Flooding in Nepal: Analyzing Incidents, Human Casualties, and Property Losses

[1]Anisha Danai, [2]Pitri Bhakta Adhikari
Tri-Chandra Multiple Campus, Tribhuvan University
[2]**pbadhikari09@gmail.com (**Corresponding Author)

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ABSTRACT

A flood occurs when river water overflows due to intense monsoon rainfall, presenting a significant disaster in the low-lying areas of Nepal. This research provides insights into various aspects of floods, including the total number of incidents, fatalities, affected households, and estimated losses that occurred over the past thirteen years. Nepal is divided into three main geographical regions: Mountains, Hills, and Terai. Rainwater from the Mountains and Hills flows into the Terai region, significantly increasing the risk of flood disasters there. In this study, data accessed through website of Government of Nepal (GON), Nepal Disaster Risk Reduction (DRR) Portal, selecting Ministry of Home Affairs (MoHA), source is used for the collection of data since 2011 A.D. Statistical tools are used on the analysis of the collected data and plotting the graph. The peak occurrence of flood incidents coincides with the monsoon season, particularly in July, August, and September. This study aims to analyze flood patterns, incident occurrences, fatalities, and property losses in recent years. It is found through the study that a minimum of one person dies after almost two flood incidents, as well as almost 35 families is directly affecting by a single flood incident in recent decade. Besides that, flood causes an estimated loss of about millions to billions each year in Nepal and the death pattern over months shows gaussian like distribution.

Keywords: Death, Disaster, Flood, Human Casualties, Incident.

Introduction

Flood is an outflow of river water due to heavy monsoon rainfall. The regions in southern Nepal are primarily affected by it. Flooding is a major disaster in the lowlands of Nepal. It is mainly like to happen near the large river basins such as Koshi, Gandaki and Karnali basins. Monsoon flood causes extreme losses of people and properties.

A flood occurs when there is an overflow of water that beats the natural or man-made banks of a river channel (Shreevastav, Tiwari, Mandal, & Singh, 2022). Nepal's vulnerable geological structure, rough terrain, seismic events, deforestation, alterations in land use, and various development projects like road construction, urban growth, and hydropower initiatives are increasing its susceptibility to natural disasters such as floods and landslides (Yagacharya &

Gautam, 2008). Considering the extent of damage and loss of life they cause, floods are seen as the most destructive disaster, especially affecting the Terai regions of Nepal (Dhakal, 2013). Floods occur often in the southern plains of Nepal, where more than half of the country's total population resides (Sharma, et al., 2019).

The total deaths caused by flood in last 13 years is 894 and flood rank third in terms of the number of incidents, following fire and landslide and fourth in terms of total deaths caused, after landslide, earthquake, and fire within the time interval of 2011-2023 Nepal Disaster Risk Reduction Portal (drrportal.gov.np). In Nepal, most of the rainfall occurs between June and September due to the impact of the summer monsoon [(Nayava, 1974) (Adhikari & Khanal, 2024)], which is responsible for causing monsoon floods. Similarly, the land use change and precipitation are the major influencing factor for flood (Shreevastav, Tiwari, Mandal, & Singh, 2022).

Uncommon flood occurrences are also observed in high-altitude urban centers such as Pokhara and Kathmandu. Taking reference of the Pokhara valley, a moderate flood unrelated to meteorological events, but with a peak discharge similar to that of typical monsoon floods ($QP=1000 m^3 s^{-1}$), has the capacity to flood approximately 0.6% (0.3 km^2) of urbanized regions and 3.2% of agricultural land (Fischer, et al., 2022). Proper drainage network must be constructed, and riverbank erosion practice must be stopped on Bishnumati river in order to reduce the risk of flood through community approach (Malla, Katwal , & Thapa , 2023). Increasing income and education levels are crucial for minimizing the impact of disasters (Toya & Skidmore, 2007).

Remote sensing technology is not yet widely employed in disaster studies and disaster management in Nepal, However, modern flood studies in Nepal make use of only a small number of satellite image. Synthetic Aperture Radar and high-resolution multispectral information taking proper statistical designs are suitable for instantaneous flood measuring (Sharma, et al., 2019). It is observed that civilized and cultivated areas are highly vulnerable to flood disaster followed by sandy areas whereas civilized lands are at large section to flood risk (Shrestha, Sapkota, & Chidi, 2022). It is found that high-resolution satellite images will simplify the process of making highly accurate image for estimating shifts in riverbank positions (Rakhal, Adhikari, Sharma, & Ghimire, 2021). Mapping river

channels, determining flood extents, and classifying land cover are essential for flood mapping and assessing damage, which is facilitated by object-based remote sensing and Geographical Information Systems (GIS) (Uddin & Shrestha, 2011). In order to bring about the fruitful decision making of flood disaster, geospatial technology is finest for giving results and inspection (Uddin, Gurung, Giriraj, & Shrestha, 2013).

Recurring flooding in Nepal is causing continuous deaths, property losses and displacement of people regardless the significant efforts by the government. Hence, the aim of this study is to analyze flood trends over the past thirteen years, including the occurrence of incidents, fatalities, property losses, impacts on affected families, as well as the number of missing and injured individuals, utilizing data from the Disaster Risk Reduction (DRR) portal report. This study can be implied by the researchers and policy makers to analyze flooding in recent decade in terms of occurrences of incidents, human casualties and property losses.

Methodology

The study is done through primary source of data collection based on online website of Government of Nepal, which is Nepal Disaster Risk Reduction (DRR) Portal selecting MoHA as a source. There are some online websites which were used for literatures such as google scholar, research-gate, science direct etc. Flood, hazard, vulnerability, risk reduction, remote sensing were the Keywords which were used while searching for the literatures. To analyze the data, some statistical tools are used such as MS Excel. Data of total number of incidents and deaths caused by flood disaster were collected from 2011 A.D. to 2023 A.D. formatting for both year wise and month wise in order to make easier to understand the recently trends of flood disaster. Tables showing detail information of incidents, deaths and other parameters are built for the comprehensive analysis. Bar graphs are used to distinguish and compare between flood incident and death data among year wise and month wise. It also helps for the easy visualization of the fluctuating variables which are death and number of incidents. The line graph is used to observe the changes of more than two variables at a time interval. It also helps for the comparative study of the data. The location map of study is shown in figure 1.

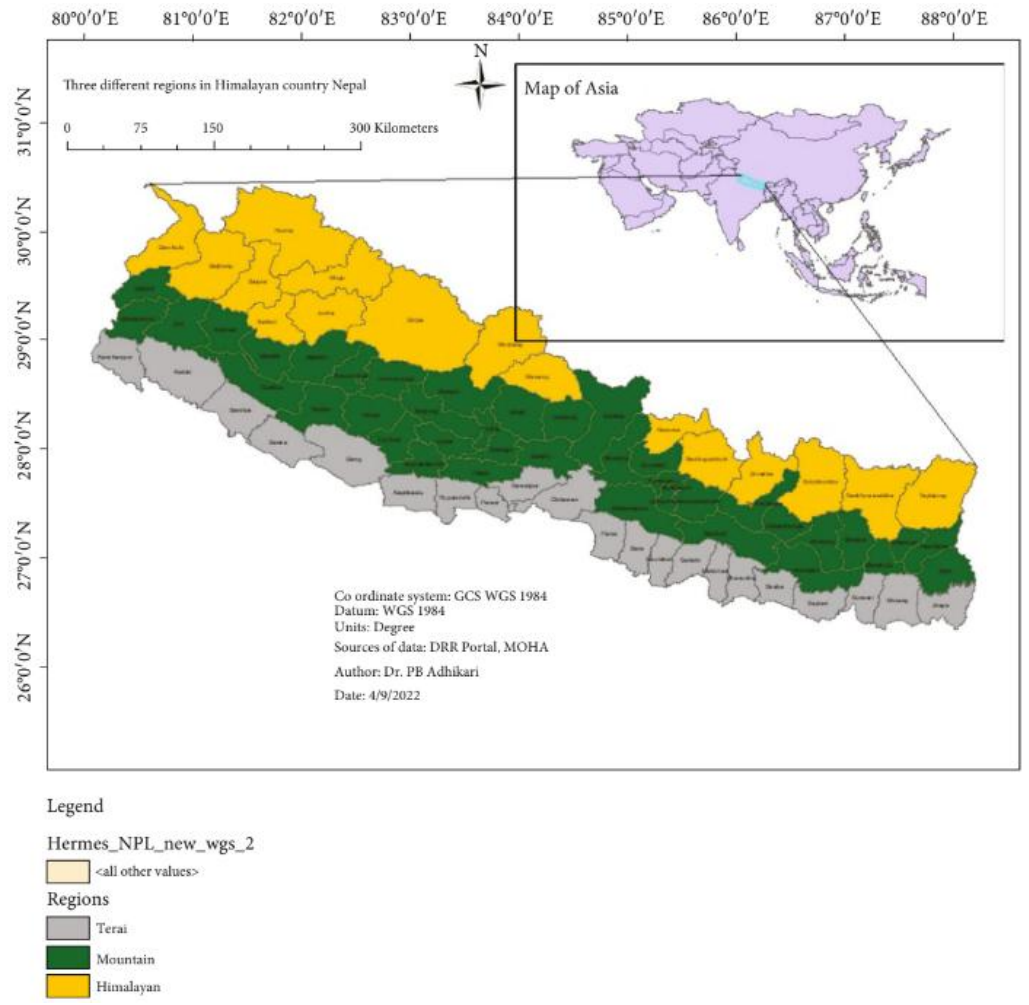

Figure 1: Location map of Nepal **(Adhikari, People Deaths and Injuries Caused by Lightning in Himalayan, 2022)**

Observation, Result and Discussion

The observation section is inclusive of flood data such as incident number, total death, missing people, injured people, affected family and estimated loss in Nepal over past thirteen years. Observer can perceive for both year wise and month wise movements for flood incidents and death as well as year wise movements for others parameters. Since Terai (plain and low lands) regions; more cultivated and civilized; the regions near large river basins are more vulnerable to flood disaster, and hence it is crucial to observe and analyze its occurrences and follow safety

precautions on heavy monsoon season. By observing the data from 2011 A.D. to 2023 A.D., we can detect the season / month which is more vulnerable to flood disaster as well as the fluctuating nature of natural disasters. Table 1 and 2 below gives the detail information about deaths and damages that flood causes every year. The data in Table 1 and 2 are taken from DRR portal selecting MoHA as a source.

Table 1: Details of Incidents and Death caused by Flood (source: Nepal Disaster Risk Reduction Portal (drrportal.gov.np))

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total Death	No. of Incident
2011	0	0	0	0	0	1	52	41	26	4	1	1	126	259
2012	0	0	0	0	0	1	3	5	0	0	0	0	9	45
2013	0	0	0	0	0	27	47	34	21	2	0	0	131	266
2014	0	0	0	0	2	8	10	104	4	1	0	0	129	65
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	15
2016	0	0	0	0	17	6	44	12	20	2	0	0	101	230
2017	0	0	0	0	1	3	16	139	3	4	0	0	166	338
2018	0	0	0	0	8	0	5	1	3	0	0	0	17	80
2019	0	0	0	0	0	0	68	3	2	0	0	0	73	206
2020	0	0	0	0	1	2	5	9	25	0	0	0	42	98
2021	0	0	0	0	0	16	12	6	9	20	0	0	63	154
2022	0	0	0	0	0	3	3	2	7	4	0	0	19	55
2023	0	0	0	0	0	9	2	3	4	0	0	0	18	156
Total	0	0	0	0	29	76	267	359	124	37	1	1	894	1967

The table 1 above reveals the distinguishable patterns of flood statistics over the period of last thirteen years in Nepal. The inequality in the occurrence of flood incident is visible in every month and year as well. Likewise in each year, inequality in incident numbers as well as death numbers is also detectable. After examining the data from 2011 A.D. to 2023 A.D., the highest number of flood occurrence is recorded at 2017 A.D. with number 338 following the highest number of fatalities (death) which is 166. Additionally, the least number of flood incidents was recorded at 2015 A.D. which is 15 in number and surprisingly, no death was observed at the same year. After nearly observing the data of flood occurrences and fatalities, it is noticed that the death rate is directly proportional to the occurrences of flood. The table 2 below gives the detail information about different variables of floods.

Table 2: Various Flood Statistics (source: Nepal Disaster Risk Reduction Portal (drrportal.gov.np)

Year	No. Incident	of Total Deaths	Missing People	Injured People	Affected Family	Estimated Loss
2011	259	126	93	19	400	512104500
2012	45	9	7	3	139	21376000
2013	266	131	133	5	892	20327300
2014	65	129	133	36	36514	14917613938
2015	15	0	3	6	23	16585000
2016	230	101	36	17	7123	30711501
2017	338	166	42	35	15118	26413500
2018	80	17	3	26	1078	34530900
2019	206	73	27	20	3075	1063495249
2020	98	42	37	11	512	49411000
2021	154	63	34	14	279	115391500
2022	55	19	15	17	142	14588000
2023	156	18	21	8	3747	260785500
Total	1967	894	584	217	69042	17083333888

The table 2 above reflects the comparative data analysis of flood incident, death of people, missing people, injured people, affected family and estimated loss since 2011 A.D. to 2023 A.D. Even though less incident of flood were occurred in 2014 A.D., highest families (36514) were affected by it resulting huge losses of properties in about one hundred billion. Moreover, the estimated loss from flood is quite large which is millions to billions in every year simultaneously affecting huge families; and a single flood incident is responsible for affecting almost 35 households. Contrasting, the injured number of people is almost half to the missing people and the number of missing people is almost half to the number of decease people. Besides that, the number of human casualties (deaths, missing and injured) is nearly equal to the total number of occurrences of incidents. Moreover, the figure 2 below from Table 1 gives more understanding about the recent trends of flood disaster in Nepal over time.

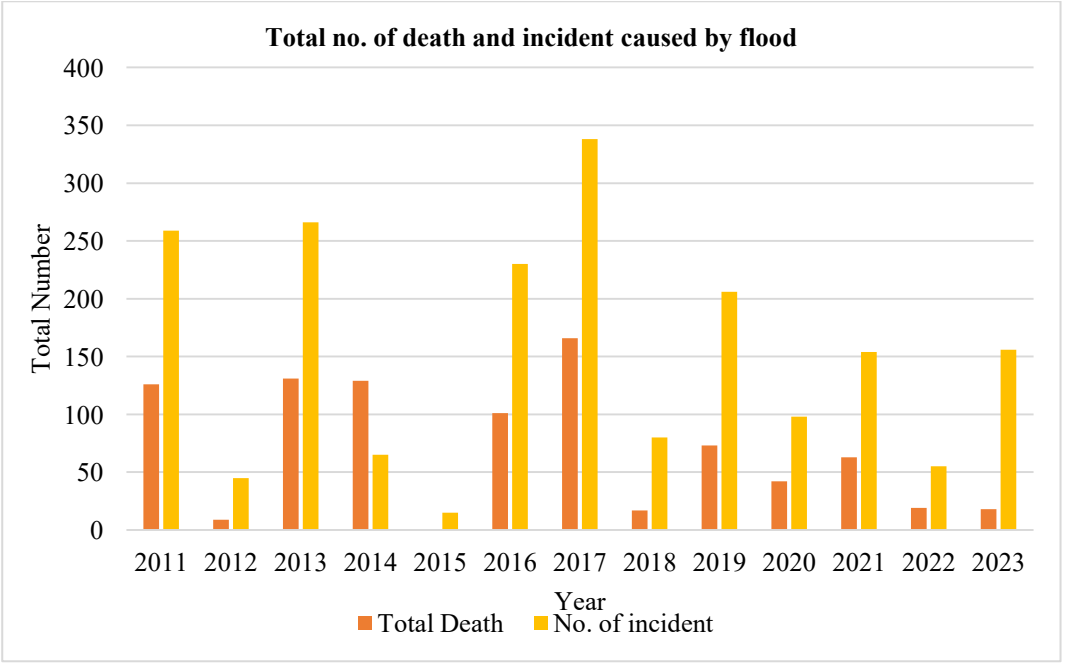

Figure 2: Year wise interpretation of number of incidents and Death

The figure 2 above conveys the year wise interpretation of total number of death and incident caused by floods. The x-axis represents the years from 2011 A.D. to 2023 A.D. and y-axis represent total numbers. The variables which are changing over time are Death and Incident. The figure above shows the discrete variation of death and incident rate over time. It is observed that the occurrence of flood is always greater than the fatality rates except for the year 2014 A.D. where high fatality is detected even though a smaller number of incidents was occurred. Bar graph shows that the people dying from flood is almost half to the occurrences of incidents resulting significant number of deaths every year. Hence it is crucial to study, analyze and understand its trends of occurrences so as to reduce human deaths.

The figure 2 below from table 1 is all about the monthly variation of occurrences of flood and deaths.

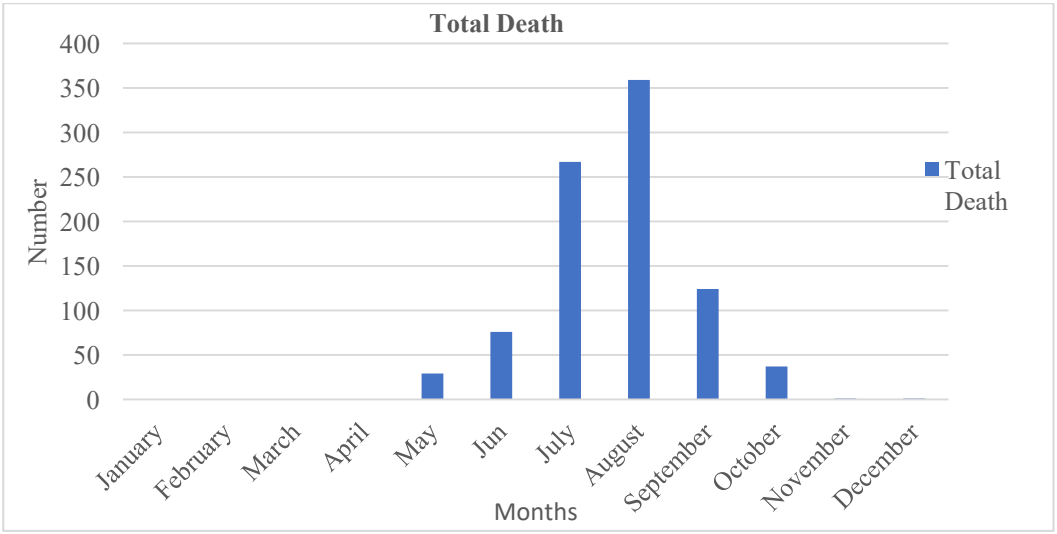

Figure 3: Month wise Interpretation of number of incident and death

The figure 3 above reflects the month wise variation of food incident counts and number of deaths they are causing since 2011 A.D. to 2023 A.D. The x-axis represents months and the y-axis represents the number of death count caused by flood. The figure shows the slow rise in deaths from May to Jun, followed by a sharp increase from July to August, reaching the peak point at the month of August thereafter gradual decline from September to October. Large number of deaths is recorded during the heavy monsoon rainfall months i.e., July and August. By the figure it is observed that the death rate over months (May to October) shows Gaussian like distribution. While in contrast, no death is recorded from January to April but small trace is seen in November to December.

Furthermore, the figure 4 below from table 2 reflects the comparative analysis of human losses and occurrences of incidents caused by flood within the time interval of 2011-2023 A.D.

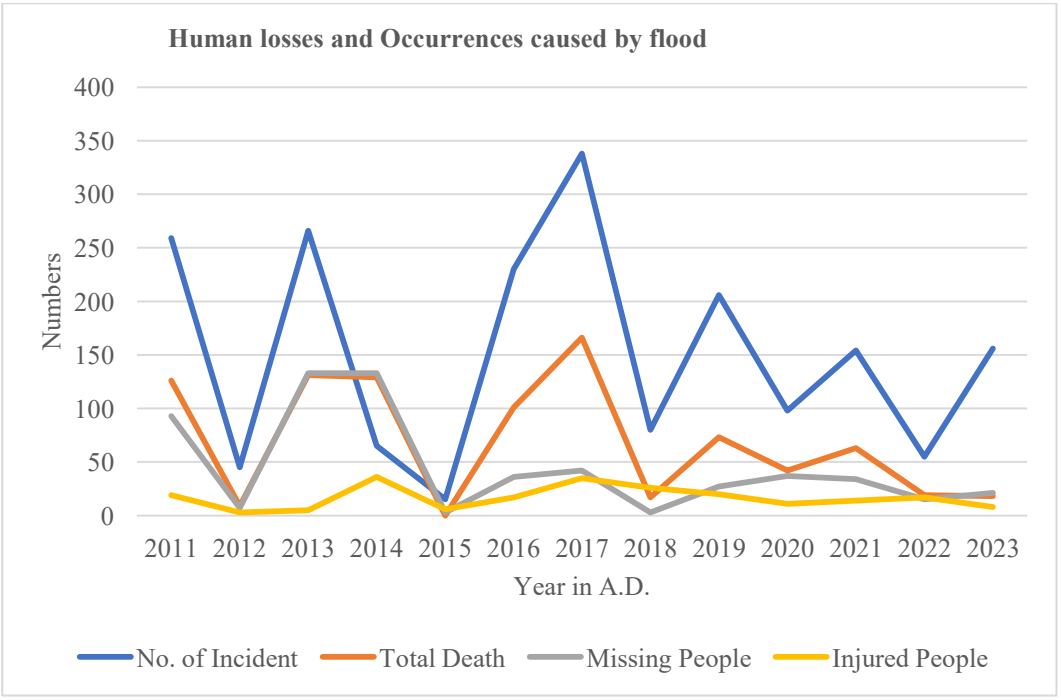

Figure 4: Year wise interpretation of occurrences of incidence and human losses

The figure above reflects about the comparative data observation and analysis of flood incident, death of people, missing people and injured people through line graph. The x-axis represents the years from 2011 A.D. to 2023 A.D. and the y-axis represent the number (counts). Initially, the missing people and death of people seems to be almost same till 2015 A.D. but then the death rate rises than the missing rate. The flood incident rate is quite high in most of the year contrasting for the injured rate of people by it. From graph, it is seen that the death, missing and injured rate of people is almost equal in 2022 A.D. and 2023 A.D.

Conclusion

Regardless the significant efforts by the government, flooding is causing high deaths and property losses. This study is done to analyze occurrences of flood incidents, deaths (human casualties), property losses in recent decade (13 years). It has been found through the study that flood causes almost half number of deaths than the incident numbers, the number of missing people is almost half to the number of decease people, causing almost half injuries to the missing people;

affecting almost 35 families by a single incident, with property losses from millions to billions of rupees in each year. This study can be beneficial for estimating its occurrences of incidents, human casualties; deaths, missing and injured and family which are directly affecting by it so as to lower the estimated loss to the researcher and various policy makers in this field. The study is limited to the data and research for the whole Nepal; hence data on flooding in particular place is missing. Further study should be done for a particular year when the casualties of people and affected families were so huge as flooding may again cause huge losses at any time depending upon the frequency of flood. In conclusion, this study provides significant perception for the researchers and policy makers in bringing further plans and policies to lower the losses of people and properties.

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References

Adhikari, P. B. (2022, June 11). People Deaths and Injuries Caused by Lightning in Himalayan. *International Journal of Geophysics, 2022*, 13. doi:https://doi.org/10.1155/2022/3630982

Adhikari, P. B., & Khanal, N. (2024, April). Seasonal variations of disasters in Nepal. *BIBECHANA, 21*(1), 1-11. doi: https://doi.org/10.3126/bibechana.v21i1.54503

Dhakal, S. (2013). Flood Hazard in Nepal and New Approach of Risk Reduction. *INTERNATIONAL JOURNAL OF LANDSLIDE AND ENVIRONMENT, 1*(1), 13-14.

Fischer, M., Brettin, J., Roessner, S., Walz, A., Fort, M., & Korup, O. (2022). Rare flood scenarios for a rapidly growing high-mountain city: pokhara, Nepal. *Natural Hazards and Earth System Sciences, 22*, 3105–3123. doi:https://doi.org/10.5194/nhess-22-3105-2022

Malla, E., Katwal , K., & Thapa , S. (2023). *Flood Management through Community Approach with Special Reference to Bishnumati River of Kathmandu in Nepal.*

Nayava, J. L. (1974, 12). Heavy monsoon rainfall in Nepal. *Weather, 29*, 443-450. doi:10.1002/j.1477-8696.1974.tb03299.

Rakhal, B., Adhikari, T. R., Sharma, S., & Ghimire, G. R. (2021). Assessment of channel shifting of Karnali Megafan in Nepal using remote sensing and GIS. *ANNALS 0F GIS*. doi:https://doi.org/10.1080/19475683.2021.1871950

Sharma, T. P., Zhang, J., Koju, U. A., Zhang, S., Bai, Y., & Suwal, M. K. (2019). Review of flood disaster studies in Nepal: A remote sensing perspective. *International Journal of Disaster Risk Reduction, 34*, 18-27. doi:https://doi.org/10.1016/j.ijdrr.2018.11.022.

Shreevastav, B. B., Tiwari, K. R., Mandal, R. A., & Singh, B. (2022). "Flood risk modeling in southern Bagmati corridor, Nepal" (a study from Sarlahi and Rautahat, Nepal). *Progress in Disaster Science, 16*. doi:https://doi.org/10.1016/j.pdisas.2022.100260.

Shrestha, B. R., Sapkota, L., & Chidi, C. L. (2022). Flood risk mapping and analysis: A case sudy of Andheri Khola catchment, Sindhuli district, Nepal. *The Geographical Journal of Nepal, 15*, 103-118. doi:https://doi.org/ 10.3126/gjn.v15i01.42889

Toya, H., & Skidmore, M. (2007). Economic development and the impacts of natural disasters. *Economics Letter, 94*, 20-25. doi:10.1016/j.econlet. 2006.06.020

Uddin, K., & Shrestha, B. (2011). ASSESSING FLOOD AND FLOOD DAMAGE USING REMOTE SENSING: A STUDY FROM SUNSARI, NEPAL. *3rd Internatinal Conference on Water & Flood Management* (pp. 293-301). Institute of Water and Flood Mnagement, BUET.

Uddin, K., Gurung, D. R., Giriraj, A., & Shrestha, B. (2013). Application of Remote Sensing and GIS for Flood Hazard Management: A Case Study from Sindh Province, Pakisthan. *American Journal of Geographic Information System, 2*(1), 1-5. doi:10.5923/j.ajgis.20130201.01

Yagacharya, K. S., & Gautam, D. K. (2008). *Floods in Nepal: Genesis, Magnitude, Frequency and Consequences.* doi:10.13140/RG.2.1.2376.8489

Nepal Disaster Risk Reduction Portal (drrportal.gov.np)