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Bhaktapur Urban Flood related Disaster Risk and Strategy after 2018

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Abstract

The urbanization led urban flooding phenomenon of the Hanumante River over the last few decades is the subject of this article. The river flows in the middle of the Bhaktapur District and connects with all municipalities. Its catchment area is 97km². The data offers deeper insights into sources, causes and impacts of the flood. All stakeholders are aware of their roles and responsibilities during the disaster. However, affected people have limited understanding and knowledge about the flood and remain in fear of another flood every year. The major cause of floods in the district is incessant rain and urbanization leads to the inundation of various low lying areas. However, increased urbanization, lack of proper planning and encroachment of river are supplementary causes of floods. Floods can be predicted and mitigated with appropriate information, tools and techniques by responsible agencies. Often disasters are a failure of responsible agencies to act timely and to understand the environmental changes and the urban push. Inundation is becoming a common phenomenon for urban people in most cities.

Keywords

Disaster, urban, flood, Hanumante river

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Introduction

Nepal is prone to water induced disasters (Water and Energy Commission Secretariat, 2011) and therefore maintaining risk free infrastructure is expensive. Nepal's monsoonal season is prone to urban flooding and rapidly growing settlements and the growing numbers of urban infrastructures work as a catalyst. When government agencies fail to address urban disasters, it derails local government structures in cities and metropolitan areas to provide institutional and infrastructural services (International Federation of Red Cross and Red Crescent Societies, 2010). The urban flooding is a serious and growing developmental challenge because of demographic growth, urbanization trends and climate changes resulting into unwanted floods and subsequent shifting of impacts accentuating. The greater challenge for policy makers and managers is to really understand the issues in order to effectively address them. Generally, urban areas equipped with hospitals, schools and colleges, business areas and social hang-out places with appropriate built-in environment. It is such realities that support livelihoods of the people and linked to urban areas for appropriate societal function.

An urban area is an administrative criteria with political boundaries having a certain population and economic function (UNICEF, 2012). Countries around the world define urban characteristics based on their own experiences, requirements and judgments. An urban hazard is a risk that threatens a city, its population and related socioeconomic activities. If a risk threatens a capital or large city, the risk may resonate beyond the area of impact. The focus is mostly on major disasters, since smaller ones are less destructive and more easily absorbed, though much of the discussion is also applicable for smaller disasters (Kreimer, Arnold, & Carl, 2004). Around 54 percent of the world's population lives in urban areas, a proportion that is expected to increase to 66 per cent by 2050. Projections shows urbanization combined with the overall growth of the world's population could add another 2.5 billion people to urban populations by 2050, with close to 90 percent of the increase concentrated in Asia and Africa (United Nations, 2014).

Crisis may be defined as "an emergency situation arising out of natural or human activity which poses a threat to human life and property or leads to large scale disruption of normal life. A crisis may degenerate into a disaster if it is not properly managed, resulting in an avoidable loss of human life and property on a large scale (Patel, 2017). A disaster is a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts (UNISDR, 2017). "Disaster Risk Reduction (DRR)" shall mean the disaster risk analysis and evaluation, prevention and mitigation of disasters and mainstreaming of disaster risk reduction activities into the development activities (Ministry of Federal Affairs and Local Development, 2013). DRR means analysis and assessment of risks before a disaster happens, disaster prevention or reduction of harms to be caused by disaster and efforts concerning the minimization of disaster risks in development activities (Government of Nepal, 2074). Disaster Management (DM) refers to the entire activities concerning DRR, disaster counteraction and disaster recovery (National Disaster Risk Reduction Management Act, 2074). A disaster is the hazard's effect on society as a result of the combination of exposure and vulnerability. So strictly

said, disasters, not hazards, cause deaths and damage (UNISDR, 2009). A hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation (UNISDR, 2009).

The scenario of a flood is changing due to urbanization and growing number of cities and towns as part of the decentralization of development in Nepal. Rural areas are urbanizing and expanding without proper planning and effective implementation of prevailing laws and guidelines. Increased municipalities are rapidly converting from rural to urban areas with built environments. One of such example is the 'Bhaktapur Flood 2018' which created an urban havoc leading to livelihood, commercial and security concerns.

The Hanumante River, a tributary of the Bagmati River, passes by the Bhaktapur District and connects to all municipalities. In 2018, it flooded the lower Bhaktapur, Madhyapurthimi and Suryabinayak Municipalities. The meandering of the river is contracted in these areas. The study areas within Hanumante River are Ward Numbers 1, 3, 4, 5, 7, 8 of Bhaktapur Municipality, Ward Numbers 5, 4, 3, 2 of Suryabinayak Municipality and Ward Numbers 9, 4, 5 of Madhyapurthimi Municipality (Figure 1). Three locations respectively Chyamasing Hanumante Bridge (North), Barahisthan Pati and Barahisthan Bridge are taken as the sample to verify the encroachment of Hanumante River and pictures taken at the field visit are also used to analyze and describe the facts.

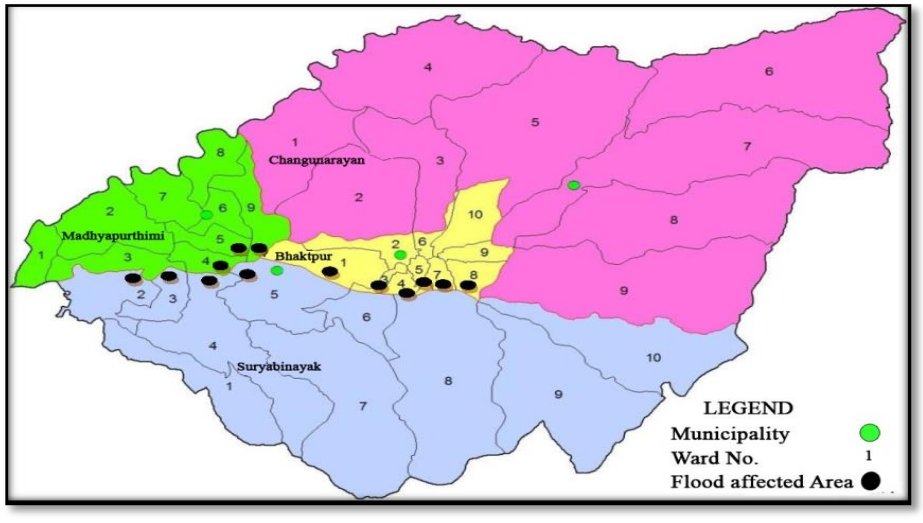

Figure 1: Topography Map of Bhaktapur with Flood Affected Wards
Source: Ministry of Federal Affairs and General Administration, 2019

Literature review

The land use pattern of Bhaktapur has changed dramatically from 1988 to 2015 due to the decrease in forest and agricultural areas and the large increase in urban built up areas. The urbanization in the nearby Arniko Highway, a section between Tinkune (Kathmandu) to Suryabinayak area, can be

observed in the six lane highway (Thapa Chhetri & Moriwaki, 2017). Outside of the highway, Right of Ways is followed by large scale semi commercial buildings. In some places, built-up areas increased by 120 percent with increased roads (Ishtiaque, Shrestha, & Chhetri, 2017).

Nepal's National Strategy for Disaster Risk Management covers the strategy and international commitment. It focuses on a 'One Window Policy' and the 'Cluster Approach' to coordinate with various organizations. It talks about the Early Warning (EW), existing challenges to mitigate the challenges and how to strengthen the response and preparedness activities. There is provision of monitoring and implementation of activities by concerned ministry, institutions and departments (Ministry of Home Affairs, 2011). The Bhaktapur District lacks appropriate implementation despite existing laws.

Methodology

The qualitative case study method is used to describe, analyze and explore the underlying questions. Collected data is analyzed structurally and articulated it with the information received from interviews, KII and field observations. The secondary data and maps from appropriate agencies are also analyzed and interpreted.

Discussion and analysis

Bhaktapur is the smallest district of Nepal covering 119 km². It is located east of Kathmandu city and known for its Newari culture and tradition. The highest point is the Bagheswori Reserve Forest at 1800m and the lowest point is the Radhe Temple at 1298m (Survey Department, Government of Nepal, 2000). Around 17.93 percent of Bhaktapurs land is covered by forest (Madhyapurthimi Municipality, 2075). Bhaktapur has four municipalities namely Bhaktapur, Madhyapurthimi, Suryabinayak and Changunarayan. It has a population of around 304,651 with a 3.01 growth rate and a population density of 2560 (Central Bureau of Statistics, 2011).

The settlement, public property and highly fertile land along the river are at high risk of flood causing the loss of investment of farmers, land and property. The Hanumante River is a 6^{th} order drainage, stretches for 18.30 km and confluences with 6^{th} order Godawari Khola. It has a drainage area of around 97.051 km² with a 53.233 km long perimeter (Shrestha, 2010). Tabyakhusi Khola flows from the Bagheswori Reserve Forest (known as Mahadev Khola), Chakhu Khola flows from Tukucha Nala and Nalachhap and meet at Hanumanghat. Then, two streams called the Hanumante River. Hanumante River (River) receives water from Sipadol Khola, Kalka Khola, Khasyan Khusum Khola, Gakhu Khola and Ghatte Khola (Survey Department, Government of Nepal, 2000). Bagheswori Reserve Forest lies at 1800m, Telkot Reserve Forest at 1600m, Nankhel at 1776m and Gundu at 1719m. They surround the urban area of Bhaktapur. The populated and urban area of Bhaktapur lies at a height of below 1400m (Survey Department, Government of Nepal, 2000). That means that all rain water flows into the Hanumante River and sometimes goes beyond the bank or streams, thereby causing floods or inundations.

The government of Nepal (GoN) identified more than 19 open places in Bhaktapur for providing various services during disasters such as humanitarian assistance, security, rescue, relief and establishment of temporary camps (Kathmandu Valley Development Authority, 2014). In 2008, GoN decided the Hanumante River's width to be 20m on both sides of the river (Bagmati Action Plan, 2009), whereas a survey map of the 2021 BS shows that the width of the river varies. The banks of the river are treated as dumping sites by municipalities. The waste is spotted everywhere at bridges as well as in and besides the river banks. There is no equipment to measure the water level and the EW in the river. Sewer pipes are directly thrown into the river. Around 37 sewerage points from Chyamasing to Thimi area are directly thrown into the river and among them about 10 sewerage points (pipes) have a diameter between 1000 and 1500 mm (GIETC Lama Raman JV, 2015).

There were no strong measures implemented by government authorities to mitigate and prevent the flood prior to the 'Bhaktapur Flood 2018.' There is a lack of proper construction of embankments, levees and other measures to protect the soil erosion. The waste thrown by inhabitants filled the river and reduced its depth. It needs to be removed prior to the rainy season. The river bank is vulnerable in many places due to weak or not enough structures. The plain area of Bhaktapur is the lowest area. Water from the periphery gathers in this place and creates inundation.

Figure 2: Garbage (A) at Chyamasing and Waste Management (B) at Barahisthan
Source: Researcher, 2019

Flood Affected Municipalities and Urbanization

The Bhaktapur, Madhyapurthimi and Suryabinayak municipalities cover the area respectively 6.88 km², 11.47 km² and 42.45 km². The population of Bhaktapur, Madhyapurthimi and Suryabinayak Municipalities are as follows: 83658, 83036 and 78490 people according to the Central Bureau of Statistics (CBS) 2011.The registration of houses in Bhaktapur Municipality (Bhaktapur Municipality, 2019), Madhyapurthimi Municipality (Madhyapurthimi Municipality, 2019) and Suryabinayak Municipality (Suryabinayak Municipality, 2019) in the last five years until Poush 2075 are shown in Table 1. The ratio of building new houses is high in Suryabinayak and low in Bhaktapur

Table 1: House Registration in Municipalities

Municipality	2071/72	2072/73	2073/74	2074/75	2075/76*
Bhaktapur	440	467	966	994	322
Madhyapurthimi	484	508	969	1035	373
Suryabinayak	467	824	688	565	1387

Source: Bhaktapur, Madhyapurthimi and Suryabinayak Municipality, 2075

Urbanization in Bhaktapur

In 2011, Bhaktapur had two municipalities (Bhaktapur and Madhyapurthimi) with population of 3,04,651 people and 54.1 percent of the population living in urban areas (National Planning Commission Secretariat, 2014). The urban population of Nepal is rapidly increasing (Department of Economic and Social Affairs, Population Division, 2019).

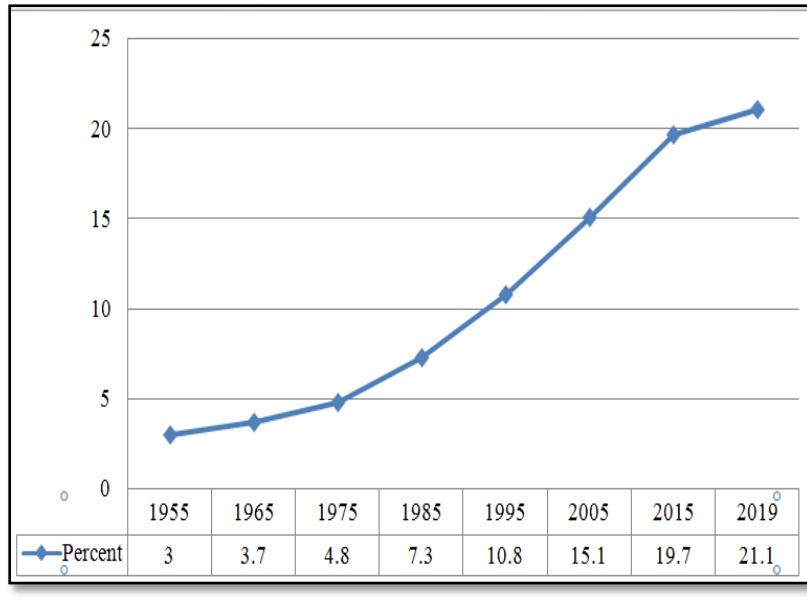

Figure 3: Urban Population Trend in Nepal from 1955-2019
Source : www.worldometers.info/world-population/nepal-population

Figure 4 shows how urbanization has increased from 1990 to 2000 and from 2000 to 2010. Developed (built-up) area is growing and agricultural land is reducing very fast. The growth rate of the population in Bhaktapur, Madhyapurthimi and Suryabinayak Municipalities are respectively 1.43, 5.67 and 3.5 percent according to the CBS 2011 (Central Bureau of Statistics, 2011). The data shows that the population is increasing rapidly in all three municipalities. There is a possibility of a further increase of the population growth rate in Suryabinayak in the near future because it is the largest municipality.

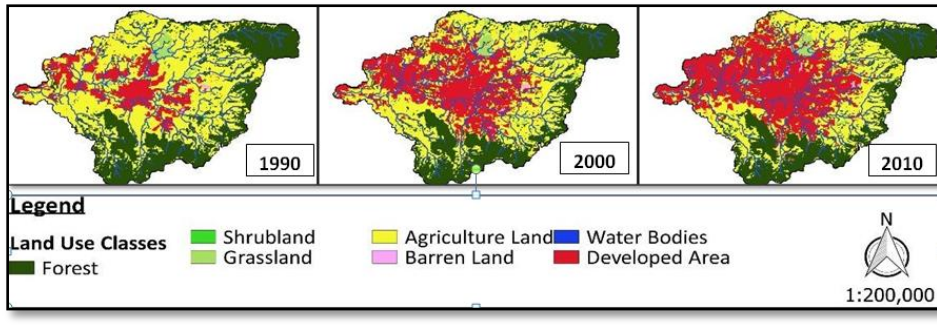

Figure 4: Changing of Land Use along the Hanumante River Basin
Source: Bagmati River Basin Improvement Project Office, 2019

The population and built up has become one of the indexes of the development of cities (Thapa Chhetri, Fujimori, & Moriwaki, 2017). Population is increasing and areas are highly concretized and equipped with tall buildings and infrastructure to accommodate the growing population and provide facilities to them.

Table 2: Population Projection of Municipalities

Municipality	Bhaktapur	Madhyapurthimi	Suryabinayak
2011	83,658	84142	78490
2018	92465	125136	100280
2020	95148	140163	107551
2030	109775	247103	152623

Source: Projected by Researcher

Figure 3, 4 and Table 2 show that the urbanization rate and the population are increasing day by day. That means that the arable land is changing into concretization. There is no community park or open place in the urban area except roads. The unplanned settlements and settlements near the river indicate that people are more vulnerable. Therefore, concerned authorities must work on the management of urban areas to diminish the vulnerabilities. Previously, the registration of houses was done by the Village Development Committees, which was no proper planning for recreational spaces, open spaces, or drainage systems. Now, municipalities are working on it to create a better organized city with proper architecture according to a clear plan.

Institutional framework

The Disaster Risk Reduction and Management Act 2074 has received clear provision from various committees from federal, province, district, and local bodies and even on the ward level. All municipalities have formed the committee according to the provision, but there is still a lot of work to be done on detail disaster mapping and recognizing vulnerabilities. During field surveys, certain lacks in the disaster planning of concerned authorities have been found. There is a lack of community disaster mechanisms. A community settlement level management disaster committee would be very important to make the community more resilient (Figure 5). In 2019 most of cities and towns of the

southern and the Himali region inundated due to rain. This indicates that there is no proper planning prior to setting up the built up areas and those guidelines are not followed while constructing the infrastructure.

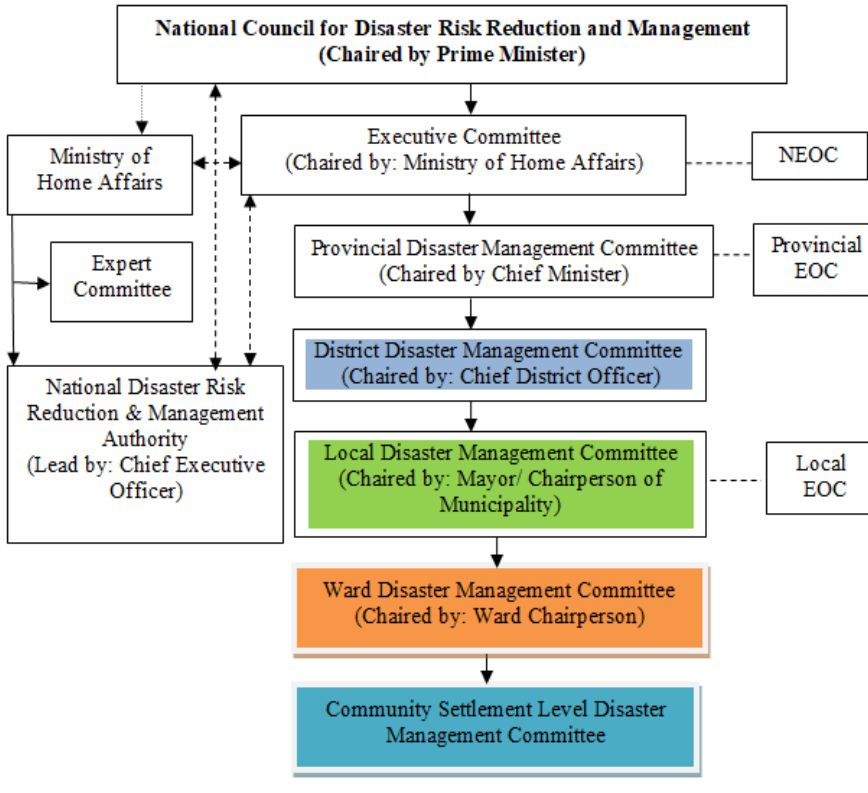

Figure 5: Institutional Framework of Disaster Management
Source: Disaster Risk Reduction and Management Act 2074

Bhaktapur Flood 2018

The 2018 Flood inundated the lower part of Bhaktapur. The flood was felt by the residents of Bhaktapur municipality around 0300h and at around 0500h in the Radhe-Radhe area. The level of water was gradually extended to Arniko Highway and the lower part of Bhaktapur came under water. The water remained at the section of Arniko Highway from Sallaghari to Thimi Chowk till 1500h on the same day.

A major cause of the flood was the heavy rainfall and the blocking of drainage facilities with garbage. Cleaning and maintenance of drainage facilities are essential to their operational reliability. Storm water retention measures are vital for the mitigation of urban floods as well as for the prevention of downstream floods. The aim of urban flood risk management is to minimize human loss and economic damages. It can't be fully avoided but it can be managed.

Building codes plays an important role in decreasing the physical vulnerability of houses and infrastructure. Flood warning systems need to be installed to communicate with the communities at risk through forecast information and warnings. The success of such a system is closely related to people's knowledge about floods and their familiarity with emergency responses to incoming floods (Tingsanchali, 2012). The office of resident coordinator pointed out the constraints regarding floods in the Terai among the clusters (Office of the Resident Coordinator, 2017). Government bodies and concerned stakeholders need to work on urban DRR in all urban areas around Nepal. Local bodies and community mechanism should activate simultaneously in order to make the community resilient to disasters.

Table 3: Flood in Urban Area from 2013-16

Place	2013	2014	2015	2016	Total
Ghorahi	1	0	0	1	2
Dhangadi	3	0	1	1	5
Budhanilkantha	1	0	0	2	3
Lahan	1	0	0	2	3
Itahari	1	0	0	1	2
Hetauda	0	0	1	1	2
Belbari	0	0	1	2	3

Source: NSET, 2016

In recent years, most cities and towns have faced the problem of water logging or inundation. The government needs to work on how to mitigate the urban floods and imply all those measures which can prevent and minimize the disaster risk. Figure 6 shows the water bodies and catchment area of rivers in Bhaktapur. It has many water bodies in the northern, western and southern parts. More than 60 percent of water in the district is channelize into the Hanumante River (Higher Powered Committee for Integrated Development of the Bagmati Civilization, 2018).

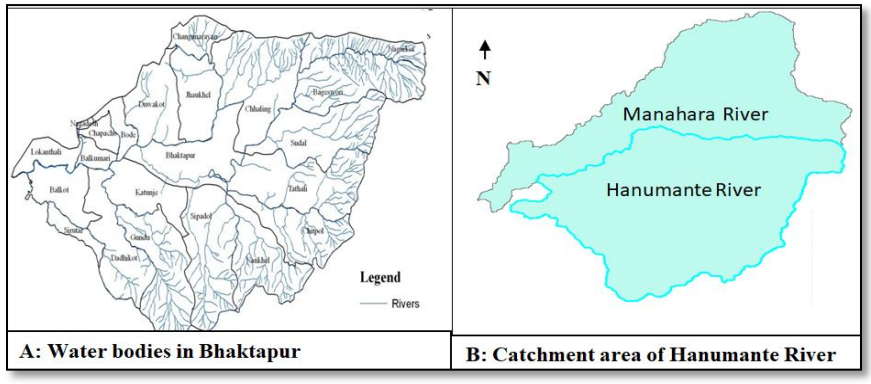

Figure 6: Water Bodies in Bhaktapur (A), Catchment area of Hanumante River (B)
Source: Bagmati River Basin Improvement Project, 2019

The flood data shows that until 2016, around 3902 people lost their life due to damages following 4162 events. 571 people were injured people, 99,113 households destroyed and, 114091 affected more and 5,43,114 livestock were killed (National Society for Earthquake Technology, 2018). There were 338, 80 and 206 incidents in respective years 2017, 2018 and 2019 (Government of Nepal, 2019). Hundreds of dwellings in Bhaktapur and Thimi were inundated due to the flash flood following the torrential rain that morning. Most of settlements in Bhaktapur and Madhyapurthimi were fully inundated. The most affected areas were Jagati, Chyamasingh, Bhelukhel, Rammandir and Barahisthan due to the deluge (Republica, 2015).

Table 3: Casualty by Flood from 1971-2016

Year	Casualty	Year	Casualty
2008	127	2014	268
2009	119	2015	13
2010	136	2016	72
2011	114	2017*	166
2012	111	2018*	17
2013	52	2019*	73

Source: Desinventar 2008 to 2016
http://www.drrportal.gov.np

The flood affected three municipalities in the lower part also called the valley of Bhaktapur. Ward No. 8, 7, 5, 4, 3 and 1 ward of Bhaktapur was flooded in the 2018 Bhaktapur flood. Chyamasing, Rammandir, Barahisthan regularly come under water. The Sallaghari area was badly affected in 2018's flood. Three Wards (No. 9, 4 and 5) of Madhyapurthimi came under water during the flood. Two wards no. 9 and 4 were badly affected and ward no. 5 was slightly affected. Four wards (no. 5, 4, 3 and 2) of Suryabinayak Municipality were affected by the 2018 flood and among them no. 5 was badly affected. Ward no. 1 of Bhaktapur, ward no. 9 and 4 of Madhyapurthimi and ward no. 4 and 9 of Suryabinayak Municipalities were the most affected wards.

Flood means "Khusibaa" in Newari language ('Khusi' means water, 'baa' means extreme). Respondents (more than 65 years) have seen flood more than seven times but they have only memory of 2015, 2016 and 2018. Respondents stated "*Floods are common for us because a decade ago there were few houses and floods came and drowned the farmland. Now the houses are built everywhere and the water disturbs human life."*

Causes of flood in Bhaktapur

The respondents and KII were asked for the cause of floods in Bhaktapur. According to respondents, the main causes of flood in Bhaktapur are as follows (Figure 7):

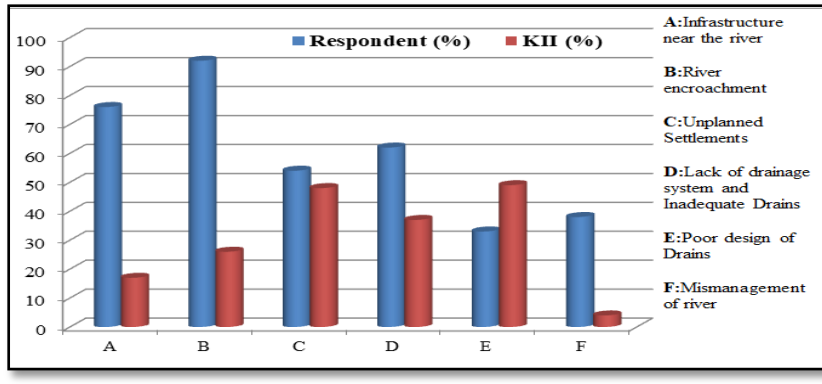

Figure 7: Causes of Flood in Bhaktapur around Hanumante River
Source: Field Survey, 2019

The causes of flood named by victims (respondents) and KII differ in infrastructure near to river (60%), river encroachment (70%) and mismanagement (40%). But there is less variation in unplanned settlements (10%), lack of inadequate drainage system (20%) and poor design of drains (10%). The views on infrastructure near to the river have a huge variation because both KII and respondents have their own perceptions. Among six, three causes are viewed similarly both by KII and respondents. The other three are subsidiary causes of the flood in Bhaktapur.

Infrastructure near the River: Around 70 percent of the respondents said the infrastructure is made too close to the river. Garment factory, washing, religious structures and houses are built very close to the river (Figure 8A, B).

Figure 8: Encroachment by the Garment and Washing Factory (A), Pati build at the Bank of river at Barahisthan (B)
Source: Field Survey by Researcher

River Encroachment: The Hanumante River is encroached in many places because it is not delineated. Around 90 percent of respondents and around 20 percent of KII gave their view on this. Figure 8A shows that the distance between the river bank and the garment factory is only four meters

(shown on round circle) when the gap is supposed to be 20 meter. At Barahisthan, the pati was built at a distance of only 7ft from the river bank (Figure 8B).

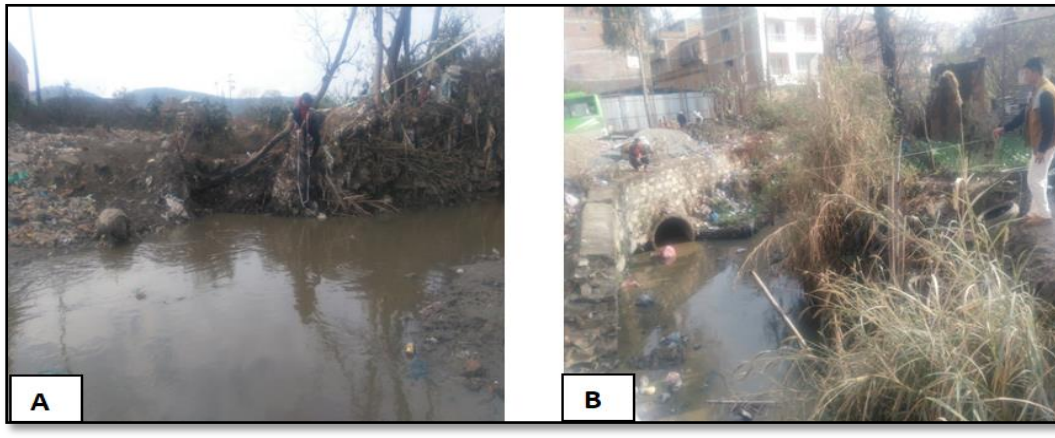

Figure 9: Unplanned Drainage (A), Mismanagement of river (B)
Source: Field Survey by Researcher

Unplanned Settlements: The Village Development Committee used to register houses without engineering and that created problems in the urbanization. There is no drainage system in the city to pass the water. Sewerage pipes are directly thrown into river (9B). The respondents stated "*Now there is no land but buildings everywhere, and added water is not charged by the land but of concretization so directly goes to river."*

Lack of Drainage System and Inadequate Drains: There are very few sewerage management systems in Bhaktapur. The rain water travels directly to the river from everywhere due to the lack of drainage and canals. Around 60 percent of respondents and 30 percent KII support this statement.

Poor Design of Drains: City, town and water bodies are not managed and planned nicely so around 50 percent of respondents think that this is also a cause for floods in Bhaktapur.

Figure10: Idols of God in the river
Source: Field Survey, 2019

Mismanagement of River: Around 40 percent of the respondents said that mismanagement of rivers is a cause of flood during the field survey. This statement is true as there is no embankment in many

places from where river easily enters into urban areas and causes inundations. The statue of Gods and Goddesses are also constructed in the river banks.

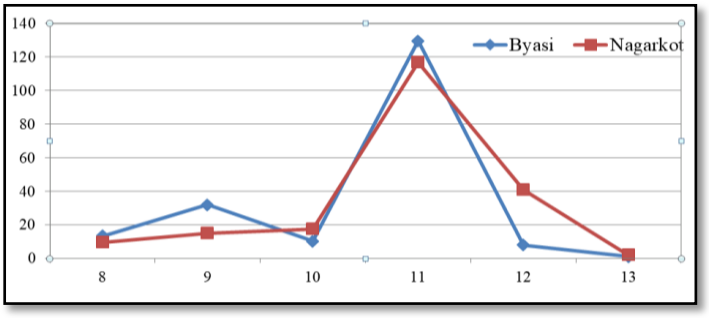

Figure 11: Rainfall Recorded at Nagarkot and Bhaktapur Station from July 8-13, 2018
Source: Department of Hydrology and Meteorology, 2019

Figure 11 shows, there was incessant rain prior to flood and on 11th July rainfall was recorded 129.6mm and 117mm respectively at Bhaktapur and Nagarkot station. According to respondents and KII, there are other causes of flood in Bhaktapur which are as follows.

a. Urban constriction of outlet.
b. Rapid urbanization.
c. River depth is filled by urban wastes and erosion.
d. Lack of drainage system.
e. Decreased ground recharge.
f. Reduced agricultural activities.
g. Unplanned settlements and construction.
h. Lack of long term effective planning.

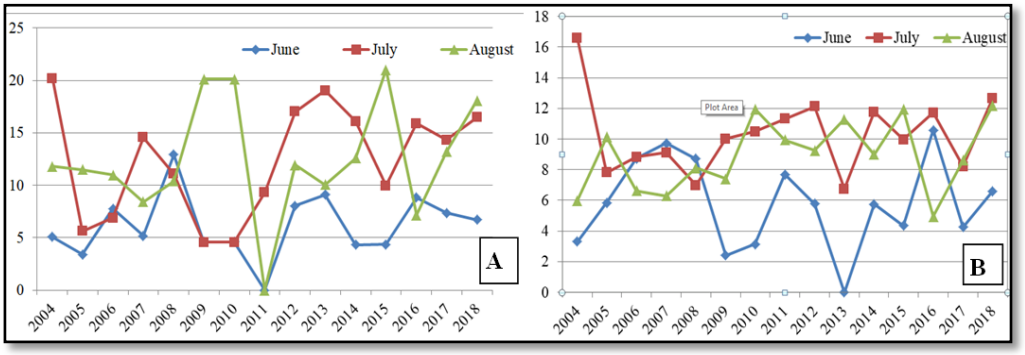

Figure 14: Precipitation Data Nagarkot (A), and Bhaktapur (B) Station
Source: Department of Hydrology and Meteorology, 2019

June, July and August make up the rainy season in which Nepal receives most of its rain. The last 15 years of rainfall data of these three months are analyzed for effect and impact. The precipitation from the Nagarkot and Bhaktapur (Figure 14A, 14B) stations shows the rainfall data from 2004 to 2018.

July and August are the rainiest months but July receives more rainfall than the other two months. Prior to the 12th July 2018, Bhaktapur received incessant rain and that caused the flood in Bhaktapur. The rainfall data of the last 30 year shows that rainfall is very high in the months of July every year in Bhaktapur. So, the government needs to work on it to forecast the flood by establishing EW. It also indicates that the concerned authorities can predict if they want to because every year in July Bhaktapur receives a lot of rain.

Table 4 shows that there are encroachments of the river by community, people and other organizations which are not properly monitored. Field survey and survey map data are not similar. It is supposed to be similar if there are no discrepancies. It means there are encroachments and mismanagements of the Hanumante River and that the area near the river is not planned according to the water body criteria.

Table 5: Length Comparison of Hanumante River in the Field and Survey Map

Place	In Field (Feet)		Other Findings	Survey Map
	Width	Depth		
West side of Bridge	29	-	-	40
Chyamasing Bridge (North	25	5	-	
East side of Chyamasing Bridge	23	-	-	36
Bridge Construction	43	6	No embankment, Sewerage point to	
Barahisthan (Pati)	64	3.6	Religious idol of Shivalinga and Goddess inside river and distance of Pati is 7ft from the river bank.	90
Gyantara School (Barahisthan)	91	10 *	*River bank to School	110

Source: Field Survey, 2019

Impacts of Flood in Bhaktapur

Water Level: The water level reached up to 10ft in some houses as many houses were made underground. Most of Bhaktapur residents bored the water level up to 4ft, Madhyapurthimi 5ft, Suryabinayak 2ft and it lasted around one week.

Figure 15: Level of Water in Different Places: Outside (A) and Inside of House (B)
Source: Field Survey, 2019

Destruction: The flood damaged 522 houses, 28 industries and factories including petrol pumps, 133 retail and wholesale shops, a bridge, roads, two hospitals and two schools (Nepal Police Bhaktapur, 2075). It has also damaged water pumps of fields and houses, grains and utensils.

Crops and Cattle: The overflowing water from the Hanumante River swept the vegetables, crops and also brought sand into the agricultural field. The sty made near the river was blown away with pigs by the river.

Livelihood: The flood affected the life of thousands of people as the Arniko Highway as it was blocked for hours due to inundation. The hospitals and schools were remaining closed for many days because of the inundation. Around 90 percent of respondents said their daily activities were hampered by inundation.

Sewer Management: The sewerage management project has been running in Bhaktapur for four years but there was no progress due to various problems. After the 'Bhaktapur Flood 2018', the progress is tremendous and there are fewer disturbances by locals than ever before (GIETC-Lama Raman JV, 2014).

Awareness Program: The disaster awareness rate was very low in the affected area. Around 63 percent did not have any idea of the disaster awareness program. However, stakeholders said they do have a disaster management plan. It means that there is a huge communication gap between them.

Hanumante Clean Campaign: The Hanumante River cleaning campaign was started to clean the waste and garbage in and around the river. The concept emerged after the 'Bhaktapur Flood 2018'. The campaign is very fruitful to clear waste and garbage from the river and its surrounding. It also creates more awareness about disasters in the community (Hanumante Cleaning Campaign, 2018).

Flood mitigation measure

The government is concerned about the flood and initiated many programs in flood affected areas especially to manage the Hanumante River. The river is not the only reason for the flood, so there are also other actions from municipalities regarding the management of urban areas. They are stricter in house registrations and engineering of houses. There are three big projects in Bhaktapur which should help mitigate the floods and manage the river:

Hanumante Corridor: The Hanumante Corridor is under construction for 2800m on both sides of the river. Construction is started from 200m north of the Radhe-Radhe Temple to Madhyapurthimi. The company has started the construction work including the work of building shoulder and tick drains (40cm) in between 30m to 40m to drain the rain into the river (Higher Powered Committee for Integrated Development of the Bagmati Civilization, 2018).

Sewerage Management Project: Kathmandu Upatyaka Khanepani Limited has started building a 12 kilometer long sewerage management project along the Hanumante River. Two water treatment plants will be constructed at Sallaghari and at Manahara River to clean the accumulated sewerage and

release it into the river. There are more than 80 incoming sewer pipes (ranging from 250 mm to 1500 mm) going into the river (GIETC-Lama Raman JV, 2014).

Hanumante Cleaning Campaign: The campaign committee is headed by the mayor of Suryabinayak municipality. He is starting an awareness program for disaster risk management in the city and along the river.

Conclusion

Urban disasters are common due to rapid urbanization in Bhaktapur. The city frequently receives floods around the periphery of the Hanumante River; especially the lower part is affected. The minimal management of the river led to increased encroachment together with incessant rain. The poor sewerage operations and waste dumping in the river are the key causes for the river flooding.

The flood can be mitigated and prevented by constructing machinery walls, embankments, clearing the waste from the river and starting other environmental interventions such as building walls. The research identified that the river covers large catchment area and that water from various sources finally ends up in the river. The waterway to the river is altered because of encroachment and waste dumping.

There must be effective and sustainable interventions to manage mitigate and prevent future floods in urban areas. The drainage systems inside the urban area need to be managed with a proper plan. The government agencies need to manage waste products of the urban area through proper planning by constructing embankments and drainage systems and clearing waste from the river and its banks. Urban floods can be predicted by installing equipments at appropriate places and establishing warning mechanism on the community level.

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