Financing Climate Resilience: An Assessment of Public Spending and Disaster Risk Funding Gaps in Nepal's Flood Sector

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Abstract

Nepal is becoming progressively susceptible to climate-induced disasters, particularly recurrent floods that continue to cause substantial economic and social repercussions. Notwithstanding significant advancements in the development of regulatory frameworks and institutional structures for disaster risk reduction and management (DRRM), the nation nonetheless encounters enduring financing deficiencies that obstruct proactive resilience enhancement. The study evaluates the magnitude of public financing deficiencies for flood-related disaster risk in Nepal by juxtaposing historical economic losses from floods with actual government and foreign funding streams from 2003 to 2023. The research uses quantitative methodologies, such as per capita normalization, GDP adjustments, and inferential statistical testing, to identify significant discrepancies between necessary and available financing. Findings suggest that although some years recorded funding surpluses, long-term trends demonstrate a normalized cumulative deficit surpassing NPR 508 million. However, beyond this apparent quantitative gap lies a deeper qualitative deficiency. Most funding remains reactive, centered on post-disaster humanitarian aid, with limited evidence in preparedness, recovery, or long-term resilience. Ex-ante financial instruments-such as insurance, catastrophe bonds, risk pooling, and contingent credit-are underutilized or absent. Despite DRRM policies being well-documented, their implementation has been weak, and financial resources often fail to support proactive disaster planning.

The Wilcoxon Signed-Rank Test confirms a statistically significant mismatch between authorized funding and actual flood-induced losses, reflecting inefficiencies in both resource allocation and institutional response. The study underscores the urgent need for a transition from reactive, ad hoc aid to a proactive, risk-informed financing approach. It recommends greater adoption of ex-ante instruments and alignment of DRR policy commitments with implementation practices. Strengthening financial planning, improving budget execution, and exploring innovative disaster finance mechanisms are essential to enhance Nepal's resilience to floods and reduce recurring economic damages.

Key Words: *Disaster Risk Financing, Flood Management, Public Expenditure, Climate Resilience, Funding Gap, Risk Transfer, Ex-ante Financing, Disaster Funding Gap*

JEL Classification: *H84, Q54, G22, O23*

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Background: Nepal's Situation: Increasing Disaster Risk and Financial Susceptibility

Nepal is highly prone to climate-induced disaster risks and frequently encounters significant disaster events with considerable exposure to many hazards. Floods and landslides, instigated by heavy monsoon rain from June to September, have caused substantial devastation, leading to the loss of lives, livelihoods, agricultural goods, and physical assets. Nepal has, on average, more than 500 disaster incidents per year, varying from small to large scale (Nepal Planning Commission [NPC], 2019). Recent years have witnessed major calamities, including the 2015 earthquake, the 2017 Terai flood, massive landslides in 2020 and 2021, and the post-monsoon rainfall disaster in 2021. In 2008 to 2017 alone, flood-related damages resulted in economic losses exceeding NRs 87,204 million (GoN, 2024). The estimated economic losses from disasters in 2022–2023 amounted to NRs 8.28 billion, of which NRs 422.85 million were due to floods and landslides (GON, 2024). In 2017, the central and eastern part of Terai suffered excessive rainfall and flash floods, resulting in damage worth NRs 17.9 billion in the agriculture sector (NPC, 2017). In 2022/23, 1,033 documented events of flooding and landslides directly impacted 7,850 families (DRR Portal, NEOC, MoHA, 2023). The 2024 flood and landslide season was among the most destructive in Nepal's recent history, with preliminary assessments by the National Disaster Risk Reduction and Management Authority (NDRRMA) estimating total losses at NPR 46.68 billion. This catastrophe significantly affected critical sectors including infrastructure, agriculture, health, and education, resulting in 249 fatalities, 177 injuries, and the displacement of more than 10,000 families (NDRRMA, 2024).

According to projections by the IPCC (2023) and the World Bank (2023a), climate-induced disasters may lead to economic losses equivalent to 1.5 percent to 3 percent of Nepal's GDP annually. Agriculture, contributing roughly 27 percent of GDP and supporting more than 65 percent of the population, remains acutely vulnerable to climate shocks. However, investments in climate-resilient and risk-reducing agricultural practices have been minimal (International Business, 2016). As early as 2009, inadequate rainfall had placed over 2 million people at risk of food insecurity in western Nepal (MOAC et al., 2009). Despite growing vulnerability, public spending on disaster risk reduction and management has hovered around 5 percent of total capital investment for over a decade, without any marked increase (Kellett & Caravani, 2013; World Bank, 2024). Financial demands following major disasters frequently outstrip available resources. For example, recovery costs from the 2017 floods were estimated at NPR 73 billion, while the total capital budget allocation for that fiscal year stood at just NPR 209 billion out of a total national budget of NPR 837 billion (ADB, 2019).

The increasing risk exposure and financial susceptibility underscore the urgency of a more robust and proactive disaster risk reduction and financing approach. Nepal has made commendable progress in creating legal and institutional frameworks, particularly with the Disaster Risk Reduction and Management Act (2017), which established a multi-tiered structure from federal to local levels and led to the formation of the

NDRRMA. However, despite these advancements, practical implementation challenges persist. The DRRM Act lacks clarity on designating disaster-prone zones and suffers from overlapping mandates due to conflicting legal provisions (Khanal, Nepal & Sharma, 2018). Many of the established policies remain partially enacted or unfunded (Wendelbo et al.,2016).

Institutional capacity is still fragmented across the three tiers of government. Responsibilities outlined in the legal framework are often inadequately implemented due to limited technical capacity, resource constraints, and bureaucratic inefficiencies, particularly at local level. Studies have shown that elected representatives and officials at sub-national levels are sometimes reluctant to adopt disaster measures that may conflict with political or local interests (Jones et al.,2014). Even though Nepal has been part of numerous international and national risk management platforms, the practical enforcement of commitments remains weak (Gaire et al.,2015).

A critical gap exists in disaster risk financing. Although the Disaster Risk Financing Strategy 2020 developed with World Bank support proposes a range of financial instruments, it fails to address key issues such as the scale of funding gaps, vulnerability targeting, and the mismatch between investment needs and available resources. Nepal's disaster-related fund flow system remains fragmented and lacks a dedicated national budget code for tracking disaster risk reduction expenditures, which hampers transparency and accountability.

Most DRRM spending is thinly spread across sectors without adequate costing, leading to major inefficiencies and unaddressed funding deficits. This issue is compounded by the limited application of risk financing instruments. Practices such as risk retention through contingency budgeting, risk assessment, and risk transfer mechanisms like insurance or private sector involvement are still in their infancy.

The reliance on foreign aid and humanitarian relief for disaster response further exacerbates Nepal's vulnerability. International support is often reactive, focused primarily on relief rather than on preparedness or mitigation, leading to delays and dependency. As Khazai et al. (2018) highlighted, local-level response mechanisms are inadequate and require significant capacity-building. Mechler (2016) and Clarke and Dercon (2016) argue that ex-ante financial instruments such as risk pooling, catastrophe bonds, and sovereign insurance schemes are more effective in reducing post-disaster recovery costs and economic disruptions. However, in Nepal, the lack of tailored instruments for both ex-ante and post-disaster scenarios continues to limit effective disaster risk management.

Understanding the economic impacts of floods and evaluating the current state of disaster risk financing in Nepal are critical for identifying the financial and institutional gaps that hinder effective disaster risk management (DRRM). In particular, tracking public expenditure, assessing the shortfall in funding-especially for flood related risks and forecasting future needs are essential for improving financial preparedness

and targeting support to vulnerable communities. Bridging these financial gaps is key to shifting from reactive, relief-based responses towards a proactive, resilient, and sustainable DRRM approach. This study contributes to that goal by analyzing historical flood trends, economic losses, and current financing mechanisms to identify funding gaps in flood risk management, thereby supporting evidence-based recommendations for strengthening Nepal's financial resilience to climate-induced disasters.

Literature Review

Overview of Disaster Risk Finance and Disaster Risk Funding Gap

Disaster Risk Financing (DRF)is a vital tool for managing the fiscal risks of natural disasters and enhancing economic resilience. It encompasses ex-ante financial instruments such as contingency funds, reserve allocations, disaster insurance, catastrophe bonds, and contingent credit lines that ensure timely access to resources. For example, the National Disaster Response Fund and contingency budgets enable immediate mobilization, while disaster-contingent credit and insurance facilitate risk transfer. Ex-post tools are activated after disasters for long term recovery and includes emergency budget reallocations, donor assistance, tax reliefs incentives and concessions, and post-disaster external credit (ADB & World Bank,2017).

Global frameworks such as the Hyogo Framework for Action and the Sendai Framework for Disaster Risk Reduction promote integrating DRF into national strategies and prioritizing pre-disaster investment to build long-term resilience (UNISDR, 2015). In line with these principles, there is a shift from reactive to proactive financial planning, with increasing preference for ex-ante approaches due to their greater cost-effectiveness and resilience benefits (Mechler, Mochizuki, & Hochrainer-Stigler, 2016). Quantifying public spending across ex-ante and ex-post financing highlights their social and economic advantages (OECD, 2012). The **risk-layering approach** further strengthens efficiency by aligning financing instruments with the severity and frequency of disaster-related.

The disaster funding gap refers to the shortfall between the financial resources needed for effective disaster preparedness, response, and recovery and the actual funds available. The funding gap is defined as the residual between total annual losses incurred due to disasters and the funding available to meet those needs (ADB,2017). Understanding and analyzing these gaps is crucial for governments, policymakers, humanitarian organizations, and stakeholders identify and quantify the funding gaps, available financial resources, improve budget planning, and prioritizes resource allocations. The Government of Nepal has conducted post-disaster needs assessments (PDNA) for large-scale disasters to obtain financial support from multilateral and bilateral agencies.

Theoretical Perspectives on Disaster Risk Management and Funding Gap

Disaster Risk Reduction and Management (DRRM) theories emphasize the interconnected social, economic, environmental, and institutional drivers that shape community vulnerability and response capacities. **Social Vulnerability Theory** argues

that disaster impacts are not solely determined by hazards but by pre-existing inequalities-such as poverty, gender, age, and access to resources-that heighten vulnerability (Cutter, Boruff, & Shirley, 2003). It suggests that funding gaps often reflect systemic neglect of marginalized populations, and that DRRM financing must prioritize social protection, inclusion, and targeted support for vulnerable groups (Wisner et al., 2004). **Systems Theory** views disaster risk as a product of interactions among various systems-social, economic, ecological, and institutional (Alexander, 2000). It supports integrated, multi-sectoral planning and risk governance that enables more coordinated and efficient allocation of disaster funding. The theory underpins the "whole-of-society" approach, promoting partnerships across government, private sector, and civil society to close funding and implementation gaps (UNISDR, 2015). **Resilience Theory** emphasizes the capacity of communities and systems to absorb shocks, adapt, and transform in response to disasters (Holling, 1973; Manyena, 2006). It informs the "build back better" principle, advocating for strategic post-disaster investment that enhances future resilience. In this context, narrowing the disaster funding gap is essential not only for recovery but also for strengthening long-term adaptive capacity (UNISDR, 2015).

Role of International Organizations in Assessing Disaster Risk Financing Gaps

International organizations like the World Bank, Asian Development Bank (ADB), and UNDRR prioritize identifying and addressing disaster risk financing gaps. The World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) Disaster Risk Financing and Insurance (DRFI) Program supports low-income countries in estimating financial needs and designing risk-aligned funding strategies (World Bank & GFDRR, 2014). The Sendai Framework (2015–2030) urges governments to integrate DRF into national plans, identify funding shortfalls, and adopt sustainable financial tools to improve preparedness, response, and recovery (UNDRR, 2015). The ADB–World Bank Guidance Note (2017) offers diagnostic tools for evaluating financial protection mechanisms, including contingency funds, insurance, and risk pooling. These international benchmarks are valuable for Nepal in assessing and reducing disaster funding gaps, particularly for flood risk management. The UNEP Adaptation Gap Report (2022) forecasts global adaptation finance needs rising from $160–$340 billion in 2030 to $315–$565 billion by 2050, highlighting persistent gaps despite commitments. In 2020, climate finance fell $17 billion short of the $100 billion annual target pledged under the UNFCCC (UN, 1992). While COP26 called for doubling adaptation finance by 2025 and COP27 established the Loss and Damage Fund, significant funding shortfalls continue to hinder the ability of vulnerable countries to adapt effectively to climate impacts (UNEP, 2022).

International Evidence on Disaster Funding Gaps:

Empirical studies highlight government efforts worldwide to identify and address DRF gaps. The Asian Development Bank (2015) collaboration with Bangladesh revealed disaster losses up to 8 percent of GDP from floods and 5 percent from cyclones between 2000 and 2013, with significant funding shortfalls and low insurance coverage, especially

for micro-insurance targeting vulnerable populations. In Vanuatu, gaps in disaster funding were found in data management, forecasting capacity and risk assessment despite existing GIS and weather infrastructure, underscoring the need for enhanced financing and national risk assessments (VMGD, 2015; NDMO, 2023). The UN OCHA (2023) estimated a $1.3 billion financing deficit for Afghanistan's 2023 Humanitarian Response Plan, aggravated by climate shocks threatening key sectors like food, WASH, and protection amidst recurring floods. Similarly, the UNDP (2023) reported cyclone damages averaging USD 88 million per event in Fiji, including annual budget, loans, and donor aid-falling far short. The report urged the creation of dedicated disaster funds, parametric insurance, and micro-insurance to enhance financial resilience. The Financial Flows and Gap Analysis: Disaster Risk Financing in Kenya (2016-2022) report identified substantial gap in disaster risk financing mechanism in Kenya with 92.9% allocated to drought response dominating the funding flows, with minimal resources for floods and locusts, calling for more flexible, hazard-responsive financing (Taylor & Mwangi, 2023). Regional risk-sharing mechanisms such as the African Risk Capacity (ARC, 2023) highlighted that collaborative funding gap analyses among African nations led to the establishment of ARC, enabling pooled risk management and timely access to disaster funds. Similarly, the Caribbean Catastrophe Risk Insurance Facility (CCRIF SPC, 2023) was formed following regional funding gap analysis, offering parametric insurance with rapid payouts to address post-disaster funding shortfalls and strengthen recovery efforts.

National Context: Funding Gap in Nepal:

Despite Nepal's progress in institutionalizing disaster risk reduction (DRR) and climate finance, a substantial disaster risk financing (DRF) gap remains, hindering its capacity to build long-term resilience. A systematic review of national frameworks, funding flows, institutional arrangements, and international support highlights challenges and opportunities in building financial resilience.

The Constitution of Nepal (2015) and the Disaster Risk Reduction and Management Act (DRRM Act, 2017) delineate clear responsibilities across federal, provincial, and local governments for managing disaster risk. The National Disaster Risk Reduction Policy (2018), National Disaster Response Framework (2019), and DRRM Strategic Action Plan (2018–2030) guide efforts to improve coordination and enhance resilience. Key institutions include the National Disaster Risk Reduction and Management Authority (NDRRMA), the National Council for Disaster Risk Reduction and Management (NCDRRM), and corresponding executive and coordination committees at various government levels (NDRRMA, 2023).

According to the National Natural Resources and Fiscal Commission Act 2074 (Part 26, Articles 250 and 251), the Government of Nepal collects revenue through taxes and customs while also receiving grants, loans, and technical assistance from development partners. These funds are pooled and redistributed across federal, provincial, district, and local levels. Nepal employs both ex-ante and ex-post disaster financing tools: contingency

budgets such as the Prime Minister Disaster Relief Fund (over NPR 280 million as of January 2024), Central Disaster Relief Fund, and reserve funds at provincial, district, municipal, and ward levels. These include the Provincial Disaster Management Fund (NPR 513.3 million, 2023), District Disaster Management Fund (NPR 592.2 million, 2023), and municipal DRR funds with balances ranging from NPR 500,000 to NPR 5 million depending on municipality type (MoHA, 2018; UN Nepal, 2023).

Sectoral budgets are regularly allocated to disaster risk reduction through federal and provincial line agencies and expended at the local level. For instance, in FY 2018/19, the Ministry of Home Affairs allocated NPR 1.85 billion; the Ministry of Energy, Water Resources and Irrigation allocated NPR 1.959 billion; and the Ministry of Agriculture, Land Management and Cooperatives allocated NPR 3.662 billion for DRR-related activities (Red Book, 2080/81). Budget allocations follow a general pattern by ecological belt: NPR 0.3–0.4 million for mountainous districts, NPR 0.4–0.5 million for hilly districts, and NPR 0.6–0.7 million for Terai districts, with additional amounts based on disaster magnitude.

Despite progress, challenges remain. Between 2018/19 and 2022/23, DRR budget allocations increased from NPR 2.73 billion to NPR 3.35 billion, indicating a positive but modest trend (Ministry of Finance, 2018–2022). Ex-post disaster financing includes budget reallocation through the "Budget Transfer Mechanism" and international borrowing. From 2003 to 2019, Nepal borrowed NPR 6.84 billion (NPR 6.74 billion from multilateral and NPR 0.1 billion from bilateral sources) for disaster recovery, including NPR 2 billion following the 2017 flood (Red Book).

Private sector contributions include insurance products for life, property, agriculture, and livestock, which serve as risk transfer mechanisms (Pant & KC, 2018). However, the use of contingent credit, insurance of public assets, and insurance-linked securities such as catastrophe bonds remains minimal or absent (World Bank, 2020). The Agriculture and Livestock Directives 2013 exist but are poorly implemented.

The DRF system in Nepal involves multiple stakeholders and structures. Public financing flows from federal and provincial governments down to local levels via District Treasury Control Offices under the Financial Comptroller General Office (FCGO). Financing actors include: (a) public institutions (ministries, departments, local governments), (b) development partners (UN, ADB, WB, ICIMOD, SAARC, RIMES), (c) INGOs and NGOs (e.g., Red Cross), and (d) private entities (e.g., FNCCI, CNI, FEWAN) and households.

Nepal's legal frameworks-including the Intergovernmental Fiscal Arrangement Act (2017), Local Government Operations Act (2017), National Natural Resources and Fiscal Commission Act (2017), and Financial Procedures and Fiscal Responsibility Act (2019)-guide fund allocation and emphasize support for vulnerable populations.

The National Planning Commission (NPC, 2018) estimated that Nepal requires approximately USD 20 billion for the period 2023–2025 and USD 30 billion for 2026–2030 to achieve the Sustainable Development Goals (SDGs). The Ministry of

Forests and Environment (MoFE, 2021a, 2021b) projects nearly USD 48 billion will be needed by 2050 to implement adaptation priorities. Despite these needs, national allocations remain limited. NDRRMA (2023) allocated only NPR 1 billion for disaster risk reduction in its long-term plan, and USAID-BHA (2024) reported that disasters caused USD 7 billion in damages from 1980 to 2020, while the government spent just NPR 50 billion on response and recovery from 2012 to 2020.

Although frameworks such as the Climate Change Budget Code and Climate Finance Framework (2017) track climate-related spending, there is no unified national budget code for DRR expenditure (CPEIR, 2011). Financial allocations across mitigation, preparedness, response, and recovery are inconsistent (DRRM Act, 2017). Dixit et al. (2016) highlight institutional weaknesses, poor transparency, and difficulties in transferring climate finance to vulnerable sub-national communities. Nepal continues to rely heavily on reactive financing mechanisms, such as foreign aid and post-disaster budget reallocations, which contributed to delays in recovery after the 2015 earthquake, causing losses equivalent to 33% of GDP (ADB, 2019).

The Disaster Risk Financing Strategy (2020), developed with World Bank support, promotes diversified financial instruments, including contingency funds, insurance, and risk pooling. The UNDP Insurance and Risk Finance Facility supports the Ministry of Finance, Insurance Authority, and NDRRMA in developing inclusive insurance products (UNDP, 2023). USAID/BHA contributed over USD 11 million in FY2022 for risk reduction and recovery programs (USAID-BHA, 2024). ICIMOD facilitates regional knowledge sharing and technical support through platforms like the Koshi Disaster Risk Reduction Knowledge Hub and the BIPAD portal (ICIMOD, 2024a, 2024b, 2024c).

The World Bank (2023b) recommends integrated strategies combining insurance, contingency funds, and risk transfer tools. The World Economic Forum (2022) and Marsh McLennan (2023) advocate for resilience, prevention, and data-driven risk reduction following the severe climate events of 2022. The ADB (2023) underlines the importance of community engagement and rapid financing for resilient recovery in the Asia-Pacific region. Historical lessons, such as from the 2010 Sindh floods, underscore the need to embed risk mitigation and preparedness in recovery planning (Ali, Mannakkara, & Wilkinson, 2020).

Closing Nepal's disaster risk financing gap will require unified budget coding for DRR, improved coordination across all government tiers, and greater financial transparency. Strengthening local institutional capacity is crucial to ensure timely fund absorption and delivery. The integration of innovative instruments such as parametric insurance and micro-insurance, alongside traditional tools, can provide timely payouts and support proactive resilience-building. Mobilizing green finance and enhancing engagement with development partners and the private sector are also critical (OPM, 2022; GoN, 2024). Implementation of Nepal's Second Nationally Determined Contribution (NDC) targets, including the development of a loss and damage strategy by 2025, will require concerted institutional and financial efforts.

Research Methodology

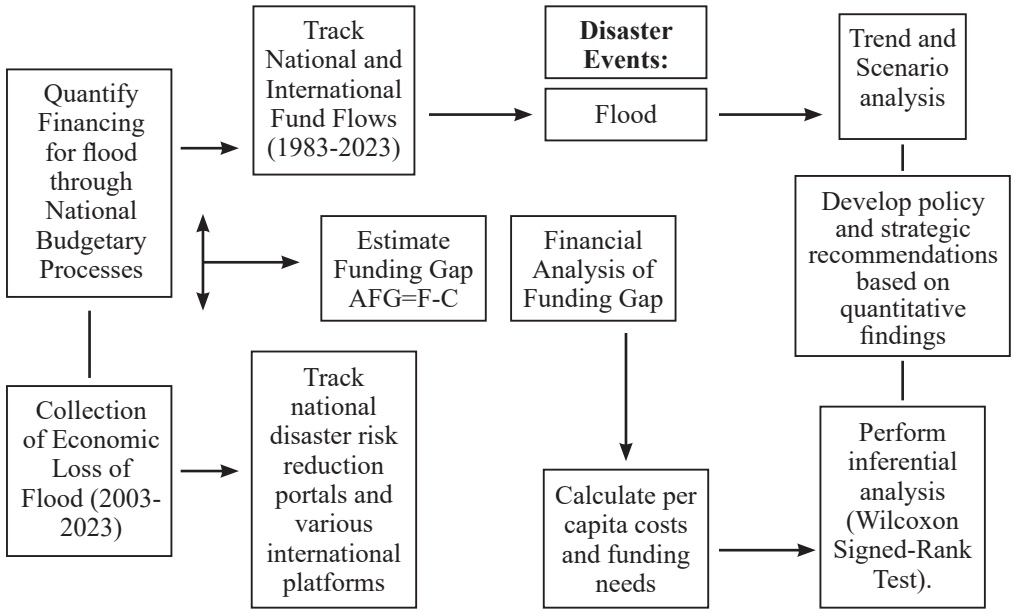
The methodology for funding gap analysis follows the guidance outlined in *"Assessing Financial Protection against Disasters: A Guidance Note on Conducting a Disaster Risk Finance Diagnostic"* (World Bank & ADB, 2014). Institutional and financial assessments are further supported by the Public Expenditure Review (PER) and the Climate Public Expenditure and Institutional Review (CPEIR) frameworks, which help track the integration of DRR spending into national planning and budgeting. The study employs a quantitative research design to analyze the funding gap in flood disaster risk management in Nepal. The three main phases of this approach are

(i) Assessment of historical economic losses from floods,
(ii) Analysis of government and international funding flows, and
(iii) Estimation of the funding gap by comparing losses with available financing.

A conceptual model (Figure 3.1) illustrates this process, emphasizing a structured evaluation of flood-induced disaster losses and financial responses. The study period spans from 1983 to 2023 for damage assessment and from 2003 to 2023 for funding data, allowing both short-term projections and long-term trend analysis.

Figure 3.1:

Conceptual Framework of the study



Source: Researcher's Collective Analysis

For the analysis, secondary data are employed. The Ministry of Home Affairs, the DRR Portal, and pertinent government papers are the sources of flood-related loss data, while the Red Book, White Book, budget speeches, the Aid Management Platform, and the Financial Tracking System (FTS) are sources of financing data. Data on yearly damages, government allotments, international donations, and loans are available from these sources. Stata is used for analysis, and Microsoft Excel is used to arrange the datasets. Government allotments, foreign grants and loans, and flood-related financial losses are totaled annually. Prior to analysis, data are cleansed, normalized, and cross-source consistent.

Using population and GDP scaling, historical data are adjusted to guarantee comparability over time. For funding and damage statistics, the ratio of current GDP to event year GDP is used to adjust each data point. Population numbers are used in the same way for population-based impacts. This scaling takes demographic growth, inflation, and economic exposure into consideration. For example, if a flood occurred in 2000, the GDP and population of that year are used as a benchmark, and numbers are modified in relation to the most recent year available.

- Among the data scaling formulae are
- Current Population divided by Event Year Population is the adjusted population.
- Total GDP minus Event Year GDP equals adjusted GDP.

This allows the conversion of event-year data into present values, accounting for inflation and demographic growth. The results are expressed through indicators such as

- Average cost per affected person
- Damage as a share of GDP
- Affected population ratio
- Per capita funding received

The study analyzed year-over-year data to understand past trends in financing and losses. By contrasting available funds with adjusted yearly flood losses, funding gaps are calculated. The discrepancy between normalized required funding and available finances is known as the average funding gap. The financing efficiency ratio, a metric that assesses how well financing has kept pace with disaster expenses over time, is calculated by dividing total funding by total losses. Understanding historical patterns is aided by descriptive statistics such as mean, median, and standard deviation. The formula is used to estimate the financing shortfall. Normalized losses and funds are used to assess trends and identify shortfalls. The Funding Efficiency Ratio (TF/A) is applied to evaluate how effectively funds have matched economic needs over time.

G=C-F

Where,

G = Average Funding Gap

C = Current Available Financing for Risk Reduction

F = Average Disaster-Related Financing Requirement

The observed financial gap in flood risk financing for catastrophes is validated by the study using both parametric and non-parametric testing. The Shapiro-Wilk test is used to verify whether the data follows a normal distribution, which is the first step in inferential analysis. The use of parametric tests like the paired t-test, which compares the average predicted funding to the actual funding to see if the differences are meaningful, is supported by a p-value greater than 0.05, showing that the data is normal. The Wilcoxon signed-rank test, on the other hand, is used as a non-parametric substitute to assess significant differences between paired data without supposing normality if the p-value is less than 0.05, suggesting a non-normal distribution (Wilcoxon, 1945). The distribution of the funding gaps is not substantially different from that of available funds, according to the null hypothesis, which asserts that there is no discernible difference between the funding gaps and the overall funding. According to the alternate theory, there is a notable difference. Time series analysis supports these hypothesis testing techniques by revealing past patterns in disaster losses and public finance allocations, which enables the prediction of future financial requirements. When combined, these statistical methods guarantee that the results made about the disaster financing gap in Nepal are solid and supported by data.

By triangulating multiple data sources and employing a rigorous analytical framework, the study provides a comprehensive picture of Nepal's disaster financing landscape. The results inform targeted policy recommendations to improve the efficiency and sufficiency of flood disaster funding.

Table 3.1.

Funding Gap

Year	Economic loss (A)	Gov. Funding (B)	International Funding		Total Funding TF= (B+C+D	Funding Gap (A-TF)	Growth Rate of Funding	Growth Rate of Economic Loss	Funding Source Contribution (%)	Funding Efficiency Ratio (TF/A)
			Grant (C)	Loan (D)						
Total										

Source: (Ozaki, 2016) and the Researcher's calculation

Hypothesis Testing

Hypothesis testing determines if there is a significant difference between paired variables. If data are normally distributed ($p > 0.05$), the Paired T-Test is used (Student,

1908). If not ($p < 0.05$), the Wilcoxon Signed-Rank Test is applied as a non-parametric alternative (Wilcoxon, 1945).

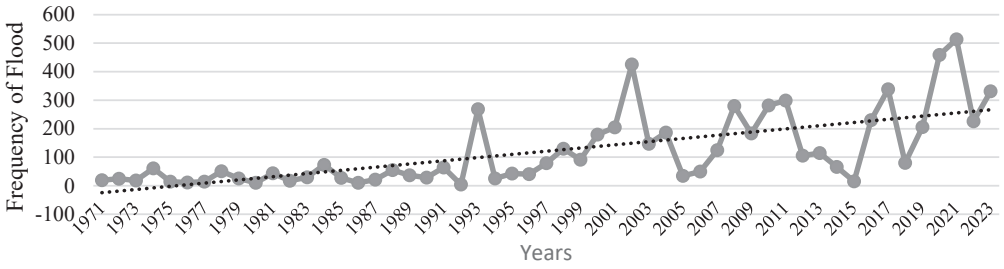
Results and Analysis

Trends and Patterns in Flood Frequency

The figure shows a distinct upward trend in flood frequency and intensity over time, with the early 1990s seeing a notable increase. In 2020 and 2021, the highest frequency was recorded.

Figure 4.1:

Temporal Analysis of Flood Frequency



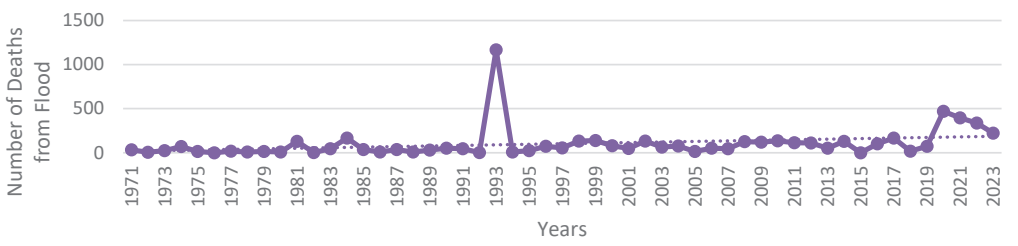
Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal*. Government of Nepal, FY 2024// http://drrportal.gov.np/*

Analysis of Flood-Induced Death Frequency

The value exhibits notable fluctuations throughout time, peaking in 2021 after a sharp rise in 1993, 1984, 1998, 2000, and 2020. Overall, the trend shows that death rates have been rising over time, with some noticeable upticks recently.

Figure 4.2:

Analysis of Flood-Induced Mortality



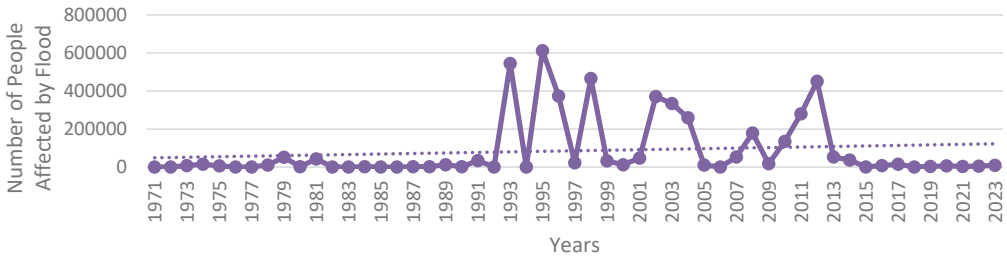
Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

Direct and Indirect Impact of Flood on Population

The percentage of people impacted by floods varies significantly over time. Extreme peaks, especially in 1993, 1995, 2008, and 2012, indicate that people were severely impacted. Overall, the chart illustrates the significant impact of significant flood disasters in some years, even though there are times when a very high number of people are impacted.

Figure 4.3:

Direct and Indirect Impacts of Floods on Affected Populations



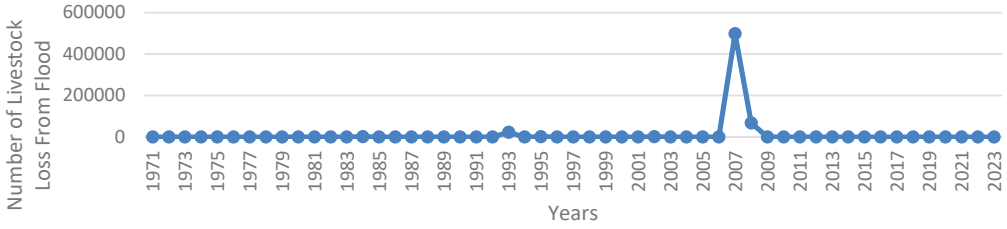
Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

Annual Livestock Losses Attributed to Floods

The annual livestock losses from floods figure varies significantly, with dramatic peaks in 1993, 2007, and 2008 indicating severe flood events. Nonetheless, there were no recorded livestock losses in the 2014–2023 fiscal years, indicating that overall livestock losses are rather modest.

Figure 4.4:

Annual Livestock Losses Attributed to Floods



Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

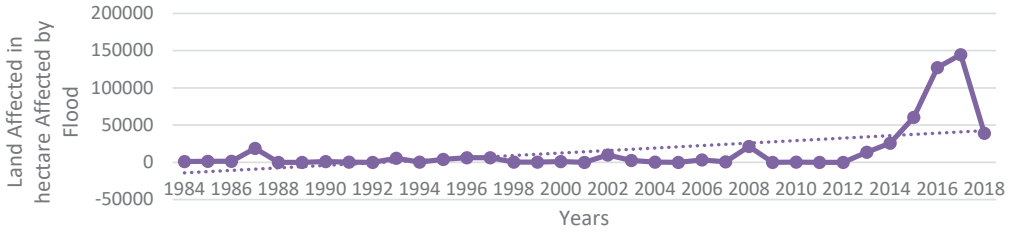
Assessment of Land Impacted by Floods:

The amount of territory impacted by flooding varies greatly, with significant effects in

several years. 134,724 hectares in 2017, 127,158 hectares in 2016, and 60,520 hectares in 2015 are notable maxima. Reports from 1988, 1989, 2001, and 2012 show that no land was impacted. Overall, the evidence shows that flooding has a considerable, although intermittent, influence on land.

Figure 4.5:

Assessment of Land Impacted by Floods



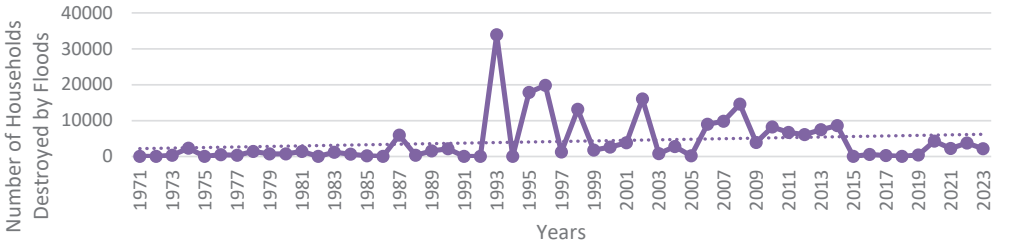
Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

Assessment of Households Destroyed by Floods:

There are notable variations over time in the data on flood-damaged households. Notable peaks can be found. The information demonstrates how the effects vary from year to year, highlighting both extreme floods and periods of improved flood control.

Figure 4.6:

Assessment of Households Destroyed by Floods:



Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

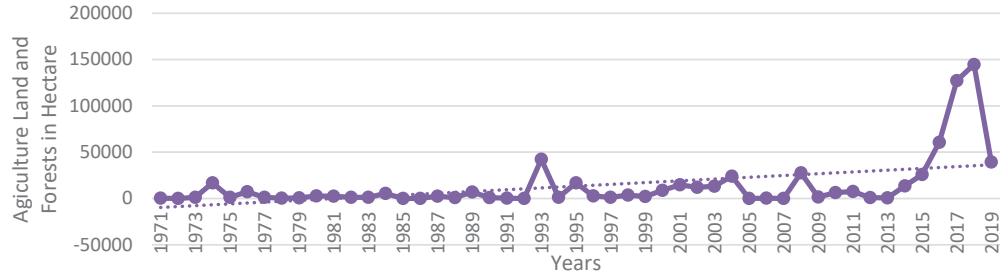
Impact of Floods on Agricultural Land and Forests:

Data on flood-related damage to forests and agricultural land shows notable oscillations, with notable peaks in 2017, 2018, and 2016 all at the same time, pointing to serious flood effects. 1992 and 2005 were the least damaged years, with less severe flooding. The overall damage to agricultural and forest lands is depicted in the figure, with significant

variation in the impact across years.

Figure 4.7:

Impact of Floods on Agricultural Land and Forests



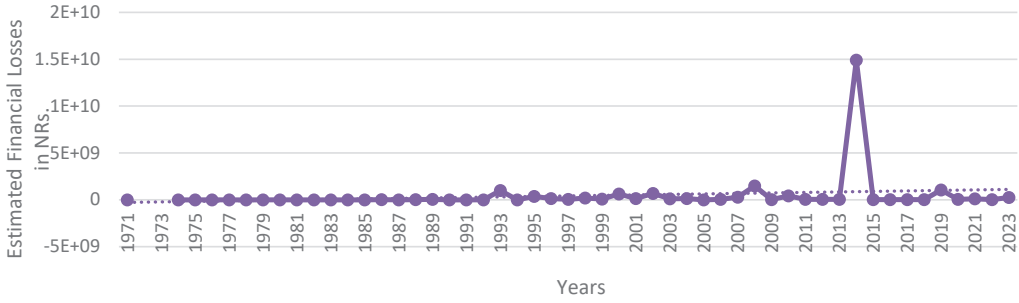
Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

Economic Impact of Flooding: Analyzing Estimated Financial Losses

Data on anticipated flood losses reveals a great deal of variation across time, with dramatic peaks indicating major financial effects. Among the noteworthy higher losses are 1,007,298,916 NRs. 5,477,386,412 in 2023, 649,176,394 in 2014, and 1993. On the other hand, there are no records of losses for other years, like 1976 and 1992. Overall, the data, which shows sharp variations in anticipated losses, emphasizes the significant financial burden of flooding. It shows changing economic impact and severity over time.

Figure 4.8:

Economic Impact of Flooding: Analyzing Estimated Financial Losses



Source: *Ministry of Home Affairs,* Disaster Risk Reduction Portal, *Government of Nepal, FY 2024 // http://drrportal.gov.np/*

Financial Flow for Flood Risk Mitigation and Management in Nepal

From 2003 to 2023, the tracking of financial flows in climate-induced disaster

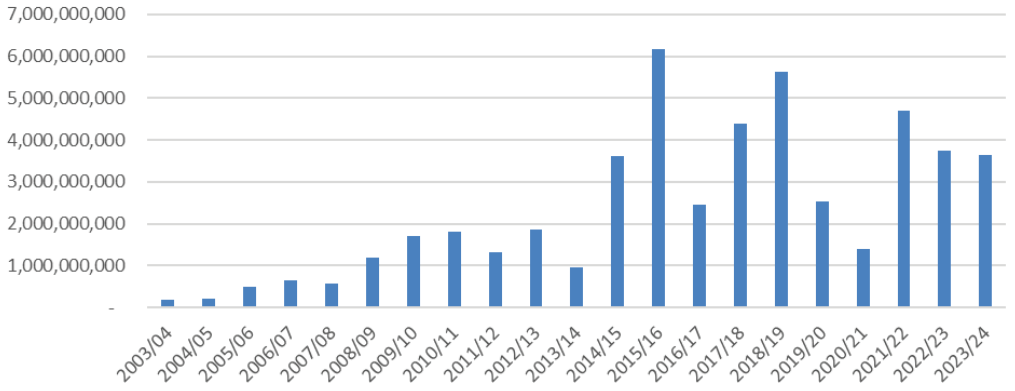
management in Nepal, specifically for flood-related activities, includes looking at the various financing sources and types that were raised to deal with the flood-induced disaster. Domestic government funds, foreign aid, and contributions from bilateral donors, non-governmental organizations, and the business sector in the form of grants, loans, and technical assistance were all included in these financial flows. Nevertheless, the following tables and data solely document and examine official avenues of money transfer. The study tracked these various money flows to identify trends, efficacy, and financing gaps during the previous 20 years.

Government Allocations and Financial Flows

The information shows how Nepal's government funded floods from 2003 and 2022. In general, the funding tends upward, with some years seeing a notable rise. The financing climbed gradually from NPR 197,870,000 in 2003–04 to significant increases in 2008–09 (NPR 1,202,634,000) and a significant peak in 2015–16 (NPR 6,169,638,000). However, reallocations or changes in priorities may have caused a dramatic drop to just NPR 42,501,119 in 2020–21. The financing showed fluctuations in disaster management allocations over time, largely rebounding to NPR 2,422,500,000 in 2021/22.

Figure 4.9:

Government Funding for Flood Management (2003-2023)



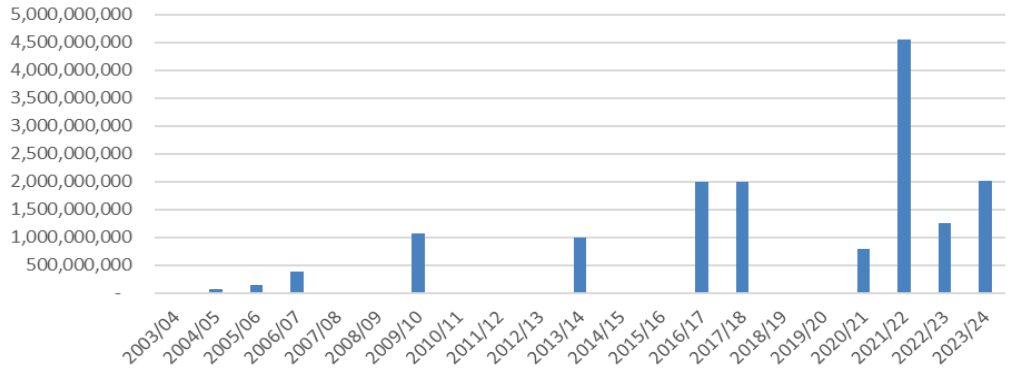
Source: *Ministry of Finance, Red Book and White Book, Fiscal Year 2024. Government of Nepal*

International Loans Funded in the Government Budget for Flood Management

From 2004–05 to 2021–2022, the government budget allocated different amounts of foreign loans for flood management. The loan allocation began at NPR 66,000,000 in 2004–05 and increased significantly in the following years, reaching a peak of NPR 1,702,862,000 in 2009–10. With NPR 2,000,000,000 each in 2016–17 and 2017–18, the largest allocations are observed during these years, suggesting strong financial support. An even larger allocation of NPR 2,799,100,000 is shown in the most recent figures from 2021–2022.

Figure 4.10:

International Loans Funded in the Government Budget for Flood Management



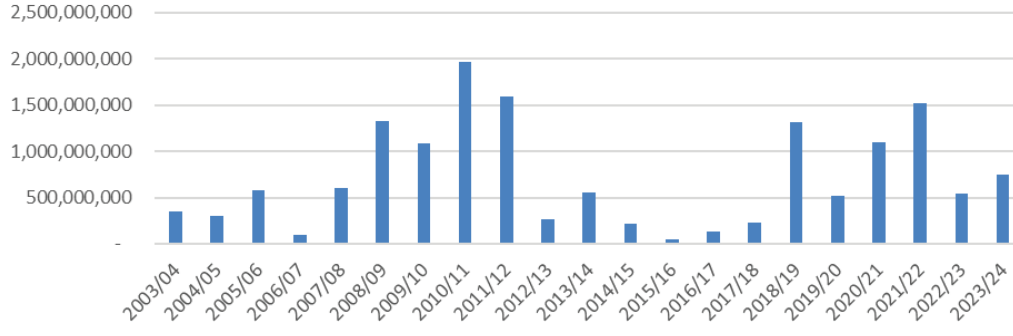
Source: *Ministry of Finance, Red Book and White Book, Fiscal Year 2024. Government of Nepal.*

International Grants Funded in the Government Budget for Flood Management

There are notable variations in the government budget for international grants for flood management from 2003–2004 to 2021–2022. At NRs. 1,970,706,000, the largest grant was recorded in 2010–11. Both foreign assistance and flexible grants, depending on flood-related needs and circumstances, are reflected in this trend. In some years, such as 2015–16, grants drastically decrease. On the other hand, notable rises in 2008–09 and 2010–11 indicate increased donor involvement in reaction to major flooding incidents. Additionally, the current trend of grant recovery in 2020–2021 and 2021–2022 points to a renewed focus on flood risk management to climate-related funding mechanisms on a global scale.

Figure 4.11:

International Grants Funded in the Government Budget for Flood Management



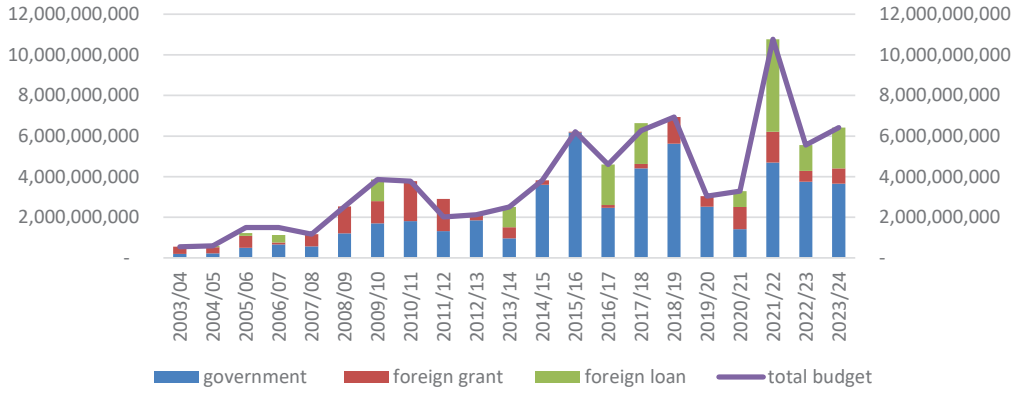
Source: *Ministry of Finance, Red Book and White Book, Fiscal Year 2024. Government of Nepal*

Total Funds in the Government Budget for Flood Management

The relationship between foreign grants, loans, and government allocations for flood management in Nepal is demonstrated from 2003–04 to 2021–2022. International grants continuously aided flood management during this time, reaching a high of NRs. 1,970,706,000 in 2010–11. The amount of foreign loans varied, with notable loans in 2009–10 (NPR 1,702,862,000) and 2021–2022 (NPR 2,799,100,000) being two examples. Additionally, government financing varied, with a considerable increase reaching NPR 6,169,638,000 in 2015/16.

Figure 4.12:

Total Funds in Government Budget for Flood Management



Source: *Ministry of Finance,* Red Book *and* White Book*, Fiscal Year 2024. Government of Nepal.*

International Funds Flow for Flood Management Excluded from Budgetary Processes

The data extracted from the Financial Tracking Service (FTS) and the Aid Management Portal, focusing on international funds flows through I/NGOs and multilateral agencies that are not incorporated into the national budgetary process. These platforms provide comprehensive records of humanitarian aid and development assistance, capturing the scale and sources of financial contributions directed towards flood risk reduction and management in Nepal. This analysis aims to highlight the financial contributions that operate outside of government budget channels, offering insights into the broader landscape of international support for flood management initiatives.

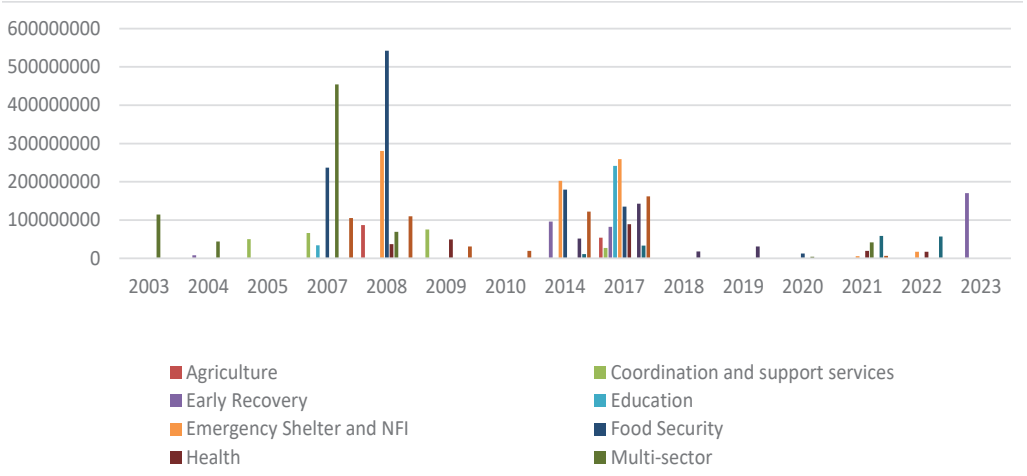
International Funds Flow in different sectors for Flood Management

Financial Tracking Service (FTS)

From 2003 to 2023, international funding for flood management in Nepal showed significant year-to-year and sectoral variation. Major allocations included $237 million for Emergency Shelter and $542 million for Food Security in 2007, and $867 million for Agriculture in 2008. Peaks also occurred in 2014 ($956 million) and 2017 ($824 million for Early Recovery). Some years, like 2010 and 2019, recorded minimal or no sectoral funding. Recent years show targeted investments, including $171 million in 2022 for Emergency Shelter and $170 million in 2023 for Early Recovery, highlighting shifting priorities and funding gaps over time.

Figure 4.13:

International Funds Flow in Different Sectors in Flood Management (FTS)



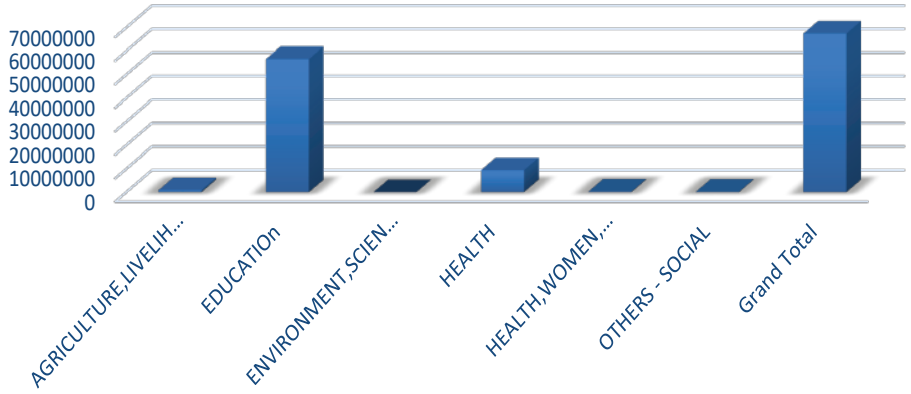
Financial Tracking Service (FTS). Funding Flows for Humanitarian Response. *Retrieved from http://fts.unocha.org/ FY, 2024.*

Aid Management Portal

Between 2010 and 2024, Nepal received substantial off-budget international funding for flood resilience and disaster response. Major contributions include $56 million from the UK's DFID for education-focused disaster resilience and $9.4 million from the EU for flood recovery in children's health. Other key donors, like UNFPA, Save the Children, and Lutheran World Relief, supported sectors such as agriculture, health, and social protection. Notably, Practical Action Nepal exceeded its planned budget by 1,238%, indicating high demand or underestimated needs. In total, $8.8 billion was allocated, with $7.9 billion utilized, reflecting strong international support for Nepal's flood management and disaster recovery efforts.

Figure 4.14:

International Funds Flow in Different Sectors for Flood Management (AMIS)



Source: *Aid Management Information System, MoF, Nepal. FY 2024. Retrieved from https://amis.mof.gov.np/*

Short-Term and Long-Term Funding Gaps for Flood-induced Economic Loss and Damage in Nepal

This section examines funding gaps in flood risk reduction and management in Nepal by comparing required financing with actual allocations. The analysis reveals that in most years between 2003 and 2023, there was no funding gap, as available funds often exceeded the economic impact of floods. For instance, in 2003/04, funding reached $546.61 million against losses of $120.16 million, resulting in a surplus of $426.45 million. A similar surplus occurred in 2004/05 and other years like 2007/08 and 2009/10. An exceptional case was 2014/15, when funding exceeded losses by over $11 billion. These trends indicate that, historically, Nepal's flood disaster funding mechanisms have largely been sufficient to cover economic losses.

Short-Term and Long-Term Funding Gaps for Flood-induced Economic Loss and Damage in Nepal

This section examines funding gaps in flood risk reduction and management in Nepal by comparing the required financing to actual funds allocated. Understanding where financial shortfalls exist is vital for developing effective strategies to strengthen flood resilience in vulnerable communities.

An annual analysis shows that in most years, there is no funding gap, as total funding consistently exceeds the economic losses from floods. For example, in 2003/04, losses amounted to USD 120.16 million, while funding reached USD 546.61 million-resulting in a surplus of USD 426.45 million. Similarly, in 2004/05, the funding exceeded losses by USD 460.52 million. This trend continued in years like 2007/08 and 2009/10. A

striking exception is 2014/15, when funding exceeded losses by over USD 11 billion. Overall, the data suggests that Nepal's flood disaster financing has generally been adequate to cover annual losses.

Table 4.4:

Total Funding and Economic Loss Analysis

Year	Growth Rate of Funding	Growth Rate of Economic Loss	Funding Source Contribution (%)			Funding Efficiency Ratio (TF/A)
			Government	Grant	Loan	
2003	-	-	36.22	63.78	0	0.55
2004	0.08	-0.65	37.48	51.33	11.19	1.73
2005	1.07	0.14	40.87	47.76	11.37	3.16
2006	-0.07	0.01	57.88	8.51	33.61	2.88
2007	0.04	3.91	48.67	51.33	0.00	0.61
2008	1.16	-0.15	47.41	52.59	0.00	1.55
2009	0.53	-0.74	44.01	28.22	27.27	9.19
2010	-0.02	2.32	47.85	51.15	0.00	2.71
2011	-0.47	-0.56	65.54	34.46	0.00	3.26
2012	0.05	1.42	87.34	12.66	0.00	1.42
2013	-0.05	1.28	38.21	21.98	39.81	0.74
2014	0.52	3.42	94.28	5.72	0.00	0.26
2015	0.63	-0.89	99.32	0.68	0.00	374.69
2016	-0.26	1.86	53.54	2.95	43.51	97.81
2017	0.36	1.28	70.27	3.67	31.89	1.03
2018	0.11	-0.99	80.96	18.04	0.00	200.43
2019	-0.56	136.67	82.86	17.14	0.00	0.65
2020	0.09	-0.63	42.91	33.24	23.85	1.87
2021	0.02	0.44	43.52	14.12	42.36	4.24
2022	-0.49	0.10	67.63	9.72	22.65	1.98
2023	0.15	0.95	56.84	11.73	31.43	1.17

Source: *Ministry of Finance, Red Book and White Book, Fiscal Year 2024. Government of Nepal.*

Analysis of Funding Gaps from 2003 to 2023 for Flood Risk Management

The analysis of funding gaps for flood risk management from 2003–2023, normalized to 2023, reveals significant discrepancies between normalized economic losses and available funding. The total normalized losses over this period amounted to 2264.96

million, while the total normalized funding reached only 1756.27 million, leading to a cumulative funding gap of 508.69 million. This shortfall suggests that, despite increases in funding in certain years, particularly from 2009 onward, the overall financial response has been insufficient to match the economic losses caused by floods. Notable years such as 2014 and 2017 experienced exceptionally high losses relative to available funding, exacerbating the gap.

Table 4.5:

Analysis of Funding Gaps from 2003 to 2023 for Flood Risk Management

year	normalized_losses_ to_2024	normalized_ funding_to_2024	normalized_ population_2024
2003	37.30	20.60	2094613.00
2004	12.42	21.52	1604222.00
2005	13.64	52.82	68572.02
2006	13.37	50.81	5804.70
2007	61.92	37.64	315129.50
2008	50.17	77.79	1051518.00
2009	12.32	113.29	107336.60
2010	39.62	107.08	767079.60
2011	16.70	54.40	1573782.00
2012	38.96	55.42	2500382.00
2013	83.45	61.99	289489.70
2014	353.88	90.74	197235.70
2015	0.39	146.72	125.70
2016	1.03	99.67	38573.92
2017	1222.80	126.16	81125.34
2018	0.65	131.08	5732.08
2019	91.09	58.93	16202.05
2020	32.49	60.67	32135.45
2021	44.41	188.06	21082.17
2022	48.03	95.13	27455.24
2023	90.33	105.76	49810.00

Total normalized_losses_to_2024	2264.96
Total normalized_funding_to_2024	1756.27
Total Funding Gap (in million)	508.69
Total Funding Gap	508689019.7

Source: *Data analyzed using Stata software.*

Hypotheses:

- **Null Hypothesis (H0):** There is no significant difference between the total funding and the funding gap for flood management (i.e., total funding = funding gap).
- **Alternative Hypothesis (H1):** There is a significant difference between the total funding and the funding gap for flood management (i.e., total funding ≠ funding gap).

Shapiro-Wilk Normality Test Results:

a. Funding Gap:

W = 0.48104, Prob. > z = 0.00000 shows that the p-value is less than 0.05, indicating that the funding gap data is not normally distributed. Therefore, non-parametric tests like the Wilcoxon Signed-Rank Test should be used for further analysis.

Table 4.6:

Shapiro-Wilk W test for Funding Gap

Variable	Obs.	W	V	z	Prob.>z
Funding Gap	21	0.48104	12.717	5.141	0.0000

Source: *Data analyzed using Stata software.*

b. Total Funding

W = 0.92025, Prob. > z = 0.08776 shows that the p-value is greater than 0.05, indicating that the total funding data follows a normal distribution.

Table 4.7:

Shapiro-Wilk W test for Total Funding

Variable	Obs.	W	V	z	Prob.>z
Funding Gap	21	0.92025	1.954	1.355	0.08776

Source: *Data analyzed using Stata software.*

c. Flood Economic Losses

W = 0.38650, Prob. > z = 0.00000 shows that the p-value is less than 0.05, indicating that the flood economic losses data is not normally distributed. Non-parametric tests like the Wilcoxon Signed-Rank Test are more appropriate.

Table 4.8:

Shapiro-Wilk W test for Flood Economic Losses

Variable	Obs.	W	V	z	Prob.>z
Funding Gap	21	0.38650	15.034	5.479	0.0000

Source: *Data analyzed using Stata software.*

Wilcoxon Signed-Rank Test

Table 4.9:

Wilcoxon Signed-Rank Test

Sign	Obs.	Sum ranks	Expected
Positive	19	197	115.5
Negative	2	34	115.5
zero	0	0	0
All	21	231	231
Unadjusted variance		827.75	
Adjustment for ties		0.00	
Adjustment for zeros		0.00	
Adjusted variance		827.75	
Total funding = funding Gap			
Z=2.833			
Prob.> |z| = 0.0046			

Source: *Data analyzed using Stata software*.

The p-value (0.0046) is less than 0.05, thus rejecting the null hypothesis. This indicates that there is a statistically significant difference between the total funding and the funding gap. The Wilcoxon signed-rank test indicates that there is a statistically significant difference between the total funding and the funding gap for flood management. This means the data suggest that the total funding and the funding gap are not equal, implying that the funding allocated does not sufficiently or effectively meet the required funding gap for flood management.

Key Insights and Concluding Observations

Between 2003 and 2023, Nepal experienced recurring flood disasters with substantial human and economic impacts. Quantitative analysis shows that in several years, the total funding-comprising government allocations, foreign grants, and loans-was sufficient or even exceeded reported flood-related losses. This suggests that the direct financial gap, when viewed in aggregate, may not be severe. However, this apparent adequacy in funding does not translate into effective disaster risk management on the ground.

Despite available funds, the persistent occurrence of high flood damages and limited recovery outcomes reveals deep qualitative gaps in disaster risk financing. Most of the funding has been reactive, focusing on post-disaster humanitarian aid, with little attention to preparedness, resilience-building, or pre-disaster financial planning. Ex-

ante instruments such as insurance, contingency funds, or risk pooling mechanisms remain largely unexplored. Even though disaster risk reduction (DRR) policies exist on paper, their implementation is weak and inconsistent.

The study also finds that while funding amounts are documented, there is a lack of transparency and strategic allocation toward long-term risk reduction. Preparedness activities, early warning systems, and resilient infrastructure remain underfunded or overlooked. Statistical tests confirm a significant discrepancy between losses and funding, but the problem lies less in funding availability and more in its limited effectiveness and poor utilization.

To enhance resilience, Nepal must shift from a reactive to a proactive disaster financing approach. This includes integrating ex-ante financial instruments, improving policy implementation, and embedding DRR funding within national and local planning processes. Without this transition, the country will remain trapped in a cycle of repeated flood losses, relief-focused responses, and under-realized resilience potential.

Acknowledgements

This research paper is part of our completed M.Phil. thesis titled "Role of Public Finance in Disaster Risk Reduction in Nepal," which was submitted to the Central Department of Economics, Tribhuvan University. Specifically, this paper incorporates findings from our thesis, particularly concerning public finance mechanisms for disaster risk reduction in Nepal. I would like to express my sincere gratitude to Dr.Rashmee Rajkrnikar, Assistant Professor, Prof. Dr. Sanjaya Acharya, Professor of Public Sector Economics, and Prof. Dr. Ram Prasad Gyanwali, the Head of the Department of Economics, at Tribhuvan University, for their invaluable guidance, support, and encouragement throughout our research. Their expertise and thoughtful suggestions have significantly contributed to the development of this study.

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ANNEX 1:

Lag GDP with Inflation Rate and Lag population with population growth rate

1Lag GDP with Inflation Rate and Lag population with population growth rate

Year	Lag gdp	Inflation Rate	Lag Population	Population Ggrowth Rate
2003				
2004	1172407	3.479114	24.10744	1.357953
2005	1213197	3.364542	24.43481	1.357948
2006	1254015	3.411672	24.76662	1.357945
2007	1296798	6.104585	25.10294	1.357949
2008	1375962	4.533137	25.44382	1.35795
2009	1438336	4.816398	25.78934	1.35795
2010	1507612	3.421818	26.13954	1.357948
2011	1559200	4.671659	26.4945	1.349999
2012	1632041	3.52515	26.85218	1.349995

Year	Lag gdp	Inflation Rate	Lag Population	Population Ggrowth Rate
2013	1689572	6.011484	27.21468	1.350004
2014	1791141	3.976055	27.58208	1.350001
2015	1862358	0.4331137	27.95444	-1.161381
2016	1870424	8.977278	27.62978	0.917999
2017	2038337	7.622379	27.88342	0.9180006
2018	2193707	6.657055	28.13939	0.9180008
2019	2339743	-2.369619	28.39771	0.9179989
2020	2284300	4.838146	28.65841	0.9180009
2021	2394818	5.631316	28.92149	0.9179994
2022	2529677	1.952542	29.18699	0.9259993
2023	2579070	3.868293	29.45726	2.521418
2024	2678836	-98.35078	30.2	5.033108
2025	44180	10.68357	31.72	1.210595
2026	48900	10.26585	32.104	1.161852
2027	53920	10.27448	32.477	1.117711
2028	59460	10.41036	32.84	1.071867
2029	65650	10.38842	33.192	1.027355
2030	72470	37.98813	33.533	0.9870797