high-risk project in the upper quartile would carry BB or below. This score could sit alongside the traditional financial risk assessment, DSCR, IRR, equity coverage which can be a needed input to project credit rating.

V. How Should Banks Allocate Capital? The Case for Climate-Differentiated Provisioning

The Basel III capital adequacy framework provides a starting architecture, but it does not yet adequately capture physical climate risk in the Nepalese banking context. NRB's Unified Directive No. 3/069 caps individual bank hydropower exposure at 50% of core capital, which is a sectoral concentration limit but not a risk-weighted one (Neupane, n.d.). As of mid-2026, combined commercial bank energy lending exceeded NPR 503 billion, yet provisioning is based on credit classification (pass, watchlist, substandard, doubtful, loss) that is considered to be backward-looking which is determined by payment behaviour rather than climate exposure (Insurance Khabar, 2026).

There should be a climate adjusted capital allocation framework for Nepalese banks consisting of three layers.



LAYER 1: *Climate Risk Weighting in Credit Appraisal*

At the point a loan is issued, every hydropower project should be assigned a Transboundary and River Basin Risk Score (TRBRS). Projects which are deemed high-risk (GLOF exposed basin, catchment crossing international border or inadequate structural design) should be assigned higher risk weight when banks calculate their risk weighted assets. Practically, this means that such projects would require the bank to hold proportionally more capital against them, since a higher risk weight increases the loan's contribution to the bank's regulatory capital requirement. For projects located in Category I GLOF exposed basins like the Trishuli, Sun Koshi, and the upper reaches of the Karnali, this could take the form of a 25-50 basis point increase in risk weighting, calibrated to Expected Annual Damage (EAD) estimates derived from GLOF modelling (Lützow et al., 2025)

LAYER 2: *Dynamic Climate Risk Provisioning*

Beyond how individual loans are weighted, Nepal Rastra Bank (NRB) should require banks to set aside reserved specifically against future climate related losses. Building these reserved during periods when conditions are calm, rather than waiting until a crisis forces losses to be recognised all at once. This mirrors the "dynamic provisioning" approach adopted by Spain and Peru after the 2008 financial crisis, where banks are required to build up buffers in good years precisely because those buffers are needed in bad ones. Since GLOF events tends to occur during the monsoon months of June to September, and are now seeming to recur as frequently as every thirteen months in some river corridors, provisioning should be built up during the preceding dry-season months, ahead of the period of highest risk.

LAYER 3: *Mandatory Climate Risk Disclosure and Concentration Limits by Basin*

Currently, energy sector lending limits are typically set as a single aggregate cap across a bank's whole portfolio. This framework proposes something that is more targeted with sub-limits set the level of individual river basins. Under such a rule, a bank's total lending exposure to projects within any one high-risk basin which is measured by where each project's water intake is located would be capped at a fixed share of its core capital for example 15%. The purpose of this basin specific limit is to prevent a single GLOF event from simultaneously triggering losses across multiple loans in the same portfolio, which could happen if a bank had over concentrated its lending within one vulnerable basin.

Taken together, these three layers are not a radical departure from established practice. They follow directly from the recommendations of the Network for Greening the Financial System (NGFS) and align with the Basel Committee on Banking Supervision's discussion paper on climate-related financial risks (Basel Committee on Banking Supervision, 2021), both of which call on banks to segment their portfolios by physical geography and to develop stress tests grounded in plausible climate scenarios.

VI. A Risk Rating for Hydropower Projects: Translating Hazard to Credit Category

Credit rating in Nepal's hydropower context currently evaluates five broad risk categories: construction risk, hydrological risk (measured by historical flow variability), offtake risk (Power Purchase Agreement term with NEA), regulatory risk, and financial risk (DSCR, gearing, promoter background) (Infomerics Credit Rating Nepal, 2023). What is structurally absent is a climate-physical risk category that formally rates:

- The probability that a GLOF or comparable extreme event will strike the project in its economic life (typically 25-35 years)
- The magnitude of revenue loss, repair cost, and debt service disruption in such an event
- The adequacy of project's physical design, insurance, and early warning provisions to bound that loss

Global credit rating agencies integrate climate risk as a factor within their existing credit analysis rather than assigning separate standalone climate ratings. S&P Global Ratings incorporates environmental, social, and governance factors where it is material to creditworthiness. Moody's publishes Environmental Issuer Profile Scores and Credit Impact Scores that quantify the influence of environmental factors on an issuer's credit profile. Fitch Ratings uses ESG Relevance Scores and Climate Vulnerability Signals as structured inputs into its rating rationale. The Climate Risk Rating (CRR) proposed here is therefore not analogous to a traditional credit rating but it is a sector-specific, hazard-focused scoring tool designed to be used as a mandatory input to the broader credit assessment of hydropower projects in glaciated basins, complementing rather than replacing the financial risk analysis conducted by rating agencies including Infomerics Nepal.

The proposed CRR is a narrowly scoped, sector-specific instrument. It does not replicate the breadth of third-party ESG ratings such as those produced by MSCI or Sustainalytics, which assess environmental, social, and governance factors across an issuer's full business operations. The CRR is concerned solely with the physical climate risk arising from glacial lake outburst floods and related hydrological hazards in the upstream catchment of a specific hydropower project. Other climate-related physical hazards relevant to Nepal's hydropower sector including landslide-dammed lake failures, monsoon-induced extreme rainfall events, and glacial retreat affecting dry-season baseflow are noted as material but are proposed as extensions to the framework in subsequent methodology development by Infomerics Nepal.

For context, a project like Rasuwagadhi Hydropower Project (111 MW) which was damaged in both the 2025 and 2026 Bhotekoshi events sits at the confluence of the Bhotekoshi and Trishuli rivers, has a transboundary catchment heavily glaciated on the Tibetan side, and is in a basin where machine learning models have identified 28 highly susceptible glacial lakes (Sattar et al., 2025). Under a TRBRS framework, this project would carry a high climate-physical score, which would be a finding that would have directly influences its original debt terms outlining: higher margin, mandatory catastrophe insurance coverage, stricter cash sweep provisions during the construction phase, and a lender-controlled debt service reserve account sized against climate event downside scenarios.

A proposed rating framework that is analogue to credit-rating scores would look like this:

TRBRS Category	**GLOF Exposure**	**Structural Adequacy**	**Rating Analogue**	**Capital Surcharge**
CRR-1	Very Low	Robust	AA/A	Nil
CRR-2	Low-Moderate	Adequate	BBB	+10 bps RWA
CRR-3	Moderate-High	Partial	BB	+25 bps RWA
CRR-4	High	Inadequate	B	+50 bps RWA + mandatory catastrophe cover
CRR-5	Extreme	Deficient	CCC	+75 bps RWA + Lender-controlled DSRA + Mandatory catastrophe cover
CRR-NR	Not Assessable	Insufficient data for GLOF	Unratable	Ineligible for unsecured

		modelling — catchment information unavailable, transboundary opacity, no hydrological records. No rating opinion can be formed.		lending pending full hazard assessment

CRR = Physical Climate Risk Rating — Hydropower (scoped to GLOF and physical river basin hazard); RWA = Risk-Weighted Assets; DSRA = Debt Service Reserve Account; bps = basis points; CRR-NR denotes absence of a rating opinion due to data insufficiency, not an assessment of extreme risk

PHYSICAL CLIMATE RISK RATING (CRR) SCALE—HYDROPOWER PROJECTS

LOGO HERE

Decreasing Risk

Rating	GLOF Exposure Level	Capital & Regulatory Requirement
CRR-1 (AA / A)	Very Low GLOF Exposure	Nil Capital Surcharge
CRR-2 (BBB)	Low-Moderate Exposure	+10 bps Risk-Weighted Asset Surcharge
CRR-3 (BB)	Moderate-High Exposure	+25 bps Risk-Weighted Asset Surcharge
CRR-4 (B)	High Exposure	+50 bps RWA + Mandatory Catastrophe Insurance
CRR-5 (CCC)	Extreme Exposure	+75 bps RWA + Lender-Controlled DSRA + Mandatory Catastrophe Cover
CRR-NR (Not Assessable)	Insufficient Data for GLOF Modelling	Ineligible for Unsecured Lending Pending Full Hazard Assessment

Increasing Capital Requirement

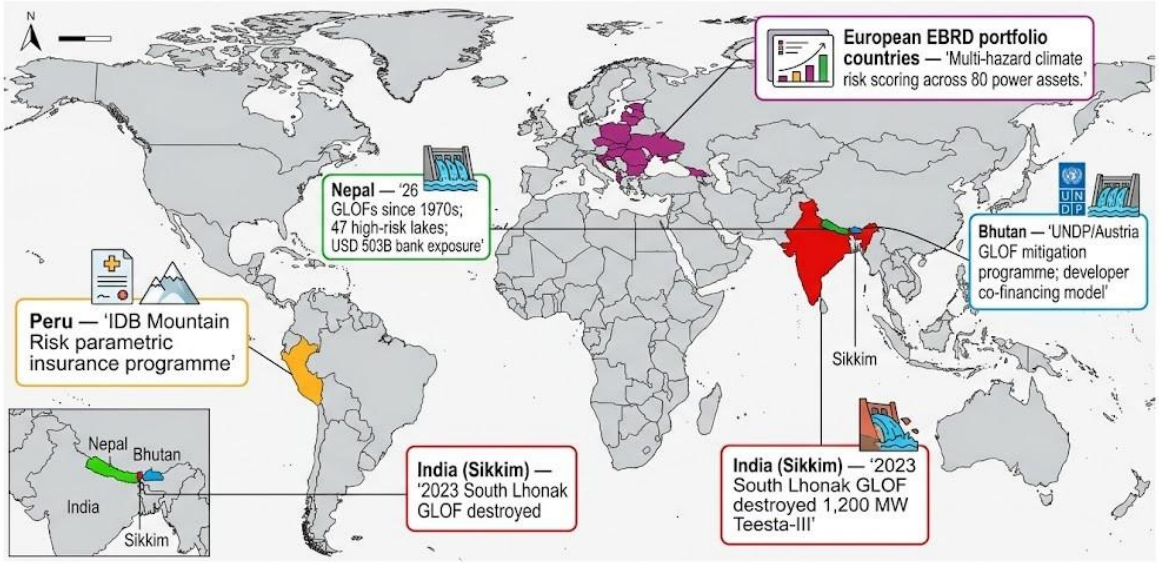
CRR = Physical Climate Risk Rating — Hydropower (scoped to GLOF and physical river basin hazard) | RWA = Risk-Weighted Assets | DSRA = Debt Service Reserve Account | bps = basis points
CRR-NR denotes the absence of a rating opinion due to data insufficiency — it is not a credit judgment and is distinct from CRR-5 (CCC), which represents an assessed extreme-risk exposure.

This rating would be assigned by credit rating agencies or independent body at project appraisal, and would be updated at each annual review, and disclosed to the Nepal Stock Exchange for listed hydropower entities and to NRB for banking supervision purposes.

VII. The Quantitative Way Forward: Are Other Countries Doing This?

The answer is yes, some are beginning to and Nepal can try adapting their approaches without trying to reinvent the wheel.

Bhutan is the most directly comparable case. Glaciers in Bhutan are receding at 30-60 metres per decade (UNDP, n.d.b.) The Royal Government, supported by UNDP and the Austrian Development Agency, implemented a structural GLOF risk reduction programme including lake drainage, early warning systems, and eco-engineering stabilisation in the Punakha-Wangdi Valley (UNDP, n.d.b.). Critically, the Punatsangchhu Hydropower Authority contributed Nu. 20 million to the programme, establishing a precedent for hydropower developers co-financing upstream risk mitigation. Bhutan's model has since been replicated in Pakistan and Nepal under UNDP information-sharing (UNDP, n.d.b). The lesson was that mitigation investment upstream reduces financial risk downstream in the loan book.



India, more specifically Sikkim, post-2023 offered a costly validation. The South Lhonak GLOF in October 2023 destroyed the 1,200 MW Teesta-III Hydroelectric Project's dam at Chungthang, which is one of the largest hydropower assets in northeast India (Down to Earth, 2026b). The scope of destruction led to a fundamental reconsideration of dam siting and design standards in GLOF-exposed catchments. This episode, alongside the 2021 Chamoli event that destroyed the Rishiganga project and killed 204 people, forms part of a growing regional pattern that demands a systemic financial response (Down to Earth, 2026b; Japan Times, 2026).

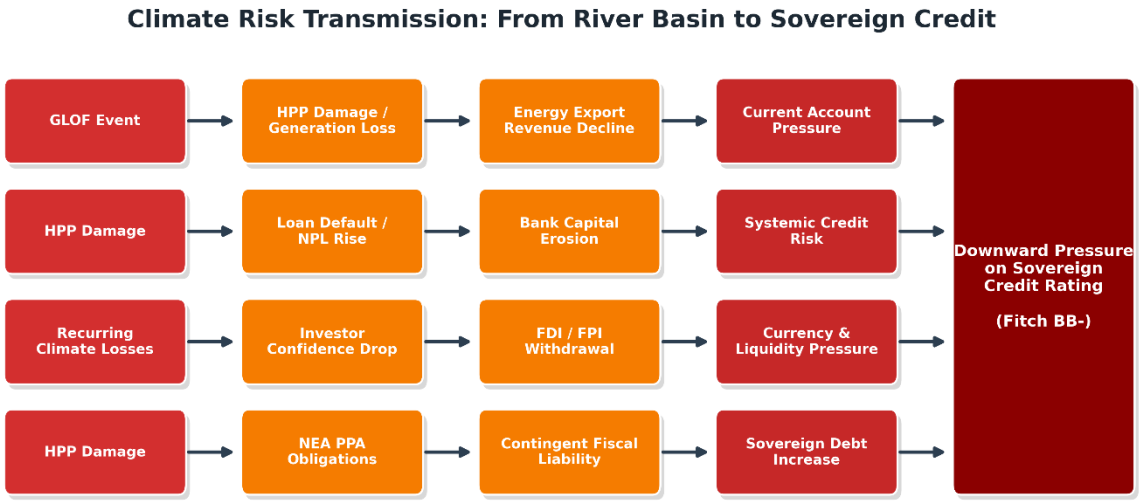
The European Bank for Reconstruction and Development (EBRD) has developed perhaps the most operationally useful international model which is a scalable methodology for multi-hazard physical climate risk assessment applied across its portfolio of 80 thermal and hydropower assets (Communication Earth & Environment, 2023). Using publicly available climate datasets (RCP 4.5 and RCP 8.5 scenarios) and hazard-specific vulnerability factors, the EBRD translated hazard severity into generation losses, finding that its hydro portfolio could experience a 1.87-5.07% loss in annual generation under RCP 4.5 (Communications Earth & Environment, 2023). This methodology or a simplified version of it can be directly applicable to Nepal's river basins using existing ICIMOD datasets, glacial lake inventories, and hydrodynamic models.

Peru provides the longest track record of GLOF risk in a hydropower context. Outburst floods from Andean glacial lakes have threatened cascade hydropower schemes for decades. Peru's Mountain Risk Insurance Programme, supported by the Inter-American Development Bank, represents an early effort to price GLOF risk into insurance structures as payout is triggered when hydrological monitors record flows above a defined threshold, irrespective of damage assessment. A small insurance product for Nepal river basins which is triggered by discharge measurement at key gauging stations would resolve the chronic problem of claims disputes and delayed recovery that follows conventional insurance settlements (Green Central Banking, 2026).

Globally, the International Hydropower Association's "Hydropower Sector Climate Resilience Guide" (International Hydropower Association, 2019) offers a four-phase methodology: *hazard screening, risk assessment, adaptation framework design, and monitoring*. It specifically addresses the failure of historical data-based approached with the assumption that future hydrological variability will mirror the past and provides a practical framework for integrating climate projections into project planning and re-evaluation. This is the gap the Nepal's current DoED Guidelines is said have failed to fill. Similarly, the WWF (World Wide Fund for Nature) Water Risk Filter has screened more than 6,000 existing and projected hydropower dams globally, finding that 75% of existing dams are in river basins with medium to very high flood risk (Byers et al., 2022), reinforcing the urgency of basin-specific risk scoring.

VIII. Macroeconomic and Sovereign Credit Implications: From Project Risk to Country Risk

The risks facing individual hydropower projects do not stay contained to those projects rather they ripple outward into Nepal's macroeconomic and ultimately its sovereign credit standing. This happens through four distinct channels.



Channel 1: Energy Security and Export Revenue: Nepal became a net electricity exporter for the first time in FY24/25 and in FY25/26 exported NPR 29.32 billion worth of electricity to India and Bangladesh, recording an NPR 18.76 billion trade surplus (Kathmandu Post, 2026c). The August 2026 disaster did not immediately undo this feat, largely because the monsoon season keeps reservoir levels high regardless. But the outlook shifts considerable once winter arrives as river flows naturally decline during the dry season and with generation capacity already damaged, Nepal risks becoming reliant on electricity imports at precisely the time it had expected to be earning export revenue (Mongabay, 2026).

Channel 2: Banking Sector Stability: Banks in Nepal currently hold NPR 503 billion in loans to the energy sector, equivalent to 9.5% of all bank lending. At the same time, non-performing loans (NPLs) at commercial banks have already been climbing from 1.2% in mid-2022 to 5.41% by mid-April 2026 (Nepal Rastra Bank, 2026). This leaves the banking system with little room to absorb a wave of climate-driven defaults hitting several large projects at once. A severe GLOF affecting multiple projects within the same river basin, a scenario that came close to happening in August 2026 could push NPLs well past what regulators have stress-tested for which could trigger breaches of banks' capital adequacy requirements and ultimately require the government to step in with capital support. Any such support would add to Nepal's public debt, which is already projected to rise from 43.6% of GDP in FY25 to 45.2% in FY26 (World Bank, 2026).

Channel 3: Investor Confidence and Foreign Capital: Nepal currently sits at an important turning point. Fitch recently issued the country's first-ever sovereign credit rating, BB-, citing favourable debt dynamics and strong foreign exchange reserves at about USD 23.55 billion which is enough to cover 18.4 months of imports (Fitch Ratings, 2024; International Monetary Fund, 2025a). These are real strengths, but if large-scale climate-driven infrastructure losses keep recurring without being properly reflected in how individual projects are assessed, or provisioned for on bank balance sheets, investors will over time start to doubt whether Nepal's hydropower sector is a sound long-term bet. Multilateral lenders such as the IFC, ADB, and World Bank are already running climate risk assessments on specific Nepali projects

(Nepal Economic Forum, 2025). If domestic banks fail to adopt comparably rigorous standards, the market risks splitting into two tiers: one being well-capitalised, multilaterally-backed projects that price risk accurately, and second being undercapitalised, domestically-financed projects that do not. This would be a divide that might encourage the riskiest projects to gravitate toward the least prepared lenders.

Channel 4: Fiscal Exposure through State-Owned Entities

The Nepal Electricity Authority (NEA), which already faces credit-evaluation difficulties due to qualified audit opinions, plays a central role here as the primary buyer of electricity under Power Purchase Agreements with private hydropower projects (Office of the Audit General, 2025). When private projects are damaged, the NEA's contractual commitments including minimum purchase obligations, support for repair and rehabilitation, and costs related to balancing the extensive power system. This creates financial liabilities that will not appear on the government's balance sheet but are effectively backed by the state. Any comprehensive climate risk framework for hydropower finance therefore needs to extend to how the NEA itself plans and provisions for climate-related contingencies.

IX. Questions That Are Their Own Answers: The Policy Imperatives

Some of the crucial points in this take the form of questions as once the facts are said plainly, the answers become almost self-evident and framing them this way helps make clear what exactly can be changed.

- *Can Nepal credibly market itself as a regional clean energy hub if a single monsoon event can wipe out one-eighth of its installed capacity?*
  Answer: At present, the answer might be not yet. The gap between aspiration and reality is precisely what the reform agenda in this article is meant to close.

- *If commercial banks in Nepal are required to direct 10% of their lending portfolio to renewable energy by 2028 (NRB, June 2025), but have no consistent way of rating the climate risk of those energy assets, are they building climate resilience or quietly concentrating climate vulnerability? (Cadmus Group, 2026)*
  Answer: The evidence seems to point to the latter. A lending quota without a matching risk-assessment standard does not quite reduce risk but it simply channels more capital into assets whose risk is going unmeasured. The regulation urgently needs a risk-quality counterpart to accompany it.

- *Is there a meaningful difference between a project financed by the IFC, which conducts a full climate risk assessment, and a project financed by a domestic bank on the strength of a personal guarantee when both carry the same Power Purchase Agreement obligations to the NEA? (Scroll.in, 2024)*

Answer: Yes, and the difference matter. In the first case, climate risk is priced into the deal while in the second it is effectively invisible. This gap creates an information asymmetry in Nepal's credit markets, one that distorts how capital gets allocated across the sector.

- *Given what is now publicly know about GLOF hazard in these river basins, can Nepal's credit rating agencies continue hydropower project ratings that do not incorporate a quantified climate-physical risk score?*
  Answer: After the August 2026 event, continuing to do so might leave the rating fundamentally incomplete as a tool for assessing project risk. This is in effect an appeal for change that this article argues for.

- *Is a transboundary GLOF an insurable, ratable, and provisionable risk or is it simply an unpredictable event or so one might call an act of God?*
  Answer: The engineering and actuarial evidence reviewed in the article clearly points to the former (Veh et al., 2020; Sattar et al., 2025). GLOFs in the Bhotekoshi-Trishuli corridor are not random events but rather they arise from identifiable hazard sources and can be modelled into quantifiable discharge scenarios, follow documented recurrence patterns, and produce measurable downstream exposure. And once an event can be modelled with this level of specificity, it can be rated for risk and once it can be rated, it can be priced.

X. Key Takeaways and a Call to Relevant Stakeholders

For Nepal Rastra Bank (NRB)

- Introduce basin-level concentration limits as a supplement to the existing 50% of core-capital energy sector cap (Neupane, n.d.).
- Mandate a forward-looking climate risk provision for banks with more than 10% energy sector exposure, consistent with NGFS guidance and BCBS d560 (Basel Committee on Banking Supervision, 2021)
- Commission or adopt a standardised GLOF hazard mapping overlay using ICIMOD's existing glacial lake inventory for integration into bank credit appraisal guidelines (ICIMOD, 2026a).
- Require stress testing of energy sector loan portfolios against a defined GLOF scenario (e.g., simultaneous damage in the Trishuli and Sun Koshi basins equivalent to August 2026 event intensity).

For Credit Rating Agencies

- Develop and publish a Physical Climate Risk Rating Hydropower (CRR) methodology for hydropower projects, scoped specifically to GLOF and physical river basin hazard and incorporating the five dimensions outlined in this article.

- Apply basin-specific GLOF hazard scores as a mandatory sub-component of any hydropower issuer or project rating (Parajuli, 2026).
- Engage with ICIMOD, WECS, and the ADB's ongoing climate risk assessment work to calibrate scores to Nepal-specific hydrological data (FutureWater, 2021).
- Differentiate ratings of projects financed under multilateral standards from those without equivalent climate risk appraisal (Kathmandu Post, 2026b).

For the Department of Electricity Development (DoED) and WECS

- Accelerate the Climate Resilient Hydropower Guideline currently under development with ICIMOD and Norway, and make adherence a condition of generation licence issuance (Kathmandu Post, 2026b).
- Require a GLOF hazard assessment and not merely a but rather as a mandatory component of the Detailed Project Report (DPR) for any project in a glaciated catchment above 2,000 metres elevation (International Hydropower Association, 2019).
- Establish an upstream monitoring and data-sharing protocol with Chinese counterparts for the Bhotekoshi, Trishuli, and Sun Koshi transboundary basins (ICIMOD, 2026a; Sattar et al., 2025).

For Hydropower Developers and Project Sponsors

- Commission independent GLOF scenario modelling at feasibility stage, not as a DPR addendum (FutureWater, 2021).
- Structure debt service reserve accounts to cover at minimum six months of principal and interest, sized against a defined climate event interruption scenario.
- Procure parametric catastrophe insurance triggered by upstream gauge readings, rather than relying solely on conventional damage-assessment insurance that takes months to settle (Green Central Banking, 2026).

For Policymakers and the Ministry of Finance

- Recognise contingent fiscal liabilities from NEA's PPA obligations on climate-exposed projects in medium-term fiscal planning (World Bank, 2026).
- Explore participation in a regional disaster risk pool which could be potentially through a BIMSTEC or HKH region mechanism to share the cost of transboundary GLOF event recovery (Green Central Banking, 2026).
- Leverage the ongoing IMF ECF program and Nepal's new Fitch BB- sovereign rating to negotiate concessional climate adaptation financing specifically for upstream GLOF risk reduction (International Monetary Fund, 2025a, 2025b).

For Nepal Stock Exchange (NEPSE)

- Require listed hydropower companies to disclose ISSB-aligned climate disclosures under IFRS S2 including basin-specific risk exposures as part of annual reporting obligations (Parajuli, 2026).

- Consider establishing a hydropower sub-index that tracks the performance of GLOF-exposed versus lower exposure projects which generated market price discovery for climate risk.

For Securities Board of Nepal (SEBON)

- Mandate ISSB-aligned (IFRS S2) aligned physical climate risk disclosures including basin-specific GLOF hazard assessments as a compulsory component of annual reports for all listed hydropower entities.
- Require all hydropower IPO prospectuses to explicitly disclose whether a quantified GLOF hazard assessment has been conducted.
- Require that any credit rating published for a listed hydropower issuer, for an IPO, a bank loan, or an annual rating review carries a Physical Climate Risk Rating Hydropower (CRR) score under the TRBRS framework, creating an incentive for rating agencies to develop and apply climate risk methodologies.

XI. Conclusion: Price the Glacier Before the Glacier Prices You

Nepal's hydropower sector occupies an extraordinary position as it is simultaneously the country's most promising economic asset and its most concentrated physical climate risk. These two facts are not in contradiction rather they are in conversation and the dialogue has been one-sided for too long. Hydrologists have modelled the outbursts (Lützow et al., 2025). ICIMOD has mapped the lakes (ICIMOD, 2026a) but what has lagged is the translation of this hazard knowledge into the language that governs capital, risk ratings, provisioning requirements, pricing spreads, and lending conditions (Kathmandu Post, 2026b; Parajuli, 2026).

August 2026 may not be the last time Nepal will lose one-eighth of its generation capacity to a climate event and the science is clear on that (npj Natural Hazards, 2026). What remains a choice is whether the next event finds Nepal's financial system better prepared with risk-rated projects, adequately provisioned banks, informed investors, and a sovereign balance sheet that has not been quietly accumulating climate contingency it cannot yet see. The framework exists internationally, the data exists locally, the regulatory will and the professional capacity in NRB, credit rating agencies and DoED are present. **What is needed now is the decision to act before the glaciers decide.**

References

Basel Committee on Banking Supervision. (2021). *Principles for the effective management and supervision of climate-related financial risks* (BCBS d560). Bank for International Settlements. https://www.bis.org/bcbs/publ/d560.pdf

Byers, A. C., Rountree, M., Watanabe, T., & Byers, E. (2022). Using the WWF Water Risk Filter to screen existing and projected hydropower projects for climate and biodiversity risks. *Water*, *14*(5), 721. https://doi.org/10.3390/W14050721

Cadmus Group. (2026, April 3). How ready are Nepal's commercial banks for the climate transition? *Cadmus Group*. https://cadmusgroup.com/are-nepals-banks-ready-for-climate-transition/

Communications Earth & Environment. (2023). A framework to assess multi-hazard physical climate risk for power generation projects from publicly-accessible sources. *Communications Earth & Environment*, *4*, 108. https://www.nature.com/articles/s43247-023-00782-w

Department of Electricity Development. (2018). *Guidelines for study of hydropower projects*. Ministry of Energy, Water Resources and Irrigation, Government of Nepal. https://www.doed.gov.np

Down to Earth. (2026a). Nepal flash flood explained: What triggered the deadly Rasuwa disaster and rising glacial lake outburst flood risks. *Down to Earth*. https://www.downtoearth.org.in/climate-change/nepal-flash-flood-what-triggered-the-deadly-event-killing-over-dozens-and-sweeping-away-villages-and-bridges

Down to Earth. (2026b). Nepal's glacial floods expose fragile hydropower: Why energy security must embed disaster resilience. *Down to Earth*. https://www.downtoearth.org.in/natural-disasters/nepal-teaches-us-that-energy-security-and-disaster-resilience-must-not-be-understood-in-silos

Fitch Ratings. (2024). *Fitch assigns Nepal first-time BB- rating; outlook stable* [Press release]. https://www.fitchratings.com/research/sovereigns/fitch-assigns-nepal-first-time-bb-rating-outlook-stable

FutureWater. (2021). *Climate risk adaptation assessment for Dudhkoshi HEP, Nepal* [Report prepared for the Asian Development Bank]. https://www.futurewater.nl/wp-content/uploads/2023/03/2021013_CRVA_Nepal_Hydropower_revised_ADB.pdf

Government of Nepal. (2026, September 10). *Rapid damage and needs assessment: August 2026 floods.* National Disaster Risk Reduction and Management Authority.

Green Central Banking. (2026, September 7). Countries face mounting financial risks as climate risk grows. *Green Central Banking*. https://greencentralbanking.com/2026/09/07/climate-risks-grow-countries-face-mounting-financial-risks-from-fragile-infrastructure/

IFRS Foundation. (2023). *IFRS S2 climate-related disclosures.* International Sustainability Standards Board. https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/ifrs-s2-climate-related-disclosures/

Infomerics Credit Rating Nepal. (2023). *Private power producers rating methodology framework*. https://infomericsnepal.com/wp-content/uploads/2023/08/1657540539.pdf

Insurance Khabar. (2026). Banking sector's Rs 5 trillion in hydropower: The backbone of prosperity or the trap of climate risk? *Insurance Khabar*. https://english.insurancekhabar.com/banking-sectors-rs-5-trillion-in-hydropower-the-backbone-of-prosperity-or-the-trap-of-climate-risk-2/

International Centre for Integrated Mountain Development (ICIMOD). (2026a). Kyirong-Rasuwa flood 2026: Nepal-China cryosphere risk. *ICIMOD*. https://www.icimod.org/kyirong-rasuwa-flood-2026-nepal-china-border/

International Centre for Integrated Mountain Development (ICIMOD). (2026b). Major flash flood sweeps through Nepal's Rasuwa district, raising fears of further downstream flooding [Press release]. https://www.icimod.org/press-release/major-flash-flood-sweeps-through-nepals-rasuwa-district-raising-fears-of-further-downstream-flooding/

International Hydropower Association (IHA). (2019). *Hydropower sector climate resilience guide*. https://www.hydropower.org/publications/hydropower-sector-climate-resilience-guide

International Monetary Fund. (2025a). Nepal: Fifth review under the extended credit facility arrangement. *IMF Staff Country Reports*, *2025*(066). https://doi.org/10.5089/9798229004336.002.A001

International Monetary Fund. (2025b). Nepal: Sixth review under the extended credit facility arrangement. *IMF Staff Country Reports*, *2025*(285). https://doi.org/10.5089/9798229026901.002

Japan Times. (2026, September 2). Fatal floods expose threats to hydropower in the roof of the world. *The Japan Times*. https://www.japantimes.co.jp/environment/2026/09/02/energy/floods-threat-hydropower-nepal/

Kathmandu Post. (2026a, August 26). Major flood damages Syabrubesi hydropower projects in Rasuwa. *The Kathmandu Post*. https://kathmandupost.com/national/2026/08/26/major-flood-damages-syabrubesi-hydropower-projects-in-rasuwa

Kathmandu Post. (2026b, September 4). Why climate change is a threat to Nepal's hydropower sector [Opinion column]. *The Kathmandu Post*. https://kathmandupost.com/columns/2026/09/04/why-climate-change-is-a-threat-to-nepal-s-hydropower-sector

Kathmandu Post. (2026c, July 24). Nepal records Rs18.76 billion electricity trade surplus in fiscal 2025-26. *The Kathmandu Post*. https://kathmandupost.com/money/2026/07/24/nepal-records-rs18-76-billion-electricity-trade-surplus-in-fiscal-2025-26

Khabarhub. (2025, August). Rasuwa flood damages eight hydropower projects, 240 MW production halted. *Khabarhub English*. https://english.khabarhub.com/2025/08/484493/

Lützow, N., Veh, G., & Korup, O. (2025). Assessing national exposure to and impact of glacial lake outburst floods considering uncertainty under data sparsity. *Hydrology and Earth System Sciences*, *29*, 733–750. https://hess.copernicus.org/articles/29/733/2025/

Mongabay. (2026, September). Nepal's flood disaster puts its hydropower-first strategy, exports to the test. *Mongabay*. https://news.mongabay.com/2026/09/nepals-flood-disaster-puts-its-hydropower-first-strategy-exports-to-the-test/

Nepal Economic Forum. (2025, June 9). Climate change threatens Nepal's hydropower future. *Nepal Economic Forum*. https://nepaleconomicforum.org/climate-change-threatens-nepals-hydropower-future/

Nepal Rastra Bank. (2026). *Banking and financial statistics* (Vol. 85). Bank Supervision Department, Nepal Rastra Bank. https://www.nrb.org.np/bfr/banking-and-financial-statistics/

Neupane, P. (n.d.). Key power project financing challenges in Nepal. *Neupane Law*. https://www.neupanelegal.com/news-detail/power-project-financing-challenges-nepal.html

npj Natural Hazards. (2026). Glacial lakes and GLOFs in a warming Himalaya-Karakoram region: Current understanding, challenges, and the way forward. *npj Natural Hazards*. https://www.nature.com/articles/s44304-026-00168-w

Office of the Auditor General. (2025). *Annual report of the Auditor General of Nepal* (61st ed.). Office of the Auditor General. https://www.oag.gov.np

Paranunez, C., & Alvarado, A. (2024). WMO Global Energy Resilience Atlas — climate risk indices for hydropower. *Energies*, *17*(12), 2947. https://doi.org/10.3390/en17122947

Parajuli, S. (2026, August 1). Credit rating practices in Nepal. https://sushilparajuli.com/credit-rating-practices-in-nepal/

SAARC Chamber. (n.d.). Nepal's energy trade. *SAARC Chamber of Commerce & Industry*. https://saarcchamber.org/nepals-energy-trade/

Sattar, A., Goswami, A., Kulkarni, A. V., & Emmer, A. (2019). GLOF risk assessment model in the Himalayas: A case study of a hydropower project in the Upper Arun River. *Water*, *11*(9), 1839. https://doi.org/10.3390/w11091839

Sattar, A., Rashid, I., Farooq, A., Nazeer, M., Wani, G. F., Ali, R., & Mir, R. A. (2025). Quantitative assessment of the GLOF risk along China–Nepal transboundary basins by integrating remote sensing, machine learning, and hydrodynamic modelling. *Remote Sensing Applications: Society and Environment*, *38*, 101448. https://www.sciencedirect.com/science/article/abs/pii/S221242092500055X

Scroll.in. (2024). Flood risks to Nepal hydropower project were known — but banks ignored them. *Scroll.in*. https://scroll.in/article/1095454/funding-banks-knew-of-flood-risks-to-nepal-hydropower-project-but-ignored-them

Shrestha, N. K., Shrestha, S., & Babel, M. S. (2024). Climate change and hydropower resilience in Nepal: An integrated modelling approach in the Madi River Basin. *H2Open Journal*, *7*(2), 199–218. https://iwaponline.com/h2open/article/7/2/199/100960/Climate-change-and-hydropower-resilience-in-Nepal

United Nations Development Programme (UNDP). (n.d.a). Protecting livelihoods and assets at risk from glacial lake outburst floods (GLOFs) and climate change-induced flooding in glacial river basins of Nepal. https://www.adaptation-undp.org/projects/protecting-livelihoods-and-assets-risk-glacial-lake-outburst-floods-glofs-and-climate

United Nations Development Programme (UNDP). (n.d.b). Reducing climate change-induced risks from glacial lake outburst floods in Bhutan. https://www.adaptation-undp.org/projects/ldcf-glof-bhutan

Urjakhabar. (2026). Unlocking Nepal's hydropower potential: Real solutions for efficiency and international trade. *Urjakhabar*. https://urjakhabar.com/en/news/2812212886

Veh, G., Korup, O., & Walz, A. (2020). Hazard from Himalayan glacier lake outburst floods. *Proceedings of the National Academy of Sciences*, *117*(2), 907–912. https://doi.org/10.1073/pnas.1914898117

Wikipedia. (2026). *2026 Nepal–Tibet floods*. https://en.wikipedia.org/wiki/2026_Nepal%E2%80%93Tibet_floods

World Bank. (2026, April). *Nepal development update*.

https://www.worldbank.org/en/country/nepal/publication/nepaldevelopmentupdate