Urban Flooding in Bago City in Lower Myanmar

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Abstract

At present, due to urbanization, the Bago city in Lower Myanmar still encounters problems such as urban flooding especially during the monsoon. The impact of flooding is driven by a combination of natural and human-induced factors such as the drainage system and waste disposal. The purpose of this study is to find the main causes of urban flooding in Bago City and to investigate how local people build resilience to the effects of urban flooding. In this paper, the management of water drainage system causing urban flooding in Bago City will be investigated to find ways. Local Communities' responses both of local government and people of the Bago City are conducted based on secondary data sources, surveying questionnaires, semi-structured interviews with local people.

1. Introduction

Urbanization is an increase of the population in urban areas. In developing countries, urbanization grows rapidly and uncontrollably and then it becomes more complex. Unsystematic urban systems lead climate changes which cause economic and social problems. Moreover, people from these countries are also facing natural disaster such as flooding and inundation almost every year.

1.1 Urbanization and Flooding Problems

The main problems caused by climate changes generated by unsystematic urbanization include flooding, inundation and drought. Common reasons of urban floods are poor drainage system, heavy seasonal rainfall, river flooding and lying on low-land areas. Domestic and unstructured waste materials which deposited on the bottom of drains and channels are the reason of poor water flow in the city and discharge waste material from factories are also included. Due to these waste materials, the rivers, streams and canals are in poor flow condition and when heavy rainfall comes, the water level immediately reaches above the danger water level and flows into the urban areas.

The poor drainage system in urban areas has direct impact on living conditions infrastructure, human health and many other sectors. The rapid increase of population, poor living conditions, and poor quality of the infrastructure also cause the urban areas' vulnerability to floods to increase.

1.2 Flooding in Myanmar

Myanmar, a Southeast Asian country, is a developing country facing serious flooding problems almost every year throughout the whole country, including coastal flooding, climate change, flash flood near dam because of poor dam management and also urban flooding. According to OCHA Myanmar's report, in the year 2015, massive floods affected more than 259,000 people, killing 69 people, displacing 39,474 households, inundating more than one million acres of farmland, and disrupting the planting seasons across 12 states and regions.

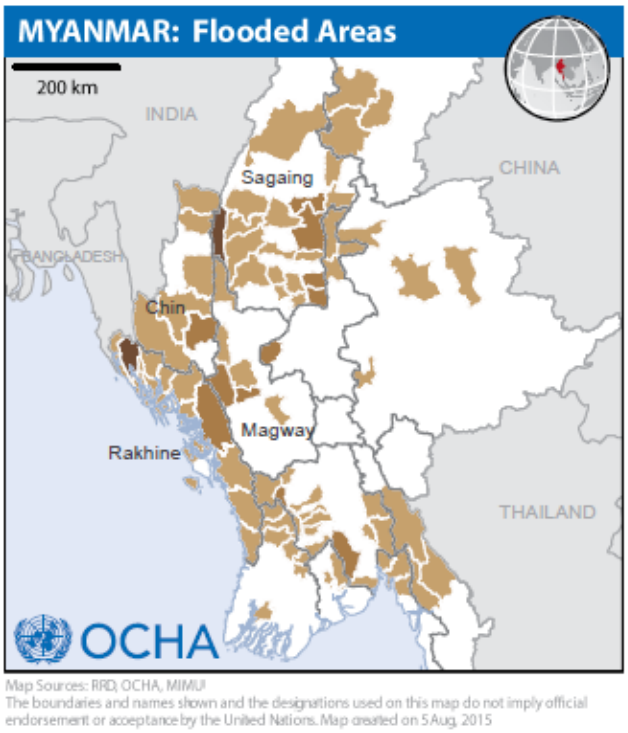

Figure 1.1 Myanmar Flooded Areas in 2015

1.3 Flooding in Bago

Bago, a secondary city in Lower Myanmar, is one of the cities facing flood almost every year as it is situated in Bago River Basin. Torrential flood occurs frequently in this area. The city of Bago occupies the low-land plains of the Bago-Sittaung river valley. The Bago River is the main drainage system that flows across the city, as well as being the city's main source of fresh water.

1.4 Works On Flooding in Bago city

As flood is a major problem in Bago city, there are some works concerning floods in that area. 1979, San Aye, Mg did a Master Degree Dissertation thesis on "Flood and Inundation in BagoCity " in Myanmar language. He stresses that Flood and inundation in Bago are caused by river flood and heavy rainfall, urging governmental plans to prevent flood. An analysis of the Bago and Sittaung River Basins was conducted by Delft University of Technology providing the information on water system, physical system, social-economical system and the water related challenges in the region including Bago city. In 2012, Htay Aung Pyae, Maung carried out a research titled " Evaluation of proposed Drainage System of Bago". The paper claims that torrential floods are worsen by poor urban drainage system, causing urban flooding as consequences. In 2013 Sheigeko Haruyama published the book

titled "Morphometoric Property and Flood Equation_ Lesson from the Bago River Basin Myanmar", analysing the water data of Bago river in detail.

1.5 Research Questions

This paper is based on the belief that it is essential to find out the followings in order to help solve the very frequent problem of frequent flood in Bago.

1. To what extent and how does the drainage system in Bago worsen torrential flood causing the frequent urban flooding?

2. How do the local government response to frequent flooding problem?

3. How do the local people participate in government response?

1.5 The Scope of the Paper

In this paper, the drainage system of Bago and the local government and local people responses will be evaluated based on primary and secondary sources with a focus on the Bago municipal area.

2. General Information of Bago City

Bago is the capital of East Bago Region and situated 180 miles from South of Nay Pyi Taw and 50 miles from North of Yangon. Bago is located at Latitude 17˚19' N and Longitude 96˚ 29' E and above 33.17 ft above Mean Sea Level (MSL). It has tropical and dry season. Annual Rainfall is 130 inches. The city of Bago occupies the low-land plains of the Bago-Sittaung river valley. The Bago River is the main drainage system that flows across the city, as well as being the city's main source of fresh water. It arises in the hills of Bago County and flows for 331 kilometers towards Yangon with a catchment area of 5348km^2, through the city of Bago, where it emerges with the Myitmaka River, from this point called the Yangon River. The width of the Bago River differs from 150m upstream to 2200m downstream. The area of the city is approximately 20 square miles. Domination livelihoods of the city are small scale industries, trades and commences. Hills and mountains are situated in the west of city area, forest area is situated in the north of city area. There is slope area from middle part to southern and the eastern part is delta area to Sittaung river basin.

Bago City lies on Yangon-Mandalay Highway road. The city has developed an elongated shape as urbanization expands rapidly following the highway. The Yangon-Mandalay Railway also runs through the city North- South and the urban slums can be found near the railway. There are 31 wards in the city area and the nine wards, which are called Oakthar Myothit (1-9) are newly founded in 1999. Geographically, the city is on low-lying flat plain even though BagoYoma and Dawna Ranges are located in the North and East respectively. (HSHD report, 2012) The highest and lowest elevations are between 53.85ft and 24.30ft above mean sea level.

The climate of Bago City follows a monsoon pattern and receives annual rainfall is about 3300mm in the rainy season. In summer, highest temperature is 34 degree centigrade in April and lowest temperature is 19 degree centigrade in January. Although BagoYoma Range offers huge draining possibilities, majority of water sources flow only into Sittaung River and its respective tributaries. However, Bago River receives tidal action. The tidal action affects flat plain area at the far downstream area of Bago River. The embankment on each side of the river protects almost all tidal action with the exception of prolong torrential rain and sequential flow from surface runoff in monsoon season. The eastern embankment of the river is higher than that of the west to protect more the eastern part as there are many government offices, hospitals and the ancient city.

Figure.3.1 Location of Bago City

2.1 Research Methodology

In order to anaylze the urban flooding in Bago city , essential data such as hydrological data, town planning and drainage system structure and maps are collected from different local authorities through interview, personal meeting and reports in their departments. For some information about Bago city, datas are collected from secondary sources like previous works. And local people response is also found out through individual interviews with 20 local people. The data are analyzed based on the model questionnaire provided in Urban Climate Change Resilience. A review of methodologies adopted under the ACCCRN initiative in India cities. Fields observations are also done three times too to see the ground situation in March and May 2017.

3.1 Flood Data of Bago City

During the monsoon season, the rain falling in the Bago river's catchment area runs through the streams and streamlets, and enters the main Bago River, and causes flooding in the river valley and floodplain. Because of these reasons, the urban area of the Bago City has been usually facing the natural disaster, specific flooding and inundation. And especially the western portion of the Bago City located in the western embankment of the Bago River is often covered with flood water.

The first warning flooding water level of the Bago observation station is fixed 9.1 m MSL. When the river water level reaches 8.6 m in high water season, it starts to spill into the low wards in Bago City. Therefore, the City's danger-level is fixed as 8.6 m MSL. According to the historical hydrologic data obtained from the Department of Meteorology and Hydrology in Yangon, during the period from 1966 to 2014, the Bago water levels exceeded over the flood danger level (9.1 m MSL) in last one decade that was occurred in 1970, 1982, 1985,1986, 1992, 1994, 1996, 1997, 2004, 2007, 2008, 2010, 2011 and 2014. (Fig 3.1)

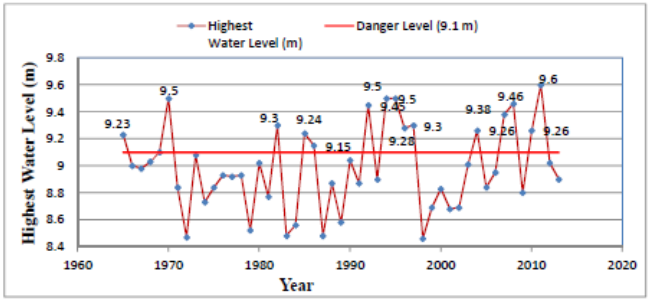

Figure 3.1, Highest water levels at Bago Station (Source: Myo Khaing, 2014)

In 2011, the water level reached 9.6 m and it is the highest record in 47 years. During that flooding, there were also severe damages and many people died. During the flood period, some of the city portions such as Zainganine (South and North), Kyuntharyar, Kalayani,Ywathit, Kyaukgyisu, Myothit, Mazin, and Ponenarsu are suffered by long period inundation. Moreover, the rice cultivated areas in rural area of Bago Region were covered with flood water. During the flood period, regular transportation by railroads and other routes between Mandalay and Yangon was temporarily disrupted.

4. Drainage System of Bago City

There are five main drains which drain out water from Bago City; three are in the eastern part and two are in the western part. Kyone (moat), Kathityoe and Kalayiteyoe creeks are the main drains for the eastern part of the city.Kathityoe Creek drains out the domestic wastewater and stormwater from the seven wards. The both parts Kyone (moat) also drains out the wastewater and stormwater from the eleven wards. Kyone (moat) and Kathityoe flow into Sainti creek and then into Sittaung River. Kalayiteyoe Creek drains out the wastewater and stormwater from the six wards. Kalayiteyoe creek flows into Bago River at the North of the City.

Mazin Stream and Pansoe Steam are also the main drains for the western part. Pansoe Stream drains out the wastewater and stormwater from the three wards from the eastern part of the city. Mazin Stream drains out the wastewater and stormwater from the three wards. These two streams flow only into the Bago River. (Table.4.1)

At the Bago City Bridge, as the water level in the Bago River reaches 840 cm MSL, the reverse flow takes place in the Mazin and Pansoe Streams located on the western side of the river, and at the flood water level of 870cm MSL in the river, there will be a reverse flow in the Kalayiteyoe creek on the eastern side.

No.	Name of Main Drains	Measurement (feet)		Reduce Level (feet)			Drain Out Areas
		Length	Width	Start Point	End Point	Diffe-rence	
1.	Kalayiteyoe	5400.0	15.0	31.0	22.0	9.0	Myotwingyi, Shinsawpu, Hantharwaddy, Myothit, Kyaukgyisu and Ywathit wards
2.	Kathitpinyoe	3400.0	10.0	35.0	21.0	14.0	Nantawyar, Bokone, Hintharkone, Shinsawpu, Leikpyarkan, Ponenarsu

							and Yonegyi wards
3.	(a) Right Hand Side of Kyone (Moat)	1400.0	185.0	22.6	18.9	3.9	Hantharwaddy, Bokone, Hintahrkone and Nantawyar wards
	(b) Left Hand Side of Kyone (Moat)	9200.0	185.0	22.6	17.3	5.3	Shinsawpu, Yonegyi, Nyaungwine (South & North), Zaypaing, Panhlaing and Thoonphayar wards
4.	Pansoe Steam	1800.0	35.0	28.0	22.0	6.0	Zainganaing (North), Mazin and Kalayarni wards
5.	Mazin Steam	6900.0	30.0	29.0	21.0	8.0	Kyunthayar, Zainganaing (South) and Kalayarni wards

Table 4.1, Main drains of Bago City and its drain out areas

Most of the roadways of the Bago City are paved with bituminous surface and majorities are concrete surface. On each side of the roadways and streets, there is a channel to drain out the surplus water. Open channel with rectangular shape brick lined drains are provided in the main roadways. Most of the channel is covered brick slabs. Open rectangular channel without brick lined are also found in the streets and main channels which drain off water. Culverts are constructed instead of access hole or manholes in every drainage intersection. Water logged areas such as lake, moat and overflow channels are prevalent. They function like retention or detention basin.

According to the field observation and interviewing some local people, 7 wards - Kyaukgyisu, Shinsawpu, Leikpyarkan, Myotwingyi, Nantawyar, Mazin and Zainganine (North) are inundated because of poor drainage system. Among them, Mazin, Zainganine (North) and Kyaukgyisu which are in low-lying area also affected by river flooding in the monsoon season.

4.1 Existing Drainage Problems

Bago City frequently comes to face flooding within city area and outskirt of the city because of heavy stormwater and inundation from the river. At least one or more flash catastrophic flooding occurs in every two or three years despite embankment built on each side. This problem is usually triggered by excessive channel flow and urban runoff. Moreover, malfunctioning drainage systems bring massive flood. The major problems of poor drainage system in the Bago are suspended solidwaste, sediments transport and deposit along the channels which all are natural and man-made causes.

Wastewater discharge, growth of vegetation, construction of urban slums and uncontrolled dumping are the major man-made causes for sediment transport and deposit in all main drains, most of the culverts and channels in the Bago City. Natural causes for sediment transport and deposit are stromwater runoff and bank erosion in all channels.

5. Local Communities' Responses to Flood Disasters

For the purposes of investigating the local governments' response to the flood, reports form departmental offices such as Irrigation Department and Department of Meteorology and Hydrology are collected and personal interviewed with the staff of these Departments.

5.1 River management facilities

The Bago River Basin including Bago City is a flood prone area in Myanmar. The urban area of Bago City is frequently flooded by the Bago River Flood. The Irrigation Department (ID) of Ministry of Agriculture and Irrigation has been overseeing the flood-prone areas and preparing facilities for the purpose of flood disaster mitigation.

As a result, drainage measures were implemented in Bago City, excavation work was done on the Bago-Sittaung Canal, and the three earthen dams, namely Kodukwe, Salu and Shwelaung, were constructed and completed in 2012. A flood diversion channel from ZaungTu weir to Moeyongyi lake was also completed in 2012. (A. Kawasaki, 2015)

To mitigate the River floods in Bago City, Bago-Sittaung Canal was dredged by Irrigation Department. Dredging and embankment work was finished in May 2014 after a four month construction period. Total project cost reached Kyat 25 billion (about 2.5 million USD), with dredged sediment amounting to 2,000,000 m^3. As the result, Bago-Sittaung Canal has increased water storage capacity and smoother water flow. According to ID staff managing the Bago-Sittaung Canal, flood disasters decreased by almost half after the dredging work. (ID report, 2014)

The two meandering bends of Bago River near Kawa township were cut by Department of Water and Improvement of River System in Bago (DWIR) to flow water smoothly in 2014. Total project cost reached kyat 1589.8 million (about 1.767 USD). According to DWIR staff managing the two bends of Bago River, floods decreased after the

cutting work. (DWIR Proposal, 2014) Besides, Irrigation Department increased the work for maintenance of reservoirs, dams and canals to mitigate the river flood disasters.

5.2 Information dissemination to local residents

For the information dissemination to local residents, the Department of Meteorology and Hydrology (DMH) of Bago represents the entire Bago Region. It summarizes the data from the four meteorological stations in the Region and reports to DMH headquarters in Nay Pyi Taw andthe Department of Meteorology and Hydrology headquarters then releases the latest data, including forecasts and warnings by using telephone lines. It also alarms when the water levels and river banks are mentioned on 24 hours basis when water levels reach 910 cm. According to Kawasaki (2015), a warning massage release system was introduced in 2014 and began operation around May 2015. It allows for automatic release warning massages to certain people, including the head of the executive office for the Bago Region and other administrators involved with disaster risk reduction.

Department of Meteorology and Hydrology also issues warning to residents through radio (Voice of Myanmar and all FM channels), television (MRTV, MWD, MRTV-4 and so on), and via loudspeakers telephones, facsimile machines and other means. After facing Flood, the national newspaper of Myanmar (Myanmar Alin) reports each day on matters of relief supplies and economic support for flood victims. This information is also available on the Ministry of Information website.

5.3 Urban Drainage System Maintenance

Both Municipal Office of Bago City and local people are responsible for urban drainage system maintenance. According the report of the Municipal Office, there was no annual maintenance until 2012. After severe flood in 2011, all the staffs and local people pay much attention to drainage system as inundation in the city is mostly caused due to poor drainage system. According to the Data from the municipal office of Bago, in 2009, the office set up a project to make better drainage system of channels besides roadways and streets of the city. In 2013, there was also a similar project for better drainage system and this project also included five main drains and culverts of the city.

After 2011 large-scale flood, Municipal office and local people make some preparation and preventive measures in case of flooding and inundation in the beginning of the monsoon in every year.

5.4 Local people's response to flood and inundation in Bago

For the purposes of investigating the local people's response to the flood, a series of individual interviews with 20 local people are carried out. Their answers and opinions can be summarized as follows.

(1) Local people see flood and inundation even as a normal case, not a serious problem

" For us, flood and inundation are no more serious problems as we have built long legged houses in flood and inundation area to prevent water coming into the house. Some houses have boats ready for transportation in flood time. The thing we can do to prevent inundation is making drainage in front of our houses better. But most houses don't do it." (From an interview with a local man)

(2) Local Community participation is very impressive in helping the flood victims but not very satisfactory in prevention of flood and inundation

" In flood time, we donate and distribute meal-packs for the victims in flood areas. Some support clothes and other supplies and so does the government " (From an interview with a local women)

"Our people participate in the prevention of flood and inundation. Some houses do not accept when we dig out the rubbish blocking in the drain in front of the houses. Sometimes we have to negotiate with them." (From an interview with a local man)

" My contribution for the prevention of inundation and flood is that I do not throw the rubbish into drains. I make the drainage in front of my house better, digging it up every year. But as other houses don't do it, the drainage doesn't come better" (From an interview with a local man)

" In our ward, we make better drains but they are blocked again by the rubbish thrown into them soon. But one thing is the place to throw them away is far from our houses." (From an interview with a local women)

(3) Some think that the government and the municipal authorities are mainly responsible for the flood and inundation and they are not satisfied with the authorities' effort.

" I think it's the government and the municipal authorities who have the main responsibilities to prevent flood and inundation but I am not quite satisfied with their insufficient effort."(From an interview with a local women)

6. Findings and Discussion

Bago drainage system is not good enough for the good flow of water while the city encounters river flood annually but the drainage system itself is found not to be the main cause of flood. There are only 3 wards in Bago which encounter inundation due to poor drainage systems and it is not as serious as in the other 6 wards annually encountering river flood. The poor drainage system contributes on annual inundation. When there is heavy rainfall, 3 wards in Bago encounter inundation on roads and streets which last a day or two due to the poor drainage caused by the system structure and rubbish blocking the flows of water.

The local government is mainly responsible for reconstruction of dams, town planning and other measures to prevent flood in the 6 wards encountering river flood. But the role of cooperation of local people and local government is greater for preventing inundation in the 3 wards. People are not aware of the community measures enough for making better drainage system in the city, relying on the authorities like in preventing the river flood.The local government should focus on systematic dam and weir management for the massive flow of water into the city in the rainy season to prevent the river flood.

7. Conclusion

Throughout the history, Bago City has been facing frequent flooding both in urban areas rural areas. Previous floods in the past had impact on economy, transportation, local people’s lives and health, causing great damages on properties, destruction of cultivated areas and water-borne diseases. In severe cases, there was loss of people’s lives and some people became homeless and they had to take much time to recover from that situation.

Till current decade, Bago City is still suffering from flooding. After severe flood in 2011, flood prevention projects are designed and local people and government work together to carry out those projects. Annual maintenance of drainage system, main drains and channels was also started after that severe flood. Local government also cooperates with NGO to perform effective prevention projects and to share the latest information about flooding with local people.

Flood prevention measures should be dedicated as long term measures. Awareness of local people about flood and inundation is also very important. Although drainage system cannot have huge impacts on regular river flood, there should be systematic town planning s to prevent inundation and other related problems during heavy rainfalls, at the same time preventing littering in the drains and the river.

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