Flood Disaster Risks to Resilient: Sustainability of Kathmandu Valley

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Abstract

Kathmandu valley is the flat land surrounded by hills in a bowl shape. Surrounding hill is the origin of Bagmati River in Bagdwar and its tributaries. The sustainability of Kathmandu valley depends on the protection of the civilization of Bagmati River basin and the natural environment. This is the key to resilient. The aim of this study is to explore multifarious effects of floods in Kathmandu valley and to analyze the effort towards resilience. This is the crucial issue of its sustainability. The qualitative and quantitative data of secondary source have been used to explain the scenario of floods, status of resilient and its sustainability. Flood disaster is the crucial issue of the Kathmandu Valley (KV) that devasted the lives of people, property and infrastructures every year in a decade. The rapid growth of unscientific urbanization settlement has been encroached the rivers, river basin and watershed area. So, the Kathmandu valley is in the verge of flood risks. There is enormous challenge to the resilience of river basin community, municipal government, and the sustainability of the Valley.

Keywords: resilience, flood risk, sustainability, unscientific urbanization, flood disaster

Introduction

Disaster itself is unpredictable. The situation becomes unprecedented as devasted the lives and property of the people. It inflicts the social, economic and natural environment which affects the global community over the time. Millions of people have been displaced, injured and killed by disaster each year. Ritchie (2022) presented that every year, between 40,000 and 50,000 people are killed by natural disasters like earthquakes, storms, floods, and drought. This is the mean for the previous several decades. World Wide Fund (WWF) (2008) states the three major impacts of natural disasters on conservation efforts. First of all, they frequently jeopardize significant conservation investments and contribute to environmental degradation when it occurs. Second, they uproot entire populations, whose frantic search for food and shelter may fuel deforestation, loss of biodiversity, and environmental degradation. Last but not least, they prepare the ground for extensive reconstruction projects that, if done in an unsustainable manner, entail the extraction of vast amounts of resources and raw materials like clay, sand, and timber, endangering already-stressed ecosystems or shifting those threats to other locations.

Numerous calamities in recent decades have attested the fact that the risk of water-related incidents has been rising globally. Droughts, mass movements, river floods, flash floods, tsunamis, and storm surges are a few of these occurrences. Flood disaster has been severe incident across the world especially south Asian countries like Nepal, India, Thailand and Bangladesh. Center for Disaster Philanthropy (CDP) (2024) mentioned that the monsoon season in South Asia is becoming more intense due to global warming. Floods between August and October claimed 57 lives, injured 28, and affected another 256,400 in Thailand. Additionally, according to same reports, 11.7 million people were impacted by the rains in India and the more than 2,000

landslides that followed, including about 117,000 who were forced to relocate to relief camps established by the district authorities. Moreover, the report presents Cox's Bazar was one of the most severely affected areas in Bangladesh. It was habitats around a million Rohingya refugees from Myanmar, including 800,000 residents of Kutupalong, the biggest and densest refugee camp in the world. This group was already at high risk prior to the catastrophe.

Nepal has high risk of natural disaster such as flood, land slide, earthquake, due to its natural structure. Global Climate Index (CDI) of 2021 states that Nepal is ranked as the 12th most climate vulnerable nation (Eckstein & LauraSchäfer, 2021). Similarly, Ministry of Home Affairs (MOHA) of 2018 ranked Kathmandu valley in 30th place for water-induced disasters and 20th place for all naturally-caused disasters. Moreover, United Nations Development Program (UNDP) of 2009 presented Nepal as the second-most flood-prone nation in South Asia. Historically floods have been occurred in Nepal frequently, during the monsoon season resulted in a substantial loss of property, life, and infrastructures. Rough terrain, unstable geological structures, frequent seismic activity, sporadic glacier lake outbursts, heavy monsoon rains, and improper land use are some of the key factors contributing to disasters that swiped out the fertile land and loss of biodiversity every year in Nepal (DWIDP, 2013). Shrestha et. al, (2020) noted that around 7599 people were died and 6.1 million people were directly affected by floods between 1954 -2018 in Nepal.

In addition to enormous loss of lives and property, the floods of 1993 in Central Nepal, the Koshi embankment breach floods of 2008, and the floods in the Mid- and Far-Western regions in 2013, 2014, and 2017 had a catastrophic effect on growth (ibid, 2020). Massive flooding in the Melamchi River on June 15, 2021, resulted catastrophic downstream destruction. Nepal experienced a lot of heavy flooding and landslides throughout the country in late September 2024 as a result of heavy rainfall. The three days (September 26–28) continuous rain caused extensive destruction, took many lives and damaged infrastructures throughout the country especially in Kathmandu, Kavre, Dhading, Nuwakot.

Kathmandu Valley is the home of eight rivers. The rivers and the watershed are the beauty of Kathmandu. Dhakal (2015) mentioned that the Kathmandu valley is surrounding by the hills of 2500-3000 meters high from the sea level. Kathmandu is the capital city surrounded by eight tributaries of Bagmati river. Bagmati is the main river among them. It is always in high risk of flood during monsoon season. This is the capital city of Nepal. Rapid urbanization, uncontrolled migration from other part of the country and the expansion of towns into the Bagmati river basins make the Kathmandu Valley susceptible to floods. Chaudhari, et al (2024) study shows that The KV watershed is one of the most flood-prone regions in Nepal due to topographical, climatic, and socioeconomic factors. Since a decade Kathmandu valley (Kathmandu, Lalitpur and Bhaktapur) has been devasting every year by flood and lost lives, property and infrastructure.

This study aims to explore the existing situation of flood risk zone of Kathmandu valley and possible effort towards resilience. This is the crucial issue of sustainability of Kathmandu Valley.

Method and Materials

The research is based on the secondary source of information. Both qualitative and quantitative data are used from the difference sources such as National Disaster Risk Redaction Management (NDRRMA), Ministry of Home Affairs (MoHA), Provincial Council, Municipal Council, District Disaster Management Committee. Different Journal articles, Newspaper articles, reports on disaster risks to resilience are also reviewed.

Result and Discussion

History of Flood Disaster of Kathmandu Valley

Kathmandu valley is an important place in terms of economic, social, administrative and political of Nepal. It is located in the central place of Nepal. Kathmandu is located at the geographic coordinates ranging from 27°38'32" to 27°45'7" North latitude and from 85°16'5" to 85°22'32" East longitude. The city is positioned at an average elevation of 1,350 meters above sea level. It experiences a sub-tropical cool temperate climate (Thapa et al., 2008).

The human civilization of Kathmandu valley is based on the Bagmati river systems, which includes eight tributaries and small streams. The system has consistently served as the primary water source for the city. The Bagmati river and its tributaries are source for consumption, irrigation, possessing religious, cultural, and social significance. The valley features have two main landforms, namely alluvial plains and flood plains along the rivers and somewhat higher river terraces, locally referred to as 'tars'. The urban region is typically level, with an incline of less than 1 degree, and the soils are mainly loamy and boulder surface characteristics (Haack and Khatiwada, 2007).

According to geological study and legendry source, the valley was believed to have a big lake called Nagdaha, the water was drained out by a saint named Manjushree. He created a passage through the ridge at the Chobhar gorge, located south of Kathmandu, thereby making the valley suitable for settlement (Dangol, 2017). The valley encompasses the entirety of Bhaktapur district, 85 percent of Kathmandu district, and 50 percent of Lalitpur district (Mohanty, 2011). The area, that is now a city, turned out a fertile farmland: principal crops grown in the outskirts of the city consist of rice, wheat, corn, potatoes, mustard, and several other types of seeds utilized for oil extraction. Now the valley is almost covered by concrete jungles.

Kathmandu valley is in high risk in flood during the monsoon. It has been experiencing a lot of floods as devasted the socio-economic life and natural environment since a decade. Bagmati river along with other eight tributaries make the major impact especially corridor and the riverside settlements. They are always at risks during the monsoon. Majority of slum settlements is in river basin has directly hit by flood every year.

The ratio of risk factor has been increased by the 0.87 annually. In July 2002, a severe incident happened when 26 events were in the Kathmandu Valley only. That claimed 28 lives, 283 people were injured, and caused property losses totaling 54,455,000 NPR (USD 545,550) (UN Habitat, 2015). Rainfall in Kathmandu reached record levels on September, 26-28, 2024 for the first time in 22 years.

According to National Disaster Risk Reduction Management Authority (NDRRMA) (2024) rainfall exceeded the previous record set in 2002 and was the highest in the recorded history in contrast to the previous record of 177 millimeters in 2002, the Tribhuvan International Airport station in Kathmandu received 239.7 millimeters of rain in a 24-hour period. This flood disaster occurred at the end of the monsoon season.

Historical Events of Floods in Kathmandu Valley

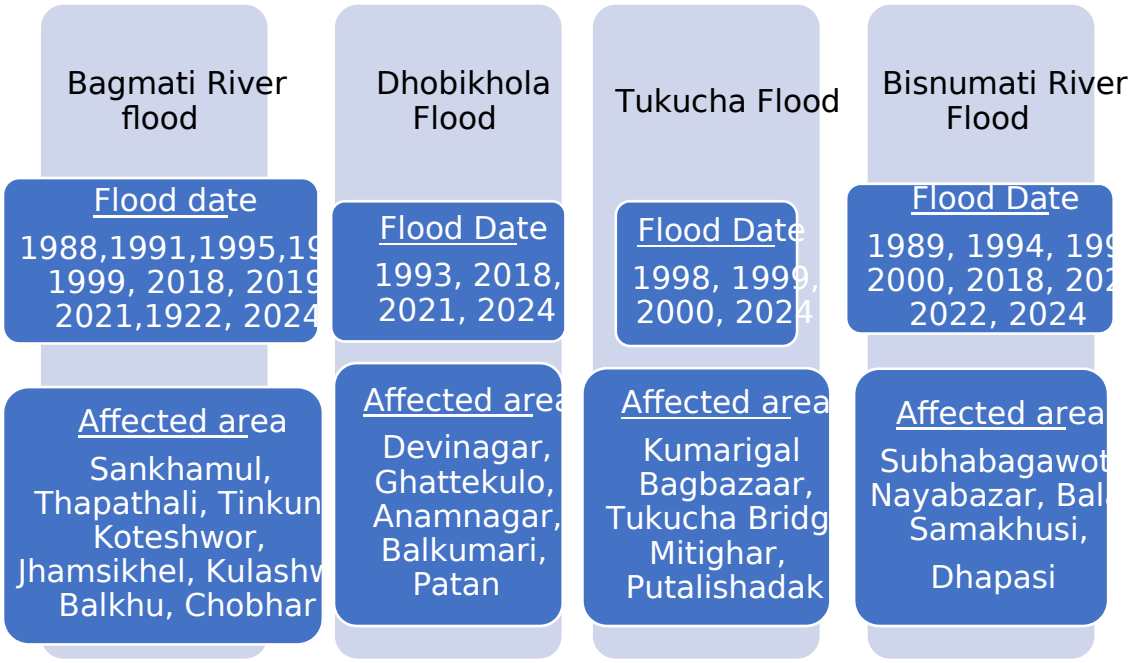
Bagmati River Flood: Bagmati river is originated from the northern hill of Kathmandu valley. It is the main river which has eight tributaries and streams including Manahara, Dhobikhola, Bisnumati, Tukucha and Balkhu Khola located in Kathmandu district. The collective water from all the streams and rivers accumulated to the Bagmati river and drain out from Chobhar. Bagmati river of Nepal has social, cultural, economic, and religious significance. Pasupati temple is situated in Bagmati river basin. It is popular for ritual activities for Hindu and was popular source for fresh water, fishing, irrigation, swimming and bathing in the past. This is mainly protecting the

biodiversity and balance of the ecology of Kathmandu Valley. However, Bagmati river flood has been devasting the riverside settlements and religious temples, bridge and other infrastructure each year since a decade. Gautam and Pokhrel (2004) stated that due to heavy rainfall in Nepal's central region, a major flood disaster occurred in the Bagmati river basin on July 19–21, 1993, the highest rainfall in Nepal's history, totaling 540 mm over 24 hours and with an intensity of up to 65 mm per hour, was recorded. The Bagmati barrage and *Kulekhani Hydropower Plant* damaged significantly as a result of the floods. The tragedy claimed the lives of roughly 1336 people, including 163 injured, and destroyed numerous houses and bridges (An approximate loss of property of NRs 4.9 billion).

The flood history of Bagmati river and its tributaries has been summarized in Figure 1

Figure I

History of Bagmati River and its Tributaries River Flood in Kathmandu District



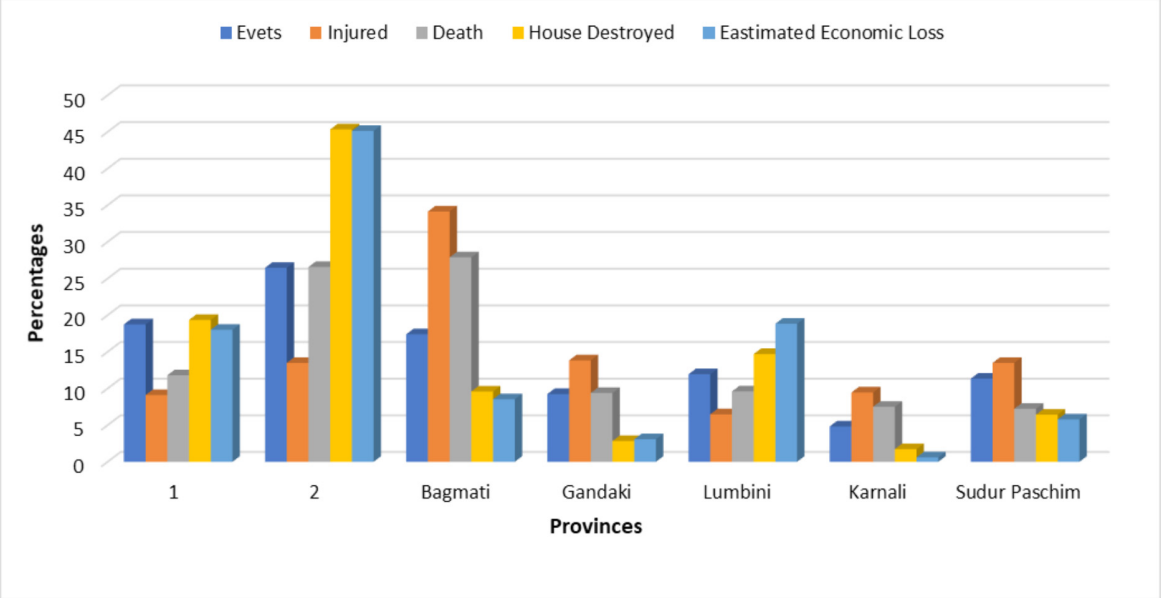
Source: Chaulagain et al. 2023, & Kathmandu Post, 2024

Bagmati and its tributaries river flood have been occurring for a long time and affected many parts of the Kathmandu valley. The flood of Bagmati river does not only affect to the residents of Kathmandu, the flood devasted to the surrounding districts and caused the floods in Terai as well. In 2024, the flood of Kathmandu Valley had been experienced the tremendous affect to the people of Kathmandu especially to the slums and the riverside settlements. NDRRMA (2024) estimated Rs 46.68 billion was lost as a result of the floods in Nepal, the nation's economy was impacted by the floods, including: Agriculture Rs 6 billion, Energy Rs 4 billion, Water Supply Rs 3.44 billion, Transportation Rs 2.52 billion and Irrigation Rs 1 billion. The heavy rain swiped out the UN park corridor and different places of Lalitpur like Kupondol, Bagdole and Karmanasa corridor as well. Bagmati river is the boarder that separated Kathmandu and Lalitpur. The flood inundated both river side settlements and infrastructure. Bagmati river along with the other associated river's flood devasted the Madesh Province and Bagmati Province more as compared to other provinces located in western part of Nepal since 1971- 2016. Poudel (2024) stated that the most extensive damage

was recorded in Bagmati province, where 9,997 households were displaced and 4,414 dwellings were completely destroyed and 7,157 partially demolished, impacting around 14,517 families.

Figure 2

Flood Disaster Devasted in the Different Province of the Country 1971-2016



Source: Shrestha, Rai & Marasini, 2020

Hanumante River Flood: Hanumante river flood has been threating to the settlements of its basin and municipal government of Bhaktapur since a decade. However, Hanumante has the historical, cultural and ritual connection to the entire Bhaktapur as a human civilization. It is a tributary river of Bagmati which has been demolishing the river side slum area and the fertile plain of Bhaktapur. There are several flooding events had occurred in the different time period. In the study of Kindermann, et al. (2020), during the 2015 and 2018 flood recorded a largest flood in the history of Bhaktapur that affected the local people, agricultural land, blocked transportation and Bridge. The flood damaged over three dozen houses and a sizable portion of farmland in 2020 (Ojha, 2020). The small size of flood has been common to the riverside especially slums. The Hanumante flood of 2024 devasted the entire rive side area and damaged enormous social economic infrastructure. Phillips and Dhakal (2024) reported that the constant rain caused the flood in Hanumante and the nearby streams that hit to schools, hospitals, factories, settlements, and business houses, shop farm, road bridge and damaged millions of dollars as estimated.

Karmanasha and Nakkhu Flood

Lalitpur district covered 50 percent of land of Kathmandu Valley (NSO, 2021). Lalitpur Metropolitan City (LMC) is one of the three major cities located in the valley. In terms of disaster risk, Lalitpur has had a number of catastrophes in the past that experienced seismic catastrophes, as well as other disasters like floods, traffic accidents, fires, landslides, droughts, etc. in the past, according to the hazard, vulnerability, capacity, and risk assessment (LDCRC, 2018). LMC is basically being suffered from flood every year. To deal with such calamities, LMC Disaster and Climate Resilience Committees (LDCRC) was established with coordination between the LDCRC. Flood disaster is crucial issue for Lalitpur like Kathmandu and Bhaktapur. The rivers of Manohara,

Karmanash, and Nakkhu have been inundated every year. Poudel (2024) presents that all schools had been closed and transportation was totally obstructed due to landslides caused by rain. Similarly, the flood-fed Karmanasha rivulet reached human habitation in Lalitpur Metropolitan City-28, flooding hundreds of houses. The flood inundated the riverside poultry farm, hospitals, schools, business house, retails shops and some government offices as well.

The flood of 2024 massively devasted the Kathmandu valley and challenged the residential and the local government. NDRRMA (2024) reported that around 170 people lost their life, 111 people were hurt and 42 were unaccounted during the flood of Kathmandu, Lalitpur and Bhaktapur. Although, the valley is the major dreamland of Nepalese people, it is highly risk area for natural calamities like earthquake, flood and landslide.

Flood Disaster Risk to Resilience of Kathmandu Valley

As already mentioned, according to legendry, the valley was a large lake that cut down in the Chobhar hill and drained out the water by Manjushree. Chobhar hill is only the drainage of the entire eight river. When the human settlement began in Katmandu Valley, it was with the fertile land of alluvial soil. It was a boon to the farmers. Before the unification of Nepal, Wiba et al. (2024) stated that agriculture production of Kathmandu Valley contributed to the national economy and exported the products to India and China. The rivers of Kathmandu Valley were the sources of irrigation, drinking water, fishing and bathing. The land was full of moisture and rich in biodiversity.

Studies reviewed that the flood of Kathmandu Valley is manmade rather than natural. The rapid and unscientific urbanization process has led to encroach the rivers, river basin and watershed area. According to NSO (2021), the total population of Kathmandu valley was 2,996,34 and the population density was 5,169 per square kilometer and the annual population growth rate was of 1.47 percent. The rapid rural urban migration is the major case of slum and squatter settlement in Kathmandu Valley (Shrestha, 2013).

The uncontrolled population migration towards the capital city of Nepal to get the better life and opportunity caused the unscientific urban development. The study conducted by Khanal and Khanal (2022), there were 65 slums with 28,412 population. And 4,696 slums settlements were found in the Bagmati river and its tributaries river basin. The river basin slums and squatter settlements of the valley are highly at risks during the monsoon. The flood is threating every year due to the artificial activities. Some tributary rivers of Bagmati are either narrowed or are under the settlements. Chhetri (2020) elucidated that more than 1465 households had already been encroached river basin of Bagmati and Bisnumati rivers.

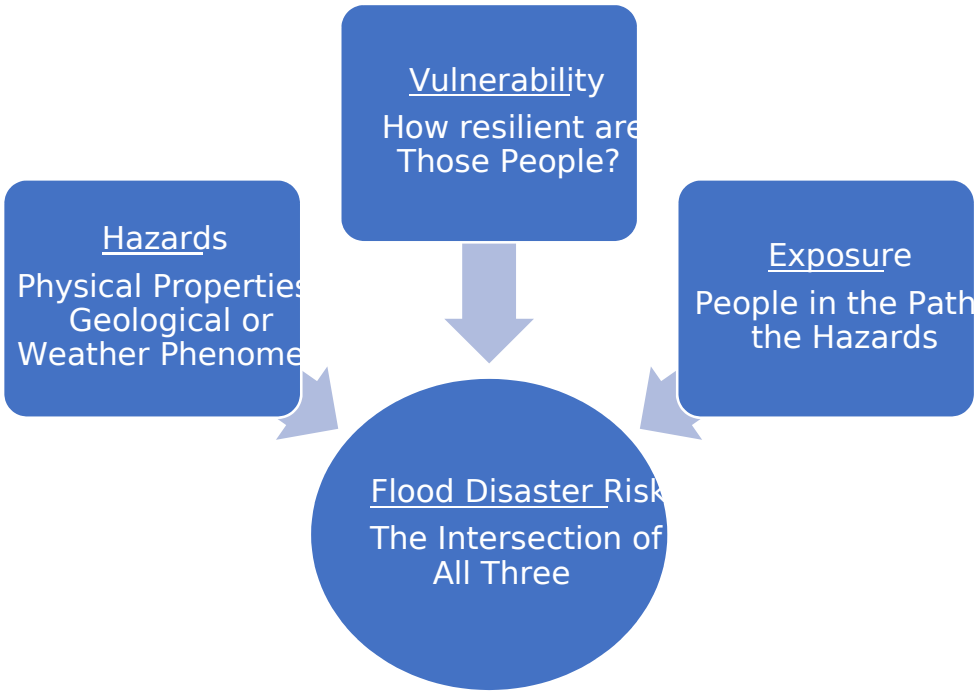
Ojha (2021) stated that the government has made a rule that human settlements should not be within 100 meters on either side of the rivers. However, after the restoration of democracy 1990 the people of Kathmandu started to encroach the river bank of Kathmandu Valley. Ghimire et al (2023) analyzed that the land use plan has been completely changed since a decade. As a result, 13.34 percent settlement rose to the river basin, 4. 56 percent of forest had fallen, 15 percent of open spaces had been decreased, the cultivated land had decreased by 5 percent and grass land increased by 11 percent. In addition, 386 percentage increased in built-up areas between 1990 and 2020 and 28 percentage reduction in forest cover from 1989 to 2019 (Khaliq, 2024). Moreover, Ghimire (2023) pointed that, the majority of the valley's local governments have already said that the region is devoid of arable land because the land is not being used in accordance with land use regulations, the valley is also facing the prospect that, in a few years, there would not be any more land available for agriculture in Kathmandu. Due to the over encroachment, the river and the expansion of cities

area resulted the concretization of Kathmandu valley, and small rain also inundated the valley during off monsoon season.

Ritchie (2024) presented that the intersection of flood disaster risk. With reference to the Kathmandu Valley, how susceptibility and exposure to hazards in this area are growing over time. In addition, it looks at the factors that contribute to the unequal and unfair experiences of these risks. The flood of the valley affected the physical properties and lives for many years.

Figure: 3

Flood Disaster Risk: The Intersection



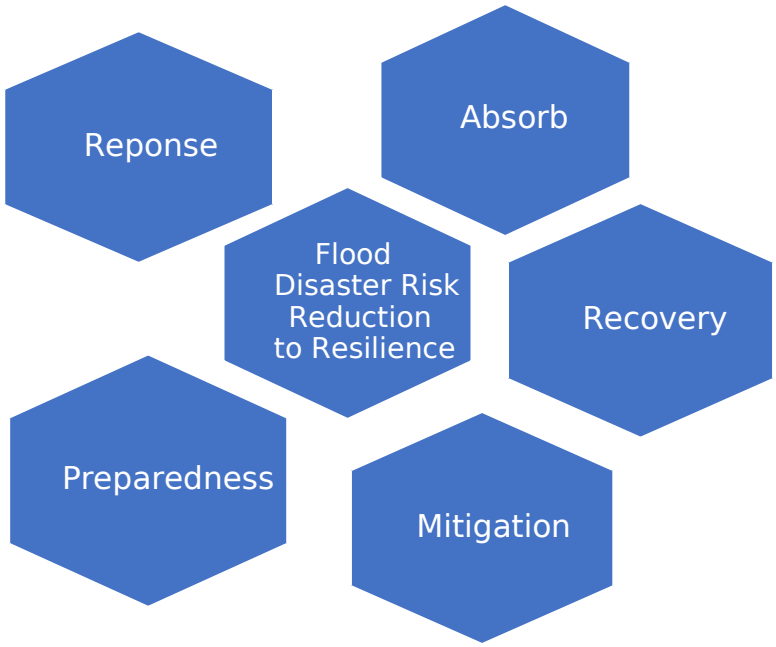
Sources: Ritchie & Auerbach, 2024

People whose livelihoods depend on nature, particularly those who depend on agriculture, are highly exposed to and sensitive to various threats. Hazard exposure is further fueled by growing urbanization, slums and squatter settlements on marginal lands due to poverty and exclusion, encroachment on river rights, and internal movement to regions prone to hazards. Insufficient technical expertise and understanding, failure to adhere to construction codes and risk-informed infrastructure development, shortcomings in DRRM governance and its integration, and poverty and exclusions are among the elements contributing to the nation's susceptibility to calamities.

Resilience is the quick response, absorb, recovery, mitigation and preparedness for the future sucks. The people of Kathmandu Valley especially river bank areas settlement, slum and squatter area are always in risk zone. The mitigation major for the risk reduction to resilience of the residence is always crucial in Nepalese context especially in Kathmandu Valley.

Figure: 4

Flood Disaster Risk Reduction to Resilience



Sources: Strong, Carpenter, & Ralph, 2020

MoHA (2022) presented that understanding the flood disaster risk by community as well as local government are the most important aspect of risks reduction. Additionally, local government should strengthen disaster risk mitigation strategy to timely mange risk. Moreover, the local government should invest in disaster risk reduction for resilience by enhancing investment for resilience building to the community, promoting public investment in disaster risk reduction and increase the private investment in disaster risk reduction, providing insurance and social security as transfer of risk. However, it is experienced that the resiliece capacity of the government and the exposure to the community is very low.

Disaster Risk Reduction to Sustainability of Kathmandu Valley

The sustainability of the Kathmandu depends on the protection of rives, watershed, open space, bio-diversity and natural environment of the Kathmandu Valley. However, haphazardly constructed buildings and unplanned development infrastructure and concretization of the land destructed the environment of Kathmandu Valley. Although the rules and regulation have been well constructed. Due to the poor implementation mechanism, the sustainability mitigation measure of the valley is being devasted by the natural disaster every year.

Basnet and Shrestha (2019) presented the sustainable urban index for the sustainability of Kathmandu Valley which is presented below.

Figure: 5

Sustainability Indicators of Kathmandu Valley

Source: Basnet & Shrestha, 2019

Some initiatives to protect from the flood in the valley, the SDG 2015, focuses on urban development and stating that "making cities and human settlements inclusive, safe, resil ient, and sustainable."The 2018 National Policy for Disaster Risk Reduction seeks to allocate a sp ecific portion of thefederal, provincial, and local governments' yearly budgets to disaster risk red uction.Additionally, it establishes the framework for the creation of disaster management funds at all the levels of government. MoHA (2022) state that the federal government has set up a Disaster Management Fund of NPR 1 billion (USD 8 million) in accordance with the DRR policy.

Forthermore, ADB (2022) launched the Bagmati River Basin Improvement Project (BRBIP) (17 July 2022-16 July 2023) which is crucial initiative aimed at restoring and revitalizing the Bagmati River and its surrounding areas in Kathmandu Valley, Nepal. Likewise, KMC (2024) claims the city's resilience has been improving by fortifying its infrastructure and putting policies in place. Despite the political, social and economic challenges, Kathmandu, Lalitpur metropolitan and Bhaktapur municipality have been implementing some environment protection activities for the sustainability of Kathmandu valley.

Open space are also the crucial valley resources that helps to absorb the rain water and recycle for the sustainability. It contributes the reduction of the flood risks. The KVDA (2015) identified 488 of these locations in Kathmandu, 346 in Lalitpur, and 53 in Bhaktapur. Public land patches, hospital, college, and school buildings, as well as riverbanks, have all been designated as open spaces, out of 887 spaces, 83 areas were designated as "public spaces" in the Nepal Gazette

(Shrestha, 2015). Similarly, MacMurdie (2024) stated that in January 2023, Global Peace Foundation (GPF) Nepal launched the Green Homes: Green Kathmandu project in partnership with Kathmandu Metropolitan City Wards 5 and 15, realizing the urgent need for sustainable development in Nepal. Efforts to conserve and maintain natural environment are essential for ensuring their continued enjoyment by present and future generations.

Conclusion

Kathmandu Valley is a prone area in terms of natural disaster for instance earthquake, flood and landslide. Flood disaster is a crucial event that devasted the life, property and infrastructure development for many decades. They are susceptible to flooding since the valley has no natural drainage. Chobhar is only a drainage area that is not sufficient for outflow of river. The rapid urbanization of Kathmandu Valley (386% increase in built-up areas between 1990 and 2020) and deforestation (28% reduction in forest cover from 1989 to 2019) have disrupted natural water processes. Due to the encroachment of river bank and open space, concretization of land, extension of settlements over the valley, flood disaster in the valley is common. The sustainability of Kathmandu depends on the protection of natural environment, enhances the social and economic capabilities of community especially slums and squatter settlements. The houses and infrastructure of the valley, local level government strategy and policy shall cope with the state rule and regulation regarding the resources and river bank. Therefore, risk reduction and management initiatives can help to resist the new threats.

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