



Consultant Report

TA9634-REG: Strengthening Integrated Flood Risk Management
November 2019

Nepal: Flood Risk Sector Assessment

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Nepal: Flood Risk Sector Assessment

TA 9634-REG: Strengthening Integrated Flood Risk
Management

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In association with Jeremy Benn Associates Ltd (JBA)



Report submitted by:

Landell Mills Ltd in association with Jeremy Benn Associates Ltd (JBA)

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Acronyms

ADB	Asian Development Bank
AAL	Average annual losses
CBDRM	Community Based Disaster Risk Management
CC	Climate Change
CEDAW	Convention on Elimination of All kinds of Discriminations Against
DPRP	Disaster Preparedness and Response Plan
DAO	District Administrative Offices
DEOC	District Emergency Operation Centers
DFID	Department for International Development
DHM	Department of Hydrology and Meteorology
DMC	Developing Member Country
DWIDP	Department of Water Induced Disaster Prevention
DWRI	Department of Water Resources and Irrigation
EU	European Union
FFEWS	Flood Forecasting and Early Warning Systems
GCM	Global Circulation Model
GDP	Gross Domestic Product
GESI	Gender Equality and Social Inclusion
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flooding
GoN	Government of Nepal
HPCIDBC	High Powered Committee for Integrated Development of Bagmati Civilization
ICIMOD	International Centre for Integrated Mountain Development
IFRM	Integrated Flood Risk Management
ILO	International Labor Organization
IRBMP	Integrated River Basin Management Plan
IUDP	integrated urban development plans
IWRM	Integrated Water Resource Management
JBA	Jeremy Benn Associates
JICA	Japan International Cooperation Agency
JWA	Japan Water Agency
KfW	Kreditanstalt für Wiederaufbau;
KSTA	Knowledge and Support Technical Assistance
LDMC	Local Disaster Management Committee
LDRMP	Local Disaster Risk Management Plan
LM	Landell Mills
MOHA	Ministry of Home Affairs
MOEWRI	Ministry of Energy, Water Resources and Irrigation
MOUD	Ministry of Urban Development
NBS	Nature-Based Solutions
NDMP	National Action Plan on Disaster Management
NGO	Non-Governmental Organization
NSDRM	National Strategy for Disaster Risk Management in Nepal
NWP	National Water Plan
OCHA	Office for the Coordination of Humanitarian Affairs
PMIA	Provincial Ministries of Internal Affairs
PMPI	Provincial Ministries of Physical Infrastructure
RBO	River Basin Organization
SDG	Sustainable Development Goals
SOP	Standard Operating Procedure
SWOT	Strengths, Weaknesses, Opportunities, Threats
TA	Technical Assistance
TRTA	Transaction Technical Assistance
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
UNDRR	United Nations Office for Disaster Risk Reduction
VCD	Village Development Committee
WECS	Water and Energy Commission Secretariat

WRPPF Water Resources Project Preparatory Facility
WRS Water Resources Strategy

Executive Summary

Context

Despite being a small country, the landscape of Nepal is diverse; it ranges from the humid plains in the south to the lofty Himalayas in the north with varied geographies, climates and flood risks. Thus, Nepal can be divided into three different geographical regions and each region extends from east to west across the country. The three different regions are: the Terai, the Middle Hills, and the Himalayas.

Flood is the most common natural disaster affecting Nepal. The principal and most destructive type of flooding is from rivers (fluvial) located within the Terai region. Apart from fluvial flooding during the monsoon, other flood risks include flash flooding from heavy rainfall in mountainous areas, Glacial Lake Outburst Flooding (GLOF), landslide induced flooding, and infrastructural flooding (such as embankment failure).

The Asian Development Bank (ADB) in 2017 estimated that Nepal's population was 28.7 million people¹. Nepal had an urban population of 10.9% in 1995 according to the United Nations Development Program, but this has accelerated to 19.3% in 2017². Additionally, there is a migration to the Terai from the mountainous and hilly regions. However, the striking issue of population growth from rural to urban areas is an increase in the number of people vulnerable to flooding as well as potential flood damage to an increasing amount of urban infrastructure.

On average, floods cause over 175 deaths each year and average annual economic losses exceeding USD 140 Million. Nepal is the tenth highest country in the world in terms of relative physical exposure to fluvial flooding, exposing possible damage to physical assets as a value equivalent to 1.4% of its GDP³. Without comprehensive flood protection or appropriate risk-sensitive urban planning, increased ongoing economic and development activity in the floodplains will likely increase the economic damage associated with floods in the coming years.

Nepal's vulnerability to flooding was demonstrated by the major flooding that occurred across South Asia in August 2017 with around 1.7 million people affected in Nepal. At least 140 people were killed, and it was estimated around 80% of the Terai was flooded⁴. The damage was estimated by the Government to be USD 584.7 Million, with a reconstruction cost of USD 375.8 Million to housing alone⁵. In this event over 900 irrigation schemes were lost, with the reconstruction of these planned to take at least three years, meaning a loss in agricultural productivity long after the end of the flood event.

Climate change is likely to have a significant impact on the frequency and intensity of extreme flood event. Increases in air temperature will make GLOF flooding more likely as glacier melting increases and large volume pro-glacial lakes form more quickly. Increases in extreme precipitation will make flash flooding more frequent; increase soil erosion potentially leading to more landslide induced flooding; and

¹ Taken from the Asian Development Bank's Statistical Database System, accessed 29-07-2019. <https://sdbs.adb.org/sdbs/>

² Taken from *Human Development Reports, Urban Population (%)*, United Nations Development Programme, accessed 29-07-2019. <http://hdr.undp.org/en/indicators/45106>

³ World Resources Institute, 2015. *World's 15 Countries with the Most People Exposed to River Floods*. <https://www.wri.org/blog/2015/03/world-s-15-countries-most-people-exposed-river-floods>

⁴ United Nations International Children's Emergency Fund website, accessed 14-08-2019, published 26-08-2017. *Nepal Humanitarian Situation Report No. 6*.

⁵ Government of Nepal, National Planning Commission, 2017. *Nepal Flood 2017: Post Flood Recovery Needs Assessment*.

increase the frequency of events where urban flooding occurs due to infrastructure being overwhelmed compared to its design.

Through the Water Resources Project Preparatory Facility (WRPPF) project, ADB is working with the government of Nepal to develop proposals for upgrading of irrigation, drainage, and flood control infrastructure. The WRPPF is the predecessor to the Priority River Basins Flood Risk Management Project.

Government's Sector Strategy

According to the Constitution of Nepal (2015), it is the responsibility of the state to prepare the necessary policy for making advance warning, preparedness, rescue, relief and rehabilitation in order to mitigate risks from natural disasters. The structures, clear roles and responsibilities of all levels are given in details in the Disaster Risk Reduction and Management Act (2017). In general, while during emergency response periods there is a clarity of purpose that facilitates good coordination, it is during periods of normal operation that IFRM coordination processes are less well defined in Nepal.

The Ministry of Home Affairs (MOHA) has overall governance of disaster management and a coordination lead role during emergencies. The Ministry of Federal Affairs and General Administration leads on the coordination with provincial and local municipal governments. The Ministry of Energy, Water Resources and Irrigation (MOEWRI)'s Department of Water Resources and Irrigation constructs and maintains major river and flood infrastructure. The installation, operation and maintenance of the national hydrometeorological observation network as well as flood forecasting is handled by MOEWRI's Department of Hydrology and Meteorology.

The Ministry of Urban Development's Department of Urban Development and Building Construction is responsible for urban planning including drainage. The country's first River Basin Organization (for the Upper Bagmati) also sits under this Ministry. Water resources policy is developed by the Water and Energy Commission Secretariat. Municipal governments are responsible for local level planning and building approvals as well implementation of various local public works including drainage.

Emergency response during a disaster is handled by the National Emergency Operation Center and District Emergency Operation Centers under MOHA. Security Agencies such as the armed forces and police usually assist as well as the International Committee of the Red Cross and NGOs.

For major floods, such as on the Terai in 2017, recovery plans are handled by the National Planning Commission which advises the Ministry of Finance and line ministries for implementing measures. If required, the National Reconstruction Agency (established after the 2015 Earthquake) assists with coordination of recovery works.

With rapid urbanization and changes in land use, the Government has made significant progress in addressing environmental concerns with a number of key strategies including the Nepal Biodiversity Strategy and Action Plan 2014-2020; the National Ramsar Strategy and Action Plan, Nepal (2018-2024); and the Forestry Sector Strategy (2016-25). Many of the objectives in these plans and strategies have direct benefits for flood risk management, although not all have statutory instruments for enforcement.

Sector Performance, Problems, and Opportunities

Build institutional and regulatory environment

Fluvial flooding on the Terai has been occurring long before humans settled in the plains and is a natural phenomenon. Therefore, the flooding mechanisms that are occurring are well understood and, in many senses, can be "expected". That is not to say that the risk of flooding is entirely managed, but the principal hazard is well understood and is identifiable. The other sources of flood risk such as flash flooding, GLOF and infrastructural flooding are also relatively easy to understand.

A large number of strategies, policies, guidelines, action plans and frameworks have already been produced, many which have excellent ideas around institutional arrangements, organizational capacity improvements and bespoke research. However, the country has entered into a Federal System with three levels of governments and the current flood risk management plans, policies and programs are better designed to work in a Unitary System. Such plans and policies require adaptation and strengthening to ensure they are functional in the new governance system.

There are a range of options that could be considered for strengthening institutions involved in flood risk management. At present, the institutional arrangements for flood risk management separates flood risk management from water resources management; includes multiple national level Ministries and Departments; and requires coordination between national, provincial and local levels of Government. Since this complex arrangement makes IFRM difficult, there is a significant urgency for strengthening and streamlining institutional arrangements for promoting the management of water (including flooding) in a more holistic manner. At the highest level this requires a comprehensive Water Policy with supporting legislation.

To ensure a more integrated approach there is a need to establish financially viable and legally empowered river basin organizations. This is in line with a proposal of the Nepali Government and work already conducted by the Water and Energy Commission Secretariat (WECS) has established a model of how these organization would operate. Further support is required to establish an appropriate legal framework to ensured that the organizations can be functionally empowered and financially sustainable.

Changing patterns of land use, rapid urbanization and inadequate planning control is causing significant issues both generally and more specifically for flood risk management. Strengthening of landuse planning practice including establishing a robust system for land zoning and other development controls will help manage the issue of new development creating new flood risks. The work undertaken under WRPPF offers a starting point for the mapping and zoning of the Terai in particular.

The issues identified in this Sector Assessment provide possible entry points for ADB (or other development partner) support. Because the Government of Nepal is going through a transitional period, the institutional challenges are significant and require considerable expertise and associated capacity building. In particular, benefits that could be drawn from ADB's experience in developing of water policy, establishing river basin organizations, and land-use planning.

Physical infrastructure

Within the Terai, and in other locations, flood defenses and infrastructure already exist. However, there are challenges with the extent to which these are "climate proofed" to accommodate possible future changes in flood risk. The Government's Standard Operating Procedure for their Flood Forecasting and Early Warning System (FFEWS) is strong and enables future investment in FFEWS to be undertaken in a consistent manner and to a high standard. The recent Koshi and West Rapti FFEWS installations build on this approach.

One of the highest priority investments in the flood risk management sector, is investment in FFEWS. There are a number of reasons for this including the small costs involved relative to large possible benefits, the existing coherent strategy, and how these systems have been established in other basins successfully. With relatively low costs and short implementation times, investment in FFEWS offers significant benefits for reducing the vulnerability and ensuring that communities have sufficient time to respond and reduce losses. FFEWS also address the issue of residual risk, that is, the flood risk associated with an event which exceeds the deign level of the flood defenses.

Embankment breaches, such as in Koshi in 2008, cause catastrophic and unexpected flooding, therefore identifying and upgrading these existing barriers is believed to be highly cost-effective. Climate proofing of existing infrastructure should consider a range of approaches including the use of

set-back embankments and designated flood storage areas, rather than just building embankments higher. NBS techniques for watershed management and embankment protection also offer advantages.

At a more local and community level, the 2017 Terai floods demonstrated that public infrastructure such as schools and drinking water supply was under-prepared for extensive flooding. Opportunities exist for flood-proofing public facilities to ensure that communities can recover more quickly.

Human Resources

The existing capacity of the stakeholders and institutions working on flood risk management in Nepal is relatively low, which is understandable as they often deal with varying hazards. Strengthening of stakeholders and the institutional system for flood risk management involves a continuous learning process. Additionally, it is believed that the Government Ministries and Departments tasked with flood risk management suffer from limited human resources. Often, skilled individuals choose to work in the private sector rather than the Government due to low salaries, and other concerns. Furthermore, there is an increasing trend in Nepal for skilled workers to look internationally for employment. The lack of enough personnel with good knowledge on IFRM can become an obstacle for effective implementation.

Therefore, retaining human resources and increasing capacity in Government departments is required for more effective IFRM. One area the Government could consider, and development partners could consider financing, is the establishment of a Centre of Excellence for water resources management. The reason for this is threefold. Firstly, it will encourage future water specialists and scientists to enter the public, rather than private sector, or move overseas. Secondly, it will improve the overall capacity of the sector in Nepal as individuals inevitably move between departments and to/from the Centers of Excellence. Thirdly, it will help the Government to retain knowledge, as it will act as a knowledge hub, rather than being spread amongst a limited number of public, and large number of private institutions at present.

The funding for this Centre of Excellence in the short term would have to be from public money sourced through existing budgets or financed from development partners. However, if developed into a commercial entity, it is suggested that like other locations in Asia, the Center could well become a competitor to other similar Government backed institutions, and ultimately in the long term, run a profit.

The Government is also recommended to consider a Human Resources Strategy for the water sector, including flood risk management. Multiple capacity building activities are being undertaken by various development partners, and it would be good to ensure that efforts are targeted across Ministries, Departments and other stakeholders to maximize benefit.

Monitoring of Glacial lake outburst flooding

The management of glacial lake outburst flooding (GLOF) has been greatly improved in recent years through the ability to monitor pro-glacial lakes from afar, and not rely on field visits alone. This significantly improves the ability to identify and track changes, but there is a long way to go in institutionalizing the risk management of GLOF.

Investment in dedicated remote sensing software, hardware and human resources offers the Government a low-cost way of improving their GLOF risk management. It is a highly attractive financial and risk management opportunity that offers huge potential benefits in a warming climate where GLOF risks will increase. The funding mechanism for this is however not entirely obvious. Potentially, as Nepal continues to exploit its hydropower potential, suppliers could be charged a small fee for GLOF monitoring, which in effect allows them to better manage and protect their assets and commercial risk.

Threats

The threats to the flood risk management sector in Nepal include the complexity of the institutional arrangements making integrated flood risk management difficult; climate change leading to increases in

flood hazard; rapid urbanization in the Terai leading to more population and assets exposed to flooding; soil erosion mobilizing sediment downstream causing primary and secondary hazards; failure of existing infrastructure if operation and maintenance is not undertaken; the difficulty in retaining talented future water managers; and, a repeat of another major disaster such as the 2015 earthquake putting the whole economy back.

1. Scope and objective

1. Under the Asian Development Bank's (ADB) Water Resources Project Preparatory Facility (WRPPF), the ADB is helping Nepal address constraints to the upgrading of irrigation, drainage, and flood control infrastructure. The project covers feasibility studies for priority projects in water resources management.
2. WRPPF Package 3: Flood Hazard Mapping and Preliminary Preparation of Flood Risk Management Projects was completed by Lahmeyer International in 2016. The main tasks included hydrological and hydrodynamic modelling, preparation of flood hazard/flood risk maps with climate change of 25 flood prone river basins in the Terai, and identification of six priority basins based on riverine flood frequency and severity, socio-economic indicators, and mortality statistics.
3. WRPPF Package 7: Preparation of Priority River Basins Flood Risk Management Project is being carried out by Mott MacDonald and is nearing completion. The project includes six river basins in the Terai chosen primarily from the river basins studied under WRPPF Package 3. The main tasks include hydrological and hydrodynamic modelling, preparation of flood hazard/flood risk maps with climate change, economic analysis, feasibility designs and detailed design for 20% as part of project preparation.
4. Included as an accompanying document to the technical work, Mott MacDonald undertook a Sector Analysis. However, the Sector Analysis carried out by the Package 7 consultants is not sufficiently comprehensive. Further, it needs to be updated to include the most recent governance situation following the new constitution recently adopted to delegate powers to provincial and local governments.
5. Under ADB TA9634, the Design and Monitoring Framework requests that sector assessments should be undertaken of integrated flood risk management in the eight target countries. Accordingly, a more comprehensive sector analysis may also inform further entry points for potential IFRM in Nepal.
6. Hence, this Sector Assessment presented here aims to:
 - Build on the sector analysis undertaken by the Package 7 consultant and develop further into a comprehensive sector assessment;
 - Review current IFRM practices and approaches in Nepal;
 - Identify entry points for IFRM (operationally and legislative);
 - Recommend how to coordinate and implement IFRM; and,
 - Comment on how cooperative federalization will affect IFRM throughout the country, where the various government departments are responsible, and how National, Provincial and Municipal interests are all served, especially with respect to riverine flooding.

2. Flood risk context

2.1. Climate and geography

2.1.1. Geographical overview

7. Nepal is a landlocked Himalayan country in South Asia (Figure 1). It is home to the world's highest mountains along its northern borders but also has relatively extensive floodplains in the southern part of the country. It stretches between the latitudes of 26°22'N and 30°27'N, and longitudes of 80°4'E and 88°12'E and is roughly aligned southeast-northwest.

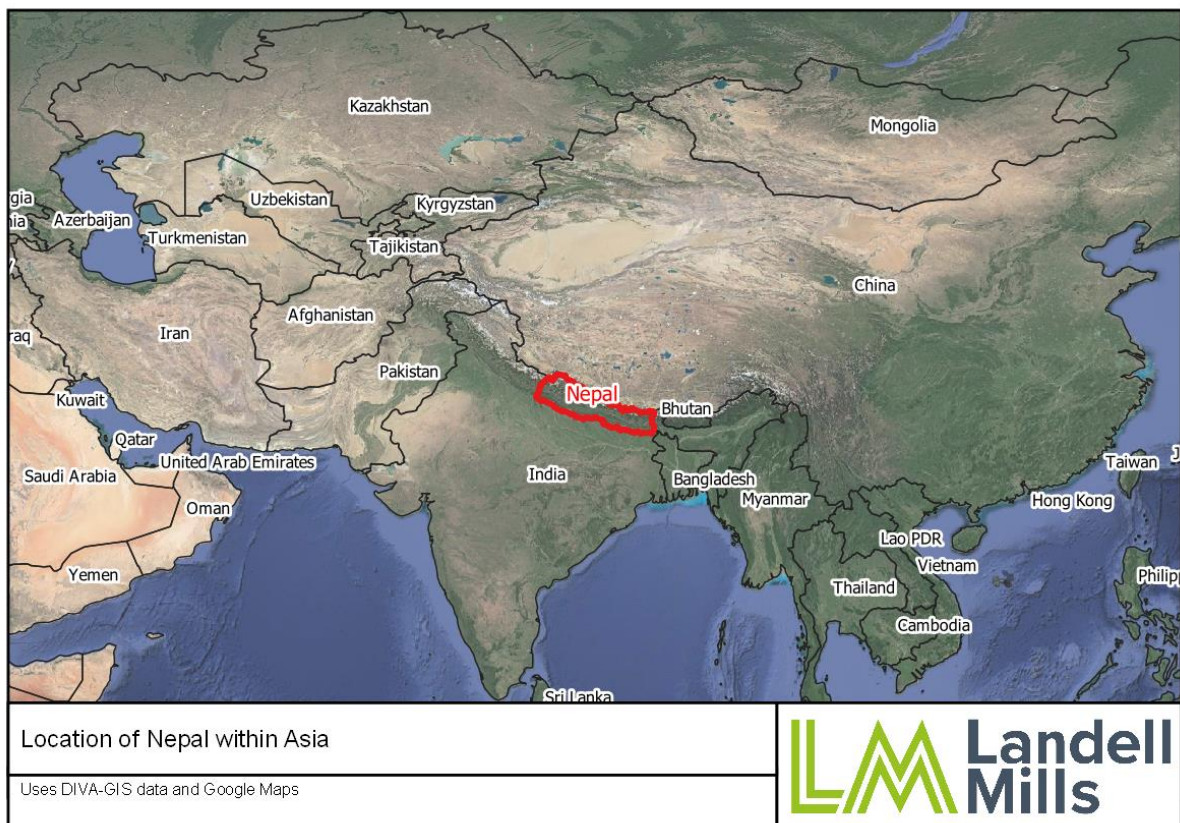


Figure 1: Location of Nepal in Asia

8. The total physical area of Nepal is approximately 147,181 square kilometers of which about 143,351 square kilometers constitutes land, and about 3,830 square kilometers constitutes permanent inland water⁶.
9. The country has an almost rectangular shape, extending from the southeast to northwest over a distance of approximately 900km and along the north-south direction with distance varying between 80 to 250km with elevation ranging from about 70m in the south to 8,848m above sea level at the peak of Mount Everest.
10. Nepal is bordered to the north by the Tibet Autonomous Region, an administrative division of the People's Republic of China, the Indian States of West Bengal and Sikkim in the east, the Indian State of Bihar in the south, and the Indian State of Uttar Pradesh in the west. It shares about 1,236 kilometers of

⁶ CIA World Factbook, accessed 29-07-2019. <https://www.cia.gov/library/publications/the-world-factbook/geos/np.html>

border with the People's Republic of China and about 1,690 kilometers of border with India. Nepal and Bangladesh are separated by a narrow strip of land about 21 kilometers wide, called the "Chicken's Neck".

11. Despite being a small country, the landscape of Nepal is diverse; it ranges from the humid plains in the south to the lofty Himalayas in the north. Thus, Nepal can be divided into three different geographical regions and each region extends from east to west across the country. The three different regions are: the Terai, the Middle Hills, and the Himalayas. Figure 2, taken from the Inception Report shows a rough delineation of the three zones based on elevation and approximate extents of glaciated areas, key cities and major floodplains.

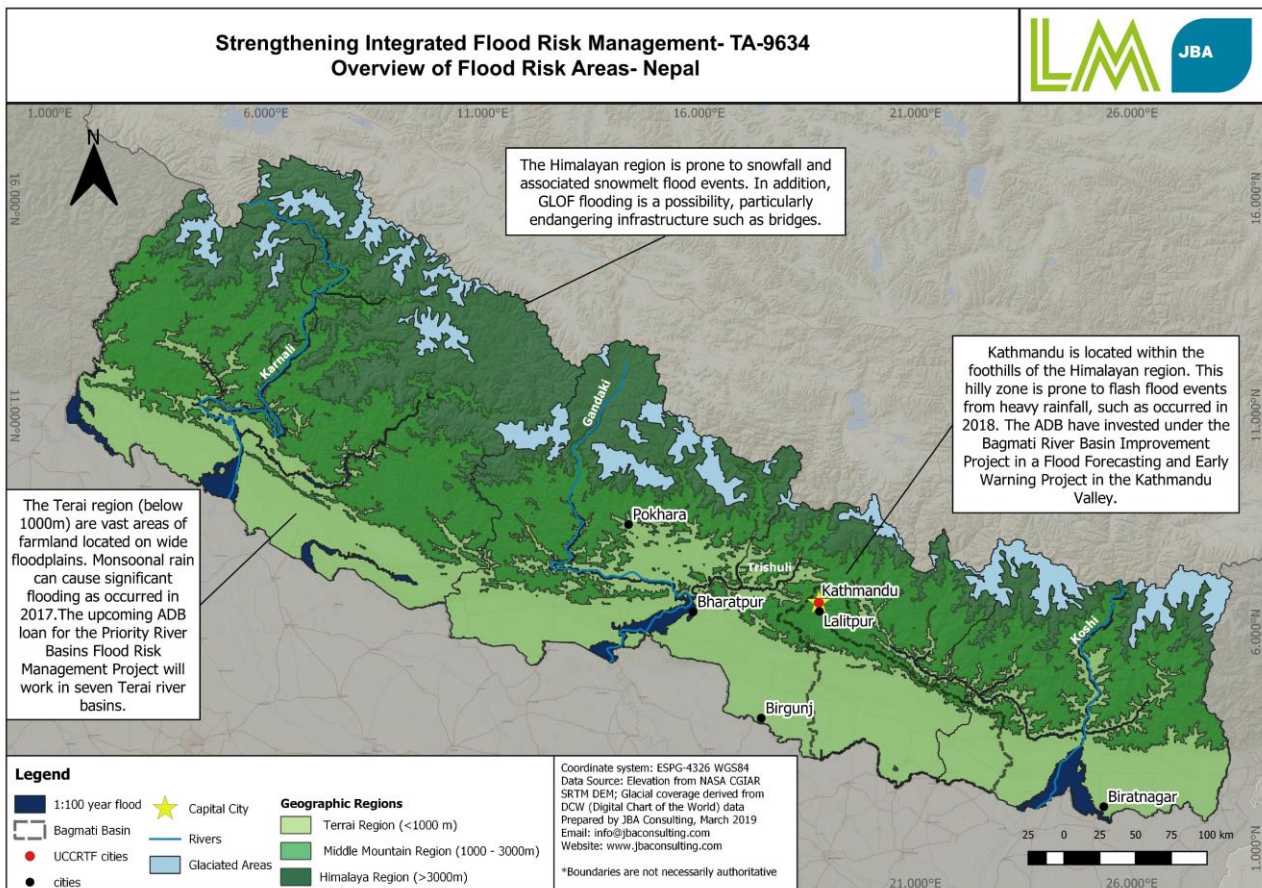


Figure 2: Overview of geographic regions of Nepal with and approximate extents of glaciated areas, key cities and major floodplains (taken from Inception Report)

12. The southern part of the country consists of low lying agricultural plainland, referred to as the Terai. It covers about 23.1% of the total area of Nepal. The Terai belt is an extension of the Ganges Plain and is in general a marshy area. This entire area is bordered with India. Historically, it was covered with tropical vegetation earlier, but is now converted into agricultural land and is the most productive area in Nepal and important for food security.
13. The Mahabharata Chain forms the Middle Hills region lying in the central section of Nepal. The altitude ranges from approximately 1,000 meters to 3,200 meters. It covers about 41.7% of the total area. The hilly region includes the capital of Nepal, Kathmandu valley.
14. The Himalayan Region, which lie in the north, comprise the world's highest mountain peaks and cover about 35.2% of the total area. It is thinly populated and there is snow coverage throughout the year in most of the area in this region. Eight of the ten highest peaks in the world are located here.

2.1.2. Climate

General climate classification

15. Climate classification (i.e. grouping of similar climate conditions for better analysis and understanding) can be a useful tool in flood risk management. One of the most popular classification systems is the Köppen-Geiger (KG, for ease) climate classification system, however its application to a country like Nepal with so many hills and mountains can be problematic. Work undertaken by the Universities of Hamburg, Helsinki and the Government of Nepal⁷ have revised the KG classification using local meteorological stations and this is reported here as a more effective baseline than general sources.
16. Mean annual temperatures across the country vary hugely, closely matching elevation differences. In the Himalayas mean annual temperatures are well below zero degrees, whilst in the Terai it is often over 24°C. There is a north-south gradient in the temperature distribution as per the elevation as mentioned. Figure 3 demonstrates mean annual temperatures.

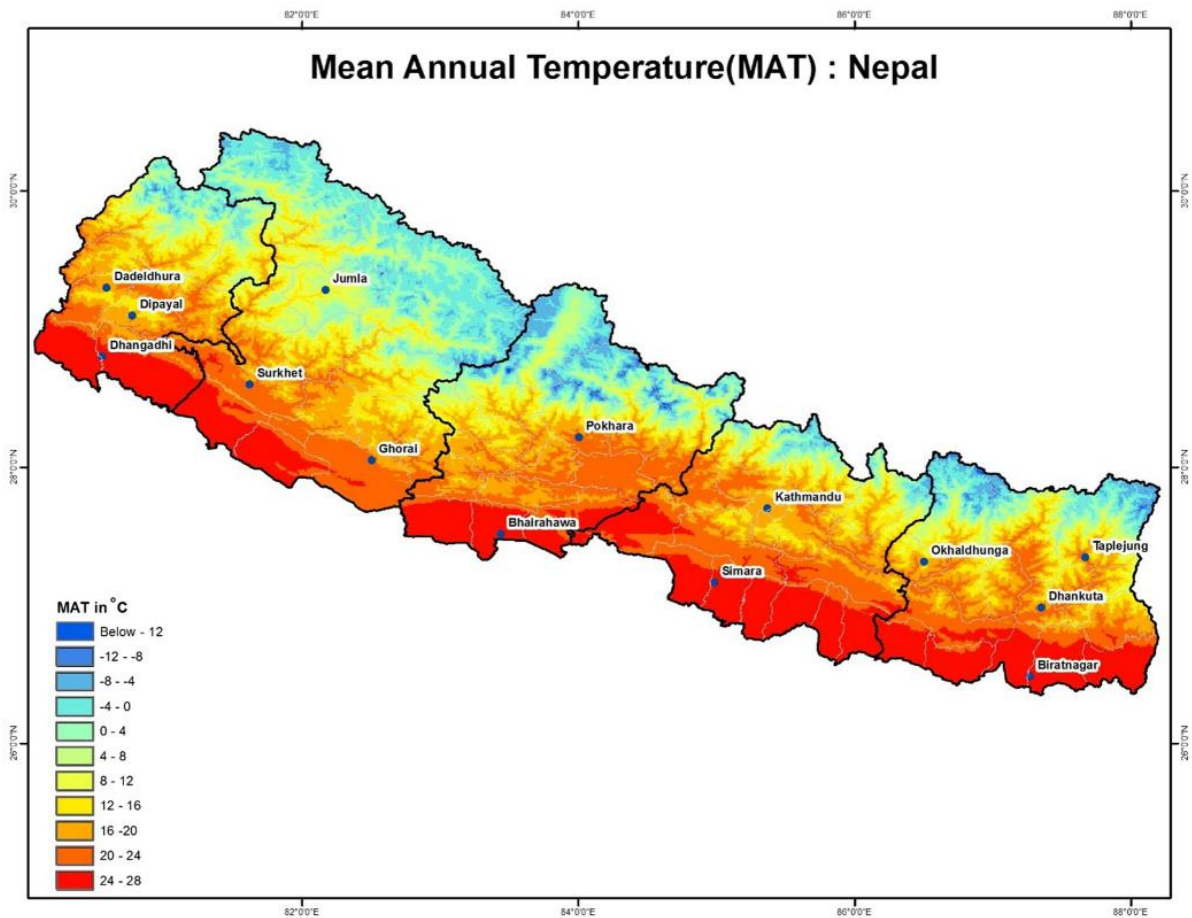


Figure 3: Mean annual temperature as taken from meteorological stations (taken from Karki et al., 2015)

17. The distribution of precipitation in Nepal is very complex and owes much to the topographic variations. There are three areas of heavy precipitation with annual precipitation between 3500mm and even over 5000mm⁸:
 1. Around the city of Pokhara, with the heaviest average precipitation records in Nepal of over 5000mm annually;

⁷ Karki, Ramchandra; Talchabhadel, Rocky; Aalto, Juha; and Kumar Baidya, Saraju. (2015). *New climatic classification of Nepal*. Theoretical and Applied Climatology. 10.1007/s00704-015-1549-0.

⁸ Dhar ON and Nandargi S (2005). *Areas of heavy precipitation in the Nepalese Himalayas*. Weather, Vol. 60, No. 12.

2. To the south of Langtang Himalayan range, just north-east of the Kathmandu valley; and,
 3. The area of Num/Chepua south of Everest.
18. Dhar and Nandargi, 2005 suggest that these high precipitation areas are located where there are large topographic differences in a short geographical distance leading to rapid ascent and condensation of moist air.
 19. Conversely, the Mustang, Manang, and Dolpa regions can be classified as arid with less than 200mm of precipitation annually on average. These areas are on the leeward side of the Annapurna mountain range effectively creating a rainfall shadow effect leading to low precipitation⁹.
 20. The Terai regions away from the mountains also show spatial variability but in general the average annual precipitation is between 1200mm and 3000mm.
 21. Figure 4 demonstrates mean annual precipitation.

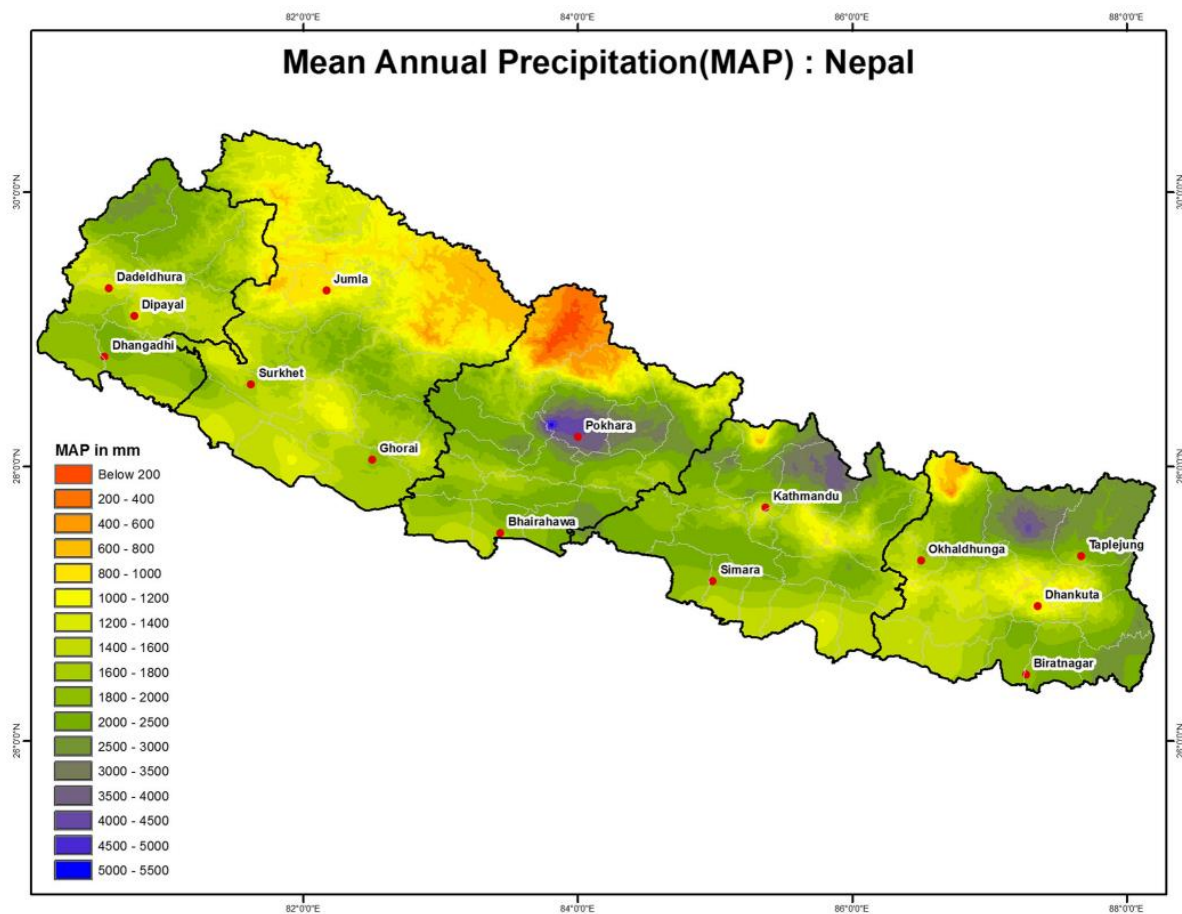


Figure 4: Mean annual precipitation as taken from meteorological stations (taken from Karki et al., 2015)

22. To complete the KG classification, the Universities of Hamburg, Helsinki and the Government of Nepal¹⁰ edited the boundary of the coldest month mean air temperature in order to ensure that areas of the Terai can be classed as Tropical Savannah (Aw), a more accurate depiction. The resultant KG map is shown in Figure 5.

⁹ Dhar, O.N. and Nandargi, S. (2002). *Precipitation distribution around the Annapurna range of Nepal Himalayas: A brief appraisal.* Journal of Meteorology 27: 377-382.

¹⁰ Karki, Ramchandra; Talchabhadel, Rocky; Aalto, Juha; and Kumar Baidya, Saraju. (2015). *New climatic classification of Nepal.* Theoretical and Applied Climatology. 10.1007/s00704-015-1549-0.

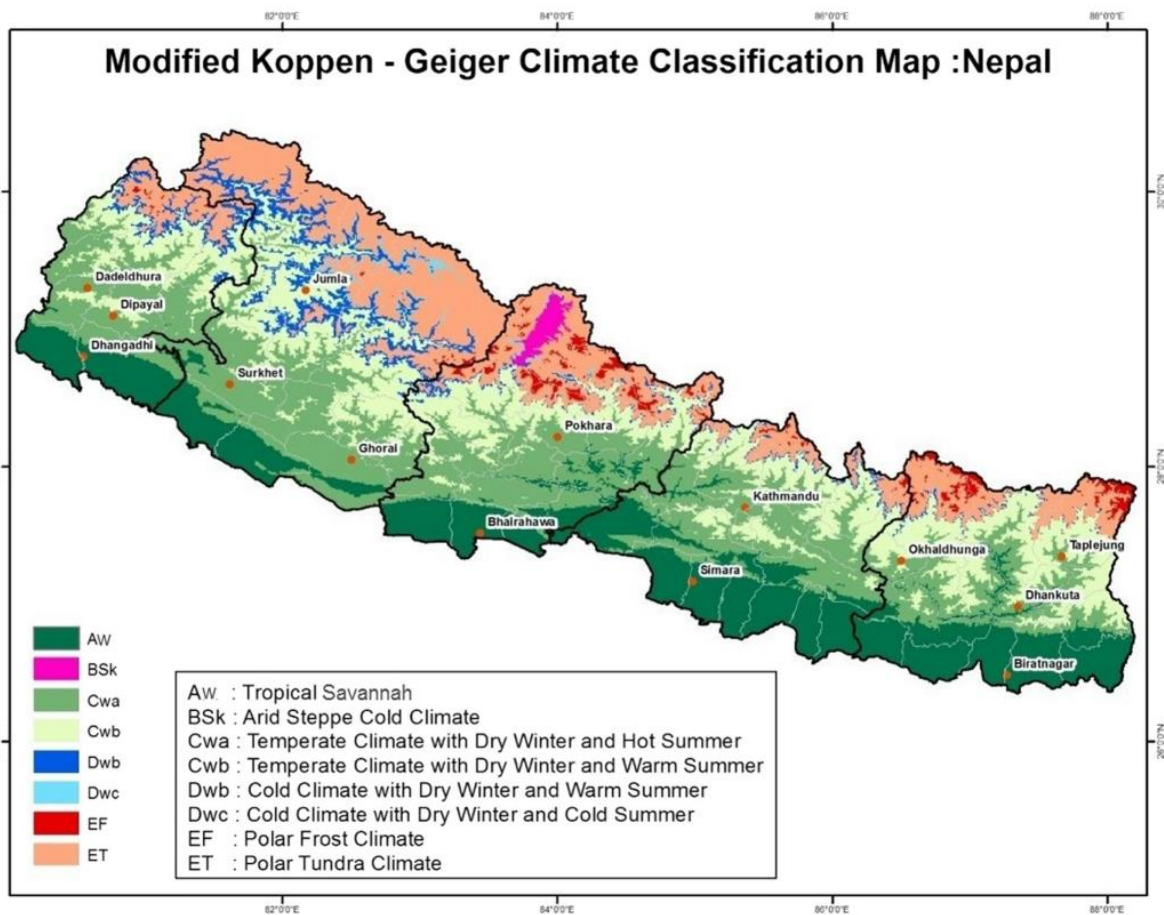


Figure 5: Climatic classification map for Nepal based on modified Köppen-Geiger method (taken from Karki et al., 2015)

23. The KG map demonstrates that most of the Himalayas are classed as Polar Tundra Climate (ET), with small areas of Polar Frost Climate (EF) and in the Mustang, Manang, and Dolpa regions where rainfall is exceptionally low, Arid Steppe Cold Climate (BSk). Together these areas cover around 20% of the country.
24. Ignoring the small areas of transitional climatic zones (Dwb and Dwc), in the Mid Hills the climate zones are Temperate Climate with Dry Winters and either Warm (Cwb) or Hot (Cwa) Summers depending on elevation. The northern regions of the Terai are mostly classified as Temperate Climate with Dry Winters and Hot Summers (Cwa) or Tropical Savannah (Aw).
25. Therefore, it can be seen that within this relatively small country, there are huge variations in temperature, precipitation and climatic zone.

Seasonality

26. As well as geographical variation, there is a significant temporal variation within the climate of Nepal, with the monsoon impacting temperature and precipitation significantly.
27. As shown in Figure 6, during the monsoon months of June to September there is a huge peak in precipitation volumes with approximately 78% of the annual total falling¹¹. Outside of these months

¹¹ The World Bank Group's Climate Change Knowledge Portal, accessed 29-07-2019.

https://climateknowledgeportal.worldbank.org/country/nepal?CCCode=NPL&ThisTab=RiskOverview%2Fclimate-data-historical%2Fadaptation%2Fadaptation%2Fclimate-sector-energy%2Fclimate-data-projections%3Fvariable%3Dpr%2Fclimate-sector-energy%2Fclimate-sector-energy%2Fclimate-data-historical&page=country_profile%2Fadaptation%2Fclimate-data-projections%3Fvariable%3Dpr%2Fvulnerability/climate-data-historical

Nepal is largely dry. Similarly, as noted above there is large variation in temperature across the country, but temporally the monsoon months are significantly hotter than the rest of the year.

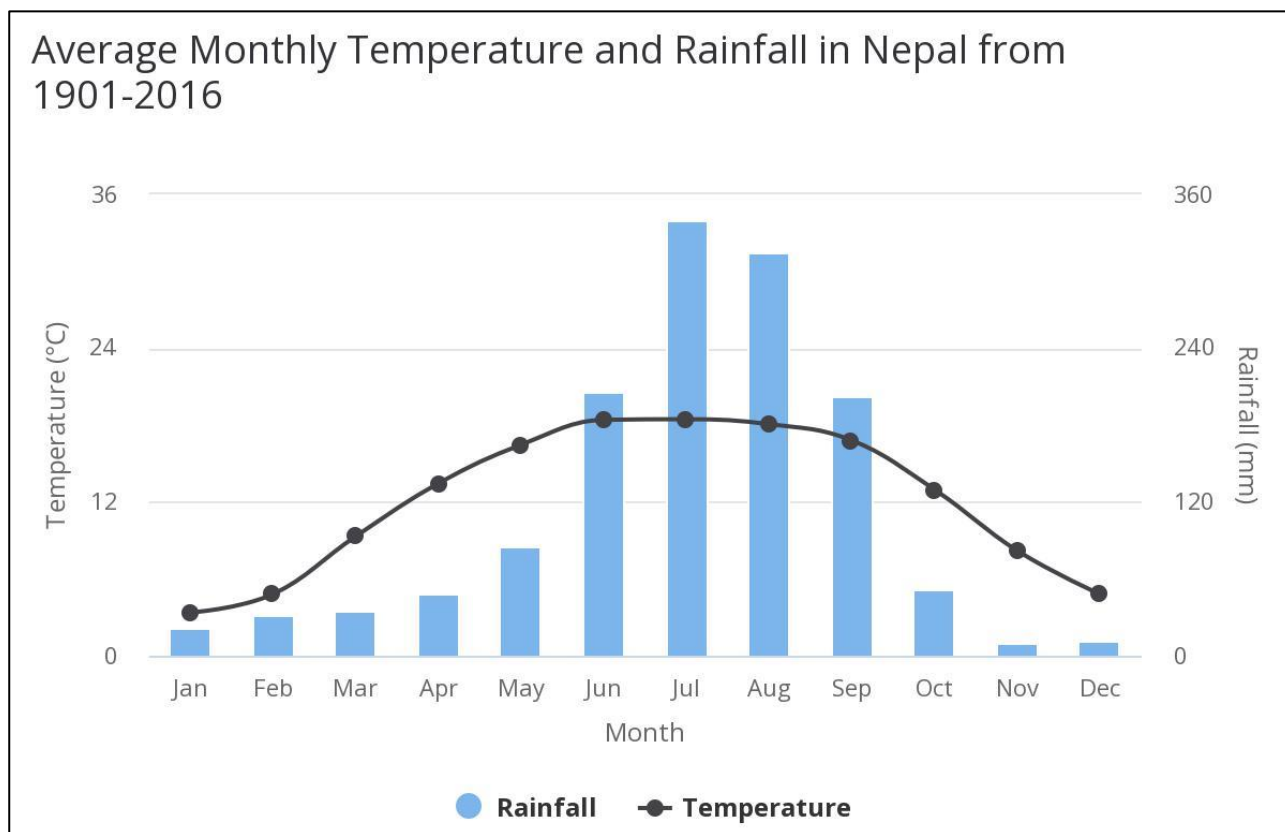


Figure 6: Average monthly temperature and rainfall in Nepal nationwide from 1901 to 2016 (taken from The World Bank Group's Climate Change Knowledge Portal, 2019)

2.1.3. River basins

28. Figure 7 shows the river basins of Nepal. The three major river basins are:

1. Koshi;
2. Gandaki; and,
3. Karnali.

29. Other medium and small river basins are the Mahakali, Babai, West Rapti, Bagmati, Kamala, Kankai, and Mechi. Many small rivers drain the southern flat region.

30. The World Bank has invested heavily in the Koshi Basin (see Section 5.3) whilst ADB has invested in the Bagmati (see Section 5.1) with plans for the future to work in West Rapti and other Terai basins.



Figure 7: River Basins of Nepal (taken from Lahmeyer International, 2018)

2.1.4. Political geography

Population

31. The ADB in 2017 estimated that Nepal's population was 28.7 million people¹². Nepal had an urban population of 10.9% in 1995 according to the United Nations Development Program, but this has accelerated to 19.3% in 2017¹³. Additionally, there is a migration to the Terai from the mountainous and hilly regions. However, the striking issue of population growth from rural to urban areas is an increase in the number of people vulnerable to flooding as well as potential flood damage to an increasing amount of urban infrastructure.
32. Figure 8 shows the population density map based on Census data from 2011, overlaid with municipalities, which clearly show high population density along the flood prone municipalities of the Terai districts.

¹² Taken from the Asian Development Bank's Statistical Database System, accessed 29-07-2019. <https://sdbs.adb.org/sdbs/>

¹³ Taken from *Human Development Reports, Urban Population (%)*, United Nations Development Programme, accessed 29-07-2019. <http://hdr.undp.org/en/indicators/45106>

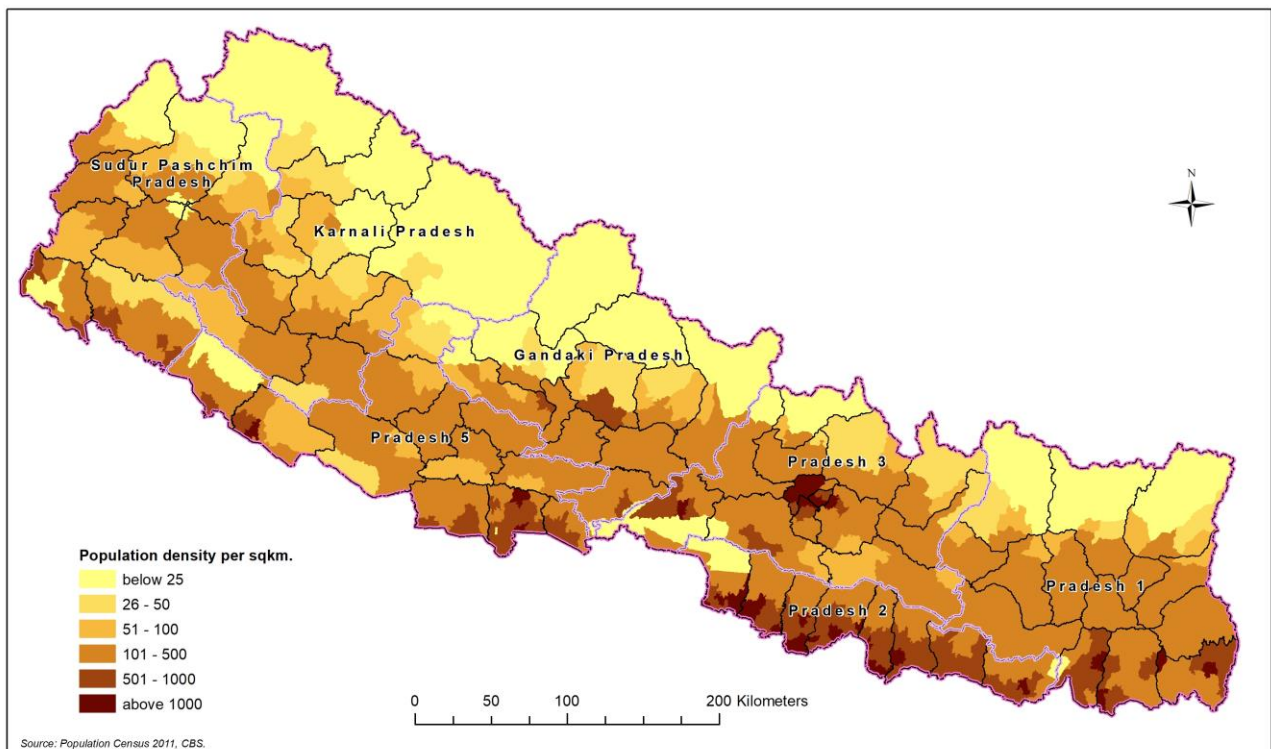


Figure 8: Population density map of Nepal (taken from Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, 2011)

Economics

33. Nepal is among the least developed countries in the world, with a Human Development Index ranking of 149 out of 189 nations¹⁴. The Gross National Income per capita in 2017 was US\$2,471¹⁵ with 15% of the population living under the poverty line of income poverty line, (US\$1.90 a day)¹⁶ and 33% of the working population classed as the working poor (i.e. US\$3.10 a day)¹⁷.
34. Agriculture is the biggest employer within the economy, providing a livelihood for almost two-thirds of the population but accounting for less than a third of GDP¹⁸. Nepal has considerable scope for exploiting its potential in hydropower, but so far very little has been prepared.
35. Challenges to Nepal's economic growth and poverty reduction include physical issues such as being landlocked with poor transport infrastructure, as well as political issues such as lack of capacity and multifaceted institutional structures. The new Constitution adds a layer of complexity to governance structures moving forwards and the country is highly susceptible to natural disasters including earthquakes and floods.

¹⁴ Taken from *Human Development Reports, Nepal, Human Development Indicators*, United Nations Development Programme, accessed 29-07-2019. <http://hdr.undp.org/en/countries/profiles/NPL>

¹⁵ Taken from *Human Development Reports, Gross national income (GNI) per capita (2011 PPP \$)*, United Nations Development Programme, accessed 29-07-2019. <http://hdr.undp.org/en/indicators/141706>

¹⁶ Taken from *Human Development Reports, Population living below income poverty line, PPP \$1.90 a day (%)*, United Nations Development Programme, accessed 29-07-2019. <http://hdr.undp.org/en/indicators/167106>

¹⁷ Taken from *Human Development Reports, Working poor at PPP\$3.10 a day (% of total employment)*, United Nations Development Programme, accessed 29-07-2019. <http://hdr.undp.org/en/indicators/153706>

¹⁸ CIA World Factbook, accessed 29-07-2019. <https://www.cia.gov/library/publications/the-world-factbook/geos/np.html>

Political boundaries and mandates

36. In 2015 Nepal radically altered its Constitution in an attempt to decentralize services and government away from the national level based in Kathmandu. This relatively new system is still being implemented and is a cooperative federal system of Government with three tiers of Governments:
- Central Government based in Kathmandu with major Ministries etc.;
 - Seven Provincial Governments; and,
 - 753 Local Municipalities (293 urban municipalities and 460 rural municipalities). In addition, 77 districts provide administrative and coordinating services to the municipalities.
37. A map of the new political boundaries is given in Figure 9.

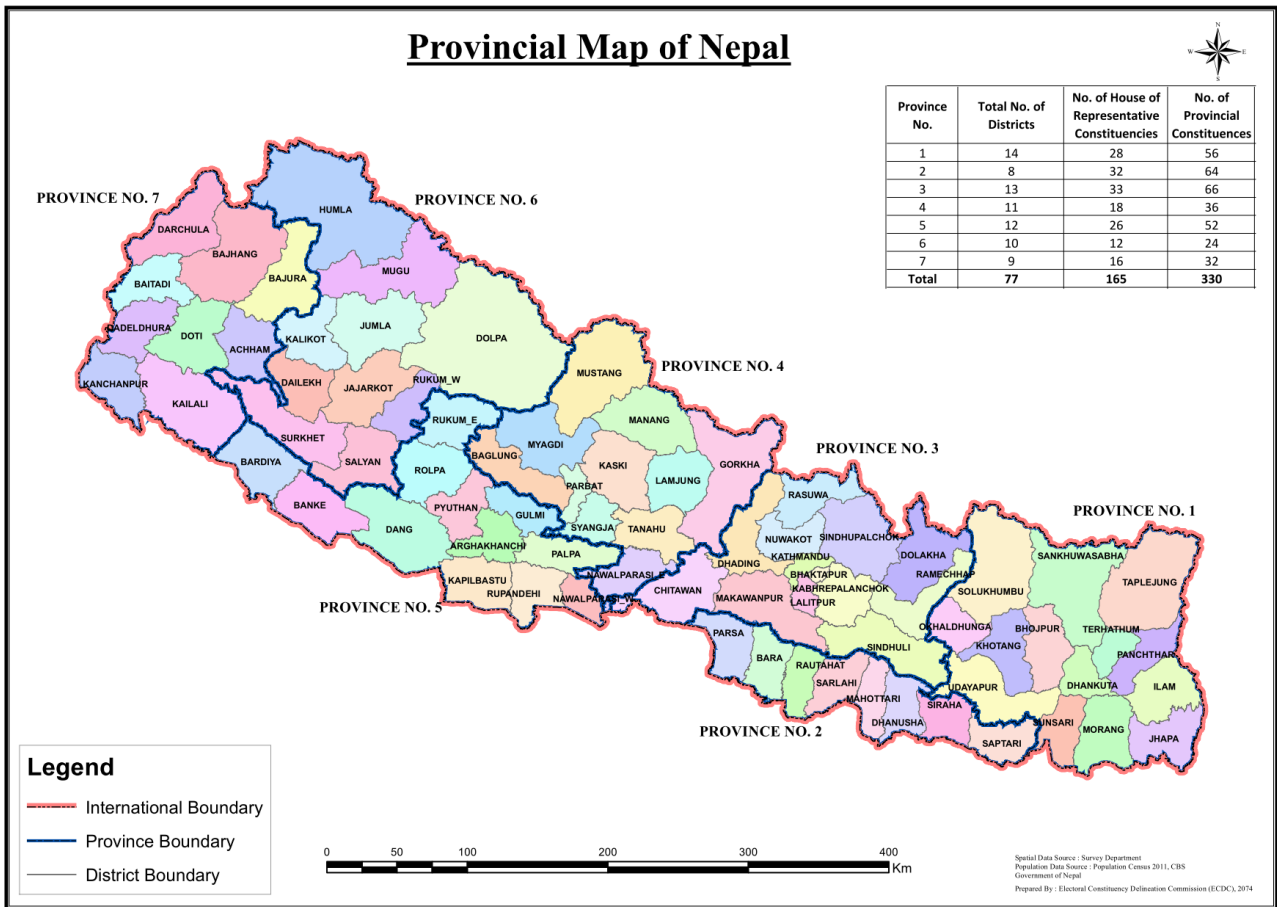


Figure 9: Political map of Nepal showing Provincial and District Boundaries (taken from Electoral Constituency Delineation Commission, Government of Nepal, 2017)

38. The new Constitution empowers Provincial governments to have a greater mandate in decision making and ruling compared to previously. The impact of this new Constitution and institutional setup on flood risk management and water resources more generally, is yet to be fully realized. This is considered further in Section 3.

2.2. Types and locations of flooding

2.2.1. Overview

39. Flood is the most common natural disaster affecting Nepal. The principal and most destructive type of flooding is from rivers (fluvial) located within the Terai region.

40. On average, floods and landslides are the causes of over 175 deaths each year, with average annual economic losses exceeding USD 140 million¹⁹. Nepal is the tenth highest country in the world in terms of relative physical exposure to river (fluvial) flooding, , exposing possible damage to physical assets as a value equivalent to 1.4% of its GDP ²⁰. By way of comparison, between 1971 and 2007 earthquakes were the cause of approximately 873 deaths (i.e. 23 deaths per year)²¹. However, the 2015 earthquake was a huge natural disaster with over 8,600 deaths and an estimate of USD 10 billion of damage²², some 15% of GDP in 2014²³.
41. Frequency and intensity of extreme flood events is said to be increasing with the impact of climate change. Without comprehensive flood protection or appropriate risk-sensitive urban planning, increased ongoing economic and development activity in the flood plains will likely increase the economic damage associated with floods in the coming years. This is discussed further in Section 2.6.
42. Apart from fluvial flooding during the monsoon, other flood risks include flash flooding from heavy rainfall in mountainous areas, Glacial Lake Outburst Flooding (GLOF), landslide induced flooding, and infrastructural flooding (such as embankment failure). Table 1 provides a summary of sources, receptors and importance of different types of flood risk in Nepal.

Table 1: Summary of sources, receptors and importance of different types of flood risk in Nepal

Type of flood risk	Source	Receptor	Importance
River (fluvial) flooding during the monsoon season	As mentioned in Section 2.1.2, the monsoon rains account for 78% of the annual total rainfall and can cause widespread large floods once river capacity is overwhelmed. These floods always coincide during the monsoon season of June to September.	The Terai region is the main receptor for these floods including large swaths of agricultural land, low-lying urban areas and infrastructure crossing the Terai.	This is the largest source of flooding to Nepal and causes the greatest loss of life and economic damage.
Flash flooding from heavy rainfall (mountainous areas)	Flash flooding in mountainous areas and the mid-hills can occur when intense rainfall falls in a short period of time leading to high surface water runoff into existing rivers and channels.	These events can happen in any of the Himalayan or middle hills regions. Due to the large volumes of water generated by surface water runoff the floods can breach existing river channels and are a risk to nearby population centers and existing infrastructure such as bridges.	Events such as the 1993 flash flooding event in the mid-hills leading to over a thousand deaths demonstrate that this type of flooding can be extremely impacting.

¹⁹ See Section 2.4

²⁰ World Resources Institute, 2015. *World's 15 Countries with the Most People Exposed to River Floods*. <https://www.wri.org/blog/2015/03/world-s-15-countries-most-people-exposed-river-floods>

²¹ See Table 23 from United Nations Development Programme, 2009. *Global Assessment of Risk: Nepal Country Report*. ISDR Global Assessment Report on Poverty and Disaster Risk 2009.

²² Mortality and damage estimates taken from International Centre for Integrated Mountain Development (ICIMOD), 2015. *Nepal Earthquake 2015 Factsheet*.

²³ Asian Development Bank, 2015. *Key Indicators for Asia and the Pacific 2015*.

Type of flood risk	Source	Receptor	Importance
Glacial Lake Outburst Flooding (GLOF)	Lakes that form from meltwater at the front of the glacier can sometimes fail leading to a rapid, sudden release of water down an existing meltwater river.	These events happen downstream of the glaciated areas of the Himalayas. Due to the large volumes of water rapidly released GLOF can breach existing river channels and are a risk to nearby population centers and existing infrastructure such as bridges.	As the locations for potential GLOF events can be closely monitored the risk in general is lower. However, when they occur they can result in catastrophic downstream flooding.
Landslide induced flooding	Similar to GLOF, landslides (usually triggered by earthquakes or the loosening of soil through precipitation and/or weathering) can create a dam across a river leading to a lake building behind it. Although these events can create permanent features, they are prone to collapse with similar effects to GLOF.	These events can happen in any of the Himalayan or middle hills regions. Due to the large volumes of water rapidly released the floods can breach existing river channels and are a risk to nearby population centers and existing infrastructure such as bridges.	With Nepal's remote mountainous terrain, landslides can be hard to monitor and therefore risks associated with landslide dam breaks are not always known. Although rare, when they occur these events can be devastating.
Infrastructural flooding (rural)	Embankment breach or bridge/culvert blockages can cause flooding.	In the cases of breaches, rapid inundation can occur with significant danger to life. Blockages can lead in the worst cases to bridge collapses.	The Koshi River embankment failure of 2008 highlights the need for regular maintenance. These events can be extremely serious.
Infrastructural flooding (urban)	Increasing urbanization is increasing impervious area and leading to the overwhelming of the sewer network.	Urban: Surrounding housing / infrastructure, transport systems, traffic congestion, health impacts due to stagnant water and contamination of storm water with sewage, people along footpaths (death and injury due to falling into open drains and manholes)	Increasing economic, social and human losses.

2.2.2. River (fluvial) flooding during the monsoon season

43. As mentioned in Section 2.1, the Terai regions of Nepal are particularly susceptible to river flooding during the monsoon season as they are natural floodplains. Rainfall is extremely seasonal (see Section 2.1.2) with the huge majority falling within the monsoon months of June to September. As well as this rainfall creating huge discharges, millions of tons of sediment are carried downstream during the monsoon season²⁴. This leads to many challenging considerations for flood risk management including changing bed morphology, sediment accumulation and river channel migration and switching.

²⁴Sinclair, H. et. al, 2017. *Improving understanding of flooding and resilience in the Terai, Nepal*. The University of Edinburgh and Practical Action.

44. The river basins within the Terai region vary, from large rivers originating from the Himalayas, medium rivers originating from the Mahabharat Hills and small rivers originating from the Siwalik and Churia Hills²⁵. These rivers vary in their flood mechanisms, with the smaller rivers more vulnerable to extreme short high-intensity storms leading to flash flooding. The geological differences also lead to different sediment loads.
45. During the monsoon season rivers are often in spate due to regular rainfall. Flooding usually occurs following high-intensity rainfall once the rivers are already at bank-full conditions. For example, in July 2019, rainfall measuring 312 mm fell at Simara in Bara within a 24-hour period leading to at least 64 deaths and over 80,000 displaced people²⁶, and 245mm was recorded in Janakpur. Even though this from developed world standards can be seen as a major event, due to the frequency and severity of Terai flooding, the United Nations only called this event a “localized situation”²⁷. Historical floods on the Terai are discussed in Section 2.3.
46. Once water is out of bank and onto the floodplain it travels south towards the Indian border as per the prevailing gradient. As well as deposition of sediment occurring in the river itself, increasing the riverbed level and therefore decreasing discharge capacity and thus increasing flood risk; sediment deposition also occurs on the floodplain which is usually farmland, potentially negatively affecting agricultural livelihoods and food production.
47. At several locations, floods cause severe bank erosion, threatening the destruction of settlements and agricultural land. The floods in the Terai region damage farmland and crops and kill livestock, which is of critical importance to livelihoods within rural, poor communities. Important infrastructure such as embankments, roads, communication infrastructure and power supply are all significantly impacted.
48. At some locations it has been observed that existing road infrastructure can be a hinderance to the passing of floodwaters²⁸. It is also worth considering that most Nepali major roads run east-west in the Terai whereas the slope is north-south. Culverts underneath highways often do not receive adequate maintenance and can be liable to blockage, further exacerbating flooding.
49. There is also evidence that downstream infrastructure in India, can have a backwatering effect on the floodplain in Nepal²⁹. Whilst this potentially increases flood risk, no long-term solution has been agreed between Nepal and India. Joint committees representing the relevant authorities of Nepal and India meet at regular intervals and also carry site visits to these areas. However, no concrete decisions have yet been reached to achieve a solution to this problem³⁰.

2.2.3. Flash flooding from heavy rainfall (mountainous areas)

50. Flash flooding in mountainous areas and the mid-hills can occur when intense rainfall falls in a short period of time leading to high surface water runoff into existing rivers and channels³¹. These floods tend

²⁵ Raj Adhikari, B., 2013. *Flooding and Inundation in Nepal Terai: Issues and Concerns*. Hydro Nepal, Issue No.12.

²⁶ reliefweb website, accessed 05-08-2019. *Nepal: Floods and Landslides - Jul 2019*. <https://reliefweb.int/disaster/fl-2019-000083-npl>

²⁷ United Nations Office of the Resident Coordinator, Nepal, 15-07-2019. *Nepal: Monsoon Flooding, Flash Update No. 2*.

²⁸ Chapagain, S., 2017. *Nepal Terai Flood of 2017: A Case Study of Gaur Municipality, Rautahat*.

²⁹ Raj Adhikari, B., 2013. (as above) and Lahmeyer International in association with Total Management Services Pvt. Ltd., 2016. *Water Resources Project Preparatory Facility: Package 3: Flood Hazard Mapping and Preliminary Preparation of Flood Risk Management Projects: Final Report Volume 1: Main Report*. Asian Development Bank.

³⁰ See: <http://www.moewri.gov.np/images/category/Minutes-Sixth-Meeting-of-JSTC.pdf>

³¹ ICIMOD, 2010. *Managing Flash Flood Risk in the Himalayas*.

to be characterized by very rapid responses and be very localized making them difficult to predict or provide early warning.

51. It should be noted at times flooding in the Terai is described as being from “flash flooding”. However, this is usually when the existing Terai rivers are already full and then there is intense rainfall leading to bank overtopping. As this type of flooding can be better predicted (i.e. as the rivers are already full) then we do not refer to the Terai flooding as “flash flooding” but deal with it in the section above.
52. These events can happen in any of the Himalayan or middle hills regions. Nepal, as with the rest of the Himalayan region, is particularly vulnerable to flash flooding as the steep sided catchments and intense monsoon rainfall can easily generate extreme surface water runoff into existing river channels.
53. Due to the large volumes of water generated, the floods can breach existing river channels and are a risk to nearby population centers and existing infrastructure such as bridges.
54. In 1993 in Central Nepal, 540mm rainfall was recorded within a 24-hour period leading to immense flooding and approximately 1,336 people dying. Around 60,000ha of agricultural land was inundated and 67 irrigation schemes washed away³².

2.2.4. Glacial Lake Outburst Flooding (GLOF)

Description

55. Glacial Lake Outburst Flooding (GLOF) is where meltwater from glaciers builds up behind an ice or moraine barrier and then ever overtops, perhaps triggered by an avalanche or landslide into the lake or fails due to hydrostatic pressure. When these events occur there is a rapid, sudden release of water down an existing meltwater river. Due to the large volumes of water rapidly released, floods can breach existing river channels and are a risk to nearby population centers and existing infrastructure such as bridges.
56. There have been a number of serious GLOF events in Nepal (see Table 2) including in 1985 at Dudh Koshi which led to around \$3 million USD worth of damage³³. This event led to many scientific papers and research into GLOF in Nepal.
57. Due to the requirement of having an upstream glacier, GLOF can be well understood with regards the locations at risk. However, due to sometimes inaccessible terrain, most risk mapping is done using satellite imagery to observe glacial lakes and their changes over time.
58. Major International Centre for Integrated Mountain Development (ICIMOD) reports in 2010 and 2011³⁴ aimed to identify potentially dangerous glacial lakes. Risk was determined by looking at glacial lakes susceptibility to failure, and the potential downstream impact in terms of loss of life and economic damage.
59. In total 49 lakes associated with a glacier were identified as being larger than 0.02 sq. km and hence could cause damage downstream. The risk assessment narrowed this number down by looking at the overall size and expansion of the lake, water levels, position, dam condition, glacier characteristics and physical conditions of the surroundings. This led to the identification of 21 “significant” lakes.
60. A ranking of the 21 “significant” lakes was undertaken using physical parameters such as distance between lake and glacier, moraine dam condition and surrounding possibility for landslides and avalanches, and socio-economic parameters such as human population downstream and the presence

³² Raj Adhikari, B., 2013. (as above)

³³ ICIMOD, 2011. *Glacial Lakes and Glacial Lake Outburst Floods in Nepal*.

³⁴ ICIMOD, 2010. *Formation of Glacial Lakes in the Hindu Kush-Himalayas and GLOF Risk Assessment*; and, as above.

of hydropower. Field investigations and GLOF hydraulic modelling were undertaken to try and understand the risk at three of the five highest ranked lakes. For these three lakes between 700 and 1,900 people live within the flood-prone area of each, with potential real estate damages rising as high as \$8.9 million USD.

61. There are a number of considerations for the management of GLOF, including:
- Identifying glacial lakes as climatic conditions change;
 - Monitoring the size of lakes and their likelihood of outburst;
 - Preparing Early Warning Systems to allow downstream populations to move away from danger areas;
 - Community participation; and,
 - Transboundary discussions with China where GLOFs can originate.

2.2.5. Landslide induced flooding

62. Landslide induced flooding is very similar to GLOF. Landslides can be triggered by earthquakes or the loosening of soil through precipitation and/or weathering and create a dam across a river leading to a lake building behind it. Although these events can create permanent features, they are prone to collapse with similar effects to GLOF.
63. Given the remoteness of much of Nepal's mountainous and hilly terrain, monitoring landslides can be very difficult. In that sense, landslide induced flooding is much harder to manage than GLOF, where glacial lakes can be observed through remote sensing and field investigations. Therefore, these events can be extremely difficult to predict.
64. Major landslide induced flood events are detailed in Table 2 and include the August 2014 event in Jure which led to 156 deaths and almost a billion Nepalese Rupees in damages³⁵.

2.2.6. Infrastructural flooding

Rural

65. Rural infrastructure flooding can occur in two main forms. Firstly, large parts of the Terai have existing embankments along the rivers, and if not monitored and maintained correctly, can fail leading to catastrophic flooding.
66. The most serious embankment breach in recent times was in Kushaha on 18th August 2008, where a Koshi River embankment failed at relatively low flows. However, the breach was sufficient to inundate a number of rural villages. In their review of the event, Sinha, R. et. al, 2014 state that "*the breach was caused primarily by poor strategies of river management, but also by poor monitoring and maintenance of the embankment, making the event partly a human-induced disaster.*" The Asian Development Bank also conducted a detailed study on flood hazard mapping and associated activities on the Koshi river in 2012.
67. The second main form of rural infrastructural flooding is the blockage or lack of capacity of culverts or bridges under east-west road infrastructure. Although culverts and bridges are sized with major floods in mind, where poor maintenance or sedimentation leads to a loss of effective flow area flooding can

³⁵ Approximately \$10.3 million USD at August 2014 rate.

occur behind the structures. In the worst cases, such as in 2007 in Rautahat District³⁶, bridges can collapse due to the hydrostatic pressure build-up.

68. In many towns and villages in the Terai, traditional ponds have also been used to retain flooding. However, these ponds are disappearing fast due to growing urbanization.

Urban

69. Although flooding in Nepal is often considered a rural issue, urban flooding in Kathmandu and smaller towns has been increasing in recent years³⁷. The impervious area in Kathmandu has increased from 9.5km² in 1980 to 37.4km² in 2010³⁸, however this huge rate of urbanization has not been matched by similar levels of investment into drainage infrastructure. Accordingly, heavy rainfall in Kathmandu often overwhelms sewer capacity and causes flooding. The story is similar in other towns across Nepal.
70. In some urban areas, natural drains called Kholas are at risk of building encroachment and lack of solid waste management can lead to garbage dumping and associated loss of conveyance and storage of runoff³⁹. Additionally, due to pressure on existing land for development, areas that previously acted as natural floodplain storage are being encroached upon in urban areas.

2.3. Past significant flood events

71. Nepal has a long history of major flood events, with some set out in Table 2.

Table 2: List of some of the past significant flood events

Date and location	Type	Description	Source of information
1926, Bagmati River Basin	River monsoon flooding	Over 50% of crops destroyed within agricultural lands.	Raj Adhikari, 2013
3 rd September 1977, Dudh Koshi	GLOF	Upstream failure of a small glacial lake led to rapid discharge into Nare Lake and subsequent overtopping of the end-moraine dam. Small loss of life but all bridges swept away for 35km downstream and debris flows alongside hillsides.	ICIMOD, 2011
September 1978, Butwal	Landslide induced flooding	Intense rainfall caused a landslide and subsequent dam burst washed away a bridge on the East-West highway and an irrigation weir.	Raj Adhikari, 2013
23 rd June 1980, Tamor	GLOF	Collapse of a moraine in the Nagma Pokhari basin led to huge damages to villages downstream (up to 71km away from source).	ICIMOD, 2011

³⁶ Raj Adhikari, B., 2013. (as above)

³⁷ Pradhan-Salike, I. and Raj Pokharel, J., 2017. *Impact of Urbanization and Climate Change on Urban Flooding: A case of the Kathmandu Valley*. Journal of Natural Resources and Development 2017; 07: 56-66.

³⁸ Kathmandu Valley Development Authority (KVDA), 2013. *Comprehensive Study of Urban Growth Trend and Forecasting of Land Use in Kathmandu Valley*. Ministry of Urban Development, Government of Nepal.

³⁹ Paudyal, G. N., 2016. *Flood Risk Management in Selected Urban Centres of Terai Region of Nepal: Guidance Note*. Asian Development Bank. TA-6498 REG: Knowledge and Innovation Support for ADB's Water Financing Program.

Date and location	Type	Description	Source of information
11 th July 1981, Bhote Koshi	GLOF	A GLOF occurred due to the drainage of the Zhangzangbo glacial lake north of the international border in Tibet. Five people were killed with 41 houses destroyed. The market at Barhabise was blocked for 36 days.	ICIMOD, 2011; ICIMOD, 2013
4 th August 1985, Dudh Koshi	GLOF	The Langmoche Glacier slopes steeply into its frontal lake. The GLOF was triggered by an ice avalanche that hit the steep glacier surface and fell suddenly into the lake. The surge wave wash over the end moraine dam and breached it. Four or five lives were lost, there was significant infrastructure damage and large parts of the trekking route to Everest base camp were destroyed. \$3million worth of damage.	ICIMOD, 2011
August 1987, Eastern Terai Region	River monsoon flooding	Major flooding of the East-West highway of up to 500mm deep.	Raj Adhikari, 2013
1993, Central Nepal	Flash flooding	540mm rainfall was recorded within a 24-hour period leading to immense flooding and approximately 1,336 people dying. Around 60,000ha of agricultural land was inundated and 67 irrigation schemes washed away.	Raj Adhikari, 2013
3 rd September 1998, Dudh Koshi	GLOF	An ice avalanche hit the Tom Pokhari Lake and the surge wave caused overtopping with approximately US\$2 million damage downstream.	ICIMOD, 2011
July 2007, Terai flooding	River monsoon flooding	At least 260,000 people were affected by major Terai flooding which killed at least 69 people and displaced nearly 10,000 families. In addition, waterborne diseases were particularly prevalent after the flooding.	Reliefweb, 2007
18 th August 2008, Kushaha	Infrastructural flooding (embankment breach)	A breach of the eastern embankment of the Koshi barrage built in the 1960s led to rapid inundation of various villages. At the time of failure, flows in the river were not significant. <i>"The breach was caused primarily by poor strategies of river management, but also by poor monitoring and maintenance of the embankment, making the event partly a human-induced disaster."</i> (Sinha, R. et. al, 2014)	Raj Adhikari, 2013; Sinha, R. et. al, 2014
September 2008, Kailali Floods	River monsoon flooding	Torrential rain led to severe flooding in the Far Western region leading to over 160,000 people affected. Over 25 people were killed and over 100,000 hectares of arable land had sedimentation. There was significant crop damage.	MercyCorps, 2009
5 th May 2012, Seti	Landslide induced flooding	A landslide triggered a flash flood which swept down the Seti River and killed at least 60 people.	Reuters, 2012

Date and location	Type	Description	Source of information
August 2014, Jure	Landslide induced flooding	In the early hours of 2 August 2014, a landslide occurred above Jure village. The massive landslide created a high dam across the Sun Koshi River. An inflow of about 160 m ³ /sec of water quickly created a large lake behind the dam. Within 13 hours the newly formed lake – which rapidly grew to a volume of an estimated 7 million cubic meters – extended about 3 km upstream, completely submerging the 2.6 MW Sanima Hydropower Station. The landslide damming caused 156 deaths and almost a billion Nepalese Rupees in damages ⁴⁰ .	OCHA, 2014
August 2017, Terai flooding	River monsoon flooding	Major flooding occurred across South Asia in August 2017 with around 1.7 million people affected in Nepal. At least 140 people were killed, and it was estimated around 80% of the Terai was flooded.	UNICEF, 2017
July 2019, Terai flooding	River monsoon flooding	Rainfall measuring 312 mm fell at Simara in Bara within a 24-hour period leading to at least 64 deaths and over 80,000 displaced people	Reliefweb, 2019

2.4. Economic impact of flooding

2.4.1. Average Annual Losses

72. Measuring the economic impact of flooding in Nepal is difficult for a number of reasons. Firstly, data in remote areas is poor with one author pointing out significant differences in the record of mortalities when comparing village, provincial or national level datasets⁴¹. Secondly, the Government records “storms”, “landslides”, “drowning” and “heavy rainfall” separately to “flooding”⁴², even though these items can be interlinked or not. Thirdly, valuing the impact of flooding remains difficult given Nepal’s varying land and agricultural uses which may have different value according to topography and access to employment or markets. Finally, the lack of insurance means that losses cannot be assessed versus claims.
- Accordingly, there are a number of different estimates, as detailed in
73. Table 3. Side by side, a number of observations are made:
- Mortality rates of around 175-200 lives lost a year appear to be consistent;
 - Average annual losses (AAL) are significantly lower when using Government data, instead of international estimates (i.e. EM-DAT);
 - Although there is a lack of comparable data, average annual losses appear to be increasing, likely linked to increased GDP;

⁴⁰ Approximately \$10.3 million USD at August 2014 rate.

⁴¹ Samir, K.C., 2013. *Community Vulnerability to Floods and Landslides in Nepal*. Ecology and Society, Vol. 18, No. 1 (Mar 2013).

⁴² Government of Nepal, Ministry of Home Affairs, 2017. *Nepal Disaster Report 2017: The Road to Sendai*.

- Given that the EM-DAT International Disaster Database is the preeminent tool for estimating losses, the figure of \$143.3m USD for AAL is taken to be the most accurate as quoted in two reliable sources (see Table 3).

Table 3: Summary of mortality and economic losses from a range of sources for Nepal

Source	Average Annual Mortalities from flooding	Average Annual Losses from flooding (m USD)
Chalise and Khanal, 2002 ⁴³	230 (1983-1998)	10.7
Yogacharya and Gautam, 2008 ⁴⁴	299 (1983-2006, GoN)	626m NPR = 8m USD at time of publication
UNDP, 2009 ⁴⁵	199 (1980-2000, DesInventar) 79 (1971-2007, EM-DAT/CRED)	Unavailable
Samir, 2013 ⁴⁶	188 (2000-2001, 2002-2006)	Unavailable
PreventionWeb, 2014 ⁴⁷	135 (National reports)	94.4 (National reports) 143.3 (EM-DAT)
Government of Nepal, 2015 ⁴⁸	175 (1972-1999) 202 (2000-2014)	Unreliable – figures believed to only consider housing damage
World Bank, 2016 ⁴⁹	Unavailable	143.3 (EM-DAT)

2.4.2. Seasonality and geographical differences

74. In Nepal, economic losses from flood risk have seasonal and geographical patterns.
75. Taking “affected people” as a proxy for economic losses, over 2.5 million people were affected by flooding in the month of July between 1971-2007, followed by the month of August with over 500,000 people⁵⁰ (see Figure 10). This matches very closely with the seasonality of the monsoon, with early monsoon rainfall in June (Figure 6) filling rivers up, but later rainfall in July and August leading to flooding, and consequently economic losses.

⁴³ Chalise, S.R. and Khanal, N.R., 2002. *Recent extreme weather events in the Nepal Himalayas*. In: Snorrason, A. and Finnsdottir, H.P., 2002, *The Extremes of the Extremes: Extraordinary Floods*.

⁴⁴ Yogacharya, K.S. and Gautam, D.K., 2008. *Floods in Nepal: Genesis, Magnitude, Frequency and Consequences*. Proc. of the International Conference on Hydrology and Climate Change in Mountainous Areas, November 15-17, 2008, Kathmandu, Nepal.

⁴⁵ United Nations Development Programme, 2009. *Global Assessment of Risk: Nepal Country Report*. ISDR Global Assessment Report on Poverty and Disaster Risk 2009.

⁴⁶ Samir, K.C., 2013. *Community Vulnerability to Floods and Landslides in Nepal*. Ecology and Society, Vol. 18, No. 1 (Mar 2013).

⁴⁷ PreventionWeb website, accessed 21-08-2019. *Nepal: Disaster & Risk Profile*. <https://www.preventionweb.net/countries/npl/data/>

⁴⁸ Government of Nepal, Ministry of Home Affairs, 2015. *Nepal Disaster Report 2015*.

⁴⁹ World Bank, 2016. *Strengthening Financial Resilience to Disasters in Asia: Catastrophe Risk Modelling and Live Hazard Data for Parametric Risk Financing in Asia: Summary Technical Report*.

⁵⁰ United Nations Development Programme, 2009. *Global Assessment of Risk: Nepal Country Report*. ISDR Global Assessment Report on Poverty and Disaster Risk 2009.

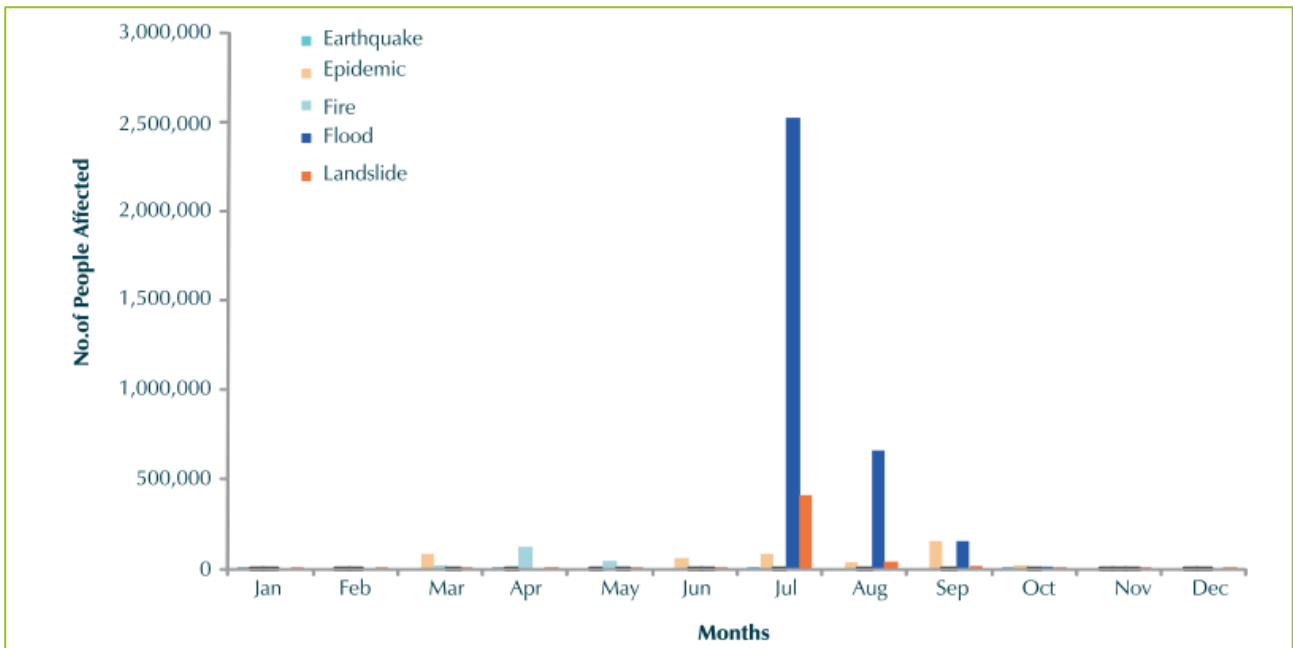


Figure 10: Seasonality of affected people by natural hazard 1971-2007 (taken from UNDP, 2009). Note: 2015 earthquake would alter earthquake statistics significantly with 8 million affected by that single event.

76. Geographically, there is also a clear difference in number of affected people, with districts in the Terai having significantly more impacts of flooding than the mid-hills or Himalayas (Figure 11). Again, this matches with the understanding that the Terai flooding is most important in terms of economic losses (Table 1).

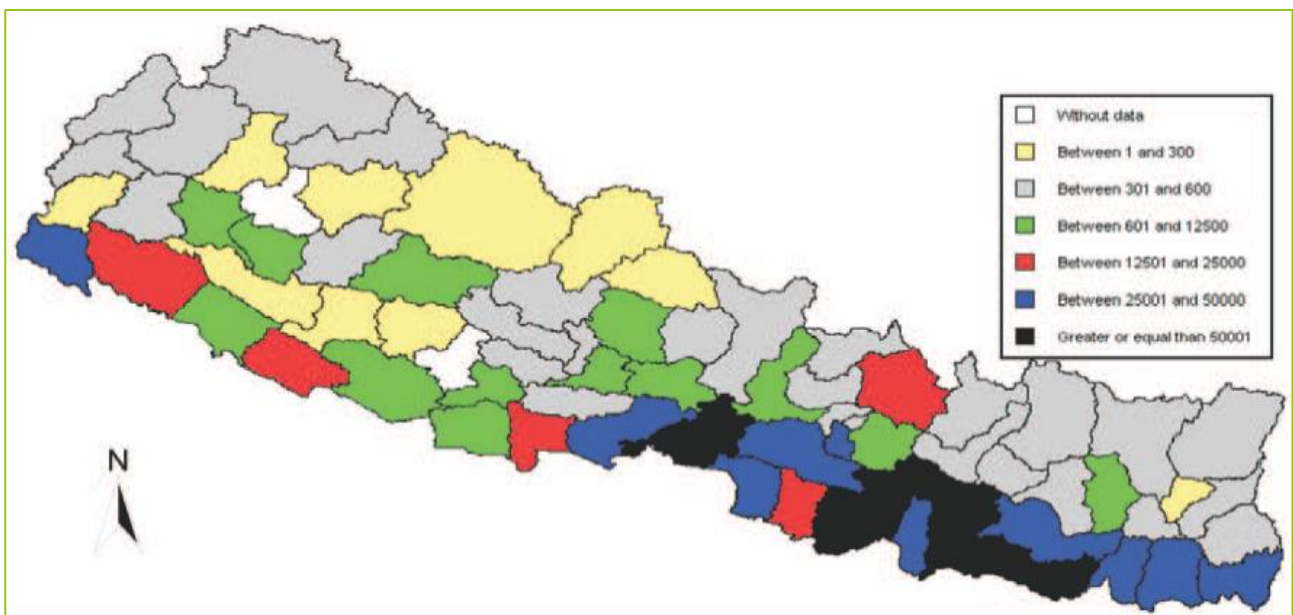


Figure 11: Number of affected people by flooding by district (taken from UNDP, 2009)

2.4.3. Terai flooding in 2017: A case study of extreme economic loss

77. The Terai flooding of 2017 serves as a case study of the possibilities of large flooding and the economic (and social) losses it can bring. It also serves as an example for the damages which are spread across various sectors of the economy.

78. The South Asia floods affected Bangladesh, India, Nepal and Pakistan with around 1.7 million people affected in Nepal. At least 140 people were killed, and it was estimated around 80% of the Terai was flooded⁵¹.
79. The Government of Nepal commissioned a report⁵² into the flooding which summarizes the economic impacts as follows:
- **Housing:** It was estimated that some 41,626 houses were completely destroyed and 150,510 houses damaged by the flooding. Using an average of housing types and costs within the affected Terai region the cost of destroyed and damaged housing was NPR 9.4billion and NPR 10.2billion respectively. Adjusted to the dollar, this works out at a total cost of USD 187.9 million (just under USD 1,000 per property affected). Using the principle of 'build-back-better', the Government aimed to improve the resilience of homes to future flooding and accordingly costed the recovery needs to be USD 375.8 million.
 - **Health and Nutrition:** The 2017 floods caused five health facilities (with associated drugs and equipment) to be destroyed. A further 94 were damaged leading to a damage cost of approximately USD 6 million. The Government has assessed an additional USD 500,000 is required for long term resilience and therefore they estimated the recovery cost to be USD 6.5 million.
 - **Education:** The majority of damage to schools was in the form of direct damage to buildings including sanitation facilities. Damage to drinking water supplies formed over 10% of the costs with loss of textbooks and equipment relatively minor compared to the structural damage. In total the Government estimated a damage cost of USD 11.5 million and a recovery need of the same value.
 - **Agriculture:** Over 126,282 ha of paddy were damaged during the flooding, with higher value crops such as vegetables and aquaculture also suffering significantly. In total crop losses and damages to Ministry assets were valued at USD 69.5 million. The majority of recovery costs are associated with the supply of agriculture and aquaculture inputs (52%), with smaller amounts for farmer machinery, infrastructure and Ministry assets. In total the government estimated a recovery need of USD 61.6 million.
 - **Livestock:** Over 812,000 poultry, 9,400 cattle and 74,000 sheds were affected by the flooding leading to losses of USD 102.7 million. Recovery needs including replacing feed and medicines, and the restocking of animals. In addition, the construction of new sheds and repairing damages to older sheds were required. In total the government estimated a recovery need of USD 26.9 million.
 - **Irrigation:** 961 irrigation schemes and river infrastructures were damaged during the flooding causing a total of USD 168.1 million damage. The recovery costs have been estimated at USD 174.4 million but will require three financial years to complete. Therefore, opportunity costs to future agriculture requiring irrigation will exist, although have not been quantified in the Government report.
 - **Transport:** Roads, bridges, culverts and the airport at Biratnagar were all damaged during the following leading to costs of USD 28.3 million, with 85% associated with the road network. The recovery costs were estimated to be the same as the damages sustained.
 - **Water and sanitation:** Damage to drinking water supplies and sanitation facilities was estimated at USD 8.5 million, with a reconstruction cost of USD 20.9 million (including resilience).

⁵¹ United Nations International Children's Emergency Fund website, accessed 14-08-2019, published 26-08-2017. *Nepal Humanitarian Situation Report No. 6*.
<https://reliefweb.int/sites/reliefweb.int/files/resources/UNICEF%20Nepal%20Humanitarian%20Situation%20Report%20No.%206%20on%20the%20Flood%20Response%20-....pdf>

⁵² Government of Nepal, National Planning Commission, 2017. *Nepal Flood 2017: Post Flood Recovery Needs Assessment*.

- **Electricity:** Damage to power distribution cost USD 2.1 million with a reconstruction cost of USD 2.3 million.

80. A summary of the damage and reconstruction costs is shown in Table 4.

Table 4: A summary of the 2017 Terai flooding damage and reconstruction costs (taken from Government of Nepal, National Planning Commission, 2017)

Item (ranked highest damage cost to lowest)	Economy sector	Estimated damage cost (USD million)	Estimated recovery / reconstruction cost (USD million)
Housing	Social	187.9	375.8
Irrigation	Production	168.1	168.1
Livestock	Production	102.7	26.9
Agriculture/aquaculture	Production	69.5	61.6
Transport	Infrastructure	28.3	28.3
Education	Social	11.5	11.5
Water and sanitation	Infrastructure	8.5	20.9
Health	Social	6.0	6.5
Electricity/power	Infrastructure	2.1	2.3
Sub-totals	Social	205.4	393.8
	Production	340.3	256.6
	Infrastructure	38.9	51.5
Grand total		584.7	701.9*

*This value is different to Government's summary value (which does not sum correctly)

81. As is demonstrated, flooding on the Terai affects a number of varied economic sectors with housing being the highest cost in terms of damage and recovery. The large increase in recovery and reconstruction costs for housing is associated with trying to improve resilience to future events through the construction of better housing, which should be welcomed.
82. Terai flooding is predominately rural and so the impacts on the rural economy are bleak. The 2017 event showed the huge loss in terms of value of crops, aquaculture and livestock. The restocking of livestock (presumably with younger, cheaper animals) is relatively cheap compared to the value lost. But the time taken for animals to mature to their full value mean that flooding continues to have an economic impact a long time after the water recedes. Similarly, in this event over 900 irrigation schemes were lost, but the reconstruction of these will take at least three years meaning a loss in agricultural productivity long after the end of the flood event.
83. Infrastructure losses are relatively low compared to social and agricultural losses. This is in part due to the underdeveloped nature of the Terai and relatively simple road infrastructure that exists. As more road (and rail) infrastructure is planned for the Terai, it is highly recommended that flood resilience is considered to ensure that recovery costs remain relatively low.

2.5. Flood forecasting and early warning systems

84. Flood forecasting and early warning systems (FFEWS) are relatively new in Nepal and specific projects are covered in more detail under the donor work section (Section 5).

85. The Government has produced a good strategy for FFEWS, which provides Standard Operating Procedures for existing and future schemes⁵³. The document aims to “*develop simplified sustainable instructions that define the roles and responsibilities of major stakeholders as well as community members.*” At the time of reporting, the Department for Hydrology and Meteorology were maintaining a network of 28 hydrological stations and 88 meteorological stations, with additional stations yet to receive telemetry.
86. Clear institutional mapping of stakeholders’ roles and responsibilities is given, as reproduced in Table 5.

Table 5: Roles and responsibilities of stakeholders and institutions in flood forecasting and early warning (directly reproduced from SOP produced by GoN, MoEWRI, DHM, 2017)

Component	Task	Responsibility
Monitoring	Manuals, guidelines, trainings and quality management	Flood Forecasting Center, DHM
	Operation, maintenance and upgrading of stations; maintenance of hydrological and meteorological equipment	District DHM offices
	Operation of telecommunication systems and software management	Outsourced with supervision by DHM
	Maintenance and operation of manual observation systems at monitoring sites	Community
	Processing data received from a telemetry/manual observation with necessary validation	Flood Forecasting Center, DHM
	Development of high-resolution spatial data	DHM
Risk Assessment	Hydrological and hydraulic modeling	Flood Forecasting Center, DHM
	Floodplain mapping and risk identification with field verification	Flood Forecasting Center, DHM
	Obtaining additional support from Common Alerting Protocol (CAP) such as Google Public Alerts and Global Flood Detection System (GFDS)	DHM
Forecast dissemination	Disseminate flash flood watches, warnings and severe flood warnings to communities and relevant agencies	DHM, NEOC, DEOC/PEOC
	Feedback through self-assessment and feedback from communities	Flood Forecasting Centre, DHM
Capacity Building	Training	Training Section, DHM
	Awareness Programs: piloting, preparation of awareness materials, seminars, workshops and interactive programs, mock-drill exercises, etc.	All key stakeholders and NGOs
	Aid provision to handicapped members of local communities	Local government agencies and NGOs
	International collaboration and management of information - Decision Support System (DSS), Global Flood Detection System (GFDS), Quantitative Precipitation Forecast (QPF) from Regional Integrated Multi-Hazard Early Warning System-RIMES, National Oceanic and Atmospheric Administration -NOAA, Tropical Rainfall Measuring System (TRMM) etc.	DHM

⁵³ Government of Nepal, Ministry of Energy, Water Resources and Irrigation, Department of Hydrology and Meteorology, 2017. *Standard Operating Procedure (SOP) for Flood Early Warning System in Nepal.*

87. In summary, the following FFEWS exist:

- The Bagmati Basin has a newly established FFEWS covering Kathmandu and downstream to the Indian border. This work was funded by ADB (Section 5.2.2).
- The Koshi Basin has a real-time FFEWS which has been operational since 2017 and can provide warnings up to 72 hours in advance. This work was funded by the World Bank (Section 5.3.1).
- The West Rapti Basin under the same project as the Koshi Basin has a similar FFEWS system (Section 5.3.2).
- Various community-based river flood and GLOF early warning systems, which are in various states of functionality (ICIMOD, 2011).

2.6. Climate change

2.6.1. Historical observations

88. As set out in Section 2.1, Nepal's climate is very much dictated by its topography with large differences in relatively small distances due to mountain ranges and prevailing winds.
89. Most Government of Nepal studies⁵⁴ show that an analysis of historical data demonstrates that maximum annual air temperature is rising between 0.04-0.06°C per year, although minimum air temperature is only rising negligibly. However, these trends are complex with warming larger at higher altitudes compared to the Terai, and in the Himalayas increasing temperature being greater in the winter, with increasing temperatures being the greater in the summer in the Terai.
90. Nationwide, perhaps due to the complexity and variability of the precipitation patterns (see Section 2.1.2) changes in precipitation are harder to discern. The latest Government report⁵⁵ suggests three trends:
1. Increase in winter, pre-monsoon and monsoon rainfall in the far western development region (not statistically significant however);
 2. Decrease in monsoon precipitation in the majority of districts east of 84E longitude (not statistically significant however); and,
 3. Decrease in monsoon precipitation in the Himalayas (not statistically significant however).
91. The scientific literature meanwhile suggests that precipitation extremes are increasing⁵⁶ and that observed precipitation changes are extremely complex and localized across the Hindu-Kush-Himalaya region⁵⁷.

⁵⁴ See: Government of Nepal, Ministry of Environment, 2010. *National Adaptation Programme to Climate Change*; Government of Nepal, Ministry of Population and Environment, Department of Hydrology and Meteorology, 2017. *Observed Climate Trend Analysis of Nepal (1971-2014)*; Government of Nepal, Central Bureau of Statistics, 2017. *National Climate Change Impact Survey 2016: A Statistical Report*.

⁵⁵ Government of Nepal, Ministry of Population and Environment, Department of Hydrology and Meteorology, 2017, as above.

⁵⁶ Karki, R., et. al., 2017. *Rising Precipitation Extremes across Nepal*. *Climate* 2017, 5, 4.

⁵⁷ ICIMOD, 2019. *The Hindu Kush Himalaya Assessment: Mountains, Climate Change, Sustainability and People*.

2.6.2. Future projections

92. The Government of Nepal does not have standard climate change projections that it has adopted for planning or other analysis. Much depends on which emissions scenario is used for future climate modelling analysis.
93. In the 2010 National Adaptation Program of Action (NAPA) it suggests air temperature increases of 1.2 to 1.4°C by 2030, and 3 to 4.7°C by 2090-2100. This would indicate an increased rate of warming to 2030, but a slowing down of warming below current levels by the end of the century. Monsoon rainfall, key to flood risk, is projected to increase by 15 to 20% according to the NAPA.
94. The comprehensive recent analysis by ICIMOD in 2019 looked at a downscaled regional climate model and global climate model for two emissions scenarios: RCP 4.5⁵⁸ and RCP 8.5⁵⁹. Nepal is located within their HKH2 area (Central Himalayas) which still shows geographical variation, but as an average they project⁶⁰:
- Summer monsoon seasons to have increased air temperature of 1.7-2.1°C or 2.3-2.7°C by 2036-2065 under RCP 4.5 or RCP 8.5 respectively. Error margins are up to ±0.9°C.
 - Winter seasons to have increased air temperature of 2.4-2.7°C or 3.3-3.4°C by 2036-2065 under RCP 4.5 or RCP 8.5 respectively. Error margins are up to ±1.3°C.
 - Increases in rainfall during the summer monsoon season of 4.4-6.7% or 9.1-10.7% by 2036-2065 under RCP 4.5 or RCP 8.5 respectively. Error margins are up to ±18%.
 - Decreases in rainfall during the winter season of -0.7 to -7.7% or -1.3 to -8.5% by 2036-2065 under RCP 4.5 or RCP 8.5 respectively. Error margins are up to ±18%.
95. In summary, air temperatures are expected to increase, particularly in winter; and precipitation projections are less certain but there is expected to be an increase during the monsoon and decrease in the winter. Furthermore, as per the Government and scientific literature (see above), extreme precipitation events are expected to increase.

2.6.3. Likely flood risk impacts

Increase in air temperature

96. Increases in air temperature may result in:
1. More glacier melting leading subsequently to GLOF; and,
 2. Increased snowmelt with increased summer floods along the rivers (in the hilly region).

Increase in monsoon rainfall

97. Increases in monsoon rainfall are likely to increase the flood risk to the Terai region in particular.

Decrease in winter rainfall

98. Flooding due to winter rainfall is extremely rare (see Figure 10), and therefore a projected decrease in winter rainfall is not expected to have any flood risk impact.

⁵⁸ Emissions in RCP 4.5 peak around 2040, at around 580ppm CO₂ by 2100

⁵⁹ Emissions in RCP 8.5 peak continue to rise throughout the 21st Century to around 1,230ppm CO₂ by 2100. This can be seen as a worst-case scenario.

⁶⁰ See Table 3.5 and Table 3.8 in ICIMOD, 2019.

Increase in extreme precipitation events

99. Any increase in extreme precipitation events is likely to make flash flooding more frequent; increase soil erosion potentially leading to more landslide induced flooding; and increase the frequency of events where urban flooding occurs due to infrastructure being overwhelmed compared to its design.

3. Institutional setting, existing legal framework and policies

3.1. Broad institutional setting

3.1.1. Constitutional arrangement

100. The Constitution of Nepal 2015 provides a clear expression of the new structure of the three tiers of government, the key elements are presented verbatim below:

Article 56: Structure of the State

(1) The main structure of the Federal Democratic Republic of Nepal shall be of three levels, namely the Federation, the State and the Local level.

(2) The Federation, State and Local levels shall exercise the power of State of Nepal pursuant to this Constitution and law.

(3) There shall be States consisting of the Districts as mentioned in Schedule-4 existing in Nepal at the time of commencement of this Constitution.

(4) There shall be Village Institutions, Municipalities and District Assemblies under the Local level. The number of Wards in a Village Institution and Municipality shall be as provided for in the Federal law.

(5) Any Special, Protected or Autonomous Region can be set by the Federal law for social, cultural protection or economic development

(6) The Federation, State and Local levels shall protect Nepal's freedom, sovereignty, territorial integrity, independence, national interest, overall development, multi-party, competitive, democratic, republican, federal system of governance, human rights and fundamental rights, rule of law, separation of powers and check and balance, egalitarian society based on pluralism and equality, inclusive representation and identity.

Article 57: Distribution of State powers

(1) The powers of the Federation shall be vested in the matters enumerated in Schedule-5, and such powers shall be exercised pursuant to this Constitution and the Federal law.

(2) The powers of a State shall be vested in the matters enumerated in Schedule-6, and such powers shall be exercised pursuant to this Constitution and the State law.

(3) The concurrent powers of the Federation and the State shall be vested in the matters enumerated in Schedule-7, and such powers shall be exercised pursuant to this Constitution, the Federal law and the State law.

(4) The powers of the Local level shall be vested in the matters enumerated in Schedule-8, and such powers shall be exercised pursuant to this Constitution and the law made by the Village Assembly or Municipal Assembly.

(5) The concurrent powers of the Federation, State and Local levels shall be vested in the matters enumerated in Schedule-9, and such powers shall be exercised pursuant to this

Constitution, the Federal law, the State law and the law made by the Village Assembly or Municipal Assembly.

(6) Any law to be made by the State Assembly, Village Assembly or Municipal Assembly pursuant to clause (3) or (5) shall be so made as not to be inconsistent with the Federal law, and any law made by the State Assembly, Village Assembly or Municipal Assembly which is inconsistent with the Federal law shall be invalid to the extent of such inconsistency.

(7) Any law to be made by the Village Assembly or Municipal Assembly pursuant to clause (5) shall be so made as not to be inconsistent with the State law, and any law made by the Village Assembly or Municipal Assembly which is inconsistent with the State law shall be invalid to the extent of such inconsistency.

Article 58: Residual powers

The Federation shall have power on any matter not enumerated in the Federal List, State List, List of Local level or Concurrent List or on any matter which is not so specified in this Constitution as to be exercised by any level.

The entirety of the government is required to exercise their mandate under the principles of cooperation, co-existence and coordination as provided under Article 232 of the Constitution. Hence all legislation created by the three tiers of government must be consistent with the federal law; and any law which is inconsistent will be null and void.

Where there are any disputes between federal and State or Local government, these have to be resolved in the spirit of Article 232 and the principles of cooperation, co-existence and coordination. It follows that there will need to be procedural provisions required by the law to enable and require these principles to be followed.

The Constitution of Nepal provides a significant source of policy related to natural resources management in general and disaster management in particular. For instance, Part 4 provides directive principles, policies and responsibilities of the State and Article 49 of the Constitution provides guiding principles. Article 50 provides directive principles and similarly, Article 51 provides State policies and Article 51 (g) provides Policies relating to protection, promotion and use of natural resources as follows:

Article 51(g)

(1) The State shall pursue a policy of conserving the natural resources available in the country by imbibing the norms of inter-generation judicious use of it and for the national interest. It shall also be about its sustainable use in an environmental friendly way. The policy shall ensure the fair distribution of the benefits generated by it by giving local people the priority and preferential rights.

(2) The State shall pursue a policy of prioritizing national investment in water resources based on people's participation and making a multi-utility development of water resources.

(3) The State shall pursue a policy of developing and producing renewable energy, ensuring cheap, easily available and dependable supply of energy, and making an appropriate use of it to meet the basic needs of the citizens.

(4) Developing a sustainable and dependable irrigation system by controlling water-related natural disasters with the management of the river systems.

(5) The State shall pursue a policy of making a sustainable use of biodiversity through the conservation and management of forests, fauna and flora, and by minimizing the negative

impacts of industrialization and physical development by promoting public awareness on environmental cleanliness and protection.

(6) The State shall pursue a policy of keeping necessary landmass as forest area in order to strike an environmental balance.

(7) The State shall pursue a policy of adopting appropriate ways of minimizing or stopping negative effects on environment if it is there, or if there is a possibility of such an impact on nature, environment, or biodiversity.

(8) The State shall formulate policies and enact laws on the basis of the principle of sustainable environment development based on pre-warning and pre-informed agreements regarding environmental protection.

(9) The State shall formulate and pursue a policy of designing a pre-warning system, disaster preparedness, rescue, relief works and rehabilitation in order to minimize the risks of natural disasters.”

101. This component of the Constitution therefore brings the management of natural resources into the modern era by bringing to the fore principles of sustainable development, environmental protection, the protection of biodiversity, flora and fauna and inter-generational equity. Similarly, much focus has been given to the development of clean energy, irrigation and disaster reduction. But how this policy is being implemented on the ground has yet to be researched and studied.
102. In view of the above policy guidance, it is important that the three tiers of governments frame consistent policy and laws as they develop and exploit the country's natural resources including water.

3.1.2. Local Government Operation Act, 2017

103. The Local Government Operation Act (2017) provides mandates and functions to local municipal governments to manage disasters, including preparedness, search and rescue, relief and rehabilitation.
104. Prior to 2017, local bodies like Village Development Committee, Municipalities and District Development Committees have been carrying out various activities for disaster risk reduction and management in accordance with the Local Self Governance Act (1999).
105. Under the provisions, local government are empowered under the heading of additional functions, duties and powers to formulate land use plan and policies, action plan and implementation as per federal and provincial level laws and regulations.
106. In relation with environmental conservation and ecological diversity issues, under the Sub-section 2 (j), Section 11: functions, duties and roles of local government, the local governments have been empowered to work on the following:
 - (12) prepare environmental conservation, ecological diversity related policies, law, standard, plan formulation, implementation, monitoring and regulation;
 - (13 & 14) reducing local level environmental hazard and pollution;
 - (15) solid waste management;
 - (17) conservation and protection of green areas; and,
 - (19) local level environmental protection by determining of environmental protection areas.
107. Under the Subsection (4), forest, wildlife, water uses, environment and ecological diversity related activities have been mandated to local governments subject to central and provincial laws and regulation.

3.1.3. Legal framework

108. According to the Constitution of Nepal (2015), it is the responsibility of the state to prepare the necessary policy for making advance warning, preparedness, rescue, relief and rehabilitation in order to mitigate risks from natural disasters. Natural Disaster (Calamity) Relief Act promulgated in 1982 is the first legal instrument in Nepal directed towards the Disaster Risk Management. This act has envisioned the Ministry of Home Affairs as the focal ministry for Disaster Risk Management. The main focus of the act is on the relief and rescue work during and after a disaster. The Water Resources Act (1992) focuses on disaster risk reduction through environmental protection. Local Self Governance Act (1999) has given authority to the local bodies to take appropriate measures for the DRM. Both the Water Resources Act and Local Self Governance Act do not spell out anything in detail on how the disaster risk management is carried out. Disaster Risk Reduction and Management Act (2017), which focuses on total spectrum of disaster management, was passed by the parliament in September 2017. The Natural Disaster Relief Act has been replaced by this act.
109. The structures, clear roles and responsibilities of all levels are given in details in the Disaster Risk Reduction and Management Act (2017). The higher-level mechanisms will mainly deal with formulating policy and programs of DRM, while the local levels will deal with the implementation aspects. For example, installing warning system is the responsibility of the local level. In the new Act, there is a provision of Disaster Management Fund at the federal, the provincial, the district and the local levels. The Act has given the security forces the responsibility of search and rescue under civilian command. According to the new Act, the Government of Nepal has the ultimate responsibility of declaring disaster emergency if circumstance emerges so. The Act has proposed National Disaster Risk Reduction and Management National Council, Executive committee and Specialist Committee. The Act has proposed National Disaster Risk Reduction and Management Authority at the Ministry of Home Affairs as the implementing arm of the government Disaster Risk Reduction and Management Act (2017) has given the power about disaster related policy making to the National Council making the province and district/local bodies as implementing agencies, which can be thought as major shortcoming of this Act.

3.1.4. National level Ministries and Departments involved in water resources and flood risk management

110. The main government organizations involved in Disaster Risk Management in general and flood disaster management in particular are:
- Ministry of Home Affairs: Mainly providing a coordination function during emergencies including mobilization of security agencies, NGOs, local administration. They also supervise the functioning of the National Emergency Operation Center and District Emergency Operations Centers;
 - Ministry of Federal Affairs and General Administration: Coordination with provincial and local municipal governments.
 - Ministry of Energy, Water Resources and Irrigation (MOEWRI): Department of Hydrology and Meteorology: Provide flood forecasting and early warning, including text messages to flood affected population and to relevant agencies;
 - MOEWRI: Department of Water Resources and Irrigation (DWRI) – Note: The Department for Water Induced Disaster Management has been merged with DWRI from 2018: implement structural flood control systems, mainly river training works and embankments;
 - Ministry of Urban Development (MOUD): Department of Urban Development & Building Construction: Controls urban planning and drainage. Also noteworthy is that the country's first River Basin Organization sits within MOUD.
 - Water and Energy Commission Secretariat: Setting Water Resources Policy;

- Security agencies to assist during response;
 - National Planning Commission for advising on recovery; and,
 - Ministry of Finance, Line Ministries and National Reconstruction Agency for implementing on recovery.
111. In general, while during emergency response periods there is a clarity of purpose that facilitates good coordination, it is during periods of normal operation that IFRM coordination processes are less well-defined in Nepal.
112. Nepal has endorsed the Hyogo Framework for Action on 2005-2015: Building the resilience of nations and communities to disaster. The National Strategy for Disaster Risk Management in Nepal (NSDRM) was prepared in 2009 to fulfil the commitments made by Nepal in international conventions. The national early warning strategic action plan (2013) has been developed by the Government of Nepal as a complementary document to the NSDRM. The need for an early warning system was mentioned in National Water Resources Strategy (2002) and the National Water Plan (2005) documents as well.
113. The Priority Action 1 of NSDRM focuses on legal, institutional and policy aspects. Almost all districts have now developed District Disaster Risk Management Plans (2010). Similarly, Local Disaster Risk Management Planning Guidelines (2011) were also formulated. Emergency operation centers were also established both at national and district levels. The Priority Action 2 focuses on hazard mapping and monitoring, and development of early warning systems (EWS).
114. Community based early warning systems have been set up in Banke, Kailali and Kanchanpur. The Department of Hydrology and Meteorology (DHM) has been upgrading hydrometric stations and already begun project on flood forecasting and early warning system. These DHM activities are in line with the recommendations of National Action Plan on Disaster Management (NDMP), National Water Plan (NWP) and the Water Resources Strategy (WRS) as well. The Priority Action 5 focuses on the preparedness for response. Disaster Preparedness and Response Plan (2011), National Disaster Response Framework (2013) were formulated to functionalize this priority. As prescribed in NSDRM, the Government of Nepal has given attention to disaster management strategies in different sectors.
115. An innovative form of international cooperation has been developed to prioritize and implement key elements of the NSDRM. This is the Nepal Risk Reduction Consortium (ADB, IFRC, UNDP, UNDRR, OCHA, World Bank) and its Flagship Programs developed in consultation with the Government and other stakeholders.
116. The new Disaster Management Act (2017) is also a recommended outcome of NSDRM and other related documents.
117. The Natural Calamity Relief Committees headed by the Chief District Officers are carrying out search, rescue and relief.

3.1.5. Provincial and municipality level governments

118. The provincial, district and local level governments involved in flood disaster management are:
- Provincial Ministries of Physical Infrastructure;
 - Provincial Ministries of Internal Affairs;
 - Local Municipalities;
 - District Emergency Operations Centers; and,
 - District Administrative Offices and District Coordination Committees.

119. Ministry of Federal Affairs and Local Development have prepared Local Disaster Risk Management Planning Guidelines (LDRMP) to make Disaster Risk Management a part of the development process at a local level. These guidelines are based on the mandates of Government of Nepal's periodic plans i.e. 2008-2010 and 2011-2013.
120. Local bodies like Village Development Committees, Municipalities and District Development Committees have been carrying out various activities for disaster risk reduction and management in accordance with the Local Self Governance Act, 1999.
121. In order to give clarity on the roles and responsibilities of all government and non-government stakeholders to respond to disaster, the National Position Paper on Disaster Risk Reduction and Management was prepared in 2019⁶¹.
122. There is increased awareness of Disaster Risk Management issues among different stakeholders and their engagements in policy formulation have made implementation of disaster risk reduction activities more systematic and easier at local levels. Capacity building at national training institutes (Nepal Administrative Staff College, Local Development Training Academy, Nepal Academy of Science and technology) has increased. Disaster Risk Reduction stakeholders share common understanding that risk reduction is an integral part of the development process of multiple stakeholders, including gender aspect

3.1.6. The first River Basin Organization, HPCIDBC

123. The Government of Nepal established a High Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC) which will implement the functions of a River Basin Organization in the Upper Bagmati (from the source of Bagmati to Katuwaldaha), in its Formation Order⁶² of 19th January 2017. The Upper Bagmati River Basin Organization became functional on 30th March 2017.
124. The Government of Nepal through WECS is also considering establishing three river basin offices covering (1) Koshi and adjacent basin in the East; (2) Gandaki and adjoining basin in the center; and, (3) Karnali and other rivers in the West. These basin offices will function within the Water and Energy Commission. It is still is uncertain when these basin offices will be established and what will be the legal mandates of these offices as regards to working as river basin organizations. The Draft Water Act (2019), which is expected to spell out the mandates, is still being finalized at the Ministry of Energy, Water Resources and Irrigation.
125. The following functions, are specific tasks for the Upper Bagmati River Basin Organization (RBO):
 - Prepare an Integrated River Basin Management Plan (IRBMP) for participatory IWRM in Bagmati and its tributaries.
 - Prepare alternate plans within the IRBMP to address the effect of climate change on water availability
 - Recommendations for water license for water use.
 - Monitor and evaluate water allocation and water quality as per issued licenses.
 - Prepare and update river flow and groundwater statistics periodically.
 - Recommendations for technical clearance to implement water projects.
 - Prepare periodic water plan for working areas of the HPCIDBC.

⁶¹ Government of Nepal, 2019. *National Position Paper On Disaster Risk Reduction and Management*.

⁶² Government of Nepal, 2017. *Formation Order of High Powered Committee for Integrated Development of Bagmati Civilization*, approved January 19, 2017

- Prepare plan for conjunctive use of ground and surface water.
 - Maintain the quality and quantity of water for environmental use.
 - Manage water for religious and cultural use.
 - Prepare plan, implement and manage community participation.
 - Organize educational and other training on IWRM for capacity building of the stakeholders.
 - Establish coordination among various sectors, resolve and recommend conflict resolution on river water use.
126. It is noted that certain functions that should probably be carried out by an RBO are not mentioned in the January 2017 Executive Order. Some of these are already part of the original Executive Order of the HPCIDBC and carried out by existing staff, others might have to be added in the future or could be carried out by other departments in close coordination with the HPCIDBC and its secretariat. Missing tasks include i) management of the river course, embankment and adjoining lands; ii) watershed/upper catchment management and iii) environmental protection.
127. However, the RBO has been met with some resistance. The Water and Energy Commission Secretariat are of the opinion that the RBO cannot undertake the above tasks given the 2015 Constitution which empowers Municipalities to undertake some of these roles. Proposed solutions by ADB and others have yet to have much success, and as such, the fledgling RBO is yet to be fully established or empowered.

3.2. Summary of stakeholders

128. Table 6 summarizes Government stakeholders involved in flood risk management in Nepal and highlights the “crowded” institutional space and overlapping horizontal (i.e. Ministries) and vertical (National to Local) responsibilities. This is represented visually in Figure 12.

Table 6: Summary of Government stakeholders involved in flood risk management in Nepal

Level	Agency	Activities
National	Ministry of Home Affairs, National Emergency Operation Center (MoHA)	Overall governance of disaster management, coordination during emergencies.
National	Ministry of Federal Affairs and General Administration	Coordination with provincial and local municipal governments.
National	Ministry of Energy, Water Resources and Irrigation (MOEWRI): Department of Hydrology and Meteorology (DHM)	Installation, operation & maintenance of Hydro-met observation network, flood hazard mapping, data management, flood forecast modelling, dissemination of early warnings
National	MOEWRI: Department of Water Resources and Irrigation (DWRI)	Flood hazard mapping, construction and maintenance of river training works, embankments, flood sluices etc. Peoples Embankment Program.
National	Ministry of Urban Development (MOUD), Department of Urban Development & Building Construction	Urban planning, preparing and updating building code, urban drainage planning and design, flood risk sensitive urban plan, land use control. Also noteworthy is that the country's first River Basin Organization sits within MOUD.
National	Water and Energy Commission Secretariat (WECS)	Sets Water Resources Policy.

Level	Agency	Activities
National	National Planning Commission (NPC)	Advises on recovery for major events.
National	Ministry of Finance (MOF), Line Ministries and National Reconstruction Agency (NRA)	Implements recovery
Provincial	Provincial Ministries of Physical Infrastructure (PMPI) and Provincial Ministries of Internal Affairs (PMIA)	Assist with response and recovery
District / Municipality	District Administrative Offices (DAO) in all 77 districts under MOHA; District Emergency Operation Centers (DEOC)	Overall governance of disaster management in the District, coordination with provincial offices, NGOS and local municipalities during emergencies.
District / Municipality	Local Municipality Governments	Approval of building designs and plans, maintenance of urban drains; response and recovery implementation as required
Multi-level	Security Agencies	Assist during response
Non-government	International Committee of the Red Cross and NGOs	Implementation of community based early warning systems in selected river systems, awareness creation on flood preparedness and risk resilience, relief & rescue operations during emergencies.

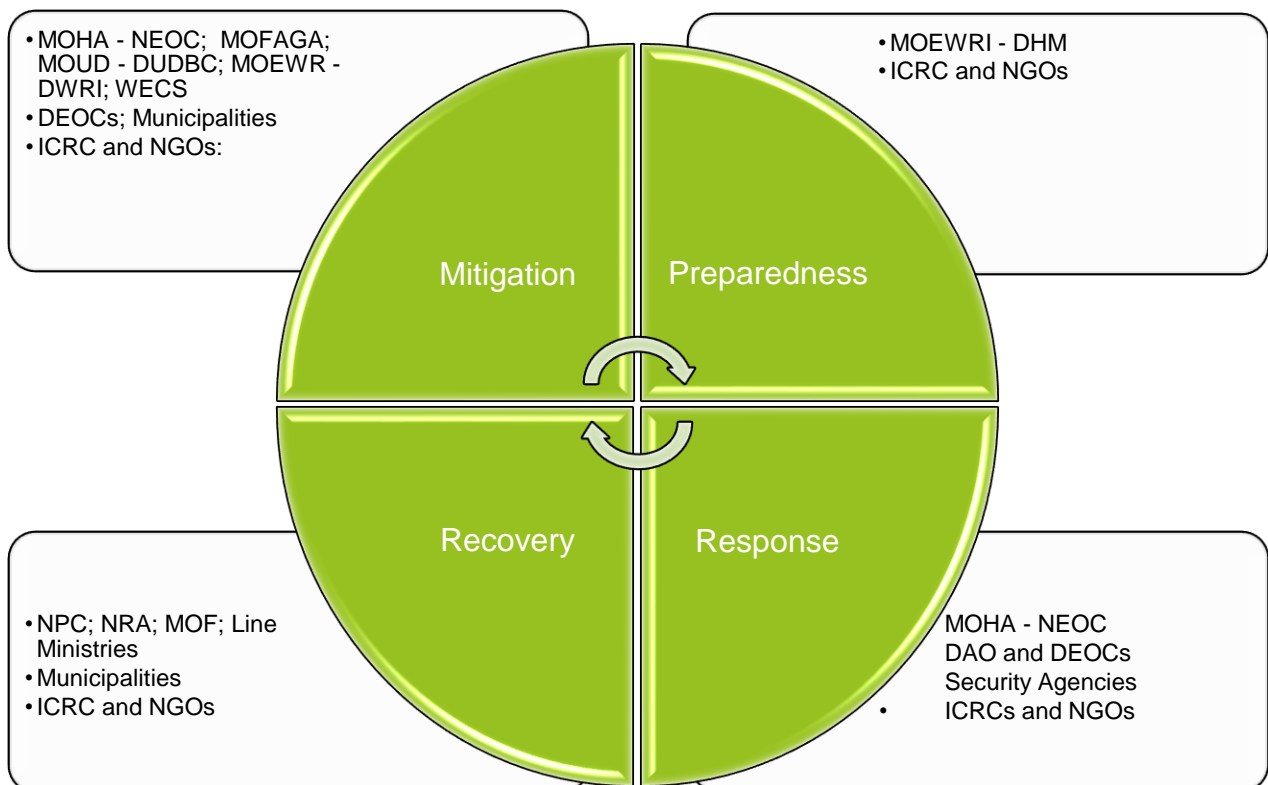


Figure 12: Summary of Government stakeholders with reference to the cycle of disaster management

3.3. Existing and proposed policies

3.3.1. National Water Plan, 2005

129. The Water and Energy Commission Secretariat started formulating the National Water Plan (NWP) in 2002, which was approved by the Government of Nepal in 2005. The NWP was prepared to operationalize the National Water Resources Strategy. NWP identified seven programs which are related to Water Induced Disaster. However, programs I, II and III are the major relevant programs in relation to this study. They are:

(I) Water-related Disaster Management Policy and Program

130. The key elements of this program are:

1. Formulation of a Water Induced Disaster mitigation policy with reference to upstream, downstream linkages;
2. Preparation of Water Induced Disaster -related Acts, Regulations and management guidelines; and,
3. Enhancing the capacity of all Water Induced Disaster -related institutions such as the Ministry of Home Affairs, Ministry of Population and Environment, Department of Water Induced Disaster Management, Department of Hydrology and Meteorology, Department of Soil Conservation and Watershed Management.

(II) Risk/Vulnerability Mapping and Zoning Program:

131. The key program elements are:

1. Preparation of water-induced hazard maps;
2. Identification of critical areas by ground inspection on priority basis; and,
3. Zoning of high-risk areas.

(III) Disaster Networking and Information System Improvement Program:

132. The key elements are:

1. Establishment and activation of disaster forecasting and early warning systems, covering floods, extreme precipitation and drought;
2. Strengthening of Communities Based Organizations, Non-Governmental Organizations (NGOs), International NGOs, local authorities, professional societies for disaster management networking; and,
3. Promotion of regional and international cooperation in WID management including:
 - a. Establishment and enhancement in cooperation with neighboring countries in data exchange and information system;
 - b. Encouragement of joint investigation into the Glacial Lake Outburst Flood risks with China; and,
 - c. Promotion of international cooperation for flood forecasting and warning system.

133. The plan was very much optimistic. If NWP could have been implemented, including programs I(c), III (a) and III (a, b) as it was designed for, Nepal would have flood forecasting and warning system across the country at this point of time. However, less has been achieved in these 10-12 years after its formulation.

3.3.2. National Adaptation Program of Action (NAPA) to Climate Change, 2010

134. The Government of Nepal has prepared the National Adaptation Program of Action (NAPA) with an aim to help Nepal understand and predict the likely impacts of climate change and improve its capacity to mitigate the negative effects by appropriate adaptation measures. Nine combined project profiles were specified in the NAPA. Among nine profiles, the third and fourth project profiles are related to Disaster Risk Reduction. The third project profile proposes activity to reduce the disaster risk at community level considering climate change. The fourth project profile is directly concerned with the activities of the DHM. The NAPA calls for establishing Early Warning Systems and flood management in order to prepare for climate change, but it does not have a multi-hazard focus.

3.3.3. Water Induced Disaster Management Policy, 2016

135. This policy emphasizes that water-induced disaster management programs should be aligned with IWRM principles and integrated river basin development concept. To align with the integrated river basin development and conservation, a master plan for water induced disaster management should be formulated at a national level while giving due recognition to the needs of local level and with full involvement of local governments. The programs have to be prioritized according to short term, medium term and long term perspectives and implemented with active community participation.

3.3.4. People's Embankment Program

136. The Department of Water Resources and Irrigation (DWRI) is implementing riverbank protection projects along most of the rivers in the Terai with seven field offices in 22 districts. The people's embankment program was established by the Department of Water Induced Disaster Management, which is now merged with DWRI.

3.3.5. Draft Water Policy (2018)

137. The National Water Resources Policy (Draft Version), 2018 has set one of its goals as to mitigate the damaging impact of flood, landslides and drought. To address the flood risk, it has emphasized flood forecasting and early warning system as one of the key strategies. The policy has clearly stated the need for regular drilling and training of the local community in these aspects to enhance their capability to deal with flooding at the local level. It also aims to improve women's involvement in order to have gender equality in water resources management issues at all levels. Further, it also stressed the role and responsibility of each institution involved in flood risk mitigation is clear.

3.4. Existing guidelines

138. In Nepal, integrated flood risk management is guided by a large number of strategies, policies, guidelines, action plans and frameworks, such as:
- National Action Plan on Disaster Management in Nepal (1996);
 - National Strategy for Disaster Risk Management (2009);
 - District Disaster Management Plan (2010);
 - Local Disaster Risk Management Planning Guidelines (2011);
 - Disaster Preparedness and Response Plans (2011);
 - Nepal Risk Reduction Consortium (2011);
 - National Disaster Response Framework (2013);
 - National Early Warning Strategy (2013);

- Periodic Plans (2012-2020); and,
 - National Disaster Risk Reduction Policy and Action Plan (2018-2030).
139. The National Action Plan on Disaster Management formulated in 1996 has specified the action plans for the following aspects of disaster management:
- Disaster preparedness;
 - Disaster response;
 - Disaster reconstruction and rehabilitation; and,
 - Disaster mitigation.
140. For each activity, the executing agencies and time of completion are also specified. In the disaster preparedness action plan, DHM's role has been specified as executing agency for the flood hazard mapping, flood forecasting and warning, and rainfall intensity mapping.
141. Based on the Hyogo Framework for Action 2005-2015 (HFA), National Strategy for Disaster Risk Management (NSDRM) was prepared by Ministry of Home Affairs in 2009. HFA is followed by the Sendai Framework for Disaster Risk Reduction 2015-2030. The NSDRM has formulated cross-sectoral and sectoral strategies for Disaster Risk Management. The priority action 2 has given focus on the establishment of hazard/risk monitoring and early warning system. The NSDRM has also proposed a new institutional structure for Disaster Risk Management. Local Disaster Management Committee LDMC is formed under the chairmanship of Municipality/Village Development Committee Head. The functions, duties and powers of LDMC have been defined by NSDRM, 2009.
142. Local Disaster Risk Management Planning Guidelines focus on the engagement of local people in the planning process for Disaster Risk Reduction. The guideline recommends going through five steps to ensure inclusive, participatory and realistic planning:
1. Coordination and Initial Preparations;
 2. Vulnerability and Capacity Assessment;
 3. Preparation of Local Disaster Risk Management Plan;
 4. Approval and Implementation of Plan; and finally,
 5. Monitoring, Evaluation and Review.
143. Since 2011, Disaster Preparedness and Response Plans DPRPs have been formulated in all 75 districts to boost Disaster Risk Management efforts and enhance emergency response and relief for local-level resilience. These plans are milestone in the Disaster Risk Management initiative. They are now listed in the Ministry of Home Affairs website to disseminate the idea to all stakeholders and to elicit feedback.
144. Recognizing the need for the immediate implementation of the NSDRM, the Nepal Risk Reduction Consortium was formed in 2011 by the Government of Nepal to develop a long-term action plan for Disaster Risk Reduction. The Nepal Risk Reduction Consortium acts as the coordinating wing of the NSDRM on behalf of the Government and it has developed five flagships. Flagship 3 focuses on the flood management in Koshi basin through detailed assessments, forecasting and mitigation activities.
145. The National Disaster Response Framework was approved by the Ministry of Home Affairs in 2013 to provide a clear, concise, and comprehensive framework for the country to deliver a more effective and coordinated national response in the event of a large-scale disaster. The National Disaster Response Framework succinctly explains the disaster response in the National System, the International Assistance process, the coordination structure for National and International Assistance, Special Operation arrangements and the National Framework.

146. Nepal's Early Warning System Strategy, which was drafted in 2010 and is still under review by GoN, will be instrumental in developing a framework for the installation, operation and maintenance of EWSs designed to avert disasters potentially associated with major hazards. The EWS Strategy envisions establishing a national-level EWS network under the leadership of the Department of Hydrology and Meteorology.
147. The Government has since produced a good strategy in 2017 for Flood Forecasting and Early Warning Systems, which provides Standard Operating Procedures for existing and future schemes⁶³. The document aims to “*develop simplified sustainable instructions that define the roles and responsibilities of major stakeholders as well as community members.*” At the time of reporting, the Department for Hydrology and Meteorology were maintaining a network of 28 hydrological stations and 88 meteorological stations, with additional stations yet to receive telemetry. Clear institutional mapping of stakeholders' roles and responsibilities is given, as reproduced in Table 5.
148. The National Water Resources Policy (Draft Version), 2017 has emphasized in flood forecasting and early warning system as one of the key strategies. Twelfth, Thirteen and Fourteen Three Year Plans (2012-2020) of Government of Nepal have given priorities for disaster management including flood disaster.
149. Government of Nepal, led by MOHA, has initiated the task of formulating 'National Disaster Risk Reduction Policy and Strategic Plan of Action: 2018-2030' in line with Sendai Framework. The draft of the policy and action plan documents uploaded in Jun 2018 is available in the website (<http://drrportal.gov.np>).

3.5. Community-based disaster risk management (CBDRM)

150. A Community Based Disaster Risk Management (CBDRM) Platform, led by the Ministry of Federal Affairs and General Administration and the International Federation of Red Cross and Red Crescent Societies has an important influence in establishing a common framework, targets and tools for implementing CBDRM across the country. The CBDRM Platform defines nine minimum characteristics of resilient communities, which are required for all CBDRM projects⁶⁴.
151. These were reviewed recently⁶⁵, and they were found to provide a useful framework for planning CBDRM activities in the Terai and should be used in the rest of the country. The nine minimum characteristics of resilient communities are:
1. Organizational base at Village Development Committee (VCD)/ward and community level;
 2. Access to Disaster Risk Reduction information;
 3. Multi-hazard risk and capacity assessments;
 4. Community preparedness/response teams;
 5. Disaster Risk Reduction/Management plan at Village Development Committee/municipality level;
 6. Disaster Risk Reduction Funds;
 7. Access to community-managed resources;

⁶³ Government of Nepal, Ministry of Energy, Water Resources and Irrigation, Department of Hydrology and Meteorology, 2017. *Standard Operating Procedure (SOP) for Flood Early Warning System in Nepal*.

⁶⁴ Mott MacDonald, 2019. *WRPPF: Preparation of Priority River Basins Flood Risk Management Project, Nepal: Community Based Disaster Risk Management*.

⁶⁵ Nepal Risk Reduction Consortium, Durham University, 2017. *Final Report: Review of the Nine Minimum Characteristics of a Disaster Resilient Community in Nepal*.

8. Local level risk/vulnerability reduction measures; and,
 9. Community based early warned systems.
152. From these, establishment of early warning systems, small mitigation measures such as safe houses and hand pumps, Disaster Management Committees and annual drills before the monsoon were found to be especially effective. However, challenges still remain around communication style and infrastructure and the impact of seasonal labor changes.

3.6. Financing of flood risk management

153. IFRM measures in Nepal are funded by the Central Government with financial supports from ADB and World Bank. Funds required for planned interventions are allocated in annual budgets. Such budgets are allocated based on needs identified by the concerned departments and on demand from local levels.
154. No other financing mechanisms – private sector or insurance – are available in Nepal. Compensation of flooded homes are only dealt on a case by case basis.
155. Recent experiences suggest that NGOs play an active role in the reconstruction and rehabilitation post flooding in addition to the Government.

4. Other key considerations

4.1. Land use planning and urban development

4.1.1. Overview

156. Effective land use planning is a critical component of IFRM⁶⁶. Land use planning is currently poorly practiced in Nepal.
157. Deficiencies in land use practice include: a) the absence of clear institutional framework for land use planning, b) non-existent or out dated plans, c) inadequate use of potential planning instruments, d) little or no enforcement, e) a lack of capacity especially at the local level to manage the planning system, f) responsibilities and mandates in flood risk, land use, and land use planning that are distributed amongst a range of agencies but without adequate coordination, and g) a lack of spatial integration in planning and controlling land use between urban and rural areas and between neighboring areas.
158. The lack of effective land use and settlement regulations has contributed to increased vulnerability to floods.

4.1.2. Policy, legal and institutional framework

159. To date development and land use in most parts of Nepal have been largely unregulated. The institutional framework is developing. The apex policy instrument for land is the National Land Policy (2019) enacted in the Land Use Act (2019). The National Land Policy absorbs objectives and provisions from the Land Use Policy (2015). Provisions in the policy include:
 - Classifying all land into eleven zones.
 - Establishing a hierarchical land use plan system comprising plans at the federal, provincial and municipal levels, whereby lower level plans conform to higher levels plans.
 - Designating vulnerable areas as risk zones, with risk mitigation measures applied, and 'at risk settlements' relocated to safe areas.
 - Relaxing land acquisition constraints to promote development projects.
 - Setting a ceiling for land ownership for different land uses and zoning types.
 - Updating records of land falling in riverbeds for conservation purposes.
 - Declaring No Go Zones adjacent to some water bodies (special rivers, lakes wetlands).
160. The Land Use Policy (2015)⁶⁷ supports the optimum use, protection and management of available land and land resources in pursuit of sustainable social, economic and ecological developments. Increasing flood risk is acknowledged as significant.

⁶⁶ Associated Programme on Flood Management (2016) *The Role of Land-Use Planning in Flood Management*, Integrated Flood Management Tools series No.7, World Meteorological Organisation. World Bank (2017) 'Land Use Planning and Urban Flood Risk Management', Urban Floods Community of Practice (UFCOP), Knowledge Notes, April 2017. Geneva; A., Jha, R., Bloch, and J. Lamond (2012) *Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century*. Washington, DC: World Bank.

⁶⁷ Ministry of Land Reform and Management (MoLRM)

161. Critical challenges identified in the policy include: a) encroachment of arable lands and forests resulting from population pressure and unmanaged urban growth, b) ineffective conservation in the Himalayan regions, high hills and Churia Zones that negatively impact on lower riparian areas, and c) the conservation, development and management of natural drainage areas (such as green belts and wetlands) to mitigate the impacts of climate change. Flood risk is highlighted as potentially impacting all land classification zones and the policy commits to the identification of 'vulnerable zones' and 'hazard maps' that must be shown in land use plans.
162. The policy commits to:
- Development of basic guidelines and standards relating to urban plans and building construction.
 - Afforestation and protection of forests, including a special plan for the Churia Bhabhar Hill Areas, and the conservation of watersheds, wetlands areas, and other parks and reserves.
 - The prohibition of activities affecting the natural flow of rivers and a presumption against encroachment into natural drainage areas.
163. The National Policy for Disaster Risk Reduction (2018) reiterates commitment to the development and management of safer settlement promoted through multi-hazard risk assessment and risk sensitive land use planning at the local level (including the adoption of a policy for the relocation of unsafe settlements)⁶⁸. The National Building Code (1993) establishes the building permit system, the certification of construction practices and implementation of land use planning measures⁶⁹.
164. The Lands Act 2021 (1964) makes provision relating to land use and the control of fragmentation and plotting. These are detailed in the Land Rules 2021 (2064) which establish procedures for determining and controlling the use of land, and the fragmentation of plots (including minimum unit size)⁷⁰. The control of land fragmentation is related to the enhancement of productivity, and its application to risk-based planning is not acknowledged. There is a provision to declare areas or settlements as insecure or unplanned and prevent further settlement. Public land acquisition is potentially a significant power in promoting flood resilient planning, and is covered in a number of acts⁷¹.
165. The National Urban Development Strategy (2017) is intended to provide strategic direction to urban development and the role to be played by the Ministry of Urban Development. It commits to urban safety and resilience including: a) the promotion of multi-hazard approach including the preparation of risk sensitive resource mapping identifying high risk areas in all urban areas and developing rapid hazard appraisal techniques, b) allowing settlement development in safer locations only and excluding risk prone and environmentally sensitive areas, and c) strengthening building codes, regulations, guidelines and planning by-laws⁷².
166. The land use and planning mandate is principally shared between the Ministry of Land Reform and Management and Ministry of Urban Development (2017).

⁶⁸ Government of Nepal (2018) *National Policy for Disaster Risk Reduction*, Ministry of Home Affairs.

⁶⁹ The Department of Urban Development and Building Construction (DUDBC).

⁷⁰ Land Rules 2021 (2064), Fourteenth Amendment 2060 (2003).

⁷¹ Town Development Committee Act 1963, Town Planning Project Implementation Act 1973, Land Acquisition Act 1977, The Lands Act 2021 (1964) and Land Rules 2021 (2064).

⁷² Urban Development and Physical Planning Division (2017) *National Urban Development Strategy*. Part A Main Document, Ministry of Urban Development, Government of Nepal.

4.1.3. Trends and challenges

Changing patterns of land use

167. Land patterns are changing rapidly in Nepal⁷³. There is a shift in the type and use of land that results in increasing flood risk. Upstream changes in land use can drastically change the characteristics of a flood, especially conversion of forested areas and wetlands into other landforms. In recent years, the frequency and intensity of flash floods have increased in the southern flat land due to uncontrolled deforestation and mining of sand and gravels in the Chure hills.
168. Between 2001/02 and 2011/12 non-agricultural land increased from 156,400 hectares to 161,900 hectares, whilst decreases were recorded in agricultural land (decreasing from 2.5 to 2.36 million hectares) and arable land (decreasing from 2.36 to 2.16 million hectares). Woodland and forest have increased from 37,200 to 54,890 hectares, but this hides significant changes in the Terai region with some areas increasing and others decreasing⁷⁴. In Kathmandu Valley the urban area increased from 3% in 1967 to 13% in 2000, whilst shrub and forest cover decreased from 43% to 25% over the same period⁷⁵. More recent analysis of the central Kathmandu Valley area for the period 1989-2016 indicates there has been considerable 412% expansion of built up areas, with a 31% loss of agricultural land⁷⁶. Similar trends are recorded elsewhere in Nepal⁷⁷.
169. Land degradation due to land clearance, quarrying, urban sprawl and commercial development, overgrazing and poor farming practices results in soil erosion in almost all parts of Nepal. This in turn manifests in high sediment yields in river basins. Approximately 2.24% of land in the ecological belt was rendered uncultivable due to flooding and soil erosion⁷⁸.
170. Internal migration has also resulted in marked effects on land use⁷⁹. There has been unabated out-migration from hill areas to the Terai. Push factors are a major determinant and include poverty, poor or absent basic amenities and lack of economic opportunities. Pull factors include proximity to basic services, roads and income opportunities.⁸⁰ These migrants are most likely to relocate to vulnerable urban floodplains in the Terai. This outflow has resulted in the abandonment of land especially at higher elevations. Where this has led to the conversion of cropland to grazing, there is reported land degradation. In other cases, however, abandonment is reducing land deterioration as natural ecosystems recover⁸¹.

⁷³ Muzzini, E. and Aparicio, G. (2013) *Urban Growth and Spatial Transition in Nepal: An Initial Assessment*, World Bank.

⁷⁴ National Planning Commission Secretariat (2016).

⁷⁵ Shrestha, B. (2011)

⁷⁶ Ishtiaque, A., Shrestha, M., and Chhetri, N., 2017. *Rapid Urban Growth in the Kathmandu Valley, Nepal: Monitoring Land Use Land Cover Dynamics of a Himalayan City with Landsat Imageries*. *Environments*. 4, 72.

⁷⁷ Rijal, S., Rimal, B. and Sloan, S., 2018, *Flood hazard mapping of a rapidly urbanizing city in the foothills (Birendranagar, Surkhet) of Nepal*. *Land*. 7, 60.

Upreti, B., Brey, T. and Ghale, Y., 2017, *New Challenges in Land Use in Nepal: Reflections on the Booming Real-estate Sector in Chitwan and Kathmandu Valley*. *Scottish Geographical Journal*

⁷⁸ National Planning Commission Secretariat (2016). Ecological belt includes mountain, hill and Terai.

⁷⁹ Jaquet, S., Kohler, T. and Schwilch, G., 2019, Labour migration in the middle hills of Nepal: consequences on land management strategies. *Sustainability*. 11,1349.

⁸⁰ Bhawana, K., Wang, T. and Gentle, P., 2017, *Internal migration and land use and land cover changes in the middle mountains of Nepal*. *Mountain Research and Development*. 37, 4: 446-55

⁸¹ Schwilch, G., Adhikari, A., Cuba, E., Jaboyedoff, M., Jaquet, S., Kaenzig, R., Liniger, H., Machaca, A., Penna, I, Sudmeier-Rieux, K. and Upreti B., 2014, *Impacts of out-migration on land management in mountain areas of Nepal and Bolivia*, Working Paper.

Rapid urbanization

171. Urbanization already presents a considerable challenge in the development of resilient cities and towns in Nepal. By 2050 it is estimated that approximately 13.5 million people, 37% of Nepal's population, will live in urban areas (up from 13% in 2000)⁸².
172. The highest concentration of urban population (around 50%) is in the Kathmandu Valley, dominated by a few large and medium sized cities. In 2018 it was reported that approximately half of Nepal's urban population lives in slums⁸³. Internal migrants resettling in available lands, often in floodplains, are most often at greatest risk from flood hazards. Substantial growth in the Kathmandu Valley occurred 1999-2009 with the in-flux of migrants from rural areas displaced by during the insurgency period and stagnant growth in the agricultural sector. The net inflow of migrants is estimated to account for 36% of the Kathmandu Valley population⁸⁴.
173. The rate of urbanization will inevitably result in both the densification of existing urban areas and the expansion of urban areas into formerly un-built areas as a result of booming real estate market and uncontrolled sub-division of land^{85,86}. Both trends result in the extension of impervious surfaces, and in combination with climate change will result in a higher risk from pluvial and fluvial flooding⁸⁷.
174. The rate of urbanization and pattern of urban development is resulting in under-designed, overburdened and poorly maintained urban drainage systems that are easily congested⁸⁸. Unregulated development and encroachment by both land brokers and squatters into public lands and into areas at high risk is further exacerbating flood risk.
175. The pace of urban development and construction is reflected in the widespread practice of extracting riverbed stones, gravel and sand as building aggregate. Extraction concessions are granted by municipalities and represent a significant source of municipal own-source revenue. The concessions do not specify the type or volume of materials to be extracted, nor the areas in which extraction can take place (other than in general principle). There is no technical scientific evidence of the volume of materials that should be safely removed each year. Extraction adjacent to river training works, and within the embankment, is practiced. There is no statutory limitation on landowners within the embankment allowing contractors to extract materials. There is no incentive to moderate and control such activities⁸⁹.

⁸² UNDESA (2018 Revision) (<https://population.un.org/wup/Download/>)

⁸³ Estimated in 2014 (World Bank development indicators) and reported in ADB, 2018, *Basic Statistics*.

⁸⁴ Ishtiaque, A., et al, 2017.

⁸⁵ National Planning Commission Secretariat (2016) *Compendium of Environment Statistics Nepal 2015*, Central Bureau of Statistics, Government of Nepal. The Kathmandu Valley comprising 21 municipalities recorded an urban density of 3738 persons per sq km – around 6.5 times greater than the national average urban density

⁸⁶ Upreti, B., Breu, T. and Ghale, Y. (2017) 'New Challenges in Land Use in Nepal: Reflections on the Booming Real-estate Sector in Chitwan and Kathmandu Valley', *Scottish Geographical Journal*. The authors report that 87% of 203 respondents reported an observed shift from agricultural to non-agricultural from two case study areas – Chitwan and Kathmandu Valley. Shrestha, B. (2011) 'The land development boom in Kathmandu Valley', International Land Coalition.

⁸⁷ Pradhan-Salike, I. and Pokharel, J. (2017) 'Impact of urbanization and climate change on urban flooding: A case of the Kathmandu Valley', *Journal of Natural Resources and Development* 07: 56-66. For Kathmandu Metropolitan City imperviousness increased from 18.71% in 1990 to 73.67% in 2010.

⁸⁸ ADB (2016) 'Guidance Note', September 2016 prepared by Guna Nidhi Paudyal.

⁸⁹ Landell Mills / JBA Consultant Mission discussions and observations (September, 2019)

Inadequate planning practice and capacity

176. The effective use of land use planning in IFRM will depend on appropriate governance structures and adequate capacity in local municipal governments on the frontline of planning practice⁹⁰. With many new municipalities declared in Nepal since 2011, many of which are peri-urban in profile, the issue of urban planning and building code implementation that addresses flood risk is a pressing concern⁹¹.
177. Municipalities have statutory responsibility for a number of areas that may have a significant effect on flood risk including planning and regulating physical infrastructure, implementing land use plans, approving building design and implementing drainage plans⁹². In reality municipalities have limited institutional, fiscal and technical capacity to effectively carry out these responsibilities^{93,94}. It is a deficit in organizational capacity that will be exacerbated by the lack of resources to match mandates in central and provincial government agencies⁹⁵.
178. Land use planning and zoning in urban areas is ill-defined and under-enforced. Land use plans are out-of-date and spatially weakly coordinated. The Department of Urban Development and Building Construction has commissioned the development integrated urban development plans (IUDP) across all municipalities⁹⁶. The IUDPs will comprise elements characteristic of urban plans in general (including land use; physical development, and; social, cultural and economic factors), and will require an 'environmental and risk sensitive land use plan'. The depth and quality of these risk assessments will be critical in the development of plans that respond to flood risk⁹⁷. Utilizing IUDPs to control development will require the development of building byelaws.
179. The Kathmandu Valley Development Authority is mandated to prepare a risk sensitive land use plan for the whole Kathmandu Valley⁹⁸. A resilience plan has been prepared but has not been formally adopted.
180. As flood risk transcends municipal boundaries, collaboration and joint action between upstream areas and neighboring municipalities will be critical and this appears to be poorly understood^{99,100}.
181. Other areas of planning practice conducive to addressing flood risk appear to be under-utilized. Zoning and land regulations do not, in general, cover density a potentially important lever for shaping a built environment that is responsive to flood risk. Land subdivision can be used to regulate the conversion of undeveloped land into building plots and is especially important in peri-urban areas. It is significant in

⁹⁰ The National Urban Development Strategy (2017) proposes spatial development framed by the on-going federalization and the promotion of local government.

⁹¹ Nepal, P. and Khan, N. (2018)

⁹² Local Government Operation Act 2074 BS

⁹³ DFID (2018) 'Cities and Infrastructure for Growth (CIG): High Level Scoping in Nepal' reports on findings from Biratnagar, Pokhara-Leknath and Nepalganj.

⁹⁴ Government of Nepal (2019) *Needs and Capacity Assessment of Fourteen Rural and Urban Municipalities on Disaster Risk Reduction and Management*, Ministry of Federal Affairs and General Administration.

⁹⁵ DWIDP & MOSTE (2014) *Water Induced Disaster Prevention Sector Adaptation Plan Framework for Guidelines: Synthesis Report on Adaptation to Climate Change*.

⁹⁶ As of September 2019, 58 are reported to have been completed, 185 are under development. .

⁹⁷ Initial indications are that the assessments may be inadequately detailed and focus on hazard, to the exclusion of exposure and vulnerability (discussions held with Anil Pokhrel, Disaster Risk Management Specialist)

⁹⁸ <http://www.kvda.gov.np/kvda-functions>. KVDA (undated) *Vision 2035 and Beyond: 20 Years Strategic Development Master Plan (2015-2035) for Kathmandu Valley*

⁹⁹ Government of Nepal (2019) *Needs and Capacity Assessment of Fourteen Rural and Urban Municipalities on Disaster Risk Reduction and Management*, Ministry of Federal Affairs and General Administration.

¹⁰⁰ Muzzini, E. and Aparicio, G. (2013) *Urban Growth and Spatial Transition in Nepal*¹¹_{SEP}: An Initial Assessment, World Bank.

controlling the density, configuration and layout of divisions and a lever for regulating and adjusting development in flood-prone areas¹⁰¹. But land management and administration systems are weakly developed¹⁰².

182. In the absence of a risk-based approach to land use planning comprising hazard maps, plans, prioritized investment and an integrated river basin approach, flood risk mitigation remains haphazard¹⁰³. A guideline for the development of a Flood Control Master Plan, flood risk maps and floodplain zoning regulation has been developed¹⁰⁴. It is yet to be formally adopted. Floodplain zoning is focused on regulating land use in the floodplains, demarcating zones by level of risk (floodway, high-risk area, risky area, moderate risk area and no risk) and specifying the types of permitted developments in these zones.
183. However, in the absence of a statutory instrument, zoning will not be legally binding and there will be no legal control on settlements developed in flood-prone areas¹⁰⁵. There is no indication how such proposals dovetail with the development of land use plans and no indication of the level of capacity and resourcing such a system would require for implementation at the local government level. Of a detailed needs and capacity analysis of 14 urban municipalities it is reported that risk assessments have not been undertaken in any municipality even in those with high flood risk, and that no code or regulation to mitigate flood risk had been prepared¹⁰⁶.
184. The strong relationship between the political space and the acquisition of land for development may inevitably result in slowed and/or skewed policy implementation, and ineffective land use planning and development control¹⁰⁷. Weak governance is cited as a key driver of the real estate boom characterized by ineffective planning and land management and the weakness of government in the face of the real estate sector lobby¹⁰⁸.

4.2. Environmental context

4.2.1. Soils

185. The majority of soils in Nepal are sandy or loamy in nature, followed by a smaller portion of clays. Soil erosion from rainfall and flooding is becoming an increasing problem across the country, with very high sediment loads been generated. This impacts upstream areas through the degradation of cultivated areas and downstream as sediment is deposited on the floodplains affecting fertility. Within the

¹⁰¹ Asian Development Bank (2016) *Reducing Disaster Risk by Managing Urban Land Use Planning: Guidance Notes for Planners*.

¹⁰² Bhandari, A. (2017) 'Land information system in Nepal', *Geospace*, Vol.III: 14-21. Chhetri, R. (2014) 'Land policy instruments in Nepal', *Journal of the Institute of Engineering*, 10, 1: 69-79

¹⁰³ DWIDP & MOSTE (2014) *Water Induced Disaster Prevention Sector Adaptation Plan Framework for Guidelines: Synthesis Report on Adaptation to Climate Change*.

¹⁰⁴ Government of Nepal (2019) *Flood Control and Management Manual*, Water and Energy Commission Secretariat.

¹⁰⁵ ADB (2018) WRPPF: Preparation of Priority River Basins Flood Risk Management Project, Nepal –Sector Analysis, prepared by Mott MacDonald.

¹⁰⁶ Government of Nepal (2019) *Needs and Capacity Assessment of Fourteen Rural and Urban Municipalities on Disaster Risk Reduction and Management*, Ministry of Federal Affairs and General Administration.

¹⁰⁷ Upreti, B., Breu, T. and Ghale, Y. (2017)

¹⁰⁸ Shrestha, B. (2011)

Kathmandu Valley some areas are estimated to produce 12,500 to 57,000 tons per sq. km per year of soil loss¹⁰⁹. These huge losses demand an improvement in soil management policies.

4.2.2. Wetlands and river basin management

186. Around 5% of Nepal’s surface area is covered by water in the form of rivers, lakes, reservoirs, ponds, marshland and irrigated paddy¹¹⁰. In total 10 sites have been designated as Ramsar sites which cover approximately 60,000ha and are located in both the mid-hills and the Terai regions. as shown in Figure 13¹¹¹.

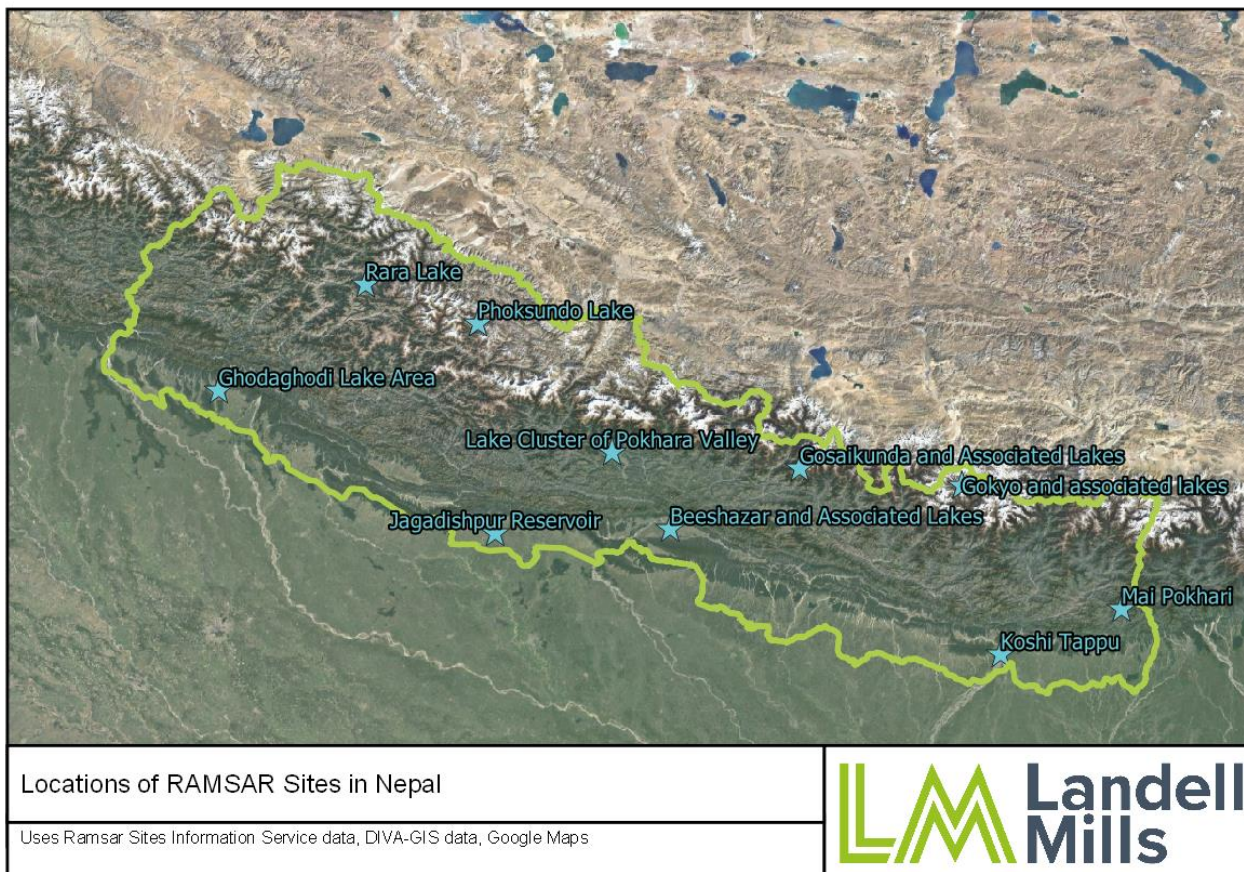


Figure 13: Locations of RAMSAR Sites in Nepal

187. The degradation and loss of wetlands is a considerable issue in Nepal. Major drivers for degradation are lack of coherent management, low capacity of institutions and increasing demand on water resources. Encroachment on wetlands by agriculture and urbanization are continuing along with increased extraction, use of water for irrigation, alien species invasion and changes in land use¹¹².
188. Although much of Nepal’s wetlands and rivers have relatively good water quality, overall there is a degradation due to urbanization, poor solid waste management and pollution. In the Kathmandu Valley, the problem is the most obvious where lack of wastewater treatment mixed with very low flows outside

¹⁰⁹ Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, 1999. *A Compendium on Environment Statistics: Nepal 1999*.

¹¹⁰ Government of Nepal, Ministry of Forests and Environment, 2018. *National Ramsar Strategy and Action Plan, Nepal (2018-2024)*.

¹¹¹ Ramsar website, accessed 21-08-2019. *Ramsar Sites Information Service: Nepal search*. https://rsis.ramsar.org/ris-search/?ff0=regionCountry_en_ss%3ANepal&paqetab=0

¹¹² Government of Nepal, Ministry of Forests and Environment, 2018, as above.

the monsoon season leaves a baseflow which in some locations is “*not appropriate even for agricultural purposes*”¹¹³.

189. On the Bagmati (Figure 14), this is a particular concern as the water is used for religious bathing. The ADB have tried to tackle these issues through the Bagmati River Basin Improvement Project (Section 5.2.2) and Kathmandu Wastewater Management Project, but further work is required to reduce untreated wastewater entering the river network in the city.



Figure 14: Bagmati River through Kathmandu with high effluent content in water and solid waste and encroachment on banks (credit: Dr Bruce Hooper, TA8500 / TA9095)

190. Under the National Water Plan of 2005, the Government has made a commitment to manage water resources in integrated approach, in line with the Dublin Principles of IWRM. However, the implementation of a coherent Water Resources Policy and Act has been difficult to achieve due to the politicization of water resources and the many stakeholders involved¹¹⁴. At a workshop in Kathmandu in June 2019 which TA9634 attended, it was clear that the Government was not yet in a position to formally adopt a Water Resources Policy or Act.
191. ADB projects such as the Bagmati River Basin Improvement Project (Section 5.2.2), TA8500 (Section and TA9095 (5.2.4) have attempted to develop the River Basin Organization concept in Nepal as a way to implement IWRM. However, although the first RBO has been established, limited progress has been made.

4.2.3. Ecology

192. As shown in Section 2.1.2 and Figure 5, Nepal has a wide variety of climatic zones due to varying topography, temperature and rainfall. This in turn creates a large number of different ecosystems and associated ecology. The Government of Nepal estimates that there are 118 different ecosystems in the country which include a huge number of different species. They state that:

*“The country occupies about 0.1 percent of the global area, but harbors 3.2 percent and 1.1 percent of the world’s known flora and fauna, respectively. This includes 5.2 percent of the world’s known mammals, 9.5 percent birds, 5.1 percent gymnosperms, and 8.2 percent bryophytes.”*¹¹⁵

¹¹³ Regmi, R.K. and Mishra, B. K., 2016. *Current Water Quality Status of Rivers in the Kathmandu Valley*. Water and Urban Initiative Working Paper Series 06 – March 2016, United Nations University.

¹¹⁴ Personal communication with Dr Bruce Hooper, ADB TA8500 Team Leader

¹¹⁵ Government of Nepal, Ministry of Forests and Soil Conservation, 2014. *Nepal Biodiversity Strategy and Action Plan 2014-2020*.

193. Furthermore, the country has a large number of endemic species, including over 280 species of plant and 160 species of animal. Unfortunately, many habitats are facing degradation, pollution is an increasing issue and invasive species and poaching are additional concerns¹¹⁶.
194. The Government's response has been to identify and create a large number of protected areas. In total approximately 19.4% of the country falls within these protected areas or buffer zones¹¹⁷. As well as geographical area, the Government has specified in law protection to 39 fauna and 19 flora species¹¹⁸.

4.2.4. Forestry

195. Forests cover some 39% of Nepal's land area according to the Government's 2016-2025 Forestry Sector Strategy¹¹⁹. It lists some of the achievements of the previous strategy and remaining challenges as set out in Table 7.

Table 7: Summary of achievements from previous Government Strategy and remaining challenges for forestry sector (taken from GoN, MoFSC, 2016)

Achievements under previous Government forestry sector	Remaining challenges within the forestry sector
Governance reforms leading to restoration of forested and controlled deforestation in the Middle Hills	Deforestation, encroachment on forests and land degradation continues in Terai
Protected area coverage to 23.3%	
Medicinal and Aromatic Plants are major exports for Nepal	Supply of forest products is less than potential and does not meet internal requirements
There is the potential for timber production whilst managing forests sustainably	Nepal still a net importer of timber
Plywood manufacture has increased	Employment and income generation is limited despite potential
Community involved in designing programs and activities	Gender and social inclusion issues around forest governance remain
Climate change recognized as a critical issue and mitigation measures beginning to be implemented	The use of forests as a mitigating factor of climate change has not been fully explored
Populations of tiger, rhinoceros and wild buffalo are increasing	
Poaching of rhinoceros is now under control	The illegal trade in wildlife continues
	Private sector involvement very limited

196. The most recent Government strategy has optimistic targets for the forestry sector including:
- An increase in overall land coverage;
 - All forested areas to have management plans;
 - Increasing community ownership and management to 60% of forests (from 40% in 2015);

¹¹⁶ Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, 2016. *Compendium of Environment Statistics: Nepal 2015*.

¹¹⁷ Asian Development Bank, 2013. *Country Environment Note: Nepal*. Country Partnership Strategy: Nepal, 2013–2017.

¹¹⁸ Government of Nepal, 2016, as above.

¹¹⁹ Government of Nepal, Ministry of Forests and Soil Conservation, 2016. *Forestry Sector Strategy (2016-25)*.

- Endangered species numbers to increase;
- Reduction in deforestation rate;
- Generation of 1.2 million jobs a year (200,000 in 2015); and,
- Increase in timber production by 300% to reduce imports to zero.

4.2.5. Waste management

197. An ADB report in 2013¹²⁰ found that solid waste management in Nepal was in a fledgling state due to the rate of urbanization, lack of public awareness and poor management. It was estimated in their survey that only around 62% of the waste is collected by municipalities, and of 58 municipalities surveyed, only 6 were using sanitary landfill. Worst still, 45 were practicing open dumping including into riverside environments.
198. However, the Government has recognized the problem and progress is being made according to the Solid Waste Management Regulations (2013) with a legal basis from the Solid Waste Management Act (2011).
199. Solid waste accumulation in riverside or floodplain areas can cause two main impacts. Firstly, in urban environments they can lead to blockage of drains and other infrastructure causing localized flooding. Secondly, solid waste can have significant impact on water quality leading to human health hazards further downstream when waste is mobilized through floodwaters.

4.3. Gender and social inclusion

200. The Government of Nepal recognizes Gender Equality and Social Inclusion (GESI) issues to be addressed in all development plans, and especially in disaster risk management activities. Women along with other marginal groups are the most vulnerable to floods. Therefore, their concerns should be addressed in implementing flood risk management programs addressed in projects in the following ways:
- Use of the Government of Nepal policy on gender and social inclusion: CEDAW (Convention on Elimination of All kinds of Discriminations Against Women (ILO 169), Sustainable Development Goals (SDG 5), GON 14th plan and poverty reduction strategy and other related plans and policies;
 - Specific field identification of key issues of exclusion, discrimination and marginalization of women, excluded, vulnerable groups, and minorities by conducting GESI analysis or impact assessment;
 - Assess the constraints and opportunities in the sector for encouraging involvement of these groups;
 - Assess the organizational capacities of the implementing organizations;
 - Stakeholders analysis on the concerned topic (GESI IFRM);
 - Develop an GESI Action Plan; and,
 - Develop an operational strategy for GESI in IFRM processes to ensure participation of the groups mentioned above and also ensure that they benefit equitably from the project interventions.

¹²⁰ Asian Development Bank, 2013. *Solid Waste Management in Nepal: Current Status and Policy Recommendations*.

5. ADB and other Development Partners' engagement

5.1. Summary table

201. Nepal attracts significant donor and development partner funding, particularly in water resources management given its economic reliance on agriculture and irrigation. ADB has invested particularly heavily in the Kathmandu Valley, with the Bagmati River Basin Improvement Project; and now in various Terai basins to improve flood risk management. The World Bank are also major development partners involved in water resources management in Nepal.

Major Development Partners

Development Partner	Project Name	Duration	Amount (\$ million)
Flood Risk Management			
ADB	Koshi Emergency Flood Damage Rehabilitation Project	2009-2015	25.6
	Strengthening Integrated Flood Risk Management	2019-2021	0.4 ^a
UNDP	Community-Based Flood and Glacial Lake Outburst Risk Reduction in Nepal	2013-2018	16.1
World Bank	End-to-end FFEWS for Koshi and West Rapti River Basins	2015-2018	0.7
Zurich Foundation	Nepal Flood Resilience Project	2013-2018	1.5
Water Resources			
ADB	Bagmati River Basin Improvement Project	2014-2020	31.5
	Bagmati River Basin Improvement Project: Additional Financing	2019-2025	78.8
	Strengthening Integrated Water Resources Management in Mountainous River Basins	2016-2019	0.7 ^b
	Water Resources Project Preparation Facility	2012-2019	13.8
Australian Aid	Koshi Basin Initiative	2012-2020	
EU	Rural Village Water Resources Management Project, Phase III in Far and Midwestern Regions in Nepal	2006-2022	60.2
JICA	Participatory Watershed Management and Local Governance Project	2009-2014	6.6
USAID	Sustainable Water Futures Development in Western Nepal	2016-2019	
World Bank	Nepal Irrigation and Water Resources Management Project	2008-2018	103.3
	River Basin Planning Project	2018-2020	

^a This regional Technical Assistance project has a total budget of \$3.0 million, across eight countries

^b This regional Technical Assistance project had a total budget of \$2.0 million, across three countries

Abbreviations: ADB – Asian Development Bank; EU – European Union; KfW – Kreditanstalt für Wiederaufbau; JICA – Japanese International Cooperation Agency; UNDP – United Nations Development Program; USAID – United States Agency for International Development

5.2. ADB projects

5.2.1. Water Resources Project Preparation Facility (2012 to present)

Overview

202. The major Water Resources Project Preparation Facility (WRPPF) is an US\$11 million grant to assist the Government of Nepal to identify and undertake feasibility studies of priority projects in irrigation, drainage and flood control infrastructure¹²¹. The work is being undertaken in a number of packages, with the most relevant to flood risk management being:

- Package 3: Flood Hazard Mapping and Risk Management Project
- Package 7: Preparation of Priority River Basins Flood Risk Management Project

Package 3: Flood Hazard Mapping and Risk Management Project

203. Under this WRPPF package, major national flood hazard and risk maps were created for various priority basins to assist in decision making and planning for flood risk management¹²².

204. Twenty-five basins were mapped using hydrological and hydraulic modelling to allow for the identification of six priority basins. Models used cross section survey data but there was a number of problems with this including land access, the dynamism of the Terai river course and mismatch with satellite data. Long term trends in the rainfall data attributable to climate change were not identified, so climate change in the models was considered through the use of the UK's HADGEM2 GCM model¹²³.

205. The model results (HEC-HMS for hydrology, and HEC-RAS for hydraulics) were used to generate various maps of flood inundation, velocity and risk. Flood hazard was defined with respect to depth, velocity and debris factor. To align with the former DWIDP's flood management policy, a greenbelt zone was identified where development would be restricted to non-residential use.

206. To prioritize the six basins, a number of variables were considered including flood frequency, severity and socio-economic indicators. There was also a desire to have a range of provinces covered. The priority basins selected were Biring, Mawa-Ratuwa, Lakhandehi, East Rapti, West Rapti and Mohana.

207. Various structural and non-structural measures were identified for further consideration. The design standard adopted for flood protection was 1 in 50 years with a climate change factor.

208. Cost benefit analysis and economic analysis was undertaken on the baseline and possible mitigation scenarios. An estimation of direct and indirect losses and benefits was undertaken. Four of the six basins gave a positive economic benefit with a 10% discount rate. Lahmeyer and TMS (2016) estimated the investment costs for the six basins to be US\$55 million.

209. Additionally, the Package 3 consultants make some interesting recommendations associated with flood risk management in Nepal including:

- The establishment of a center of modelling excellence within the Government;

¹²¹ Asian Development Bank website, *Nepal: Water Resources Project Preparatory Facility*, accessed 31-07-2019.
<https://www.adb.org/projects/45206-001/main#project-pds>

¹²² Lahmeyer International in association with Total Management Services Pvt. Ltd., 2016. *Water Resources Project Preparatory Facility: Package 3: Flood Hazard Mapping and Preliminary Preparation of Flood Risk Management Projects: Final Report Volume 1: Main Report*. Asian Development Bank.

¹²³ See Met Office (UK) website, *HadGEM2 family: Met Office climate prediction model*, accessed 04-08-2019.
<https://www.metoffice.gov.uk/research/modelling-systems/unified-model/climate-models/hadgem2>

- The creation of a digital GIS inventory of all existing and planned flood mitigation structures to ensure an integrated approach to flood risk management; and,
 - Improved liaison with the Indian Government to monitor and understand their operational rules for flood control structures in India near the Nepal border which may have an impact on flood extent and severity in Nepal.
210. We would agree with all of these recommendations as prudent integrated flood risk management measures for Nepal.

Package 7: Preparation of Priority River Basins Flood Risk Management Project

211. Following on from Package 3, the Government of Nepal has requested the ADB to support the development of the Priority River Basins Flood Risk Management Project, which focuses on five¹²⁴ of the six priority river basins identified under Package 3 plus two additional basins: Khutiya and Bakraha. All of these basins are within the Terai region. It is estimated that these seven basins contain a population of 95,000 people that are exposed to a 1-in-50-year flood. The flood risk is expected to increase as more people and assets locate in vulnerable areas in the Terai Region, which will be further exacerbated by climate change¹²⁵. The project is still in the preparation phase with an ongoing TRTA and a loan fact finding mission scheduled for October 2019. Approval for the loan is expected in 2020.
212. Landell Mills has been given access to many of the TRTA documents, and principally focused on the West Rapti basin as this will be the first basin taken forward to construction¹²⁶. Therefore, the KSTA is timely to help support and shape the proposed loan project.
213. The West Rapti basin covers an area of 6,370 km² in the central part of the Terai, principally located within Province Number 5. Some of the urban areas along the banks of the river are affected by frequent floods causing damage to properties, displacement of population, food insecurity, health and sanitation issues, interruption of access to basic services, and losses in agricultural production¹²⁷.
214. A review of the West Rapti modelling approach and testing steady versus dynamic modelling is currently underway by the KSTA and reported elsewhere. It is hoped this third-party review can assist the ADB to finalize project preparation.

5.2.2. Bagmati River Basin Improvement Project (2014 to present)

215. The Bagmati River Basin Improvement Project aims to improve water security and resilience to potential climate change impact in the Bagmati River Basin. The project has formed the first Nepali river basin organization, the High Powered Committee for Integrated Development of Bagmati Civilization, to lead on IWRM in the basin. The project has financed the construction of an upstream dam, weirs to improve water oxygenation, riverbank beautification, and community initiatives to improve the river environment in Kathmandu Valley¹²⁸.
216. The project has five outputs of which to the fourth is of most interest to this sector assessment. This fourth output is to establish a “*functioning flood forecasting and early warning system for the Bagmati*”

¹²⁴ Not Biring Basin due to unfavourable economics, see Lahmeyer and TMS (2016).

¹²⁵ Asian Development Bank website, *Nepal: Priority River Basins Flood Risk Management Project*, accessed 04-08-2019. <https://www.adb.org/projects/52195-001/main#project-overview>

¹²⁶ Correct at the time of writing (August 2019).

¹²⁷ Mott MacDonald in association with Total Management Services Pvt. Ltd., 2018. *WRPPF: Preparation of Priority River Basins Flood Risk Management Project, Nepal River Hydrology Assessment: West Rapti Basin*.

¹²⁸ Asian Development Bank website, *Nepal: Bagmati River Basin Improvement Project*, accessed 30-07-2019. <https://www.adb.org/projects/43448-013/main#project-pds>

River Basin.” The Japanese Water Agency alongside two partners were contracted to undertake these works with activities including upgrading the existing flood forecasting system, installing a flood early warning system, and increasing community awareness and capacity for flood response.

217. The Japan Water Agency (JWA) final report¹²⁹ sets out the components of the implemented flood forecasting and early warning system (FFEWS) as reproduced in Figure 15.

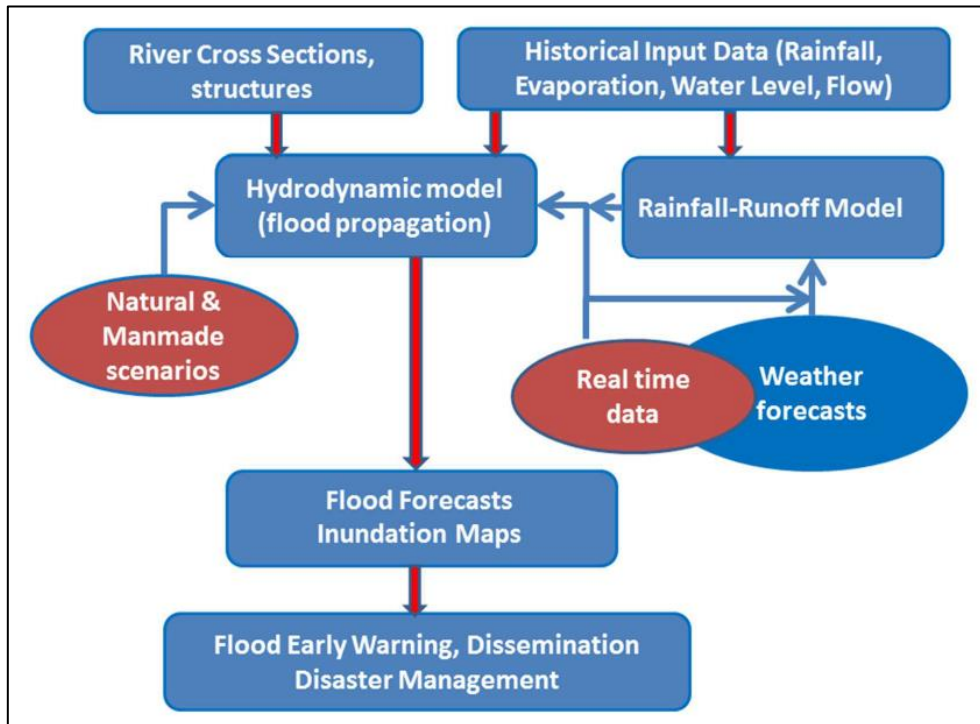


Figure 15: Components of the Bagmati Flood Forecasting and Early Warning System (taken from JWA et. al, 2018)

218. The FFEWS is based on a set of hydrological and hydrodynamic models of the Bagmati river basin. The hydrological model represents the rainfall-runoff process from the catchments of the Bagmati River and its tributaries. The hydrodynamic model simulates the propagation of flood from upstream to downstream by routing the flows in a dynamic (unsteady) way.
219. Calibration and validation proved to be difficult for JWA as there was inadequate real time data from DHM. When trialing the system in the monsoon season of 2017 it was shown that the accuracy was not as desired. The use of satellite rainfall data was trialed but this also proved to have bias.
220. Therefore, with the support of ADB TA9095: *Strengthening Integrated Water Resources Management in Mountainous River Basins* six real time water level stations along the Bagmati River were installed in 2017 and now integrated into DHM's real time network.
221. To aid capacity development of the various stakeholders in the use of the FFEWS, JWA arranged a series of training events including specialized training at Asian Institute of Technology Bangkok, a study tour to Bangladesh to observe similar systems, and a final handover training in April 2018.

5.2.3. Koshi Emergency Flood Damage Rehabilitation Project (2012)

222. A study was carried out for the Koshi river in 2012 by the Department of Water Induced Disaster Prevention (DWIDP) with support from ADB. The main objective of this study was to prepare flood hazard and vulnerability maps of Koshi River from Chatra to Koshi Barrage.

¹²⁹ Japan Water Agency, Yachiyo Engineering Co. Ltd and Total Management Services Pvt. Ltd, 2018. *Bagmati River Basin Improvement Project: Draft –Final Report*

223. The geometry behind the embankment became very complex after the 2008 embankment breach, which required detailed topographical data. Based on one-dimensional modelling, flood analysis and hazard mapping were carried out.
224. Flood inundation analysis was carried out for 1 in 25, 50 and 100 year return periods. Considering the higher flood levels, the identified vulnerable settlements and high hazard zones for 1 in 25, 50 and 100 year return period floods were found to be the villages of Shukrabare, Rajabas, Khairatol and Shivchok and, Galphadiya.
225. Additionally, areas susceptible to bank erosion and thus vulnerable to flooding were identified. Flood evacuation routes and shelter points in case of flooding to the settlements were also assessed.

5.2.4. TA8500 and TA9095: Support to Bagmati RBO (2015-2019)

226. ADB has recently funded two Technical Assistance projects to support the fledgling Upper Bagmati RBO (see 3.1.6):

TA8500: Institutional and Legal Support for Improved Water Management Systems in Nepal and Formation of the Bagmati River Basin Organization

227. Activities include(d):

- Developing a policy and legal and institutional framework to support operationalization of IWRM under Nepal's new constitution;
- Capacity building so that WECS and associated river basin management institutions (including Bagmati RBO) are able to quickly initiate the implementation of the new water legislation; and,
- The new federal water policy and legislation is developed through a thorough and multilevel consultative process and is guided by knowledgeable parliamentarians and water leaders.

228. The implementation of a coherent Water Resources Policy and Act has been difficult to achieve due to the politization of water resources and the many stakeholders involved¹³⁰. At a workshop in Kathmandu in June 2019 which TA9634 attended, it was clear that the Government was not yet in a position to formally adopt a Water Resources Policy or Act.

TA9095: Strengthening Integrated Water Resources Management in Mountainous River Basins (Nepal one of three target countries)

229. The work in Nepal included:

- Providing an external advisory service team to the RBO who wrote a series of technical notes on strengthening the organization;
- Institutionalizing a performance benchmarking assessment of the RBO;
- Supporting the development of a Decision Support System;
- Delivering both in-country training through bespoke workshops and training sessions as well as providing support for relevant study tours for key executives; and,
- Supporting the procurement of water monitoring facilities by advising on the design and location of this equipment for the FFEWS network.

¹³⁰ Personal communication with Dr Bruce Hooper, ADB TA8500 Team Leader

230. The TA (also implemented by Landell Mills) is due to finish in November 2019 and has had some limited success. Challenges have included the lack of clarity over the legal mandates of the RBO, a lack of leadership, and competing institutions.

5.3. Others

5.3.1. End to end FFEWS for Koshi Basin (World Bank)

231. Under the World Bank supported project *Building Resilience to Climate Related Hazards*, the Department for Hydrology and Meteorology has developed a real time flood forecasting and early warning system, which is operational since 2017. It provides model-based flood forecast and warning up to 72 hours in advance. The web-based system is illustrated in Figure 16.

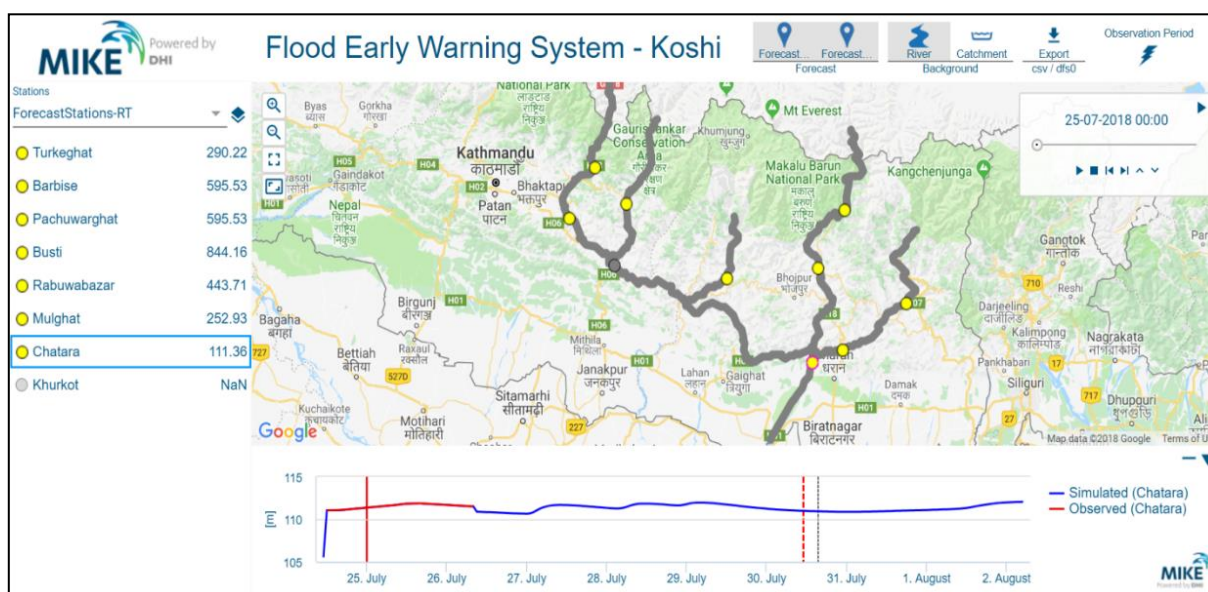


Figure 16: Web viewer of Flood Forecasting and Early Warning System for Koshi Basin (taken from DHM, 2017)

232. In addition to providing real time flood forecasts, this project also generated flood hazard maps in the lower areas of the basins for a series of return periods. Figure 17 shows an example of a flood hazard map generated with an assumed breach of a Koshi embankment.

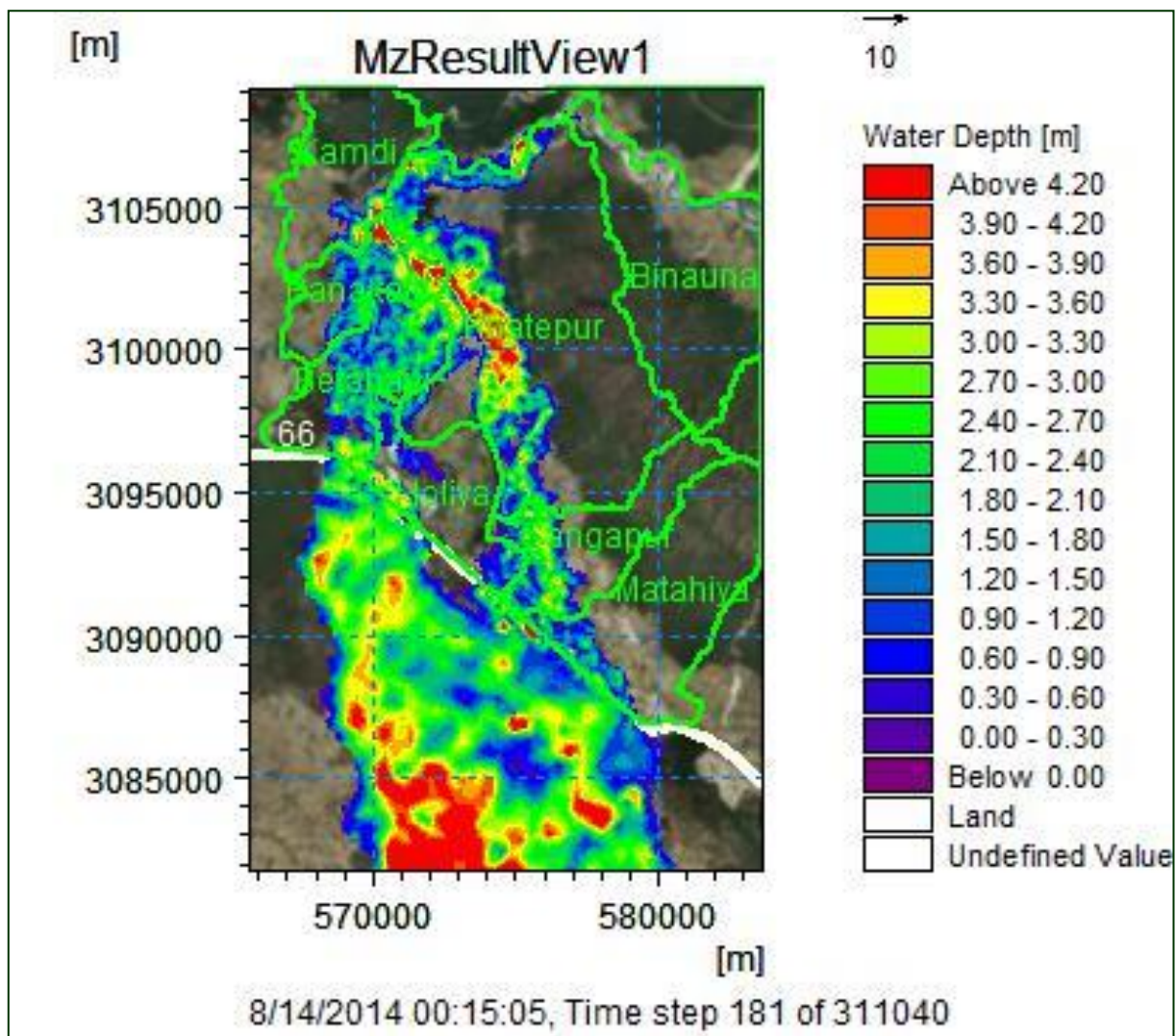


Figure 17: Flood hazard map for an embankment breach scenario with a 1 in 100 year flood (taken from DHM, 2017)

5.3.2. End to end FFEWS for West Rapti Basin (World Bank)

233. A real time FFEWS was developed for the West Rapti Basin, under the World Bank project, similar to the Koshi Basin. Figure 18 shows an example flood hazard and risk map for the West Rapti Basin.

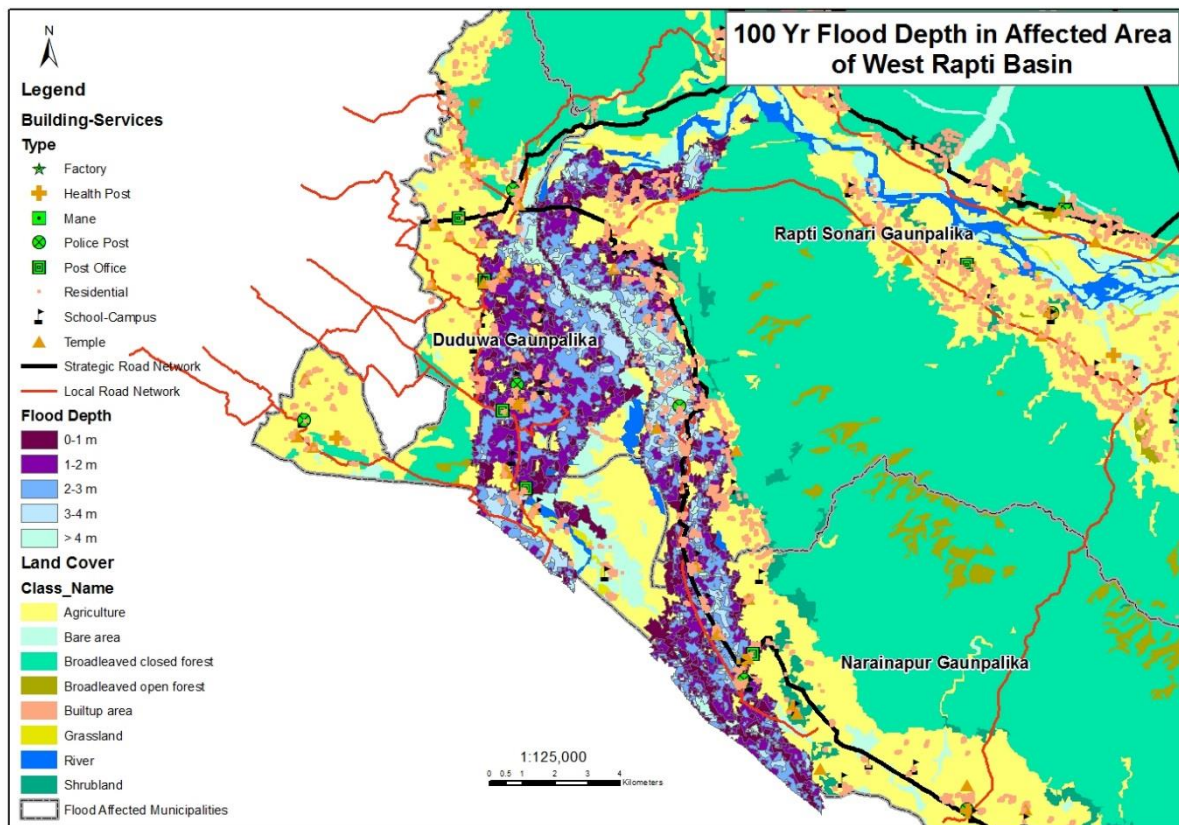


Figure 18: Example flood hazard map for the West Rapti basin (taken from DHM, 2017)

5.3.3. World Bank River Basin Planning Project (ongoing)

234. The Water and Energy Commission Secretariat with the support of the World Bank has taken up a project to prepare river basin master plans and hydropower development master plans for all the river basins of Nepal. The ten major and medium river basins are: (1) Koshi, (2) Gandaki, (3) Karnali, (4) Mahakali, (5) Babai, (6) West Rapti, (7) Bagmati, (8), Kamala, (9) Kankai and 10) Mechi.
235. Other river basins in the southern part of the country draining into India are grouped into four southern blocks; namely, Southern Block-1 consisting of Khutia, Mohana, Donda, Chaoudhar and other small local rivers; Southern Block-2a consisting of Banganga, Tinau, Rohini and other small local rivers; Southern Block-2b consisting of Lal Bakeya and other small local rivers; Southern Block-3 consisting of Khando, Balan, Ratu, Lakhendehi and other small local rivers; Southern Block-4 consisting of Mawa, Ratwa, Biring, Budhi, Chisang, and other smaller rivers (as shown in Figure 19).
236. Flood disaster management will be a major component of the basin plans in the southern rivers.



Figure 19: River Basins of Nepal (taken from Lahmeyer International, 2018, duplicate of Figure 7)

5.3.4. NGOs and others

237. The main international NGOs involved in flood disaster risk management activities are Mercy Corps, Oxfam and Practical Action. National NGOs involved include the Centre of Resilience Development, Disaster Preparedness Network and National Disaster Risk Management Forum. The Nepal Red Cross Society and United Nations Development Program are the main organizations involved in disaster risk reduction activities.
238. One of the major NGO projects was funded by the Zurich Foundation and implemented by Practical Action in partnership with Nepal Red Cross Society and the Centre for Social Development Research. This USD 1.5 million project ran between July 2013 and 2018 and had five outputs:
- Improved FFEWS through capacity development of DHM and MOHA;
 - Improved community flood resilience;
 - Improved sub-national flood resilience including up-scaling of best practices of community level flood resilience nationwide;
 - Improved national capacity for flood resilience through influencing in policy, legislation and governance; and,
 - Enhanced cross-border and region-wide flood risk reduction.

5.4. Nature-based Solutions

239. Nature-based Solutions (NBS) within flood risk management in Nepal is a new concept with no significant work to date. The 2019 Flood Control and Management Manual¹³¹ has a section in it around bio-engineering, which covers some methods of reducing soil erosion and riverbank stabilization.

¹³¹ Government of Nepal, Water and Energy Commission Secretariat, 2019. *Flood Control and Management Manual*.

However, this should be considered as “greening” hard infrastructure, rather than finding NBS to assist in mitigating flood risk.

240. The clear opportunity for NBS in Nepal is twofold. Firstly, in the hills, planting of additional forestry and subsequent management offers significant opportunities to reduce soil mobilization and downstream sedimentation issues (Section). No doubt additionally forestry would also reduce rainfall-runoff and hence lower the chance of flash flooding. Interestingly, it has been noted in the research literature that a surprising benefit of urban migration is that in some rural areas natural vegetation is re-establishing and reducing soil erosion¹³².
241. Secondly, the scale of flooding on the Terai is so large that NBS alone cannot properly manage or mitigate the impacts. However, NBS measures such as allowing room for the river, designated flood storage areas and setback flood embankments may be part of the wider adaption necessary to truly manage these floodplains in an integrated way.

¹³² Schwilch, Gudrun & Adhikari, Anu & Jaboyedoff, Michel & Jaquet, Stéphanie & Kaenzig, Raoul & Liniger, Hanspeter & Penna, Ivanna & Sudmeier-Rieux, Karen & Upreti, Bishnu, 2017. *Impacts of Outmigration on Land Management in a Nepali Mountain Area*. 10.1007/978-3-319-33880-4_11.

6. SWOT analysis

6.1. Strengths

242. Some of the identified strengths in flood risk management in Nepal are discussed below:

- **Well understood flooding mechanisms:** Fluvial flooding on the Terai has been occurring long before humans settled in the plains and is a natural phenomenon. Therefore, the flooding mechanisms that are occurring are well understood and, in many senses, can be “expected”. That is not to say that the risk of flooding is entirely managed, but the principal hazard is well understood and is identifiable. The other sources of flood risk discussed here are also relatively easy to understand.
- **Large amounts of funding for climate related research:** Nepal has been identified as particularly sensitive to climate change due to its reliance on the Himalayan mountains for water resources. Therefore, the scientific community is able to leverage considerable funding for climate related research. However, downscaling this research into risk management practice remains some way off.
- **Monitoring of GLOF risk vastly improved through remote sensing improvements:** The management of GLOF has been greatly improved in recent years through the ability to monitor proglacial lakes from afar, and not rely on field visits alone. This significantly improves the ability to identify and track changes, but there is a long way to go in institutionalizing the risk management of GLOF.
- **A large number of strategies, policies, guidelines, action plans and frameworks already exist:** In Nepal, a large number of documents have already been produced, many which have excellent ideas around institutional arrangements, organizational capacity improvements and bespoke research. However, the adoption of these strategies and plans remains challenging given the complexity of the institutional arrangements.
- **Existing flood defenses in place:** Within the Terai, and in other locations, flood defenses and infrastructure already exist. However, there are challenges around the extent to which these are “climate proofed” to accommodate possible future changes in flood risk. Additionally, the Koshi embankment failure of 2012 shows that investment is still required in existing infrastructure.
- **The Government has produced a solid, workable Standard Operating Procedure for FFEWS:** The Government’s Standard Operating Procedure for FFEWS is strong and enables future investment in FFEWS to be undertaken in a consistent manner and to a high standard. The recent Koshi and West Rapti FFEWS build on this approach.
- **Decentralization is not new:** Although the 2015 Constitution of Nepal has forced legal changes in all sectors around decentralization, in disaster risk management it is not new. Municipalities and Provincial Governments have been working with the Central Government since 1999 on disaster risk management, therefore lines of communication and ways of working do not need to be newly established. The chance to empower local mayors as champions of flood risk management is positive.
- **Investment:** There is a keenness on behalf of the major multinational banks to invest in flood risk management in Nepal which is demonstrable from various recent loan projects. Following consultation, it is believed that if Nepal could adopt a Water Resources Law and Policy that encompassed IWRM, flood risk management and hydropower considerations, further investment would be forthcoming.

- **The existence of a water policy making body in the Government:** The Water and Energy Commission Secretariat is a natural home for water resources and flood risk management policy to be considered. A holistic view of water is required, and WECS is the natural home for this. However, flood risk management has sat with disaster risk management, causing overlaps and gaps.
- **A framework for Community Based Disaster Risk Management exists:** There are many NGOs already working in Nepal, and the concept of CBDRM is not new. Therefore, it is encouraging that a framework for standardizing efforts has been suggested.

6.2. Weaknesses

243. Some of the identified weaknesses and gaps in flood risk management in Nepal are discussed below:

- **Challenges of integration of plans and policies with and within the Governing System:** Now the country has entered into Federal System with three levels of governments, the current flood risk management plans, policies and programs are better designed to work in a Unitary System. Such plans and policies require additional work to ensure they are functional as per the new system of governance. An example of this is the Draft Water Policy of 2018, where flood risk management was not particularly considered in the context of decentralization.
- **Challenges to ensure proper coordination:** Due to the large number of stakeholders, it is difficult for effective coordination, although during disaster response this has been seen to occur. The different stakeholders include three tiers of Government, development partners, and implementing agencies like NGOs, CSOs, Private Sector Companies and Communities. Within Government there are different Ministries and Departments involved in different aspects of flood risk management. The number of different Ministries and Departments with different roles and responsibilities makes the implementation of *integrated* flood risk management more complicated.
- **Low capacity of stakeholders and institutions:** The existing capacity of the stakeholders and institutions working on flood risk management in Nepal is relatively low, which is understandable as they often deal with varying hazards. Strengthening of stakeholders and the institutional system for flood risk management involves a continuous learning process. Additionally, it is believed that the Government Ministries and Departments tasked with flood risk management suffer from limited Human Resources. The lack of enough personnel with good knowledge on IFRM can become an obstacle for effective implementation.
- **Human Resources preferring the private sector, or overseas:** Skilled human resources are choosing to work in the private sector rather than the Government due to low salaries, and other concerns. Furthermore, there is an increasing trend in Nepal for skilled workers to look overseas for employment.
- **Insufficient financial resources:** The Government budget in Nepal is stretched due to many competing needs, and although various disaster risk management policy provisions have been pledged, financial backing remains a challenge for the Government. At present, the flood risk management sector in Nepal is underfunded.
- **An understandable focus on recovery rather than resilience:** At present due to the constraints mentioned above, flood risk management in Nepal is focused on short-term emergency response rather than long-term resilience and planning. Pre-disaster preparedness is key for the long-term management of flood risk and to minimize economic damage, but the Government requires assistance to enable this to occur.
- **Data gaps and challenges with data management:** Due to lack of financial resources, there is a lack of a comprehensive hydrological and meteorological monitoring network in Nepal, although this is beginning to change following recent investments. Data collection at the local versus national level can show differences and data sharing and management is not necessarily consistent. This

challenge is also seen at an international level, as it is noted that datasets for economic losses vary significantly against international bodies and interested third parties such as reinsurance companies.

- **Variance in flood risk mapping:** Fluvial flooding, GLOF and urban flood risks have all been mapped to various degrees, with some significant gaps, and some work only presented in the academic or private sphere. Having consistent flood risk mapping would be an excellent first step towards coherent IFRM. The ADB's recent investment in flood risk and hazard mapping of 25 Terai basins is an excellent first step in addressing these concerns.
- **Limited Monitoring and Evaluation of the sector:** The Government's own Monitoring and Evaluating of its performance in flood risk management is yet to be institutionalized given the number of stakeholders involved. The ADB attempted to introduce the concept of self-evaluation through River Basin Organization benchmarking under TA9095, but to date this has been more of an academic than practical exercise for the target organizations (WECS and HPCIDBC).

6.3. Opportunities

244. Regarding potential investment opportunities, or areas that the Government could focus on to try and improve flood risk management:

- **Improving institutional coordination:** There is a historic opportunity for the Central Government to establish a streamlined institutional arrangement for flood risk management in the country. At a time in Nepal's history where a new Constitution is being implemented through various legal instruments, there is an opportunity for the Government to set a future course in flood risk management that can influence a generation. Elected local mayors offer the opportunity for effective local leadership with a mandate.
- **Institutional strengthening:** Capacity amongst stakeholders remains low but is improving due to various development partners' activities. With the implementation of the new Constitution, the Government has an opportunity to take a long-term view on human resources and identify the future leaders and decision-makers and focus on their strengthening. For institutions as a whole to have their capacity raised there should be a focused Human Resources Strategy for water resources and flood risk management.
- **Establishment of a Centre of Excellence:** Terms such as "brain drain" have been used describe the loss of intellectual capital overseas, with many talented young Nepali professionals in the USA or Australia. To reduce this loss, an example from Bangladesh is suggested. In Dhaka, the Government established the *Institute of Water Modelling* and the *Centre for Environmental and Geographic Information Services* to create Centers of Excellence in their various fields. Initially a Government Agency with higher salaries before becoming increasingly privatized, these Centers attracted high quality graduates and technical staff that allowed for the whole sector to improve its standing and outputs. Outsourcing Government contracts for the technical side of water resources and environmental management has improved the Government's ability to manage effectively, and also kept intellectual capital in the country. These institutes now are at a level to provide high-level consultancy to other Asian countries and this model is very attractive for the Nepal Government to consider.
- **Investment in FFEWS:** The Government's SOP for FFEWS offers a platform for further investment and expansion of the existing network. The successful implementation of projects in the Koshi, West Rapti and Bagmati basins offer examples to how other locations can be rolled out.
- **Existing infrastructure and the incorporation of NBS:** The Koshi embankment collapse of 2008 has demonstrated that existing infrastructure still requires ongoing investment to ensure that flood risk is managed most effectively. In addition, many of the embankments already built do not necessarily take into account the changing climate, and therefore climate "proofing" existing

infrastructure can be relatively low cost (compared to construction of new infrastructure) for high benefit (compared to a breach or failure). At the same time, NBS such as setback embankments, room for the river and designated flood storage areas in the Terai should be considered. Further upstream, afforestation and enhanced agricultural practices offer additional potential benefits.

- **Operation and Maintenance:** Operation and Maintenance in most countries is a challenge to fund, which is also the case in Nepal. The benefits of prioritizing this budget expenditure are well known, and it is recommended that this is undertaken wherever possible to decrease the risk of infrastructure failure. It is noted that the World Bank have considered a cost recovery model for their FFEWS projects to fund Operation and Maintenance.
- **Community resilience:** Further work can be done around improving communities' resilience to flooding. This includes two key matters: Firstly, improving communities' infrastructure resilience – including homes, schools and drinking water infrastructure. The 2017 Terai flooding showed the huge potential for better built homes to be more resilient to flooding¹³³. Secondly, improving communities' ability to (a) minimize loss of life through improved warning systems, and (b) recover quicker by having the necessary tools and knowledge.
- **Pro-glacial lake monitoring:** Investment in dedicated remote sensing software, hardware and human resources offers the Government a low-cost way of improving their GLOF risk management. It is a highly attractive financial and risk management opportunity that offers huge potential benefits in a warming climate where GLOF risks will increase.
- **Supporting the Forestry Sector Strategy:** The Government's Forestry Sector Strategy sets out ambitious targets to improve the management and governance of forests as well as a huge increase in jobs. Given the importance of catchment management to long term flood risk in the Himalayan region, and in Nepal in particular, there is an opportunity for the ADB and other development partners to invest in supporting the forestry sector which has multiple benefits, including job creation and flood risk reduction.
- **Improving soil management and conservation:** Similarly, soil erosion is a significant issue in Nepal with sediment deposition during flooding creating significant agricultural issues. Therefore, there is an opportunity for investment in better soil management techniques through improved agricultural techniques to decrease erosion and improve flood risk management.
- **Tackling land use planning issues:** The idea of zoning development has been floated through various policies and guidelines, but to date there is no legal enforcement of these issues. Land use directly impacts both flood hazard (through potential for increased runoff) and risk (through potential to place more people in higher risk areas).

6.4. Threats

245. Nepal remains a country with a high vulnerability to a number of internal and external pressures which could negatively impact IFRM implementation. These threats include:

- **Complex institutional arrangements:** In Nepal, flood risk management is institutionally placed between water resources institutions and those associated with disaster risk management at various levels of Government. This complicates coordination efforts to ensure integrated flood risk management. However, there are also historic opportunities for the Government with the new Constitution. At present there is not a holistic approach to water resources but it is hoped this might be achieved through the planned new act and policy.

¹³³ See Government of Nepal, National Planning Commission, 2017.

- **Climate change:** Nepal remains at a very high risk from climate change impacts. Although predicted changes in precipitation are complicated, it seems more extreme events will become more common, leading to the potential for increase in flooding. Warming air temperature is predicted by all the model ensembles, which will further increase glacial melt and accordingly the build-up of pro-glacial lakes, and therefore an increase in GLOF risk.
- **Urbanization:** Uncontrolled development in Kathmandu and other urban centers is causing an increased frequency in urban infrastructural flooding. Furthermore, the draw of urban centers in the Terai is placing more people at risk of flooding, and new housing is often built with limited consideration of flood resilience. As exposure increases, there is potential that the economic costs of flooding will increase at a faster rate than would be associated with improving living standards only.
- **Soil erosion:** The loss of soil and degradation of land is an issue for both agriculturalists and IFRM planners. It has been seen that the impact of this mobilized sediment downstream can cause significant secondary impacts from flooding when agricultural land is inundated by sediment that does not add to the fertility of the land.
- **Operation and Maintenance:** The 2008 Koshi embankment demonstrated that failure of existing infrastructure can have devastating impacts. The funds required to remediate the damage were extremely large. Prioritizing Government budgets to cover the costs of the Operation and Maintenance of existing infrastructure will offer a long term positive cost-benefit ratio.
- **Retention of talented future water managers:** As mentioned previously, Nepal is a huge exporter of labor, with 28% of GDP accounted for by overseas remittances in 2018¹³⁴. With this trend so prevalent, there is a high probability that Nepal will not retain all of its talented graduates / technical staff within the water resources and flood risk management sector.
- **A repeat of another major disaster such as the 2015 earthquake:** The 2015 earthquake is estimated to have affected nearly a quarter of the population, and it can be argued that the country has still not fully recovered from the event of four years ago. Should another major disaster occur, the impacts will be felt across all Government and economic sectors.

¹³⁴ The Kathmandu Post, 10-04-2019, accessed 02-09-2019. *Nepal is 19th largest receiver of remittances with \$8.1 billion.*
<https://kathmandupost.com/money/2019/04/10/nepal-is-19th-largest-receiver-of-remittances-with-81-billion>

7. Summary of recommendations and risks

7.1. Recommendations

7.1.1. Overview

- 246. This Sector Assessment has set out to provide the context for flood risk management in Nepal, explain the institutional arrangements and other key considerations, before analyzing the strengths, weaknesses, opportunities and threats for the sector.
- 247. There are a number of IFRM investment opportunities for the Government and development partners such as the ADB to bring real value and benefit. As set out in Section 6.3, these are incredibly varied from further strengthening of the FFEWS network using the Government’s recent guidelines, investing in GLOF monitoring facilities, through to tackling catchment management issues such as forestry and soil erosion.
- 248. This report includes below the types and sequencing of the priority investments in the sector and whether they may be financed from public, private, or public–private sources. This is summarized in Table 8.

Table 8: Summary of potential key types of interventions and investment in priority order

Type of intervention and investment:	Building institutional and regulatory environment	Physical infrastructure
Highest Priority	Create a solid legal basis for institutions	FFEWS
↓	Support basin organizations	Upgrading existing major infrastructure (e.g. embankments)
	Tackle land use planning including zoning of floodplains	Upgrading community infrastructure (e.g. water supply network)
	Center of Excellence	Ensure flood compliant design in future infrastructure
Decreasing importance	HR Strategy	GLOF monitoring

7.1.2. Build institutional and regulatory environment

Priorities

- 249. The analysis identifies a range of areas where strengthening is required. With regard to national level institutional structures, there are a range of options that could be considered including streamlining the existing institutional arrangements. At present, the institutional arrangements for flood risk management separates flood risk management from water resources management; includes multiple national level Ministries and Departments; and requires coordination between national, provincial and local levels of Government. This complex arrangement makes IFRM difficult. A potential option is for IFRM to be considered as part of the broader water resources sector, for which the Government has stated it is committed to implementing an integrated approach (i.e. IWRM). There is an opportunity with the planned new Water Resources Policy and Law to streamline responsibilities in the light of the new Constitution. Further investments by development partners will be much strengthened by institutional coherence and cooperation.

250. Therefore, the highest priority for donors is to support the Government in the strengthening of the institutional arrangements, promoting the management of water in a holistic manner. One approach to this is to support the Government to pass a comprehensive Water Policy and accompanying legislation. To date, both the ADB and World Bank have assisted with this progress, and it is hoped that future assistance can be leveraged to enable a platform for integrated approaches to flood risk management.
251. A second step, would be to support the establishment of the basin organizations proposed by the Nepali Government. A suggestion of what these organizations would look like has already been produced by WECS, with some work done by the ADB to assess and support these proposals. A key area for donor involvement could be to look into how these future bodies (established within an appropriate legal framework) could become financially sustainable. Even prior to their establishment, further work could be done in looking at possible measures to generate income from water users (or others, such as international tourists) which will then incentivize their creation.
252. Thirdly, alongside these specific flood risk management considerations, it is strongly believed that progress should be made in Land Use Planning. As set out in our report, changing patterns of land use, rapid urbanization and inadequate planning practice is causing significant issues generally, and within the management of flood risk. Donors should prioritize helping the Government to properly zone land for development with regards flood risk and only permit certain development within each zone. The work undertaken by the Package 3 consultants for ADB offers a starting point for the mapping and zoning of the Terai in particular.

Additional items

253. As mentioned above, retaining Human Resources and increasing capacity in Government departments is required for more effective IFRM. One area the Government could consider, and the ADB could consider financing, is the establishment of a Centre of Excellence for water resources management. The reason for this is threefold. Firstly, it will encourage future water specialists and scientists to enter the public, rather than private sector, or move overseas. Secondly, it will improve the overall capacity of the sector in Nepal as individuals inevitably move between departments and to/from the Centers of Excellence. Thirdly, it will help the Government to retain knowledge, as it will act as a knowledge hub, rather than being spread amongst a limited number of public, and large number of private institutions at present.
254. The funding for this Centre of Excellence in the short term would have to be from public money sourced through existing budgets or financed from development partners. However, if developed into a commercial entity, it is suggested that like other locations in Asia, the Center could well become a competitor to other similar Government backed institutions, and ultimately in the long term, run a profit.
255. The Government is also recommended to consider a Human Resources Strategy for the water sector, including flood risk management. Multiple capacity building activities are being undertaken by various development partners, and it would be good to ensure that efforts are targeted across Ministries, Departments and other stakeholders to maximize benefit.

7.1.3. Physical infrastructure

Priorities

256. There is a need for infrastructure to further consider flood resilience given a potential for increasing hazard from climate change, particularly in the Terai region. As urbanization, and therefore exposure, increases in the Terai, more road (and rail) infrastructure is planned. It is highly recommended that flood resilience is considered to ensure that recovery costs remain relatively low. The same is true of housing, educational buildings and health facilities.

257. One of the highest priority investments in the flood risk management sector, is investment in FFEWS. There are a number of reasons for this including the small costs involved but large possible benefits, the existing coherent strategy for FFEWS developed by DHM, and how these systems have been established in other basins successfully. History has shown that major natural disasters such as the 2015 earthquake and 2017 Terai floods have put Nepal's economic growth back substantially. FFEWS offers an opportunity to help mitigate the impacts with relatively low costs and construction times.
258. Secondly, upgrading existing infrastructure and incorporating NBS where possible is highly desirable. Embankment breaches can cause catastrophic and unexpected flooding, as seen in Koshi 2008 and therefore identifying and upgrading these existing barriers is believed to be highly cost-effective. Climate proofing of existing infrastructure could also take the opportunity to utilize NBS techniques, such as set back embankments and designated flood storage areas, rather than just building embankments higher.
259. Additionally, at a more local and community level, the 2017 Terai floods demonstrated that public infrastructure such as schools and drinking water supply was under prepared for extensive flooding. There appears to be an investment opportunity for flood-proofing these public goods to ensure that communities can recover from flooding much quicker.
260. Thirdly, an observation from the consultancy team is that the design of major road (and now possible rail) infrastructure considers flooding in only a limited manner. Rather than only seeing flooding as an issue to be mitigated against, this infrastructure could be designed to manage flood risk in a holistic manner through altering flow direction, volumetric storage upstream and throttling flow to a certain discharge through bridges and culverts. Ensure flood compliant design in future infrastructure is desirable.

Additional items

261. Investment in dedicated remote sensing software, hardware and human resources offers the Government a low-cost way of improving their GLOF risk management. It is a highly attractive financial and risk management opportunity that offers huge potential benefits in a warming climate where GLOF risks will increase. The funding mechanism for this is however not entirely obvious. Potentially, as Nepal continues to exploit its hydropower potential, suppliers could be charged a small fee for GLOF monitoring, which in effect allows them to better manage and protect their assets, and own commercial risk.

7.1.4. Other considerations

262. As with many parts of the world, funding for Operation and Maintenance is difficult to ringfence. The benefits of prioritizing this budget expenditure are well known, and it is recommended that this is undertaken wherever possible. It is noted that the World Bank have considered a cost recovery model for their FFEWS projects to fund Operation and Maintenance. Another option could be demonstrating to the Ministry of Finance that money spent on Operation and Maintenance will ensure that significant rehabilitation costs are avoided in the future, and therefore there is an internal driver to prioritize these budgets.
263. Soil erosion is a significant issue in Nepal with sediment deposition during flooding creating significant agricultural issues. Investment in agricultural practices and the forestry sector will lead to a decrease in erosion and improvement in flood risk management. The Government's holistic Forestry Sector Strategy offers multiple potential opportunities for investment.
264. Although often politically challenging, it is recommended that flood risk management is considered at a transboundary scale. Recent history has shown that the 2017 Terai floods were linked to further flooding across South Asia and so the Government's actions in Nepal impact India downstream. Similarly, flood risk infrastructure in India is likely to have a backwatering affect in Nepal, suggesting a

coordinated approach is required. At a smaller scale, GLOF floods in the 1980s originated in China, but had their impacts in Nepal. Therefore, monitoring of GLOF risks with Chinese counterparts is recommended.

7.2. Risks

265. The threats to the flood risk management sector in Nepal are set out in Section 6.4, and can be summarized as:

- Complex institutional arrangements making integrated flood risk management difficult;
- Climate change leading to increases in flood hazard;
- Rapid urbanization in the Terai is leading to more population and assets exposed to flooding;
- Soil erosion mobilizes sediment downstream causing primary and secondary hazards;
- Failure of existing infrastructure if Operation and Maintenance not undertaken;
- Difficulty in retaining talented future water managers; and,
- A repeat of another major disaster such as the 2015 earthquake putting the whole economy back.

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