

Emergency and Disaster Reports

ISSN 2340-9932

Vol 8, Num 4, 2021



Monographic issue

Disaster Risk Profile of Nepal

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Letter from the Editors

The Emergency and Disaster Reports is a journal edited by the Unit for Research in Emergency and Disaster of the Department of Medicine of the University of Oviedo aimed to introduce research papers, monographic reviews and technical reports related to the fields of Medicine and Public Health in the contexts of emergency and disaster. Both situations are events that can deeply affect the health, the economy, the environment, and the development of the affected populations.

The topics covered by the journal include a wide range of issues related to the different dimensions of the phenomena of emergency and disaster, ranging from the study of the risk factors, patterns of frequency and distribution, characteristics, impacts, prevention, preparedness, mitigation, response, humanitarian aid, standards of intervention, operative research, recovery, rehabilitation, resilience and policies, strategies, and actions to address these phenomena from a risk reduction approach. In the last thirty years has been substantial progress in the above-mentioned areas in part thanks to a better scientific knowledge of the subject. The journal aims to contribute to this progress by facilitating the dissemination of the results of research in this field.

This monographic issue is about the disaster risk profile of Nepal. Nepal is a small landlocked country located in the South Asia. It is a Himalayan country and is widely recognized for its extreme mountains. Natural hazards pose the most common and devastating disasters in Nepal. Due to the country's complex topography, diverse geography, active tectonic plates, and natural environmental factors, Nepal is extremely vulnerable to disaster. The INFORM global risk index for Nepal is 5.2 in the year 2021, thus, placing the country in a high-risk category. Nepal ranks 4th, 11th, and 30th position out of 200 countries in term of vulnerability to climate change, earthquake, and flood respectively.

In addition to geophysical and hydro-meteorological conditions, factors such as poor socio-economic conditions of people, poverty, weak human development index, unplanned and scattered human settlement, environmental pollution, and challenges to mainstream disaster risk reduction in sustainable development and rational planning process further exaggerate the risk of disaster in Nepal.

This monographic issue analyzes the disaster risk (hazard, exposure and vulnerability) of Nepal including the trend and loss (in term of death, injury, families affected, and economic

loss) of a major disaster that occurred in Nepal for the last 10 years from the year 2011-2020. The data on disaster incidents used in the report are based on the Nepal Ministry of Home Affairs's (focal ministry for disaster risk reduction and management in Nepal) disaster risk reduction portal database from 2011-2020. Based on the DRR portal database, simple numerical calculations were used for quantitative analysis, and subsequently, the information was summarized in form of tables, figures, and graphs.

Disaster risk management initiatives, existing disaster risk management institutions and mandate, the current status of the country for sendai framework for disaster risk reduction, issues in the implementation of disaster risk reduction and climate policy, and future challenges and priority areas of Nepal are also explained in this report.

Prof. Pedro Arcos, Prof. Rafael Castro

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ORIGINAL RESEARCH



Disaster Risk Profile of Nepal

Prinka Singh

List of Abbreviations

AAL	Average Annual Loss
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
CBO	Community-based Organization
CC	Climate Change
CNDRC	Central Natural Disaster Relief Committee
CR	Climate Resilience
CSSF	Comprehensive School Safety Framework
DHM	Department of Hydrology and Meteorology
DIMS	Disaster Information Management System
DoH	Department of Health
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DRRM	Disaster Risk Reduction Management
DUDBC	Department of Urban Development and Building Construction
EOC	Emergency Operation Center
EWS	Early Warning System
GDP	Gross Domestic Product
GLOF	Glacier Lake Outburst Flooding
GoN	Government of Nepal
HDI	Human Development Index
HFA	Hyogo Framework for Action
IDNDR	International Decade for Natural Disaster Reduction
IFRC	International Federation of Red Cross and Red Crescent Societies
INFORM	Index for Risk Management
INGO	International Non-governmental Organization
KM	Kilometer
MoAD	Ministry of Agriculture Development
MoE	Ministry of Education
MoEn	Ministry of Environment
MoFALD	Ministry of Federal Affairs and Local Development
MoFSC	Ministry of Forests and Soil Conservation
MoHA	Ministry of Home Affairs
MoHP	Ministry of Health and Population
MoI	Ministry of Industries
MoSTE	Ministry of Science and Technology and Environment
MoUD	Ministry of Urban Development
MoWRs	Ministry of Water Resources

NDRRMA	National Disaster Risk Reduction and Management Authority
NGO	Non-governmental Organization
NPC	National Planning Commission
NRA	National Reconstruction Authority
NRCS	Nepal Red Cross Society
NRRC	Nepal Risk Reduction Consortium
NSDRM	National Strategy for Disaster Risk Management
NST	Nepal Standard Time
PDRF	Post-disaster Recovery Framework
SAR	Search and Rescue
SDG	Sustainable Development Goal
SFDRR	Sendai Framework for Disaster Risk Reduction
SOP	Standard Operating Procedures
SSP	School Safety Program
UN	United Nations
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
VDC	Village Development Committee
WECS	Water and Energy Commission

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1. Introduction

1.1. General Background

Nepal is officially known as the Federal Democratic Republic of Nepal (1). It is located in South Asia and is a small landlocked nation (1). It is located between the latitudes of 26'22" to 30'27" in north and the longitudes of 80°4' to 88°01'2" in the east (1). It has a total landmass area of 147,516 square kilometers (KM) (2). It runs 145 to 241 KM from north to south and 885 KM from east to west (2). Nepal shares its border with the Republic of India and the People's Republic of China (1). China is located to the northern border to Nepal whereas India shares borders to Nepal in the east, south, and west (1). Nepal while maintaining its independent nation-state,

Characteristics	Remarks
Capital	Kathmandu
Official Language	Nepali
Government	Federal Parliamentary Republic
Total Area	147,516 square kilometer
Gross Domestic Product (GDP) growth rate	7.91%
Human Development Index (HDI)	0.602: Medium (142th out of 189 countries)
Life expectancy	71.7 years
Population below the poverty line	11.20%
Table 1: Demographics Information of Nepal Source: https://www.worldometers.info/demographics/nepal-demographics	

is working progressively to maintain a balance between its two neighbor countries with their foreign policy (1). Nepal is a Himalayan country and is recognized for its extreme mountains (1). Among the global highest top 10 peaks, eight are situated in Nepal including the world highest peak Mount Everest (1).

1.2. Geography

In terms of topographic features from north to south, Nepal is divided into three geographical regions-Himalayan, Mountain Hill, and Plain Terai (2). 15% of the total area is covered by the Himalayan region, 68% by mountain hill region, and 17% by plain terai respectively (2). Therefore, Nepal has a rough landscape and topography with complex geographical structures and variable climatic conditions (2). It is characterized by an active tectonic process resulting in continued seismic activities (2). The altitude of the country rises from 70 meters in Terai to 8848 meters Mount Everest in the north within a short horizontal distance of 145 to 241 KM (2). Since the country has a sharp vertical landscape, this makes Nepal highly vulnerable to multiple hazards including potential water-induced disasters such as flood, landslide, soil erosion, debris flow, and slope failure (2).

1.3. Administrative Division

Nepal is a federal republic that consists of 7 provinces (1). There are 8 to 14 districts in each province (1). The districts are further divided into local units known as urban municipalities and rural municipalities (1). The local units, in turn, are composed of wards (1). Nepal has a total of 753 local units which includes 6 metropolitan municipalities, 11 sub-metropolitan municipalities, and 276 municipalities for a total of 293 urban municipalities and 460 rural municipalities (2). There are 6,743 wards in total (2).

Each local government has its local authority, power, and jurisdiction, and thus, they can enjoy legislative, executive, and limited judicial power in their local territory (2). The provinces have a unicameral parliamentary Westminster system of governance (2). Some absolute powers are exercised by provincial and local governments whereas some powers are shared between federal and/or provincial governments (2).

1.4. Demography

According to the Nepal census 2011, the total population of Nepal is 26,494,504 which shows a population growth rate of 1.35 per annum (3). Likewise, 5,427,302 were the total number of households reported in the country (3). Among the total number of households, there were 5,423,297 individual households and 4,005 institutional households (Barracks, Hostels, Monasteries, etc) (3).

Nepal is declared as a secular state in March 2008 (3). Nepal is a multi-ethnic, multicultural, multilingual, and multireligious country (2). There are four major language groups in Nepal which are Indo-Aryan, Tibeto-barmen, Mongolian, and indigenous language isolates (2). This diversity makes Nepal a diverse linguistic heritage (2). Further, there are 102 ethnic groups, 92 linguistic and 6 religious people living in Nepal with peace, social harmony, and unity (2). The Nepalese population mostly consists of Indo-Aryan and Mongol races (2). In terms of religion, the majority of the population are Hindus (80.6%) followed by Buddhist (10.7%), Islam (4.2%), Kirat (3.6%), Christians (0.5%), and the others (0.4%) (2).

1.5. Socio-economic

The Human Development Index of Nepal is 0.602 and ranks 142 positions globally (4). The life expectancy at birth in Nepal is 71.7 years where female life expectancy is 73.2 years whereas male life expectancy is 70.1 years (4). Similarly, the literacy rate of men is 89% whereas the literacy rate of women is only 69% (4). Likewise, the total fertility rate is 2.3 births per woman (4). The neonatal mortality rate is 21 deaths per 1000 live births while the under-five mortality rate is 39 deaths per 1,000 live births (4). In between the years 1996 and 2016, the neonatal mortality rate fell from 50 to 21 deaths per 1,000 live births, infant mortality declined from 78 to 32 deaths per 1,000 live births, and under-five mortality decreased from 118 to 39 deaths per 1000 live births (4).

1.6. Climate

There are five climatic zones and conditions in Nepal broadly corresponding to the altitudes from subtropical to arctic (2). The tropical and subtropical zone lies below 1200 meters, the temperate zone is in between 1200 to 2400 meters, the cold zone lays in between 2400 to 3600 meters, the subarctic zone is in between 3600 to 4000 meters and the arctic zone lies above 4400 meters (2). There are four major seasons in Nepal- winter, spring, summer, and autumn (2). Winter is in between December to February, spring is in between March to May, summer starts from June till August, and finally, autumn is in between September to November (2). From June to mid-September, the monsoon becomes active that brings about 80% of the rainfall during that period (2). The rest of the seasons are usually dry (1). The most pleasant seasons in Nepal are spring and autumn (2). During winter, in the Himalayan and mountain region, the temperature declines to freeze with a high level of snowfall (2).

2. Risk Profile of Nepal

2.1. Background

Natural hazards pose the most common and devastating disasters in Nepal (5). Due to the country's complex topography, diverse geography, active tectonic plates, and natural environmental factors, Nepal is extremely vulnerable to disasters (5).

Vulnerability to Hazards	Ranking (out of 200 countries)
Climate Change	4 th
Earthquake	11 th
Flood	30 th

Table 2: Vulnerability Ranking of Nepal to major Hazards
 Source: <https://www.np.undp.org/content/nepal/en/home/energy-environment-climate-and-disaster-risk-management/in-depth.html>

Table 2 shows that Nepal rank 4th, 11th and 30th position out of 200 countries in term of vulnerability to climate change, earthquake, and flood respectively. Flood and landslides are the major natural disasters that occur in Nepal (6). Further, Nepal is also equally at risk due to its seismic activity (6). Nepal is geographically unstable due to the subduction of the Indian tectonic plate into the Eurasian (Tibetan) plate that has been continually thrusting the Himalayas upwards since its formation millions of years ago (6).

In addition to geophysical and hydro-meteorological conditions, factors such as poor socio-economic conditions of the people, poverty, weak HDI, unplanned and scattered human settlements in the rural areas, large scale unplanned urban concentration, environmental pollution, inadequate coping abilities of communities, and challenges to mainstream disaster risk reduction (DRR) in sustainable development and rational planning process further exaggerate the risk of disaster (6).

2.2. Country Risk Status

The Index for Risk Management (INFORM) Global Risk Index for Nepal is 5.2 in 2021 placing the country in a high-risk category. The trend of INFORM risk and lack of coping capacity in the last 3 years of Nepal shows a similar pattern. However, hazard and exposure show an increasing trend whereas vulnerability shows decreasing trend for the last 3 years.

Likewise, in the year 2021. hazard and exposure dimensions were high with a score of 5.7. Similarly, vulnerability and lack of coping capacity were medium with a score of 4.5 and 5.6 respectively.

The trend of inform risk and lack of coping capacity in the last 3 years of Nepal is in a similar pattern. However, the hazard and exposure dimension shows an increasing trend whereas the vulnerability dimension shows a decreasing trend for the last 3 years.

2.3. Major Natural and Man-made Hazards in Nepal

Due to the rugged topography and variable climatic conditions, Nepal which is located in the central Himalayan range is one of the most disaster-prone countries in the world (7). The major disasters that occur in Nepal in the past which have significantly damaged the infrastructure, environment, and have contributed to physical and economic loss include earthquakes, landslides, floods, fire, and thunderbolts (7).

Nepal's topography varies from the Himalayan mountain range and hills to low-lying plains which creates an equally diverse setting for disasters to occur (6). For example, due to monsoon rains and a complex river system, seasonal flooding mostly occurred in the Terai plains (6). Likewise, on the other hand, hilly and mountainous regions are at high risk for landslides and Glacier Lake Outburst Flooding (GLOF) events due to the vicinity of glacier lakes (6). In addition, due to unplanned urban expansion and growth, urban areas are most vulnerable to seismic activity (6). Similarly, mountainous regions are also vulnerable to seismic activity as earthquake-induced landslides are more likely to occur there (6). However, it is important to remember that earthquakes have the potential to affect the whole country (6).

As per the economic vulnerability analysis of Nepal, due to its large exposure to risk and the high level of hazards, Nepal exhibits the largest economic losses (7). These phenomena not only cause loss of lives and properties but can also equally damage and poses threat to physical infrastructure and can also disturb the economic development of the country (7). The most commonly occurring hazards in Nepal and their likely zones are given below (7).

Types of Hazard	Prevalence
Natural Hazards	
Earthquake	All over the country (all parts of Nepal is vulnerable to earthquake)
Flood	Terai and middle hills
Landslide and landslide dam break	Hills and mountains
Debris flow	Hills and mountains (severe in areas if elevation greater than 1700 meter that is covered by glacial deposits of the previous ice-age)
Glacier Lakes Outburst Flood (GLOF)	Origin at the tongue of glaciers in higher Himalayas, higher mountains, and flow reach up to middle hill regions
Avalanche	Higher Himalayas
Forest fire	Hills and terai (forest belt at foot of southernmost hills)
Drought	All over the country
Storms/hailstones	Hills
Man-induced Hazard	
Epidemics	Terai and hills, and also in lower parts of a mountain region
Fire settlement	Mostly in terai and also in mid-hill region
Accidents	Urban areas along with road network
Industrial/technological hazards	Urban and industrial areas
Soil erosion	Hilly región
Soil disruptions	Follows disaster-affected areas and politically disturbed areas

Table 3: Major Natural and Man-made Hazards in Nepal

Natural and Man-Made Disaster in Nepal (2000-2020)

Type		Category	Death	Injured	Affected
Natural	Hydrological	Flood	2,836	1,245	4,231,746
		Landslide	1,089	141	374,896
	Climatological	Drought	0	0	503,000
		Wildfire	11	0	0
	Geophysical	Earthquake	8,976	20,449	5,810,099
	Biological	Epidemic	764		65,080
	Meteorological	Extreme temperature	267	200	25,200
Storm		111	787	15,029	
Technological		Transport accident	1,448	518	544
		Miscellaneous accident	81	99	2,166
Total			15,583	23,439	11,027,760

Table 4: Natural and Man-made Disaster in Nepal (2000-2020)Source: <https://public.emdat.be/data>

Table 4 shows that from 2000-2020, 15,583 people were killed, 23,439 people were injured and about 11 million people were affected by disaster in Nepal. Among the total number of death, 57.60% (n=8976) were reported from earthquakes followed by flood (18.19%), transport accidents (9.29%), and landslides (6.98%).

Disaster	Number of events	Death	Affected Family	Injured
Fire	14,711	651	20,700	1,946
Thunderbolt	2,194	995	2,087	2,657
Landslide	2,121	1,206	7,565	996
Flood	1,602	794	64,874	178
Heavy Rainfall	1,244	96	5,029	270
Animal Incidents	613	88	1,056	434
Wind Storm	588	82	16,043	1,444
Cold Wave	116	116	48	0
Snake Bite	116	65	116	56
Earthquake	95	8,969	10	22,304
High altitude	83	78	85	13
Epidemic	76	95	442	1,916
Storm	67	63	42	46
Boat Capsize	31	50	39	45
Avalanche	19	40	11	23
Air Crash	8	56	12	38

Hail Storm	8	0	2,042	2
Hail Stone	8	0	3,127	0
Forest Fire	7	0	2	0
Snow Storm	5	12	165	0
Flash Flood	3	43	31	0
Wire Bridge Accident	2	0	0	0
Bridge Collapse	1	2	0	12
Sinkhole	1	0	1	0
Other	226	124	326	201
Total	23,945	13,625	123,853	32,581

Table 5: Natural and Man-made Disaster in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Table 5 represents that a total of 23,945 disaster events was recorded between the period 2011-2020 in Nepal. The maximum event reported was fire (61.43%) followed by a thunderbolt (9.16%), landslide (8.85%), and flood (6.69%). The number of deaths for the period of 2011-2020 summed up to 13,625. 32,581 people were injured and 123,853 families were affected by disaster. Earthquakes, landslides, thunderbolts, and floods were major disasters in terms of deaths.

2.4. Trend of Disaster in Nepal (2011-2020)

In Nepal, MoHA is a focal ministry for disaster risk management and it has taken the lead in post-disaster response especially in managing rescue and relief operations through the mobilization of security forces and other humanitarian actors which is organized by Disaster Relief Committees at the national, provincial, district, and local levels (6). The MoHA maintained an open publicly accessible free DRR portal that has been critical in providing access to information and updates on DRM operations in Nepal (6). It serves as a depository station as well as a data bank for DRM legal frameworks, strategies, and plans as well as information on disaster occurrences and response initiatives as well as other DRM operations (6). Thus, the data of disaster incidents used in this report are based on MoHA's DRR portal database from 2011-2020. The database includes information on:

- Year, month, and date of occurrence of disaster
- Name of district, Village Development Committee (VDC)/municipality, and ward of occurrence of disaster
- Number of persons killed and injured from disaster
- Number of families affected by disaster
- Economic loss from disaster
- Number of government and private houses partially and completely damaged by disaster
- Loss of cattle/livestock from disaster

Based on the DRR portal database, simple numerical calculations were used for quantitative analysis, and subsequently, the information was summarized in the form of tables, figures, and graphs by using excel. In this report, disaster casualties are defined as the sum of deaths and injuries resulting from a disaster. Moreover, to calculate the disaster death rate per million populations, the total number of disaster fatalities was divided by the average population for the period of 2011-2020 and then the resultant was multiplied by 1,000,000.

Sources used for the population of Nepal

<https://www.worldometers.info/world-population/nepal-population/>

<https://data.worldbank.org/indicator/SP.POP.TOTL?end=2019&locations=NP&start=2011>

2.4.1. Disaster Events in Nepal

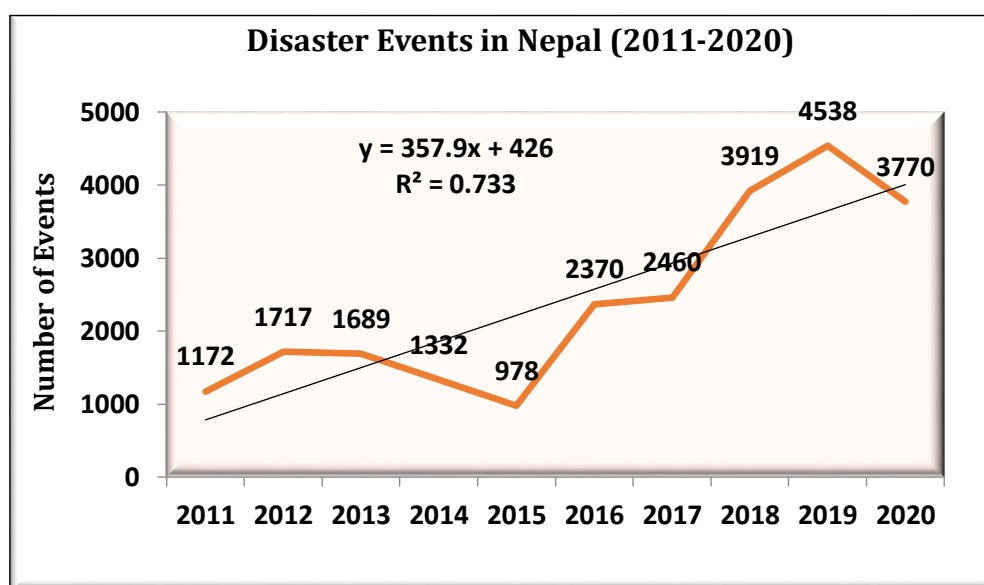


Figure 1: Disaster Events in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 1 represents that the number of disaster events for the past 10 years shows an increasing trend. The number of disaster incidents increased by 221.67% in the year 2020 compared to the year 2011. R-square value of 0.733 further suggests the strong temporal relationship between the number of disaster incidents with time. The highest number of disaster events were reported in the year 2019 (disaster events=4538) followed by the year 2018 (disaster events=3919). This increase in the number of disaster events could be because of improving the recording and reporting system of catastrophic events with time. Furthermore, Nepal is experiencing climate change, which is causing the regular temperature, rainfall, and monsoon pattern to fluctuate. Likewise, poverty, migration, urbanization, and environmental degradation are also constantly increased. These factors might also have increased the number of disaster events over time.

2.4.2. Disaster Events in Province of Nepal

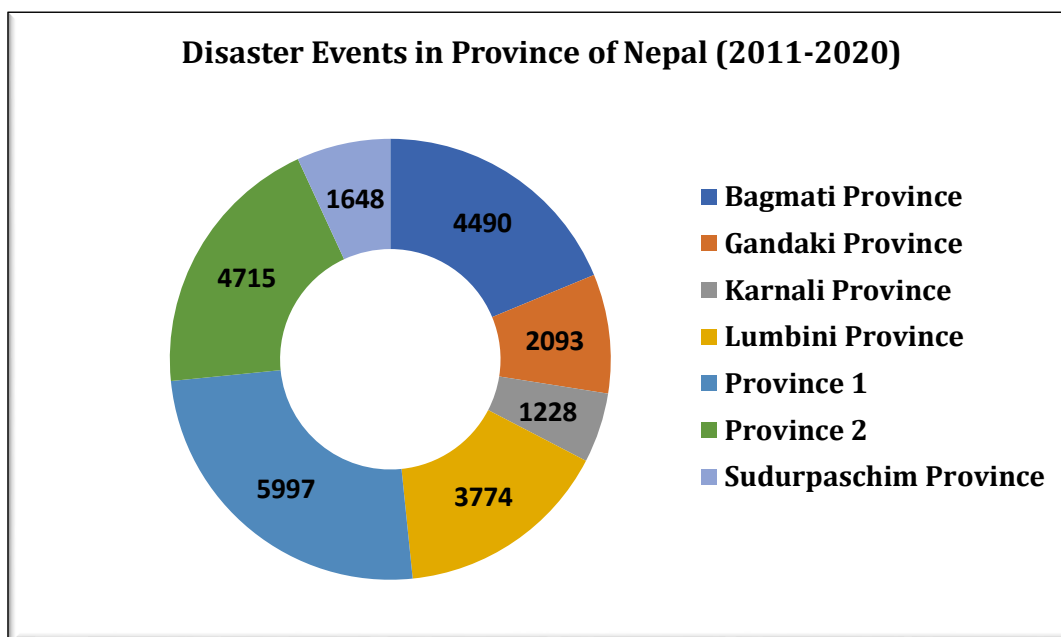


Figure 2: Disaster Events in Province of Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

There is a total of 7 provinces in Nepal and each province consists of 8 to 14 districts. Figure 2 reveals that the numbers of disaster events from the period 2011-2020 were highest in Province 1 (25.04%) followed by Province 2 (19.69%), Bagmati Province (18.75%), Lumbini Province (15.76%), Gandaki Province (8.74%), Karnali Province (6.88%), and Sudurpaschim Province (5.13%).

2.4.3. Disaster Casualties in Province of Nepal

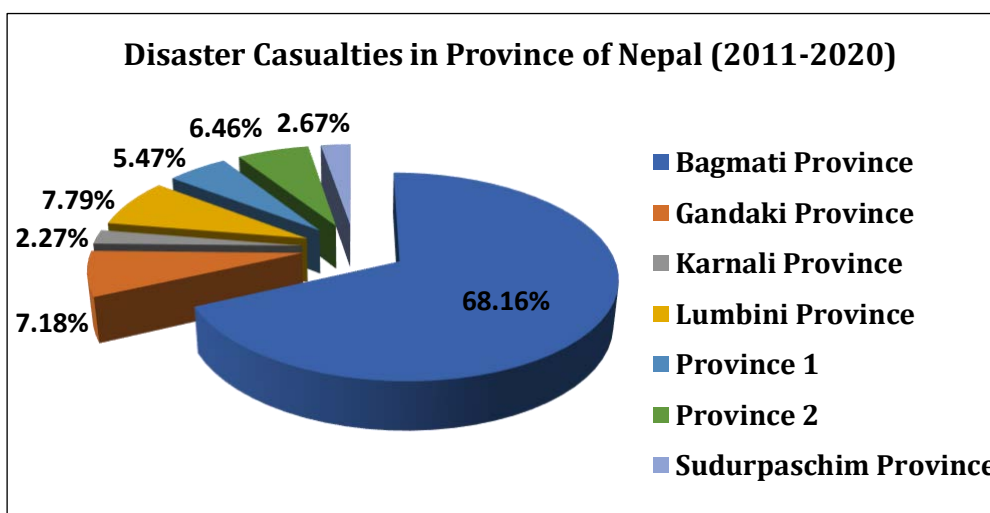


Figure 3: Disaster Casualties in Province of Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 3 shows that the more than two-third of casualties were reported from Bagmati Province (68.16%) followed by Lumbini Province (7.79%), and Gandaki Province (7.18%). Likewise, 6.46%, 5.47%, 2.67% and 2.27% of disaster casualties were reported from Province 2, Province 1, Karnali Province, and Sudurpaschim Province respectively.

2.4.4. Death and Death Rate from Disaster in Nepal

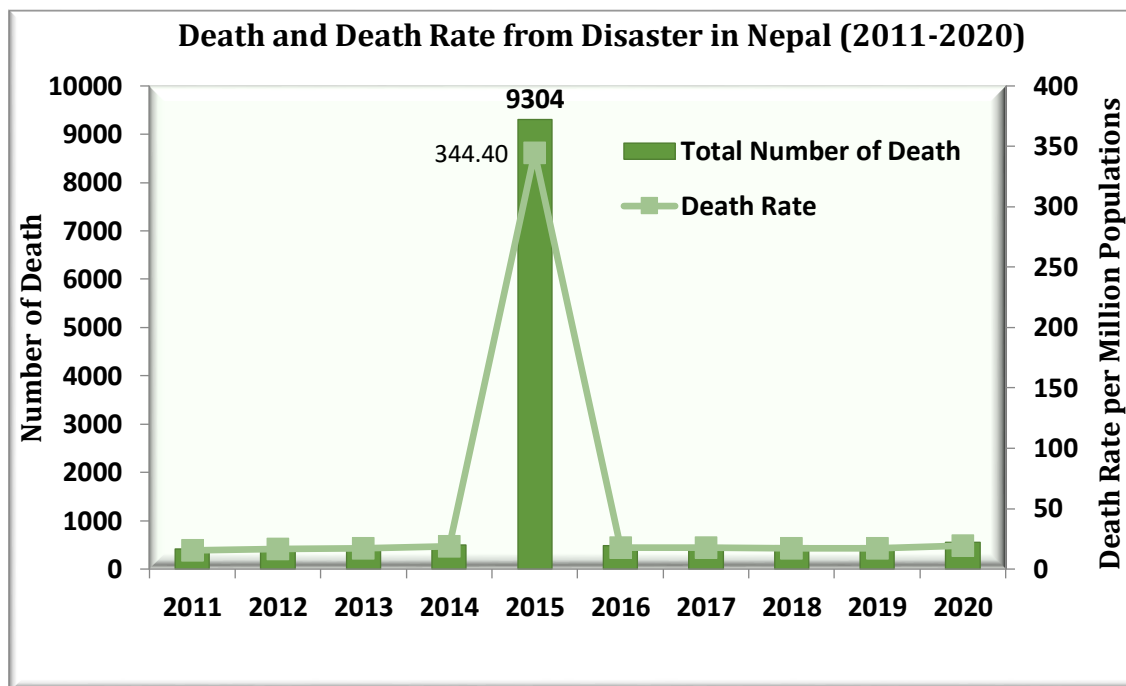


Figure 4: Death and Death Rate from Disaster in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 4 shows that with compared to the year 2011, the number of fatalities of disaster increased by 33.73% in the year 2020. The death rate from disaster per million populations in the year 2011 and 2020 was 15.46 and 19.19 respectively. The number of deaths and death rate shows a gradual increasing pattern from 2011 till 2014. In 2015, the number of deaths and death rate dramatically increased (number of deaths=9,304 and death rate=344.40 per million population) by 20 folds. It was because of massive earthquake that occurred in April 2015 resulting in large number of casualties. From 2016 to 2018, the trend was in fluctuating pattern followed by upward trend in the year 2019 and 2020.

2.4.5. Injury and Families affected by Disaster in Nepal

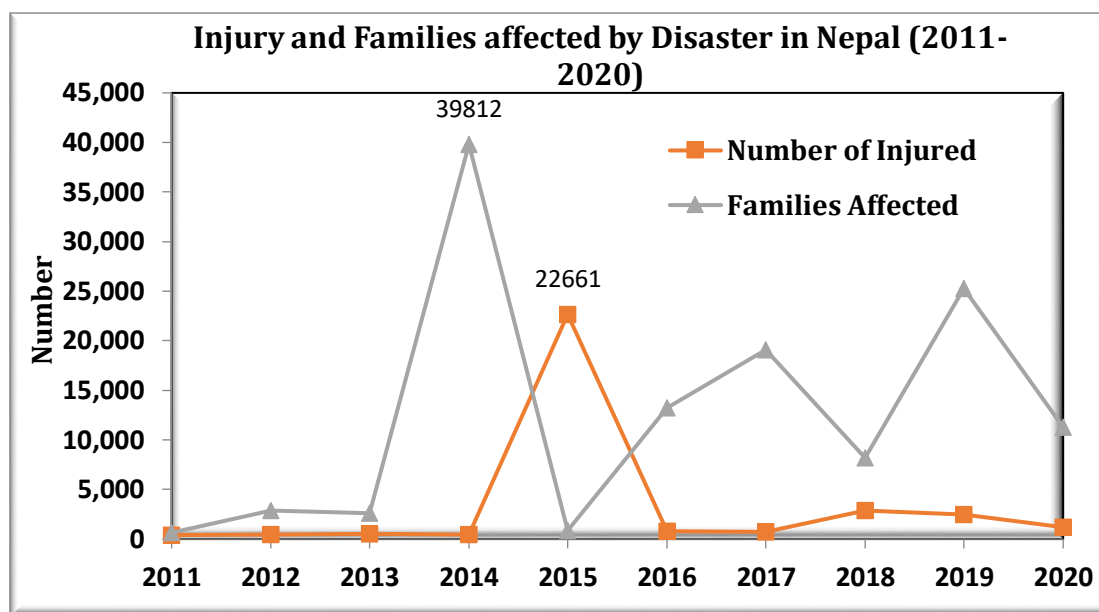


Figure 5: Injury and Families affected by Disaster in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 5 indicates that the number of injured from disaster was 1,175 and 408 in the year 2020 and 2011 respectively. The maximum number of injuries were reported in the year 2015 because of the Nepal earthquake 2015 leaving many people injured. Similarly, the number of families affected by disaster was 11,314 in 2020 whereas 649 in 2011. The maximum number of families affected was reported in the year 2014 which was 39,812. It was because of massive deadliest landslides of the year 2014 that block the Sunkoshi River which poses flood risk for many people thereby making them displaced from their own home.

2.4.6. Disaster Casualties in Nepal

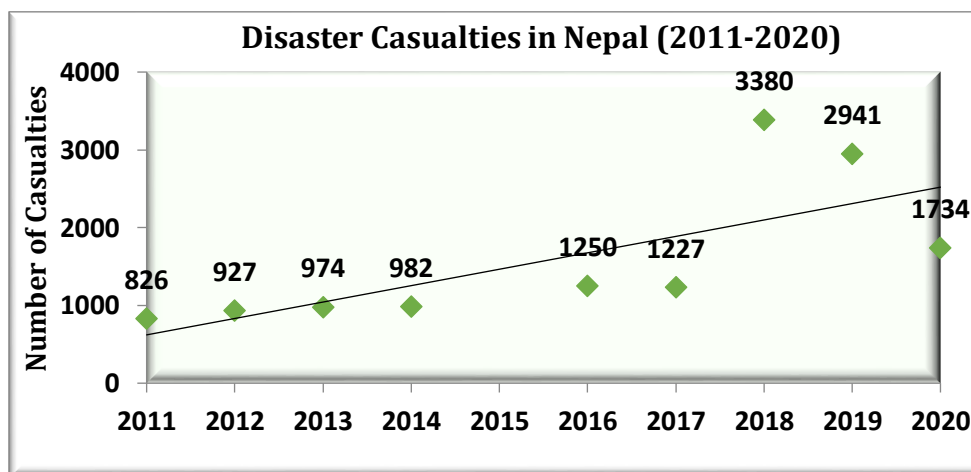


Figure 6: Disaster Casualties in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 6 indicates that the number of overall disaster casualties shows an increasing trend for the last 10 years. The graph shows a linear relationship between the number of disaster casualties and time with a correlation coefficient of 0.72, thereby, indicating a strong temporal relationship between the disaster casualties and time.

(Note: Year 2015 was excluded for this analysis because of large number of casualties in that year reported mostly from earthquake only)

2.4.7. Monthly Trend of Disaster Events and Casualties in Nepa

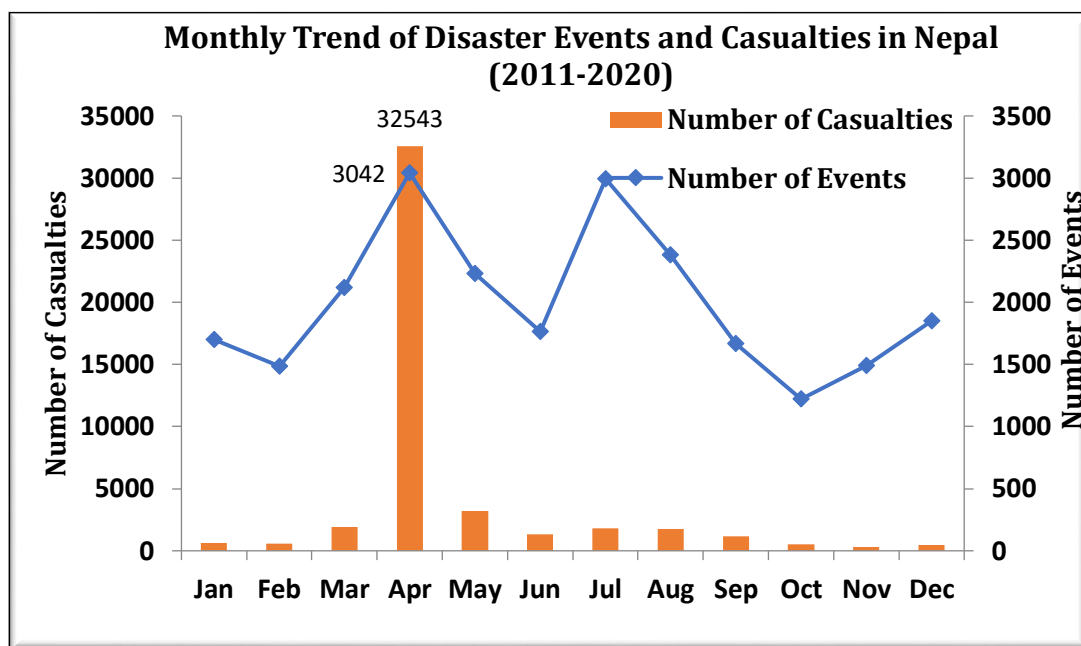


Figure 7: Monthly Trend of Disaster Events and Casualties in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 7 reveals that the disaster casualties and disaster events declined in February month in compared to January that subsequently increased in March and attained the highest peak at April (with 3,042 events and 32,543 casualties). From May to December, both disaster casualties and disaster events shows a fluctuating trend. The second peak for disaster casualties and disaster events were observed in the month of May and July respectively. Likewise, the lowest number of disaster casualties were reported in the month of November (casualties=281) whereas lowest number of disaster events were reported in the month of October (events=1,221).

2.4.8. Seasonal Trend of Disaster Events and Casualties in Nepal

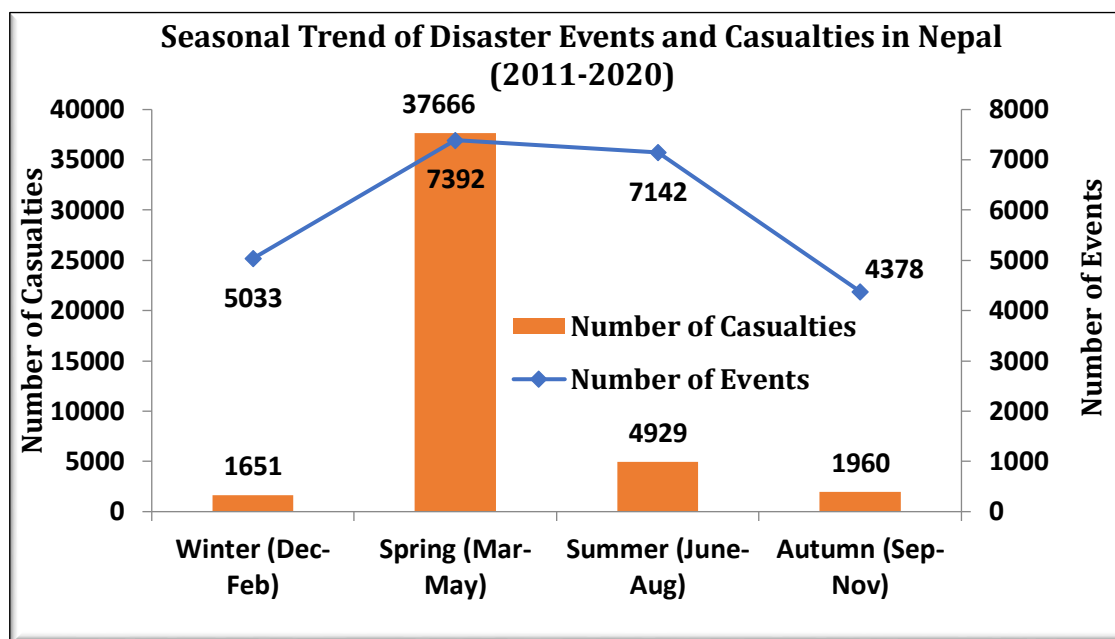


Figure 8: Seasonal Trend of Disaster Events and Casualties in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 8 shows that the maximum number of disaster events and disaster casualties occur in the spring season (81.52% of disaster casualties and 30.87% of disaster events) from March to May followed by summer (10.67% of disaster casualties and 29.83% of disaster events) from June to August, Autumn (4.24% of disaster casualties and 18.28% of disaster events) from September to November, and winter season (3.57% of disaster casualties and 21.02% of disaster events) from December to February. In Nepal, the monsoon becomes active from June to mid-September which brings about 80% of the rainfall during that period and disaster events were mostly seen in pre-monsoon.

2.4.9. Top 10 Disaster Incidents in Nepal (2011-2020)

Date	Incident	Province/District	VDC/Municipalities	Number of Casualties
25 April 2015	Earthquake	All over Nepal		31,264
26-30 May 2018	Epidemic	Lumbini Province/Dang	Shantinagar Rural Municipality	1,837
31 March 2019	Wind Storm	Province 2/Bara	Pheta Rural Municipality	1,149
6 June 2019	Wind Storm	Sudurpaschim Province/Kailali	Dhangadhi Submetropolitan City	86
2 August	Landslide	Bagmati	Mankha VDC	80

2014		Province/Sindupalchowk		
14 August 2014	Flood	Karnali Province/Surkhet	NA	60
12 June 2015	Landslide	Province 1/Taplejung	NA	47
26 October 2016	Fire	Bagmati Province/Makwanpur	Hetauda Submetropolitan City	47
14 August 2020	Landslide	Bagmati Province/Sindupalchowk	Jugal Rural Municipality	42
13 August 2014	Flood	Lumbini Province/Bardiya	NA	35

Table 6: Top 10 Disaster Incidents in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Table 6 indicates the top 10 disaster incidents in terms of casualties in Nepal for the period of 2011-2020. This is based on the total cumulative occurrence of disaster casualties of particular incidents at a particular point/period of time. These 10 events have resulted about 74.99% of total disaster casualties from 2011-2020. The largest casualty incident reported was earthquake on 25 April 2015 that resulted in 31,264 casualties followed by an epidemic on 26-30 May 2018 that reported 1,837 casualties. It has been observed that, out of these 10 events, 6 have occurred during the summer season alone. Out of these 10 disaster events, the maximum occurred in Bagmati Province (3 out of 10) followed by Lumbini Province (2 out of 10).

2.5. Exposure

2.5.1. Migration and Employment

Search for better employment opportunities is one of the main factors of domestic migration in Nepal (8). Due to the large-scale migration of people for agriculture and better employment opportunities, the Terai plains and large cities like such as Lalitpur, Bhaktapur, and Kathmandu are the fastest expanding in the country whereas mountainous areas are suffering negative population growth (8). Poverty, lack of economic possibilities, and lack of basic facilities in rural areas are just a few of the many push factors that induce domestic and international migration (8). Migration has also aided uncontrolled urbanization in Kathmandu, the capital city of the country (8). Between 1992 and 2012, Kathmandu Valley had a 211% expansion in its built-up areas but at the price of equivalent loss of agricultural land (8). As a result, urban dangers in Kathmandu valley have elevated because of these uncontrolled practices along with dramatically increased congestion (8). Furthermore, the districts of the Terai plains are facing exceptionally high youth unemployment as a result of excessive internal migration for probable agricultural jobs and opportunities (8). As the Terai region is very vulnerable to seasonal floods, an increasing population and a high number of

jobless people may indicate increased vulnerabilities as a result of poverty in the Terai plains (8).

2.5.2. Environment Degradation

Another area of concern is environmental degradation and deterioration which is the outcome of inadequate land use and land cover planning as well as unregulated urbanization (8). Unplanned settlement is accompanied by an increase in the number of squatters, river contamination from untreated wastewater and industrial waste discharged directly into rivers, insufficient sanitary facilities, and poor solid waste management (8). This represents a serious health concern because persons living in filthy surroundings are more likely to come into touch with pollutants that can transmit diarrheal illnesses (8). Furthermore, populations living near stagnant bodies of water are more susceptible to contract cholera, typhoid, and mosquito-borne infections, particularly during the monsoon season (8). Poor waste management also influences groundwater (8). It has been shown that more than half of the Kathmandu valley is vulnerable to groundwater contamination (8). In addition, lung diseases including bronchitis and asthma are becoming more common as a result of air pollution (8).

2.6. Vulnerability

2.6.1. Physical Vulnerability

Hydroelectric power has been regarded as a significant resource for future economic growth to enhance the stagnant industrial and manufacturing sectors (8). This is because the future of industrial growth in Nepal is significantly reliant on constant and sustainable energy production (8). Although hydropower generates 90% of Nepal's electricity, the present built capacity is just 786 megawatts as compared to the theoretical maximum production capability of 43,000 megawatts (8).

To improve the efficient use of water resources, the Government has invested in around 223 dam projects that are now in various phases of development around the nation (8). The trend of building large-scale hydropower plants in high-risk areas is not without worry (8). Earthquakes and landslide dams that block rivers can disrupt operations and can cause damage to facilities (8). In addition, droughts have a significant influence on hydroelectric energy generation since it is dependent on steady river flow (8). Besides, dams have an impact on river ecosystems thereby affecting natural fish populations and the fishermen's livelihoods (8). Likewise, increasing the dependency of agriculture on seismically sensitive reservoirs can put the hydropower facilities' safety in concern (8).

Most of the development sites are also located in areas that are especially prone to GLOF incidents (8). Furthermore, many of the newly constructed structures are seismically dangerous due to a lack of seismic technology, qualified masons or engineers, and the perceived high cost of seismic-resilient construction (8). Because the majority of the destroyed buildings were non-engineered stone or masonry structures,

the repercussions of dangerous building methods became visible during the 2015 earthquake (8).

2.6.2. Social Vulnerability

For the formation of disaster risk, multi-dimensional vulnerability plays an important role (8). Incorporating evaluations of socio-economic characteristics (such as caste, ethnicity, job, and gender) that contribute to social vulnerability, as indicated by an awareness of geographical qualities and intersectionality particular to certain demographic traits, is critical to understanding the creation of disaster risk (8). For example, as a result of hazards affecting agricultural productivity in the nation, around 13% of the population is malnourished (8). However, the consequences of food scarcity are not uniformly spread (8). Moderate stunting due to malnourishment is more likely to affect children living in mountainous areas and children of working women (8). Likewise, severe stunting is more common in children from rural areas and children from the poorest households (8). Furthermore, the emigration of male populations leaves vulnerable groups such as women, elderly and children inhabiting the rural regions and they are highly dependent on subsistent farming or remittances sent by men (8). As a result of their reliance on small-scale agriculture and restricted access to other livelihood alternatives because of their socio-economic status, women in rural areas are becoming increasingly vulnerable to hazards and climate change (8).

2.7. Disaster Loss

Nepal is seeing an increase in the number of deaths and damages as a result of numerous natural and man-made disasters (9). Many people have died, been injured, or gone missing as a result of natural catastrophes (9). Similarly, disaster in Nepal has also resulted in the loss of animals, infrastructure and agricultural land (9).

Damage and Loss from Disaster in Nepal (2011-2020)

Incident	Estimated Loss (in US\$)	Govt. Houses Fully Damaged	Govt. Houses Partially Damaged	Private House Fully Damaged	Private House Partially Damaged	Cattle Loss
Animal Incidents	138,639	0	1	22	417	4
Avalanche	0	0	0	0	0	250
Earthquake	47,035	2,687	3,776	773,110	299,034	0
Epidemic	15,393	0	0	0	0	0
Fire	163,067,933	4	4	16,259	2,760	13,877
Flash Flood	94,070	0	0	31	0	69
Flood	142,753,079	0	0	11,248	41,875	2,826
Forest Fire	6,157	0	0	0	0	0

Hail Storm	0	0	0	0	2,039	0
Hail Stone	6,764	0	0	0	2	0
Heavy Rainfall	3,386,057	3	1	1,097	551	296
Landslide	14,692,284	3	0	2,765	2,520	2,977
Other	27,379	0	0	12	69	10
Sinkhole	30,359	0	0	0	0	0
Snow Storm	453,977	0	0	0	0	1,634
Storm	97,536	0	0	103	132	0
Thunderbolt	523,649	0	0	132	303	2,121
Wind Storm	1,550,541	0	2	2,081	3,987	3,604
Total	326,890,852	2,697	3,784	806,860	353,689	27,668

Table 7: Damage and Loss from Disaster in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Table 7 reveals that from 2011 to 2020 fire, flood, and landslide were major disasters in terms of damages and losses. There was loss of about 327 million US dollars from disaster during the period of 2011-2020. In between the year 2011-2020, a total of 2,697 and 3,764 government houses were fully and partially damaged. Likewise, 806,860 and 353,689 private houses were fully and partially damaged. There were 27,668 losses of cattle as well during that period.

2.8. Economic Loss from Disaster in Nepal

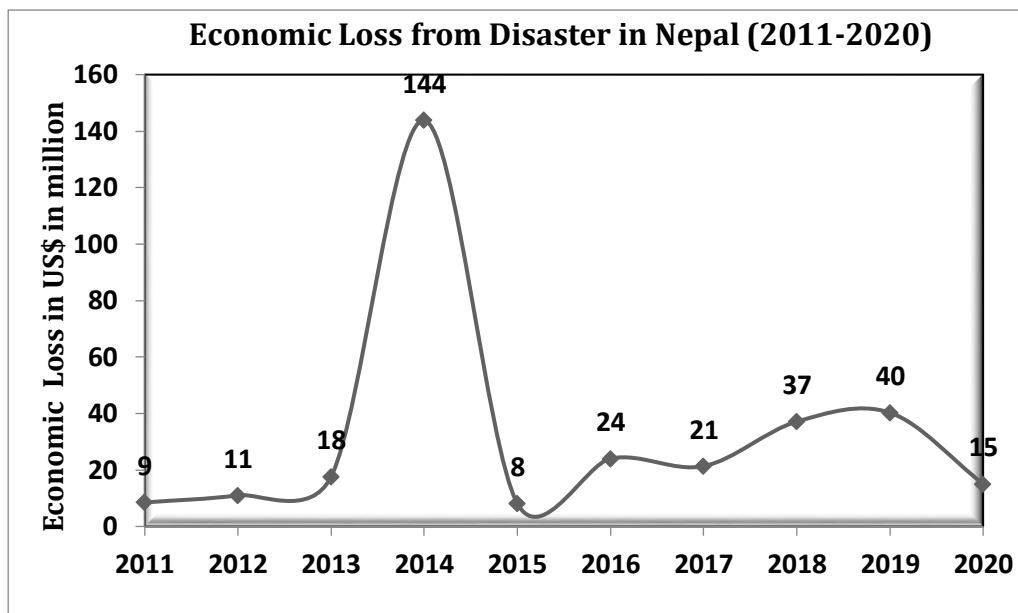


Figure 9: Economic Loss from Disaster in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 9 illustrates that there was a total loss of about 327 million US dollars during the period from 2011-2020 from disaster. The economic loss for the last 10 period shows the fluctuation trend with the highest peak in 2014 with an economic loss of 144 million US dollars.

3. Major Disasters in Nepal

3.1. Landslide

3.1.1. Introduction

Landslide is one of the most prevalent and common natural hazards in hilly and mountainous areas of Nepal (10). Landslides are caused by both natural and human factors such as steep slopes, weak geology, heavy rainfall, deforestation, and unplanned human developments (10). Anthropogenic activities such as poor land usage, expansion into susceptible land slopes and unplanned development activities such as road and irrigation canal-building without sufficient protection and protection measures in the susceptible mountain belt have further heightened the danger of landslide (11). Because of the steep topography and fragile ecosystems, the hilly regions of Nepal in the Siwalik, Mahabharat range, Midland, and also the fore and the upper Himalayas are especially prone to landslides (11).

3.1.2. Trend of Landslide in Nepal (2011-2020)

3.1.2.1. Landslide Events in Nepal

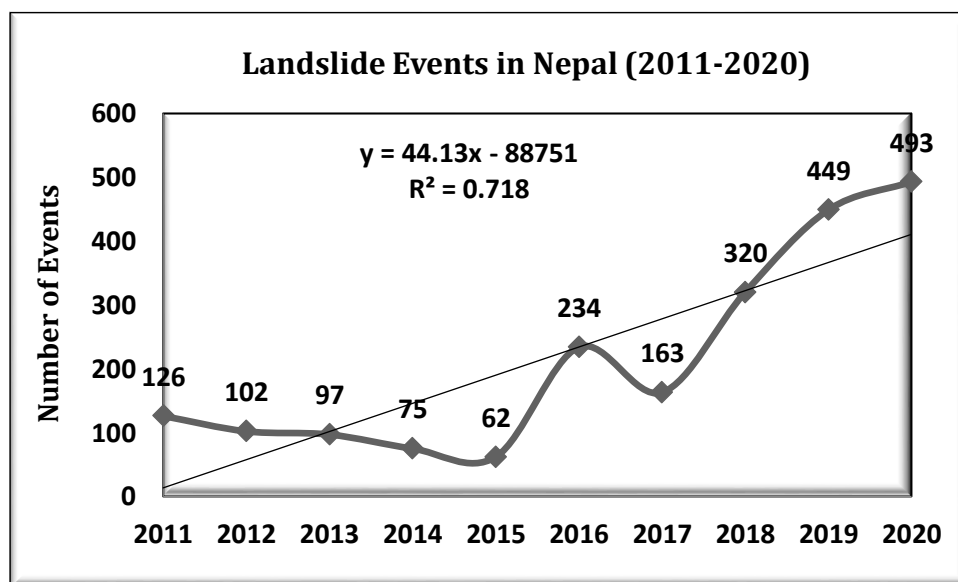


Figure 10: Landslide Events in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 10 represents that the number of events of landslide for last 4 years is in increasing trend. The number of landslide events shows a declining pattern from the year 2011 to 2015. From 2015, the trend shows an upward trend with slight decline in the number of events in the year 2017. Further, r-square value of 0.718 suggests the strong temporal relationship between the number of landslides incidents with time.

3.1.2.2. Death, Injury, and Families affected by Landslide in Nepal

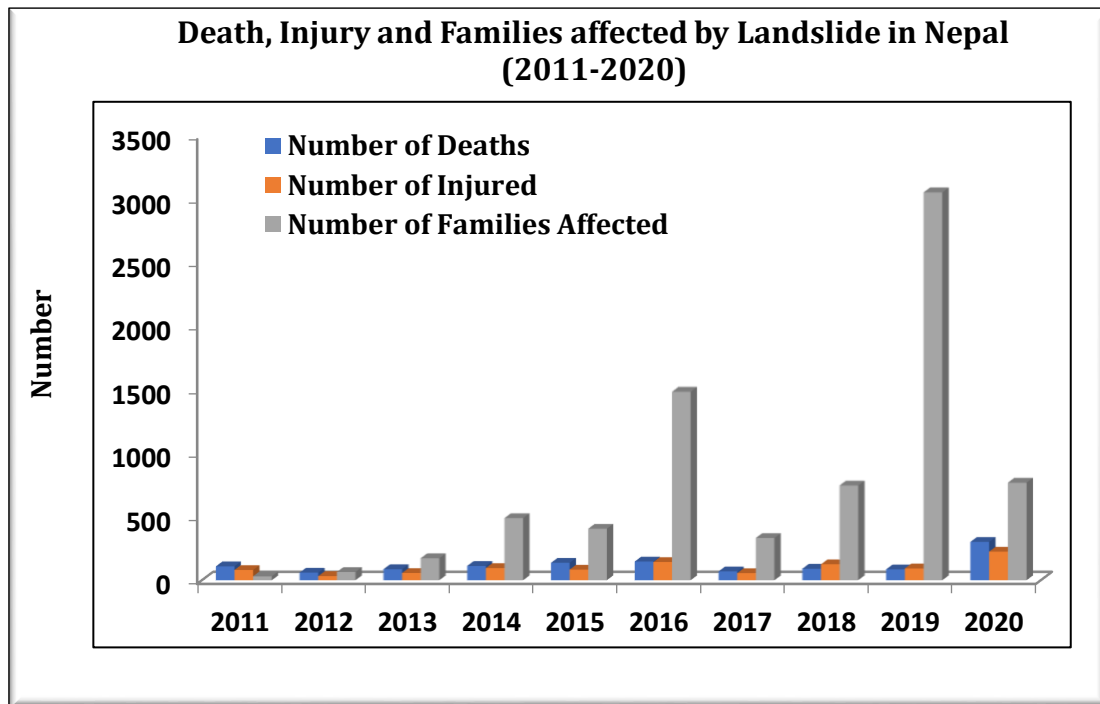


Figure 11: Death, Injury and Families affected by Landslide in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 11 indicates that the number of deaths, injuries, and affected families due to landslides for the past 10 years shows an increasing trend. The number of death from landslide incidents increased by 175.45% in the year 2020 compared to the year 2011. Likewise, the mortality due to landslide were reported highest in the year 2020 (death=303) and lowest in the year 2012 (death=60). Similarly, the number of injured people resulting from landslide was raised by 179.01% in the year 2020 compared to the year 2011. Likewise, the injury due to landslide were reported highest in the year 2020 (injury=226) and lowest in the year 2012 (injury=33). Lastly, in compared to year 2011, the number of families affected by landslide increased by about 25 folds. The maximum and minimum number of families affected by landslide were reported in the 2019 (families affected=3054) and 2011 (families affected=31) respectively.

3.1.3. Landslide Events in Nepal

Nepal Landslides (Nepal Disaster Risk Reduction Portal, media) (ECHO Daily Flash of 25 September 2020)

Over the previous few days, widespread landslides driven by heavy rain occurred in Shyanja District (Gandaki Province) and Palpa District (Lumbini Province) that results in many deaths and damage. According to the Nepal Disaster Risk Reduction Portal, 9 people perished in Waling municipality in Shyanja District while one person is still missing following a separate incident in Kaligandaki Rural Municipality. In Rambha Rural Municipality, one person has died and five others are missing in Palpa District. Furthermore, 6 residences in the impacted districts have been destroyed. Since the start of the monsoon season, 288 individuals have died as a result of landslides. Moreover, moderate to heavy rain is forecast throughout the central and eastern provinces during the next 24 hours.

Source: <https://reliefweb.int/report/nepal/nepal-landslides-echo-daily-flash-14-september-2020>

Landslides continue to wreak havoc in different parts of the country (18 May 2021)

Over the last three days, more than 40 individuals have died and numerous more have gone missing as a result of monsoon-related tragedies. Torrential rains over the last three days have caused floods and landslides in various regions of the nation, killing more than 40 people and displacing hundreds of families. Teams from the Nepal Army, Armed Police Force, and Nepal Police have been summoned to search for the missing people. Many houses have been displaced as a result of the landslides and those who have survived the disaster have been relocated to temporary shelters at various schools and public buildings.

Source: <https://kathmandupost.com/national/2020/07/12/landslides-continue-to-wreak-havoc-in-different-parts-of-the-country>

3.2. Floods

3.2.1. Introduction

Heavy rainfall is a prominent source of flood in Nepal during the rainy season and it is one of the most prevalent, highly damaging, and widespread natural dangers as well (12). Nepal is believed to have around 6,000 rivers and rivulets running from north to south (12). Snow-fed rivers such as the Koshi, Narayani, Karnali, and Mahakali are perennial rivers among them (12). They flow from the Himalayas and snow-capped mountains and pass through the hills to the Terai plains (12). During the monsoon season (June-September), these rivers flood and inflict damage to villages, croplands, and people and animals that remained within the river basins (12). According to the historical statistics, Nepal had catastrophic floods in the Tinao basin (1978), the Koshi River (1980), the Tadi River Basin (1985), the Sunkoshi Basin (1987), and a disastrous cloud burst in the Kulekhani region (1993), which claimed the lives of 1336 people (6).

3.2.2. Trend of Flood in Nepal (2011-2020)

3.2.2.1. Flood Events in Nepal

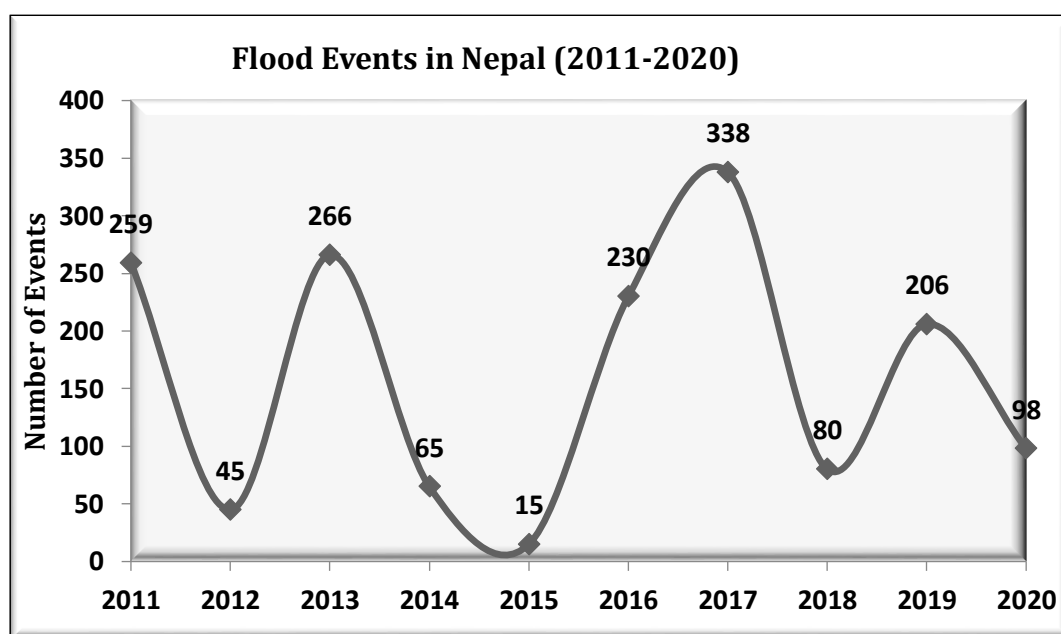


Figure 12: Flood Events in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 12 explains that the total number of events of flood for the last 10 years is in fluctuating trend with the highest and lowest number of events reported in the year 2017 (events=338) and 2015 (events=15) respectively.

3.2.2.2. Death and Injury from Flood in Nepal

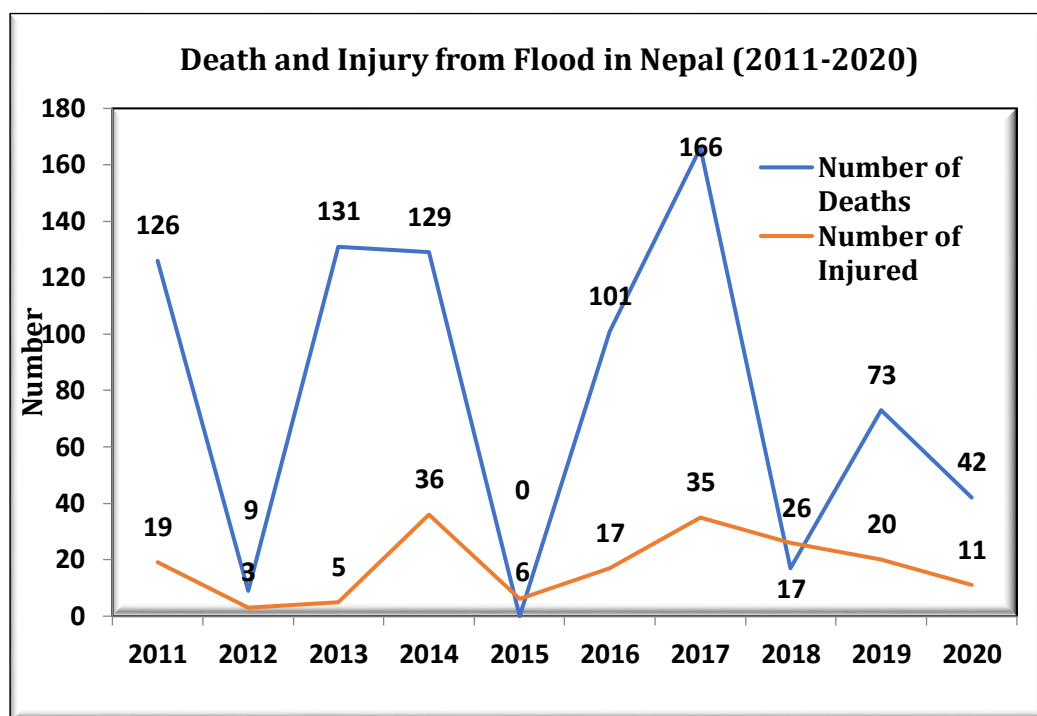


Figure 13: Death and Injury from Flood in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 13 shows the number of deaths and injuries from floods for the past 10 years is in fluctuating trend. The number of death from flood declined by 62.16% in the year 2020 compared to the year 2011. Likewise, the mortality due to flood were reported highest in the year 2017 (death=166) and lowest in the year 2015 (death=0). Similarly, the number of injured people resulting from flood was decreased by 42.10% in the year 2020 compared to the year 2011. Likewise, the injury due to flood were reported highest in the year 2014 (injury=36) and lowest in the year 2012 (injury=3).

3.2.2.3. Families affected by Flood in Nepal

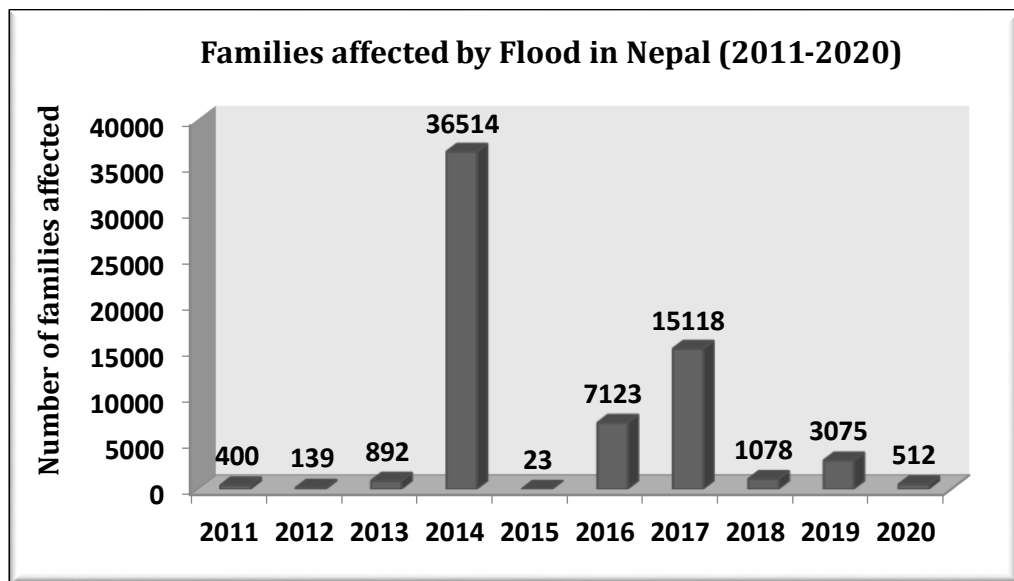


Figure 14: Families affected by Flood in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 14 reveals that the number of families affected by flood for the past 10 years is in fluctuating trend. The maximum and minimum number of families affected by flood were reported in the year 2014 (families affected=36,514) and 2015 (families affected=23) respectively.

3.2.3. Flood Events in Nepal

Over 30 Dead or Missing after Floods and Landslides in Sindupalchowk (September 2020)

According to Nepal's National Disaster Risk Reduction and Management Authority (NDRRMA), around 30 persons have died or gone missing as a result of landslides and flooding caused by heavy rain in Bahrabise municipality, Sindupalchowk District as on 12 and 13 September. According to the most recent reports, 11 individuals have died and another 20 are still missing. Five persons have been injured. According to the NDRRMA, 17 households have been impacted and 11 dwellings have been buried or carried away. Military and police teams have been mobilized to assist with relief and rescue operations that have been impeded by adverse weather. According to Nepal's Department of Hydrology and Meteorology, the neighboring weather station at Gumthang (also Dumthang), Sindupalchowk District reported 77.6mm of rain on 12 September and 141.2mm on 13 September.

Source: <http://floodlist.com/asia/nepal-floods-landslides-sindhupalchok-september-2020>

Floods, landslides kill 40 in Nepal, many missing (11 July 2020)

Heavy rains caused flash floods and landslides in western Nepal, killing at least 40 people and displacing hundreds. 20 people were killed and at least 13 others were missing in Myagdi district which is 200 kilometers (125 miles) northwest of capital city Kathmandu, where numerous buildings were damaged. Rescuers are searching for individuals who are still missing in Myagdi and 50 people have been airlifted to safety. Landslides and flash floods are typical occurrences in mountainous Nepal during the June-September monsoon season every year.

Source: <https://www.reuters.com/article/us-nepal-floods-idUSKCN24C070>

3.3. Earthquake

3.3.1. Introduction

Nepal experiences earthquakes regularly along the major active faults along the east to west alignment (13). Historical data and continuing seismological investigations have clearly shown that Nepal's entire area is prone to earthquakes and is located in an active seismic zone (13). The seismic pattern has been spatially split into three clusters of events: western, central, and eastern Nepal (13). It has been said that the most susceptible areas include Siwalik, the lower Himalayas, and the frontal section of the higher Himalayas (13). According to historical records, the nation saw four large earthquakes which were the Bihar-Nepal earthquake (1934), the Bajhang earthquake (1980), the Udayapur earthquake (1988), and the Gorkha earthquake (2015) (13). According to the Global Report on Disaster Risk, Nepal ranks 11th in terms of earthquake risk due to the repeated frequency with which earthquakes occur in Nepal (13).

3.3.2. Trend of Earthquake in Nepal (2011-2020)

3.3.2.1. Earthquake Events in Nepal

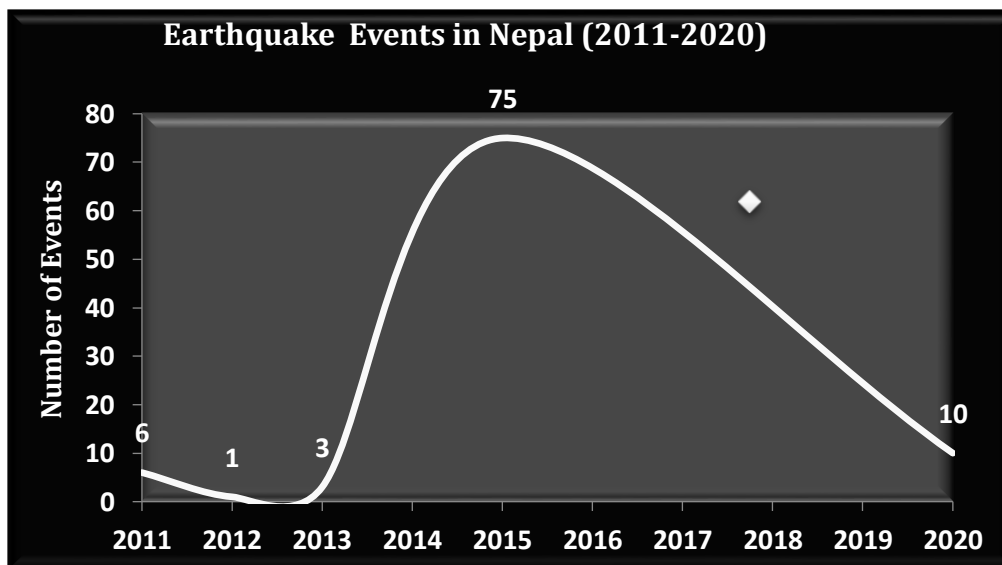


Figure 15: Earthquake Events in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 15 explains that the number of events of earthquakes for the last 10 years is in fluctuating trend with the highest number of events reported in the year 2015.

3.3.2.2. Death and Injury from Earthquake in Nepal

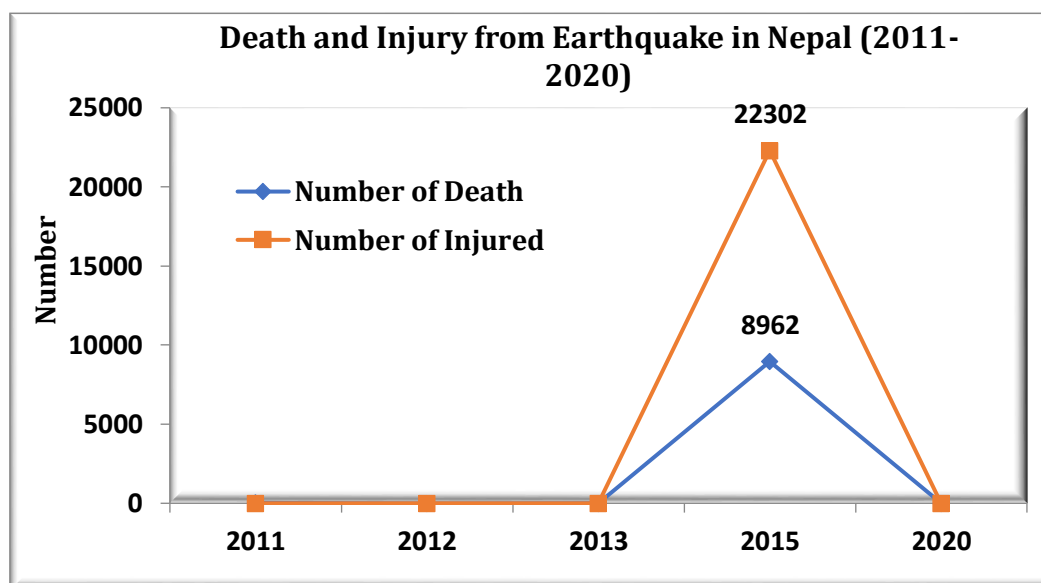


Figure 16: Death and Injury from Earthquake in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 16 shows that the deadliest earthquake seen in the past 10 years was in April 2015 where 8,962 people were killed and 22,302 people were injured.

3.3.3. Nepal Earthquake 2015

The Nepal earthquake (also known as the Gorkha earthquake) of magnitude 7.8 with an epicenter 77 kilometers northwest of Kathmandu and a depth of around 15 kilometers claimed the lives of around 9000 people and injured over 22,000 more (14). It happened on 25 April 2015 at 11:56 a.m. Nepal Standard Time (NST) with a maximum Mercalli Intensity of IX (Violent) (14). The earthquake is believed to have been greater than the 1934 earthquake, perhaps making it the biggest earthquake recorded in Nepal in over a century (14). The earthquake occurred in the Himalayan arc at the subduction contact between the Indian Plate and the Eurasian plate (15). The primary shock caused damage to several structures, buildings, and infrastructure in both urban and rural locations (15). The damage pattern findings show that most of the damaged buildings were stone or brick masonry constructions with little or no seismic features (15). The majority of the RC structures, on the other hand, escaped unscathed (15). This was a strong signal that proper structural design is essential for reducing the risk of earthquakes in Nepal (15). Following the primary shock, a series of aftershocks occurred at 15-30 minute intervals (15). On April 26, 2015, at 12:54 NST, a magnitude 6.9 aftershock struck the same location with the epicenter roughly 17 kilometers south of Kodari, Nepal (15). Over thirty-eight aftershocks of magnitude 4.5 or more occurred the day after the initial earthquakes which include one of magnitude 6.8 (15). Almost every day for the next three weeks, aftershocks were observed around the region (15). Almost one in three had a magnitude of five or greater (15).

3.4. Fire

3.4.1. Introduction

Among the total number of households in the country, agro-based households account for almost 78% (6). Thus, around 86% of the population in rural regions lives in buildings built of earthen wire, stone, and wood (6). In Nepal, houses for residential purposes are a built-in cluster basis that makes them more prone to catching fire and spreading quickly due to their proximity, particularly during the dry season (5).

3.4.2. Trend of Fire in Nepal (2011-2020)

3.4.2.1. Fire Events in Nepal

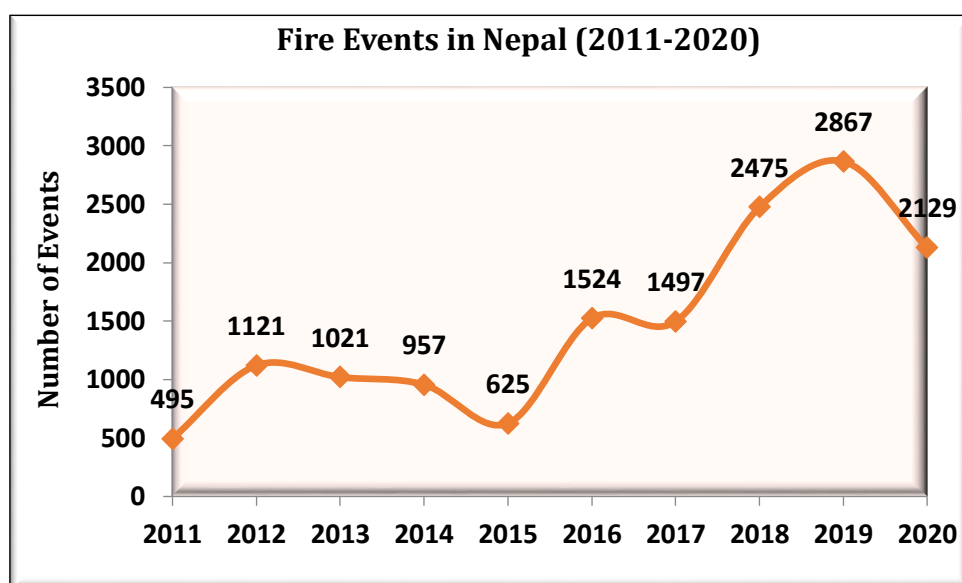


Figure 17: Fire Events in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 17 shows that the number of fire incidents has increased by 330% in the year 2020 compared to the year 2011. The highest and lowest number of reported fire incidents was in the year 2019 (events=2867) and 2011 (events=495) respectively.

3.4.2.2. Death, Injury, and Families affected by Fire in Nepal

Year	Number of death	Number of injured	Number of affected families
2011	25	67	150
2012	77	134	2,512
2013	59	115	1,554
2014	67	98	194
2015	75	67	311
2016	63	244	3,465
2017	63	217	2,403
2018	87	340	3,623
2019	78	346	3,795

2020	57	318	2,693
Total	651	1,946	20,700

Table 8: Death, Injury and Families affected by Fire in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Table 8 illustrates that the number of deaths, injuries, and affected families due to fire for the past 10 years is in increasing trend. The number of death from fire increased by 128% in the year 2020 compared to the year 2011. Likewise, the mortality due to fire were reported highest in the year 2018 (death=87) and lowest in the year 2011 (death=25). Similarly, the number of injured people resulting from fire was raised by 374.62% in the year 2020 compared to the year 2011. Likewise, the injury due to fire were reported highest in the year 2019 (injury=346) and lowest in the year 2011 and 2015 (injury=67). Lastly, in compared to year 2011, the number of families affected by fire increased by about 28 folds. The maximum and minimum number of families affected by fire were reported in the 2019 (families affected=3795) and 2011 (families affected=150) respectively

3.5. Thunderbolt

3.5.1. Introduction

Lightning remains one of the country's deadliest natural catastrophes which take the lives of dozens of people each year (16). In between the years 14 April 2018 to 9 April 2019, lightning killed 67 people and wounded 397, according to the Nepal Emergency Operation Centre (8). Despite the ongoing loss of lives and property due to lightning strikes, the authorities involved are struggling hard to limit the number of deaths and property losses (8). Every year, around 100 individuals are killed by lightning strikes (16). Nonetheless, lightning strikes do not receive the greater attention they deserve since they do not kill a significant number of people at once (16). Following the enormous yearly damage, the Nepalese government established nine lightning detection stations in 2017 (16). The operation of these stations, which would cover the whole nation and collect data on lightning events from all regions of the country, was also intended to contribute to reducing the number of people killed in lightning events after identifying thunderstorm-prone zones (16). However, lightning has continued to kill individuals around the country (6).

In addition, the government has begun awareness efforts in places that have been regularly struck by lightning in recent years (16). Furthermore, the government intends to include a provision in construction rules that require the installation of earthing systems or lightning protection systems at least in public facilities such as hospitals, schools, waiting rooms, and other areas where a large number of people are expected to gather (16).

3.5.2. Trend of Thunderbolt in Nepal (2011-2020)

3.5.2.1. Thunderbolt Events in Nepal

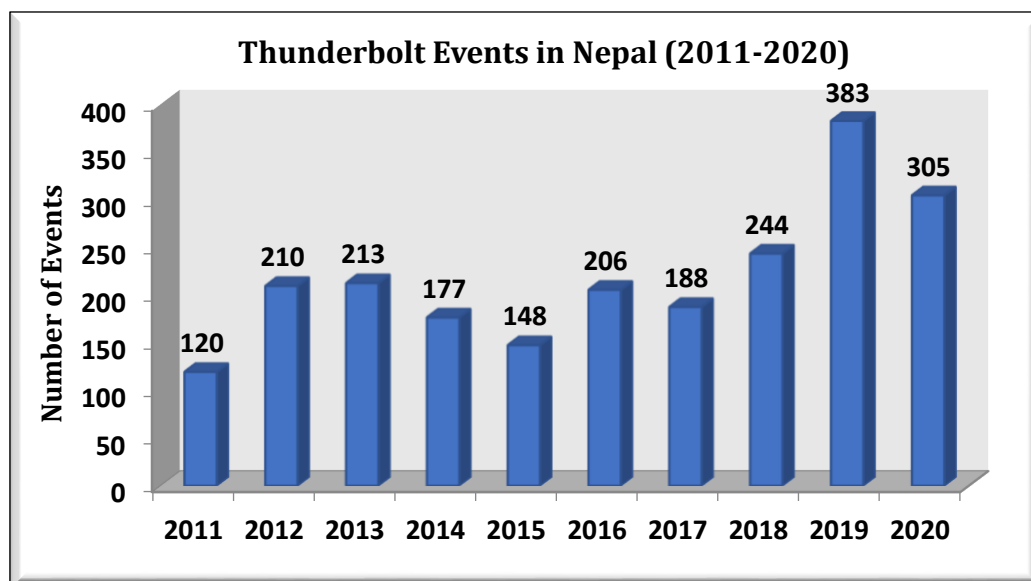


Figure 18: Thunderbolt Events in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 18 indicates that the number of thunderbolts incidents has increased by 154% in the year 2020 compared to the year 2011. The highest number of reported lighting events was in the year 2019 (events=383) and lowest in the year 2011 (events=120).

3.5.2.2. Death, Injury, and Families affected by Thunderbolt in Nepal

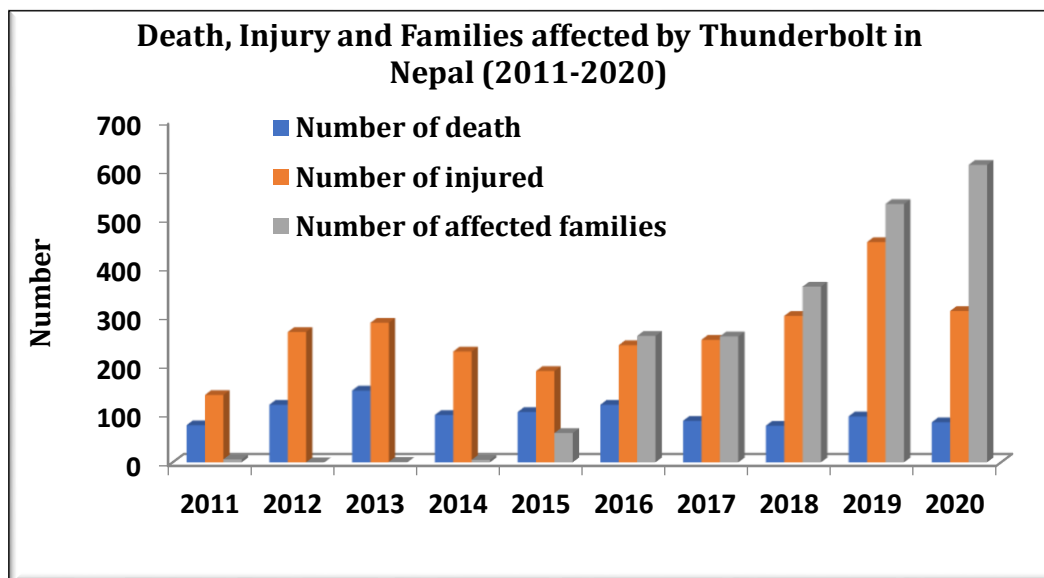


Figure 19: Death, Injury and Families affected by from Thunderbolt in Nepal (2011-2020)

Source: <http://drrportal.gov.np/>

Figure 19 displays that the number of deaths and injuries due to thunderbolt for the past 10 years is in fluctuating trend. Likewise, the number of families affected by thunderbolt shows an increasing trend for the last 5 years. The number of death from lightning increased by 7.89% in the year 2020 compared to the year 2011. Likewise, the mortality due to thunderbolts were reported highest in the year 2013 (death=147) and lowest in the year 2018 (death=75). Similarly, the number of injured people resulting from lightning was raised by 124.63% in the year 2020 compared to the year 2011. Likewise, the injury due to lightning were reported highest in the year 2020 (injury=310) and lowest in the year 2011 (injury=138). Lastly, in compared to year 2011, the number of families affected by thunderbolts increased by about 100 times. The maximum and minimum number of families affected by lightning were reported in the 2020 (families affected=609) and 2012 (families affected=0) respectively

3.5.3. Thunderbolt Events in Nepal

Despite technology in place, lightning continues to be a major killer in Nepal (19 May 2021)

Although the country possesses nine lightning detection centers and a weather radar station, they have not been used to their full potential due to a lack of manpower and maintenance concerns.

"In the last decade, around 100 individuals have died each year as a result of lightning strikes. Further, lightning casualties have been more than flood casualties" said Anil Pokhrel, Chief Executive Officer of the National Disaster Risk Reduction and Management Authority.

Statistics from 2011/12 to 2018/19 reveal that 773 deaths and 1,695 injuries from thunder strikes making the lightning the country's second-deadliest disaster after the 2015 earthquake which killed over 9,000 people. However, during that period, other disasters such as landslides and floods gained more attention from the government in terms of preparations and response. Since April 13 of this year, a total of 54 people have been killed and 181 have been wounded in lightning strikes. There have been 23 deaths since the beginning of the monsoon.

Source: <https://kathmandupost.com/climate-environment/2020/08/28/despite-technology-in-place-lightning-continues-to-be-a-major-killer-in-nepal>

Lightning kills more people than floods in Nepal (12 April 2019)

Every year, lightning kills 24,000 people throughout the world. Nepal is the country with the highest number of lightning fatalities per unit area. Electric storms kill more people in Nepal each year than in the rest of North America. The terrain of Nepal, as well as the proximity of the eastern mountains to moisture from the Bay of Bengal, makes the nation more prone to thunderstorms. Another factor contributing to the country's high fatality rate is that Nepal is one of the most densely populated mountainous countries in the world and thus the lightning from storm clouds travels much shorter distances to the ground in the high mountains.

Source: <https://www.nepalitimes.com/banner/lightning-kills-more-people-than-floods-in-nepal/>

4. Disaster Risk Reduction Management (DRRM) Initiatives

4.1. The Paradigm Shift in Disaster Risk Management (DRM)

With the implementation of the **Natural Calamity Relief Act in 1982**, Nepal became the first country in the South Asian region to have a disaster-specific act (8). The act allowed for the formation of Natural Disaster Relief Committees at the national, sub-national, district, and local levels as well as a method for allocating relief funds (8). The Government of Nepal (GoN) issued the **National Action Plan for Disaster Management in 1996** which was followed by an act by Nepal's commitment to the International Decade of Natural Disaster Reduction (8). The action plan served as the framework to include a disaster management component in the **Local Self Governance Act which was drafted in 1999** (8).

Since the 10th Five-Year Development Plan (2002-2007) and following periodic plans, disaster risk reduction has received increased emphasis (8). Since 2009, the institutional framework for disaster risk management has been significantly enhanced with the implementation of the **National Strategy for Disaster Risk Management (NSDRM)** which is in line with Nepal's commitment to the Hyogo Framework for Action (HFA) (8). This plan which identifies 29 prioritized risk reduction and mitigation tasks, signalled a paradigm change from a disaster response-focused approach to a more comprehensive disaster risk reduction management framework that includes prevention, mitigation, preparedness, response, and recovery (8). Nepal has recently developed a better legal framework to launch DRR operations and initiatives which is contributed by the constitutional clause on DRM, followed by a DRRM act and a strategic plan of action (8).

4.2. Disaster Risk Management Legislation and Policy Development

In the list of concurrent powers of the federal, provincial, and municipal levels, the Nepalese Constitution identifies disaster management as one of the important concerns of all tiers of government (federal, provincial, and municipal) (6). The government endorsed a comprehensive DRRM Act, 2017 to realize and meet the vision and objectives of the constitution (6). Later in 2018, the government further endorsed the National Policy on Disaster Risk Reduction, 2018, and the Disaster Risk Reduction National Strategic Plan of Action (2018-2030) to scale up and strengthen the government's DRM (8). This act and strategy are critical in giving strategic direction for mainstreaming disaster risk reduction into the development process and strengthening the disaster resilience in Nepal (8).

4.2.1. Disaster Risk Management in Federal Context

The Nepalese Constitution of 2015 formally established Nepal as the Federal Democratic Republic with three levels of government founded on the principles of coexistence, collaboration, and coordination (17). In addition to the federal government, 7 province and 753 local level governments were established, each with its own set of

exclusive and concurrent rights and duties (including mandates for disaster risk management) (8). Nepal's new federal state structure and governance system give potential and offer opportunities to institutionalize a far more decentralized system of disaster risk management in Nepal (17). The Nepal Government (Work Division) Regulation 2017 has established the duties and jurisdictions of all federal ministries where **MoHA is designated as the nodal Ministry for the overall coordination of disaster management efforts across the country** with a disaster risk reduction mandate (8). The transition to federalism has offered the government and stakeholders a unique chance to build on previous success and reduce the current and future dangers by emphasizing greater disaster risk management by all sectors at all levels (8). It is important to remember that the administrative and governance systems of Nepal play an important role in increasing resilience against disaster risk (8). It works to enable decentralized planning with the engagement of local people in the local and community level process that is influenced by and is crucial in achieving successful disaster risk reduction but it must be properly planned, implemented, and followed up on (8).

4.2.2. Constitution of Nepal 2015

For the first time, disaster management is identified and mentioned in the constitution of Nepal 2015 (17). It emphasizes the state's ownership and importance in disaster management and prevention with a focus on early warning, disaster preparedness, rescue, relief, and rehabilitation for preventing water-related disasters, providing sustainable and dependable irrigation through river management and mitigating the possible catastrophe risks (17).

Natural and human-induced disaster preparedness, rescue, relief, and rehabilitation actions are mentioned in schedule 7 of the constitution as concurrent competencies of the federal and provincial governments (Table 9) (17). Similarly, **disaster management is stated as the sole duty and responsibility of local governments in schedule 8** and it is mentioned as a **concurrent power of all tiers of governments in schedule 9** (Table 9) (17).

Therefore, disaster risk management has been highlighted as one of the main tasks and responsibilities of all levels of government (17).

Schedule	Subject of Schedule	Provisions related to DRM
Solo Power		
5	Federal powers/jurisdiction	Land use policy, housing development policy, tourism policy, and environment adaption
6	Provincial powers/jurisdiction	Land management and forest, water, and environment management
8	Local-level powers/jurisdiction	Disaster management
Concurrent Power		
7	Federal and provincial powers/Jurisdiction	Natural and man-made disaster preparedness, rescue, relief, and rehabilitation
9	Federal, provincial and local powers/Jurisdiction	Disaster management

Table 9: Constitutional Provisions on DRM Responsibility

4.2.3. Disaster Risk Reduction and Management Act 2017

The Disaster Risk Reduction and Management (DRRM) Act was passed in 2017 to replace the Natural Calamity Relief Act of 1982 (8). Disaster management committees were constituted at the provincial, district, and municipal levels as a result of this law (8). This act strengthens the government's efforts to elevate disaster risk management activities and approach to a new height (8). It prioritizes disaster risk reduction over disaster response (8). The act further establishes the DRRM council as the country's top policymaking body (8). The Council is led at the federal level by the Prime Minister and the provincial level by the Chief Minister (8). The mayor or chairperson of municipal levels leads the local disaster management committees (8). The DRRM Act's main elements and features are the council's ability and authority to support DRRM policies and their implementation at all levels (8). It also establishes a distinct separate entity-the NDRRMA which is responsible to oversee disaster risk management (8). There are also specialist committees that provide technical knowledge on DRM planning, response, and recovery (8). Likewise, there should be disaster management funds at all tiers of government that they manage (8). There is a need to publish DRRM actions every year and make them public to increase transparency, accountability and reflect DRRM efforts (8).

4.2.4. Local Government Operation Act 2017

The Local Government Operation Act of 2017 replaced the Local Governance Act of 1999 which was guided by the constitution on Nepal 2015 (8). Under the duty, obligation, and rights of rural and urban municipalities, the 2017 act specified functions for all elements of disaster risk reduction (8). It also covered actions relating to building construction permit approval, monitoring, and assessment following the national

building code and standard as well as DRR policy, planning, program creation, implementation, monitoring, regulation, and evaluation to create safer communities (8).

4.2.5. Public Health Service Act 2018

The Public Health Service Act of 2018 is a pioneering act that ensures effective, consistent, high-quality, and accessible access to health care as well as free basic and emergency health services for everybody (18). It mandates that all health facilities should provide emergency health care services and follow referral processes (18). It aims to reduce the risk of public health through food, pollution, hygiene, and waste management, industries and urbanization, public health-friendly public infrastructure, and safety (18). It further assures the availability of emergency medical treatment and its management by deploying rapid response health teams (18). It includes a need for all levels of government to establish emergency medical response plans (18). It also includes a mechanism for local governments to declare a public health emergency in their jurisdiction and suggest to the GoN how to regulate and mitigate its effects based on the severity of the public health emergency (18).

4.2.6. National Policy for Disaster Risk Reduction 2018

The National Policy for DRR 2018 was developed and approved to create a safer, more adaptable, and resilient nation by decreasing current risks and preventing new and prospective disaster risks (19). This policy takes into account national demands as well as international agreements and obligations and is more focused on meeting the aims and commitments set in the Sendai Framework for Disaster Risk Reduction (SFDRR), the Sustainable Development Goals (SDG), and the Paris Climate Change Agreement (19). It has specified 59 activities to cover all sectors and assigned tasks and duties to sector ministries to carry out sectoral activities (19).

4.2.7. Disaster Risk Reduction National Strategic Plan of Action (2018-2030)

The DRR National Strategic Plan of Action (2018-2030) is inspired by the SFDRR 2015-2030 and has taken a comprehensive approach to ensure long-term development by including disaster risk reduction into the sustainable development process (20). This action plan has defined four priority areas and 18 priority activities based on the guiding concept of SFDRR (20). For each priority action, strategic activities are identified for 2018 to 2020 as short-term interventions, 2018 to 2025 as mid-term interventions, and 2018 to 2030 as long-term interventions and continuing actions (20). This strategic plan of action has established the vision for disaster risk reduction while taking into account of target established by the Sustainable Development Goals 2030 in terms of significantly decreasing the effect of disasters on a national scale (20). It seeks to minimize disaster mortality, the number of disaster-affected individuals, the direct economic loss in GDP from disasters, the damage to essential infrastructure and critical infrastructure and interruption of essential services, building resilience, implementing DRM policies and action plans at the province and municipal levels and significantly increasing the availability and use of multi-hazard early warning systems (EWS) as well

as disaster risk information and assessments (20). The significant reduction of disaster risk and loss of life, as well as the economic, physical, social, cultural, and environmental assets of individuals, businesses, and communities throughout the country, are essential targets aimed at reducing the impact of a disaster (20).

4.2.8. 15th Periodic Plan (2019-2023)

To contribute to the objective of a safe and resilient Nepal, the 15th periodic plan (2019-2023) has concentrated on reducing human, material, economic, social, cultural, and environmental loss caused by all types of natural disasters and non-natural disasters (21). It works to integrate risk mitigation into sectoral development processes at the federal, provincial, and municipal levels, as well as to promote public, corporate, and community investment, partnerships, and collaboration to decrease disaster risk and enhance resilience (21).

4.2.9. National Disaster Risk Reduction and Management Authority (NDRRM)

The National Strategy for Disaster Risk Management (NSDRM) recognized the need for a separate and specialized organization and authority for disaster risk reduction for the first time in 2009 (8). For this, the DRRM Act of 2017 established the NDRRMA (8). The principal responsibility of this authority is to operationalize disaster risk and management functions, establish required provisions for regular cooperation with stakeholders, carry out response operations, search and rescue, relief, early recovery, recovery plan and execute disaster-related programs (8). This authority is in charge of regulating risk reduction-related activities and also have an incident commander in the event of an emergency (8).

Apart from these, the summary of all legislative frameworks of Nepal for disaster risk reduction and climate resilience is explained in table 10 (8).

Implementation	Legislation	Scope	Purpose
Ministry of Home Affairs	Natural Calamity Relief Act 1982	National, districts, and municipalities	A legal tool aimed towards emergency response. The MoHA was given ultimate responsibility for disaster management actions as a result of this act.
Local governance	Local Self Governance Act 1999	Municipalities	Local governments have been given administrative authority over the full local development process, including disaster risk reduction.
Ministry of Home Affairs	National Action Plan for Disaster Risk Management 1996	National, districts, and municipalities	Action plans for both the pre and post disaster phase.
Ministry of Home Affairs	National Strategy for Disaster Risk Management (NSDRM) 2009	National	Aims to implement 20 strategies to shift Nepal's response-focused disaster management approach to a more comprehensive and proactive risk reduction strategy.
Government of Nepal	Nepal's New Constitution 2015	National, districts, and municipalities	DRM is mentioned for the first time in article 51, and DRM has been allocated as a concurrent obligation for all levels of government.
Ministry of Home Affairs	Disaster Risk Reduction and Management Act 2017	National	Natural Calamity Relief Act of 1982 was replaced, and disaster risk management is viewed as a process concentrating on various stages of the disaster management cycle.
Ministry of Home	Local Government	Districts and	Outlines the tasks and

Affairs	Operation Act 2017	municipalities	obligations of local governments in disaster risk reduction and management.
Ministry of Home Affairs	National Policy for Disaster Risk Reduction 2018	National	Serves as the national disaster risk reduction framework, associated with the SFDRR objective of sustainable development through DRR activities, and climate change (CC) adaptation.
Ministry of Home Affairs	DRR National Strategic Plan of Action (2018-2030)	National	Priorities of actions are directed at the concluding years of SFDRR.

Table 10: Nepal's Legislative Frameworks for Disaster Risk Reduction and Climate Resilience

4.3. Existing DRM Institutions and Mandate

In Nepal, several organizations play important roles in disaster risk prevention and management. The following is a summary of their profiles:

4.3.1. Office of the Prime Minister and Council of Ministers

During the disaster, the Prime Minister's Office and the Council of Ministers provide strategic guidance and an outline of emergency operations including the declaration of emergencies (5). It also guarantees the flow of appropriate funding from the government's relief fund and the mobilization of other sources of funds needed for successful rescue and relief operations (5). Following the Nepal earthquake 2015, it has played an important part in supervising the national reconstruction Authority (NRA) and providing oversight of rehabilitation and rebuilding efforts (6).

4.3.2. Ministry of Home Affairs

MoHA is Nepal's focal ministry for disaster risk management and it has taken the lead in post-disaster response especially in managing rescue and relief operations through the mobilization of security forces and other humanitarian actors which is organized by Disaster Relief Committees at the national, provincial, district and local levels (6).

4.3.3. Ministry of Federal Affairs and Local Development (MoFALD)

MoFALD plays a key role in strengthening local governments' strategic and practical capacities for incorporating disaster risk reduction into periodic planning plans (5). It developed several guidelines and manuals to assist local governments in developing a harmonized DRM strategy following the 14-step Planning Guidelines (5). As a member

of the District Emergency Relief Committee, it has also played an important part in post-disaster response and recovery (5).

4.3.4. National Planning Commission (NPC)

The NPC takes the lead in mainstreaming CC adaption and DRR into national strategies and programs (periodic and annual plans) and ensuring that DRR policies are consistent with other national and sectoral policies (5). It also advises sectoral ministries on developing risk-resilient development strategies and has recently drafted guidance for them on mainstreaming (5). Following the Nepal earthquake 2015, it was critical in finalizing post-disaster need assessments, designing strategies for resilient recovery and rebuilding, mobilizing support, and establishing NRA (5).

4.3.5. Water and Energy Commission (WECS)

WECS is essential in undertaking empirical research on rivers and streams as well as designing strategies and proposals for long-term water quality management at the river basin and sub-basin levels (5). During the development of such proposals, attention is paid to identifying existing and potential risks resulting from water-related hazards as well as efforts to mitigate such risks during execution (5).

4.3.6. Central Natural Disaster Relief Committee (CNDRC)

The CNDRC which has 27 members and is chaired by the MoHA is the highest institutional body appointed by the Natural Calamities Relief Act of 1982 to provide successful and productive relief while also maintaining cooperation between government and non-government agencies (5). The Committee meets at least twice a year or as required to address the problems and challenges faced by any disaster at any time (5). The existence of CNDRC was over with the enactment and endorsement of the new DRRM Act of 2017 (8).

4.3.7. Ministry of Irrigation through Department of Water Induced Disaster Management

The Ministry of Irrigation through the Department of Water Induced Disaster Management is responsible for developing and enforcing policies on water-induced disaster management, flood management, and river training (5). Likewise, the Ministry also works to reduce potential disaster risk during the development of new irrigation schemes or the maintenance of existing ones (5).

4.3.8. Ministry of Education (MoE)

MoE is responsible for designing education curricula and the technological capability in DRM (5). Furthermore, in collaboration with the Ministry of Urban Development's (MoUD) Department of Urban Development and Building Construction (DUDBC), it has prepared earthquake-resilient building construction guidelines for schools and raised awareness campaigns on earthquake protection and resilient building construction for school staffs, students, and school management committees (6).

4.3.9. Ministry of Urban Development (MoUD)

The MoUD is in charge of making human settlements more resilient to natural and man-made disasters (5). In planning human settlements and towns, MoUD has made significant efforts to incorporate integrated policies and strategies aimed at integration, resource efficiency, disaster prevention, and resilience (6). The introduction of risk-sensitive land use planning and the compliance of building codes for resilient construction in Nepal, in the light of a complex ecological environment vulnerable to disasters of different types, are the ministry's top priorities (5). The Ministry directs and provides the required advice to the DUDBC for it to provide reliable and productive technological assistance to enforce risk-informed strategy (5).

4.3.10. Other Ministries

Other ministries working on DRM include (8):

- Ministry of Forests and Soil Conservation (MoFSC)
- Ministry of Environment (MoEn)
- Ministry of Science and Technology and Environment (MoSTE)
- Ministry of Health and Population (MoHP)
- Ministry of Industries (MoI)
- Ministry of Agriculture Development (MoAD)
- Ministry of Water Resources (MoWRs)

4.4. Disaster Preparedness: Resources and Capacity

There are several continuing activities to enhance readiness for effective and timely disaster response and the GoN has expedited institutional capacity building as well as the preservation of resources focused on response and disaster risk reduction following the 2015 earthquake (5). However, additional standardization of institutional capacity development and resource management at all levels is required (6). Following the provisions of the DRRM act, provincial and municipal governments have begun distributing funding for DRM activities and are in the early phases of standardizing institutional capability (8).

4.4.1. Emergency Operation Centers

An Emergency Operations Center (EOC) is a command and control center that is in charge of carrying out the concepts and principles of emergency preparedness and emergency management (6). During an emergency, EOC facilities can also perform disaster management duties at several levels to ensure the continuation of activities at those levels (6). Strategic and operational decisions are also made by an EOC (6). The common role of EOCs is to collect, collate, and analyze data, to plan and implement disaster response, to lead response coordination, to mobilize and coordinate search and rescue (SAR) teams, to coordinate relief distribution, logistics management, and operation, to ensure organizational continuity within the framework of relevant regulations, and to assist cluster activation and mobilization, to make choices that safeguard life and property and to communicate those choices to all relevant authorities

and individuals (6). **A national EOC was formed in 2010, and since then, 6 province EOCs, 70 district EOCs, and 2 municipal EOCs have been formed** (8). In addition to this, there are other sectoral emergency operation centers such as national and provincial Health EOCs (8).

4.4.2. Warehouses

The MoHA has set up five provincial warehouses with pre-stocked stockpiles of relief materials as well as the equipment and other materials needed to respond to a disaster (7). The regional administration offices have been in charge of these warehouses but its control will soon be transferred and handed over to the provincial governments (7). Response-related equipment, as well as food and non-food items for relief purposes, are prepositioned in these warehouses (7). These items are stockpiled jointly in collaboration with the government, private sector, Nepal Red Cross Society (NRCS), other humanitarian partners, and security forces (7). Humanitarian partners have also managed and maintained warehouses around the different parts of the nation for the stockpiling of non-food relief items to help the government's attempts to reach the impacted households within the first critical hours following a disaster (8).

4.4.3. Early Warning System

The Department of Hydrology and Meteorology (DHM) is a GoN body that is responsible for monitoring Nepal's hydrological and meteorological activity (5). Its scope covers river hydrology, climate, agro-meteorology, sediment, air quality, water quality, limnology, snow hydrology, glaciology, wind, and solar energy monitoring (5). General weather predictions, as well as aviation weather forecasts, are the regular services provided by DHM (8).

DHM maintains 51 hydrological stations and 282 meteorological stations around the nation which includes the prediction of hydro-meteorological phenomena and potential repercussions (8). There are 27 flood forecasting stations and some additional community levels where upstream communities provide preventative information to downstream towns such as the rise in river level of water (8). The mass alert system is often implemented in collaboration and partnership with the affected area's telecom service provider (8). Further, the Department of Health (DoH) of MoHP monitored the probable epidemics and outbreaks of illnesses regularly for early response and prevention by utilizing information from more than 80 sentinel locations through an Early Warning and Reporting System and Integrated Disease Surveillance System (6).

4.4.4. The DRR Portal and Use of Social Media

The MoHA maintained DRR portal has been critical in providing access to information and updates on DRM operations in Nepal (6). It serves as a depository station as well as a data bank for DRM legal frameworks, strategies, and plans as well as information on disaster occurrences and response initiatives as well as other DRM operations (8). It not only keeps track of early warning information and updates but also disseminates it via social media (8).

5. Hyogo Framework of Action to Sendai Framework for Disaster Risk Reduction

5.1. Nepal's Response to Yokohama Strategy

The World Conference on Natural Disaster Reduction was held in Yokohama, Japan, on the 23-27 of May 1994 as part of the International Decade for Natural Disaster Reduction (IDNDR), 1990-2000 (5). The Yokohama Strategy and its related Plan of Action for a Safer World were adopted by the Conference for the decade and beyond (5). The Yokohama Plan of Action pledged to promote and expand international cooperation in the prevention, reduction, and mitigation of natural and other disasters with a focus on (5):

- Human and institutional capacity building and strengthening
- Technology sharing, collection, dissemination, and utilization of information
- Resource mobilization

Nepal Status: Nepal formed the IDNDR National Committee in response to the Yokohama Plan of Action which created the National Action Plan on Disaster Management in Nepal which was adopted by the government in 1996 (6). This Plan of Action, primarily in the form of a matrix, outlined preparations, response, reconstruction and rehabilitation, and mitigation with priority actions, completion dates, and roles assigned to implementing agencies (6). The action plan also established a monitoring and evaluation committee to oversee the implementation, which however remained weak (6).

5.2. Nepal Achievements: Hyogo Framework of Action (2005-2015)

According to the UN Office for Disaster Risk Reduction, HFA covered disasters caused by natural hazards as well as linked environmental and technical hazards and risks (5). As a result, HFA lent a holistic and multi-hazard perspective to DRM and how it can have a substantial influence on social, economic, cultural, and environmental systems, as mentioned in the Yokohama Strategy (5).

HFA Priorities for action were to (5):

- Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation
- Identify, assess and monitor disaster risks and enhance early warning
- Use of knowledge, innovation, and education to build a culture of safety and resilience
- Reduce the underlying risk factors
- Strengthen disaster preparedness for effective response at all levels

Nepal's performance in putting HFA's commitments into action has been inconsistent (6). As indicated by the national status reports submitted to the UN on the implementation of the HFA, Nepal's progress and successes remained uneven (6). The

final report to the UN, titled "National Progress Report on the Implementation of the Hyogo Framework for Action" as well as an independent review of DRM integration into development plans, demonstrate that while there have been some successes, there is still a lot of room for improvement (6). The GoN mandated that local governments set aside 5% of their budget toward DRM (6). A comprehensive guideline and approach for mainstreaming DRR into development are still under making (6).

Policy and institutional framework strengthening remained largely unachieved (6). During the review period, the long-awaited Disaster Management Act could not be approved (6). In lack of a high-level dedicated national DRR institution throughout the HFA period, disaster preparedness efforts were primarily carried out by MoHA while efforts on DRR mainstreaming, recovery planning, seismic resilience building, and disaster mitigation were carried out by other agencies in conjunction with MoHA (6).

A high-level CC council established under the Prime Minister's leadership to assist inter-sectoral cooperation on CC action was not effective (6). However, with the passage of a new DRRM Act, a new DRR institution at the national level, linked to province, district and municipal levels has already been established (6).

MoFALD, in partnership with the International Federation of Red Cross and Red Crescent Societies (IFRC), created a set of criteria to define "community resilience" and utilized this as a standardized methodology to assess the community's resilience level (6). The information gathered from this was then used to identify community capacity gaps and plan interventions to address those gaps (6). Using this method, 635 VDCs and municipalities (roughly one-quarter of the population) were reached (6). Furthermore, MoFALD assisted 58 municipalities in establishing fire brigade services and was instrumental in the funding of a crop and livestock insurance system (6). During this time, national and district level land use mapping, including that of 254 VDCs, was completed, and an EWS was established in seven major river basins (6). However, the approval of an 'Early Warning Strategic Action Plan' to guide the installation, operation, and maintenance of EWS across the country was still pending, and local capacities for multi-hazard risk assessment could not be developed (6).

During the review period, national capacities for emergency preparedness and response were strengthened through the establishment of a NEOC in Kathmandu and the expansion of a network of EOC across the country, which included 5 in regions, 49 in districts, and 1 in the municipality (6). For emergencies, EOCs are now equipped with a 24/7 communication system and Standard operating procedures (SOP), and they have played an important role in conducting simulation exercises in many districts (6).

With the assistance of NRCS, 12 warehouses were established in strategic locations during the review period with a capacity to support a maximum of 36,000 families (8). This was far less than the agreed-upon goal of establishing a network of warehouses

with adequate food supplies across the country (8). Likewise, 83 safe open spaces for emergency response within Kathmandu Valley were identified by the government (5).

As a primary response mechanism for making an immediate response and providing early recovery support, a nationally owned humanitarian cluster system approach has proven to be very effective (6). For providing humanitarian assistance in the aftermath of a disaster, 11 humanitarian clusters representing members from government, non-government, donors, and United Nation (UN) agencies have been established (6). Each cluster is also working on early recovery plans that are integrated with cluster-specific response plans (6).

To respond to the post-2015 earthquake recovery and reconstruction needs, NRA was established on December 25, 2015, for a five-year term to lead and manage the recovery and reconstruction of damaged houses and infrastructure (5). Under the guidance of the Post-Disaster Recovery Framework (PDRF) (2016-2020), the NRA aims to complete the entire reconstruction work within five years, in collaboration with development partners, based on the principles of Build Back Better (5).

5.3. Nepal Current Status: Sendai Framework of Disaster Risk Reduction

By 2030, the Sendai Framework aims to achieve a significant reduction in disaster risk and losses in lives, livelihoods, and health, as well as in the economic, physical, social, cultural, and environmental assets of individuals, businesses, communities, and countries (5). This anticipated outcome would be tracked using indicators against seven targets (5). The priority areas of SFDRR include (5):

5.3.1. Understanding Disaster Risk

Understanding disaster risk is primarily concerned with conducting periodic disaster risk assessments and disseminating risk information to policymakers and other players involved in disaster risk reduction strategies (5). A complete and robust disaster information management system capable of producing up-to-date information on disaster loss and damage as well as predicted disaster risks is required for this (5). This should be followed by a framework for frequent information distribution regarding the existence and characteristics of hazards as well as exposure and susceptibility to aid risk-informed development (5).

Nepal Current Status: Nepal has a mechanism for gathering data on past disaster occurrences, losses, and damage (5). However, the system is severely flawed (5). MoHA collects, compiles, and maintains disaster data in an online DRR portal which was introduced as the key component of functioning Disaster Information Management System (DIMS) (5). Due to the low institutional ability to link disaster information with development planning, the establishment of DIMS was never prioritized over the main business of the MoHA and the existing system was underutilized (5). Data on losses and damages were not linked to hazard and socio-economic data nor are they related to

geographical and physiographic data (5). There is no framework in place for performing periodic risk assessments and thus limited skill for analyzing existing data leads to poor knowledge of existing and future disaster trends and their potential implications on development as well as undermining the chance to properly notify policymakers about the dangers (6). National capacity deficits in disaster knowledge are further exacerbated by the absence of a dedicated DRR training institute (6).

5.3.2. Strengthening Disaster Risk Governance to manage Disaster Risk

Progress on disaster risk reduction is determined by how disaster risk management priorities are incorporated into a country's current governance structure at the national, sub-national, and even local levels in terms of planning, implementation, and monitoring of development outcomes (5). A separate system for delivering outcomes on disaster risk reduction-decreasing loss and damage caused by the disaster and avoiding the creation of new risks outside of the existing governance mechanism can neither be successful nor long-lasting (5). Only via a risk-informed governance framework can disaster risk reduction priorities be integrated into national and sectoral plans and budgets (5).

Nepal Current Status: Despite having achieved noteworthy achievement in developing disaster management laws and regulations in the past as compared to many other nations, Nepal continues to lag far behind in implementing essential timely changes, which significantly pushes Nepal's risk management strategy backwards and makes it purely response focused (5). The NSDRM attempted to shift Nepal's response-focused disaster management method to a more comprehensive and proactive risk reduction strategy, but it was impeded by a lack of a progressive DRM law and a dedicated national DRM agency (5). Even though the NSDRM's direction concept explicitly mentions gender sensitivity and social inclusion, practical implementation could not prioritize inclusive DRRM (5). As a result, disaster risk mitigation, response, and recovery did not receive significant consideration in national planning, and activities were primarily influenced by an ad hoc approach to meeting demands (5). The promulgation of the new DRM Law (2017), and the completion of a long-term national DRR strategy and strategic action plan linked with SFDRR goals reflect the government's strong commitment to strengthening disaster resilience by constructing a risk-governance framework at all levels (5). A new institutional architecture being developed by the government under the terms of the new DRM Law is intended to implement risk-governance in each of the three levels of government established under the new federal structure (5).

5.3.3. Disaster Preparedness for Effective Response and Build Back Better

Being prepared for a disaster and responding successfully implies having the knowledge and abilities to successfully predict, respond to, and recover from disaster impacts (5). Capabilities are required to manage all sorts of emergencies and to shift from the response phase to the recovery phase (5). Effective disaster response is built on good

preparations guided by risk analysis and effective early warning (5). Capabilities for contingency and evacuation planning, stockpiling of emergency equipment and supplies, simulation exercises, and a coordination and communication system during a disaster are all critical (5). This must be supplemented with formal institutional, legal, and fiscal capacity (5).

Nepal Current Status: Nepal's capacity for reacting to small-scale disasters has grown pretty substantially in recent years mostly for flood dangers (6). Because of numerous policies, guidelines, manuals, and regulatory provisions related to DRR, previous work on early warning, developing contingency plans, conducting relief operations and emergency management has been relatively successful despite the presence of some capacity gaps concerning trained and skilled human resources and equipment on SAR within security forces (including Nepal Army, Armed Police Force, and Nepal Police) and abilities to make gender-responsive disaster response (6). National capacities required to respond to medium to large disasters across the country must be supplemented through the deployment of a pool of dedicated Light and Medium SAR Teams and community-based first responders in strategic locations, as well as the provision of adequate equipment and infrastructure for SAR training and operations (6). Nepal's capacity for disaster recovery is inhibited by overlapping institutional mandates and a lack of attention to post-disaster recovery (6).

Before 2015, the process of developing a national recovery framework had progressed to the point of clarifying the roles and responsibilities of various institutions during recovery (5). However, the process was not completed, and it wasn't until the devastating earthquake of 2015 that the concept of resilient recovery and reconstruction gained traction (5). To expedite the recovery and reconstruction of earthquake-affected houses, infrastructure, and livelihoods, the government passed the National Reconstruction Act 2015 which resulted in the establishment of the NRA and the formulation of the Reconstruction and Rehabilitation Policy and PDRF in 2016 (5). These policies are guiding the ongoing post-earthquake recovery and reconstruction (5).

5.3.4. Investing in Disaster Risk Reduction for Resilience

Approaches to disaster risk reduction frequently face severe setbacks due to insufficient budget allocations from regular funding sources (5). Public and private investments in DRR are critical for implementing both structural and non-structural measures to improve people's, communities, and society's economic, social, health, and cultural resilience (5). Investing in such DRR measures not only supports innovation, growth, and job creation but also saves lives, prevents and reduces losses, and ensures effective recovery and rehabilitation (5).

Nepal Current Status: Nepal's investment in DRM has been most unpredictable and lopsided in favor of post-disaster relief, guided by CNDRRC decisions (6). Approaches to

DRR mainstreaming into national and sectoral plans and budgets based on periodic risk assessments and provisions of risk-sensitive land-use plans are not yet institutionalized and thus limiting investment for risk reduction, mitigation, and resilience-building (6). In Nepal, bringing private investments for risk reduction is still in its early stages (6). However, the Nepal Rastra Bank's (the central bank of Nepal) mandatory provisions which apply to banking and financing institutions for the approval of construction loans only for code-compliant building designs have created positive incentives for encouraging seismic resilience (6). There is a rising possibility to engage in risk transfer via a successful insurance system which would eventually prompt the construction of safety nets and cover loss and damage to individual assets and communal infrastructure (6).

6. Stakeholder Analysis

In Nepal, a diverse range of DRR stakeholders has played a critical role in accelerating DRR momentum and people-centered development (19). The **Nepal Risk Reduction Consortium (NRRC) established in 2011** has functioned as a unique multi-stakeholder platform to assist the GoN in executing the National Strategy for Disaster Risk Management by connecting the spectrum of development operations and humanitarian knowledge, technical assistance, and finance (8). **International non-governmental organizations (INGOs), non-governmental organizations (NGOs), community-based organizations (CBOs), the private sector, academia, and technical institutes** have collaborated with the GoN on capacity building and technology transfer programs among other projects through the MoHA and several line agencies (19). The **World Bank** has also offered ongoing assistance (19). Agriculture, irrigation, and infrastructure development, as well as telecommunications, roadways, electricity and water supply, and sanitation, have received the majority of its attention (8). Likewise, **Asian Development Bank (ADB)** also provided financing for road and transportation facility renovation and supported gender equality initiatives in the transportation industry (8).

ADB has also played an important role in promoting and funding school safety, notably the **School Safety Program (SSP) for retrofitting schools in Kathmandu Valley since 2011 and the reconstruction of earthquake-resistant schools following the 2015 earthquake** (8). The Child-Centered Disaster Risk Reduction Consortium comprised of Plan International Nepal, Save the Children International Nepal and World Vision International Nepal was formed in 2014 to assist this initiative (20). The consortium's important contribution is a harmonized school safety model that contextualizes the Comprehensive School Safety Framework (CSSF) in Nepal (20). The safe school initiatives were carried out in partnership with the Department of Education and the National Centre for Education Development (20).

Similarly, Nepal works with a diverse range of stakeholders including **UN agencies and other international development partners** to respond to emergencies by using a **cluster-based approach** that was introduced in 2009 (19). **NRCS** is also an important stakeholder in response activities and in actively mobilizing local volunteers (20). Volunteers are ready to deploy throughout all 77 districts through their robust network (20).

7. Issues in Implementation of DRR and Climate Policy

The 2015 Constitution transforms Nepal into a federal democratic republic with three tiers of government: federal, provincial, and local (17). It aspires to improve inclusive governance and proportional representation via three tiers of government (17). This constitution which aims to create an equal and diverse society while also ensuring people's prosperity provides a strong legal foundation for achieving SFDRR priorities, mandates outlined in the climate agreement, and SDG objectives and targets (8). The present goals for achieving comprehensive DRR and climate resilience (CR) overlap on multiple occasions and have comparable characteristics (8).

However, to achieve fully functioning local administration at the ward and municipal level with integrated DRR activities, the newly established local administrative organizations must be oriented with existing requirements given forth in DRM and local government acts, rules, regulations, directives, and plans (8). Furthermore, the newly established local government needs well-trained human resources, enough funding, and strengthened institutional abilities (6).

Thus, despite the synergies and strategic approach, a lack of local level abilities prevents the intents from being effectively materialized (6). Furthermore, there is a need to incorporate concerns for widespread social issues such as poverty, migration, livelihoods, and internal displacement, all of which have multifaceted links with the DRR domain and contribute to the achievement of SDGs and poverty reduction (5).

8. Future Challenges, Future of Disaster Risk and Priority Issues

8.1. Future Challenges

According to the 2015 Constitution, the political, social, and economic development in Nepal is envisaged to undergo a significant transition in the next few years (17). Such goals for change, however, will not only establish the overall environment and context for future growth but will also be a driving factor in either exacerbating or mitigating disaster and climate risks (19). Growing urbanization and the construction of critical facilities and infrastructure provide an opportunity for the government to begin preparing for and establishing targeted sectoral resilience (19). In addition, because the economic growth is heavily dependent on capitalizing on opportunities, significant investments in youthful people with minimal reliance, industry, and manufacturing are essential to optimize the growth potential (20). Large-scale disasters, on the other hand, may seriously impede this transition from an agricultural economy to production and industry (8). The cumulative effects of widespread risk such as monsoonal floods and landslides, drought, regional sedimentation, and rapid melting of snow and glaciers can exacerbate the socio-economic vulnerability of agrarian-based livelihoods that may restrict the rural development and thus the long-term consequences may take years to become apparent (8).

The economy's transformation is also dependent on the energy industry (8). Developing hydroelectric facilities around the country, on the other hand, raises several of the causal and correlative concerns (8). These facilities are vulnerable to natural hazards such as GLOFs and further, they endanger natural river ecosystems and cause secondary vulnerabilities in agriculture owing to greater reliance on irrigation reservoirs (6). Huge reservoirs may also have an influence on weather patterns because of greater precipitation and large reservoirs further have been found to intensify seismic waves (6).

As a result, Nepal has a huge challenge in terms of long-term sustainable future growth and development (8). To improve coherence and maximize the benefits, more integrated efforts across multiple development areas must be sought (19). In an urban setting, a master plan for urban development should include housing, infrastructure, environment, disaster, and climate-resilient urban design, social welfare, and inclusive urban growth (20). Inter-agency cooperation and collaboration are required for this to happen and therefore platforms should be created among critical stakeholders (8).

8.2. Future of Disaster Risk in Nepal

CC forecasts are dire (8). It is projected that the now most productive terai regions will bear the brunt of the repercussions of climate change (8). The projected direct costs of climate change to vulnerable areas (such as agriculture and energy generation) are predicted to be as high as 3% of total GDP by 2050 (8). Likewise, flooding is predicted to

account for 82.93% of the AAL in the future (6). Moreover, monsoonal precipitation is expected to rise by 15-20% by the mid-century (8). These are serious issues because of the influence of CC on increasing precipitation in Nepal, which exacerbates the consequences of water-related catastrophes (6). Another rising concern is agricultural losses caused by periods of excessive precipitation or drought, which have an impact on food security and livelihoods (8). Given the projected population estimates, minimizing the effects of climate-induced hazards on production are critical (8). By 2050, the population is predicted to exceed 46 million people and all of whom will require additional resources and safe land-use planning (8).

Nepal's Development Vision for 2030 strives to average annual GDP growth of 9-10% to enter the ranks of middle-income countries (20). This development, however, is mainly reliant on new hydropower facilities, which are being built in a very risky environment and are vulnerable to increased danger of earthquakes, landslides, and GLOFs (8). Hazards exacerbated by CC may jeopardize the goals to use water resources thereby threatening the future hopes for industrial growth (8). Even if the industry suffers a surge in expansion, it is likely to raise environmental issues (8). Similarly, increased infrastructure development is also expected to produce new hotspots for landslides (5). Moreover, explosives for constructing transportation and infrastructure and informal road construction have the potential to destabilize slopes owing to loss of vegetation, soil erosion, and loss of slope toes (5). Therefore, pollution and environmental deterioration are likely to accompany development if sustainable practices and rational planning processes are not prioritized (6).

8.3. Priority Issues

Nepal has expressed its commitment to grow via resilient and sustainable development following the SDGs (20). The highly relevant targets such as SDG 11 and SDG 13, DRR and CR are included in implementation priorities (20). Nepal is likewise enthusiastic about incorporating SFDRR into national initiatives depending on its risk profile, major gaps, and requirements (20). With the endorsement of the DRM Act in 2017, the government is in the process to revive institutional arrangements among various agencies and different levels of authority within the federal system (19). The government also planned to revise existing DRR rules and regulations to solve overlap, conflict, and deficiencies in the legal requirements and provisions (19).

But, disaster and climate data collection, analysis, and management remain insufficient and it is also inaccessible to most of the local level planners and private sector (5). To sustain the process of prioritizing investments and furthering awareness of the sectoral consequences of CC and disaster in the vulnerable sectors, data collection and analysis should be strengthened at all levels of government through technical assistance and capacity building process (6). There is still a need to collect local-level risk information based on the level of risk for all urban and rural municipalities (6). Private houses, schools, and health care facilities as well as government and public buildings were

among the vulnerable sectors for which additional data are needed to assess disaster risk (20). Risk information should also be acquired by conducting multi-hazard risk assessments based on extensive and sectoral data (20). Systematic data collection, management, and consolidation from many sources are seen as a necessary first step in risk analysis, post-disaster needs assessments, and tracking nation progress against SFDRR global targets (8). In response to this need, MoHA, United Nations International Strategy for Disaster Reduction (UNISDR), United Nations Development Programme (UNDP) and Asian Disaster Preparedness Center (ADPC) have already establishment of DIMS (8).

Likewise, other targets identified in the Nation DRR Policy (2018) and National DRR Strategic Action Plan (2018-2030) include end-to-end multi-hazard early warnings, enhanced public investment in resilient infrastructure, expanded emergency response capabilities, and better standards for search and rescue (20). Localization of the DRR and CR agendas should also be emphasized as a top priority for the government (20). In a situation of limited resources and low local capacity, the ability of sub-national level disaster authorities to respond to and handle catastrophe situations must be quickly enforced (19). Therefore, empowering provinces and local governments to play effective and efficient roles in leading DRM operations in their respective areas should be stressed more in the future (20).

9. Conclusion

Nepal's DRR law and regulatory measures indicated a paradigm change in disaster management. This shifting emphasis on enhancing legal frameworks, policy and planning, organizational elements, institutional abilities, and partnerships for DRM over the years. According to existing laws, Nepal has been guided by disaster risk reduction principles and has delegated disaster management responsibilities to all three levels of government. These provisions assigned tasks and obligations for disaster risk management to the three tiers of government. The Disaster Risk Reduction National Strategic Plan of Action 2018-2030 which was developed by the goals and target of the SDG and SFDRR, advanced the strategic priorities and activities that lead to disaster risk reduction activities in Nepal. Therefore, Nepal should focus its endeavors on the successful execution of the National Disaster Risk Reduction Strategic Plan of Action (2018-2030) to fulfill the international responsibilities while also making Nepal resilient to disasters.

According to the documented disaster occurrences from 2011-2020, water-induced disasters claim the majority of loss and damages in Nepal. Likewise, fire also resulted in substantially bigger economic losses and fire events are far more concentrated in urban/metropolitan areas. During this time, the localization of policies, resources, abilities, and institutions was a top priority. There has been significant success in establishing disaster risk management funds as well as significant progress toward achieving the goal of sub-national and localization of policies.

In accordance with the challenges encountered while implementation and executing DRR policies and priorities, the following are some of the important lessons learned that can guide strategies and actions for future endeavors (6):

- Substantial work has been made toward the formation of the NDRRMA. The establishment of authority would be a big step forward in disaster governance in Nepal.
- The progress made in localizing policies, institutions, and resources at the sub-national level is very desirable. It is also critical to verify that the policies and their subsequent execution are consistent. To that purpose, the close and proactive participation of all levels of government and relevant stakeholders must be enhanced.
- According to the legal provisions, disaster management funds have been established in all three levels of government. However, a special act on fund management would further promote clarity and effectiveness when using the fund.
- In Nepal, risk assessment is a top priority. To achieve the minimal requirements of assessment, hazard-specific standards should be agreed upon based on scientific methods and local needs. Risk assessments at the national and sub-national levels should be carried out to understand the severity of risks to

support evidence-based risk-sensitive development planning for risk reduction and avoid the emergence of new hazards in the future. Therefore, every government entity should manage resources to develop multi-hazard risk profiles over time.

- More specific efforts should be made to empower vulnerable groups such as children, women, senior citizens, and persons with disabilities as well as develop stakeholders' skills for participatory methods in planning, readiness, response, and rehabilitation.
- In Nepal, there is a rising tendency of disaster-related displacements which may be hastened by the effects of CC. Thus, appropriate policy legislation and execution on disaster displacement would lessen the associated risks.
- Management of DRR-related information, its collection, the establishment of a single platform, and providing access to everyone is a critical problem. To answer this critical necessity, DIMS must be institutionalized at all levels of government. Priority should be given to arranging for necessary resources and capacity-building initiatives at the relevant levels.
- The establishment and strengthening of emergency operations centers are critical for efficient emergency response. Similarly, there should be an emphasis on strengthening the capability of agencies directly involved in disaster management as well.
- It is critical to integrate disaster risk reduction into the development and sustainable planning process to achieve sustainable development. Disaster risk and impact assessments, as well as environmental impact assessments, should be included in development planning.
- Based on the concept of the "whole of society" approach to disaster risk reduction, the ongoing stakeholder involvement and expanded collaboration with the private sector would improve partnership for effective disaster management.
- Inclusion of disaster risk management in formal and informal education systems would be an effective strategy for fostering a "culture of safety."
- EWS should be included in the legislative framework and enlarged and hazard-specific monitoring and warning systems should be enhanced.
- DRR budgeting should be centered on implementing disaster initiatives in Nepal. A separate budget code allocation will account for Nepal's investment in disaster management which will enable tracking progress and assuring public investment in disaster management in Nepal.
- A formal mechanism and system should be developed for frequent and periodic monitoring of the DRR strategic action plan and other DRR initiatives to assess progress and alter the plan as needed to ensure inclusivity in all DRR operations.

10. References

1. CFE-DM. Nepal Disaster Management Reference Handbook. 456 Hornet Avenue JBPHH, HI 96860-3503: Center for Excellence in Disaster Management and Humanitarian Assistance; 2017.
2. MOHA, ADRC. Disaster Risk Management: Policies and Practices in Nepal: Country Profile. Ministry of Home Affairs Nepal, Asian Disaster Reduction Center; 2011.
3. Central Bureau of Statistics. National Population and Housing Census: National Report. Kathmandu, Nepal: National Planning Commission Secretariat, Government of Nepal; 2011.
4. Ministry of Health Nepal, New ERA, ICF. Nepal Demographic and Health Survey 2016. Kathmandu, Nepal: Ministry of Health, Nepal; 2017.
5. Ministry of Home Affairs. Nepal Disaster Report, 2017: The Road to Sendai. Kathmandu: Government of Nepal; 2018.
6. Ministry of Home Affairs. Nepal Disaster Report 2019. Kathmandu: Government of Nepal; 2019.
7. Shrestha BR. An Assessment of Disaster Loss and Damage in Nepal. *Geogr Base.* 2019 Oct 27;6:42–51.
8. UNDRR. Disaster Risk Reduction in Nepal: Status Report 2019. Bangkok, Thailand: United Nations Office for Disaster Risk Reduction (UNDRR), Regional Office for Asia and the Pacific; 2019.
9. Adhikari S, Adhikary D. An Account of Nepal Disasters and Economic Fallout. Project Research And Management Associates; 2019.
10. Ao M, Zhang L, Dong Y, Su L, Shi X, Balz T, et al. Characterizing the Evolution Life Cycle of the Sunkoshi Landslide in Nepal with Multi-source SAR Data. *Sci Rep.* 2020;10(1):17988.
11. Nepal N, Chen J, Chen H, Wang X, Pangali Sharma TP. Assessment of landslide susceptibility along the Araniko Highway in Poiqu/Bhote Koshi/Sun Koshi Watershed, Nepal Himalaya. *Prog Disaster Sci.* 2019 Oct;3:100037.
12. Gautam DK, Phaiju AG. Community Based Approach to Flood Early Warning in West Rapti River Basin of Nepal. *IDRiM J.* 2013;3(1):155–69.
13. Shantharaju S, Venkataramana K. Nepal Earthquake 2015: A case study. In Kumamoto University, Japan; 2016.
14. Goda K, Kiyota T, Pokhrel RM, Chiaro G, Katagiri T, Sharma K, et al. The 2015 Gorkha Nepal Earthquake: Insights from Earthquake Damage Survey. *Front Built Environ.* 2015 Jun 22;1.
15. Adhikari LB, Gautam UP, Koirala BP, Bhattarai M, Kandel T, Gupta RM, et al. The aftershock sequence of the 2015 April 25 Gorkha–Nepal earthquake. *Geophys J Int.* 2015 Dec 1;203(3):2119–24.
16. Aryal D. Pre-Monsoon Thunderstorms in Nepal. *Int J Rural Dev Environ Health Res.* 2018;2(3):39–45.
17. Secretariat, Constituent Assembly and Singha Durbar. The Constitution of Nepal 2015. Kathmandu: Constituent Assembly Secretariat, Government of Nepal; 2015.

18. Federal Parliament. The Public Health Service Act 2018. Kathmandu: Government of Nepal; 2018.
19. Ministry of Home Affairs. National Policy for Disaster Risk Reduction 2018. Kathmandu: Government of Nepal; 2018.
20. Ministry of Home Affairs. Disaster Risk Reduction National Strategic Plan of Action 2018 – 2030. Kathmandu: Government of Nepal; 2018.
21. National Planning Commission. The Fifteenth Plan: Fiscal Year 2019/20 – 2023/24. Kathmandu: Government of Nepal; 2020.