ANATOMY OF AN OVERLAY ANALYSIS IN EXAMINING VULNERABILITY FACTORS OF FLOODED AREA IN BAGO REGION, MYANMAR

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ABSTRACT: Heavy rains caused floods and landslides in several parts of Myanmar since June 2015. On 30 July, Cyclone Komen made landfall in Bangladesh, bringing strong winds and additional heavy rains to the country, which resulted in widespread flooding across 12 of the country's 14 states and regions (Ayeyarwady, Bago, Chin, Kachin, Kayin, Magway, Mandalay, Mon, Rakhine, Sagaing, Shan,and Yangon). 2018 is also remarkable year for natural disaster, flooding in central and lower Myanmar.
Bago Region is mostly affected by flooding yearly. It is located in the southern central part of Myanmar. Vulnerability Factors concerning natural disaster in Bago Region will be studied from the geoprocessing point of view such as surface feature and spatial analysis of natural and human phenomena. The region is located among Bago Yoma, Kachin Hill and Rakhine Yoma. The eastern and western parts of Bago Yoma are the flat land area, the farm land. The main economy of the region is the extraction of teak and farming. The objectives of the paper are to study the most natural disaster affected areas in Bago Region and to examine why it is affected by flood yearly. Interpolation Analysis and Geoprocessing overlay analysis are applied. Bago Region is low-lying area between ranges and hill. The Bago-Sittaung floodplain exists of two river basins: Bago river basin and Sittaung river basin. The result shows that the important vulnerability factors are its topography, land cover, relative slope and economic activities such as timber extraction.

1. INTRODUCTION

Topography, climate and human activities play a major role in the outbreak of natural disaster. Among these factors, topography is the most important factor. Bago Region is located between Kachin Hill in the east, Bago Yoma in the central and Rakhine Yoma in the west. Sittaung River and Ayeyarwady River pass through the region. Because of these natural setting, farm lands are flooded yearly. The aim of the paper is to highlight the topography of the area. The objectives of the paper are to study the most flooded areas in Bago Region and to examine the reasons for being affected yearly.
Bago Region is located between 16°45'N and 19°20'N and 94°35'E and 97°10'E. It has a population of 4,867,373 (2014). It occupies an area of 39,400 square kilometres (15,214 sq mi) divided into the four districts of Bago, Pyay, Tharrawaddy and Taungoo. Bago, the divisional capital, is the fourth largest town of Myanmar.
In this paper, it has four parts. Section 1 is the description of natural disaster, section 2 highlights the most affected areas by flooding in Bago Region, section 3 is found out that why Bago Region is affected by flood and conclusion.

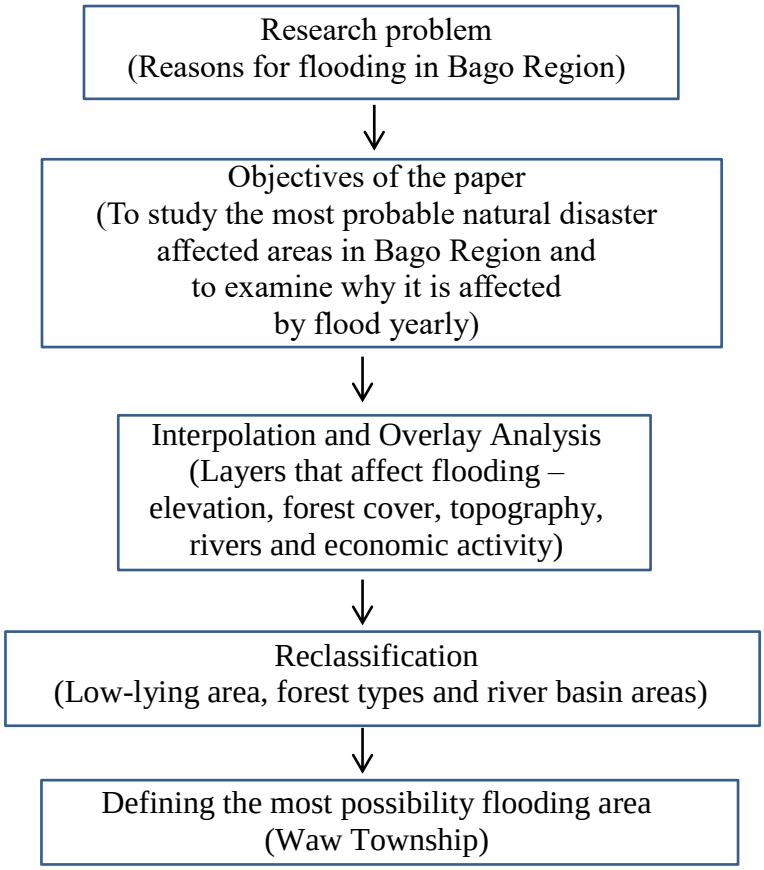


Figure 1. Research Framework

2. DESCRIPTION OF NATURAL DISASTER

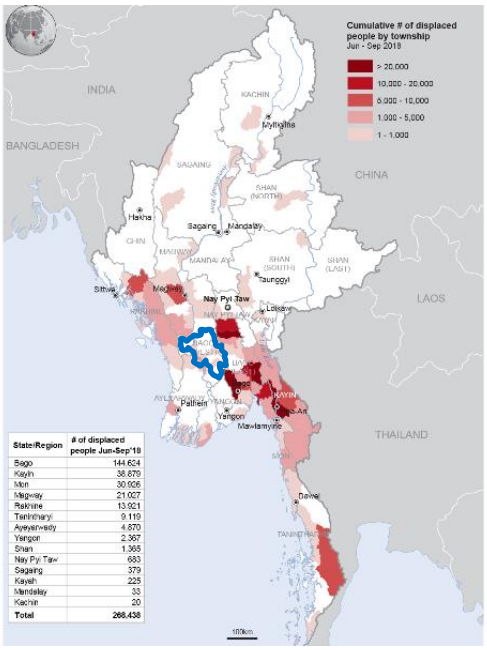


Figure 2: Natural Disaster, flooding, Risk in Myanmar, 2018
Source: [8] disaster flood 2018

Heavy seasonal monsoon has brought strong winds and heavy rains across large parts of Myanmar since the beginning of July 2018, causing increased water levels in major rivers (Ayeyarwady, Chindwin, Sittaung, Thanlwin and Kaladan) and floods in many regions and

states. As of 11 September 2018, Nay Pyi Taw, Bago, Tanintharyi, Magway, Sagaing and Ayeyarwady regions as well as Mon and Kayin states have been affected.
Among them Bago Region is the most affected area as 144,624 people had been temporarily displaced due to floods that started in July. The displaced had taken shelter in evacuation sites or stayed with relatives and host families. It is followed by Kayin and Mon States in the southeast and Magway Region in central Myanmar.
As of September 2018, the estimated number of affected households in most-affected areas of Bago region, Mon and Kayin states was 21,930 (Mon State – 5,727, Bago region – 11,974, Kayin – 4,229). While the immediate threat to lives is no longer present, significant needs remain among the most vulnerable affected population. Most of the people in the evacuation sites or those have to live with host families and relatives.
A spillway of the Swar Chaung Dam broke and caused sudden flooding in Yedashe Township, Bago Region. More than 54,000 people from 18 village tracts have been affected and some 16,600 people were evacuated. At least four people were reportedly killed and two people are missing. Paddy fields in affected areas were reportedly severely damaged. The Myanmar authorities, the Myanmar Red Cross Society, and local civil society organizations coordinated search and rescue efforts and provided assistance including food, cash, drinking water, temporary shelters, medical assistance, and other relief items to affected people.
The areas most affected by the flooding were Yedashe, Taungoo, Oktwin and Kyaut Gyi and Waw townships. More than 78,500 people were reportedly evacuated, although the total number of people affected is likely to be higher. Some 600 acres of farmland were destroyed, but more than 60,000 acres were flooded and damaged to some degree. This is likely to affect the livelihoods of local people in rural areas and rely on agriculture as their main source of livelihood. Among these affected areas, Waw Township is the second highest population density area and located closely to Sittaung River, and downward area of Swa Chaugn Dam. This situation can be clearly seen in Figure 3.
In addition, despite significant progress and investments in disaster risk reduction, millions of people in different parts of Myanmar face the ever-present risk of natural disasters in one of Asia's most disaster-prone countries.

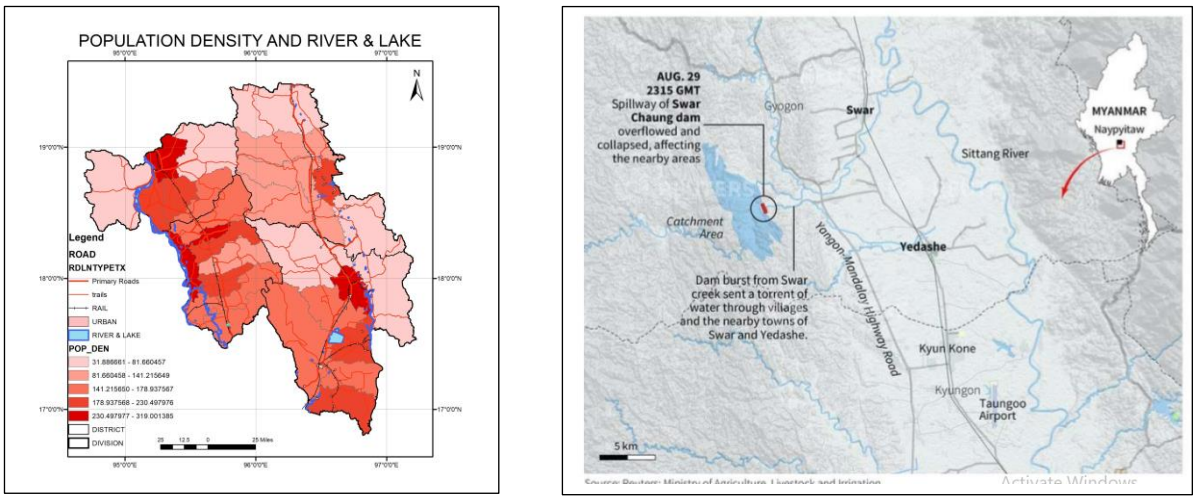


Figure 3 (a) and (b) : Population Density in Bago Region and Probable flooded Area
Source: Population Census in 2014/ Reuters; Ministry of Agriculture, Livestock and Irrigation

3. RESULT AND DISCUSSION

3.1.The most affected areas by Flooding in Bago Region

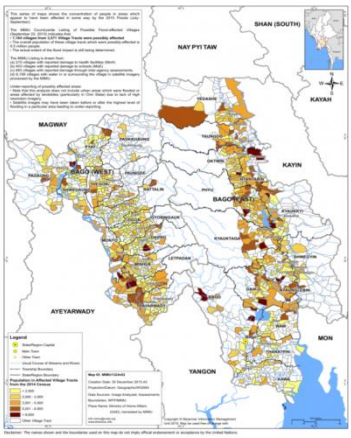


Figure 4: Flood-prone Areas in Bago Region
Source: MIMU, 2015 and MIMU, 2017

Because of the overflow of Sittaung river basin, Bago, Waw, Dike-U, Nyaung Lay Pin, Shwegyin, Kyauktaga and Kyauk Kyi townships located in the eastern part of Bago Region are most affected by flooding.
Because of the overflow of lower part of Ayeyarwady river basin, Monyo and Padaung townships located in the western part of Bago Region are most affected by flooding.
The main economy of the region is the extraction of teak and farming and many thousands of farm lands are flooded
Map shows the concentration of people in areas which appear to have been affected by the 2015 floods between July and September. Population in affected village tracts are shown in graduated color.

Rainfall and Rivers

The Shwegyin River in Shwegyin, Bago Region reached 8.8 metres on 28 July (flood stage is 7 metres). On the same day, the Bago River in Bago, Bago Region reached 9.7 metres (flood stage is 8.8 metres).
The following day the Sittoung River in Madauk, Bago Region, reached 12.70 metres, well over flood stage of 10.70 metres. The Sittoung River in Taungoo, Bago Region reached 6.2 metres, just above flood stage of 6 metres.
Myanmar's Department Of Meteorology And Hydrology said that Zaung Tu in Bago Region, recorded record rainfall on 25 July, with 198 mm falling in 24 hours in 2018, beating the previous high of 144 mm set in July 2007.

3.2. Why Bago Region is affected by flood

The reasons why Bago region is flooded by flood yearly can be analysed by overlay analysis, the spatial analysis tool of Geographic Information System.
In Geographic Information System, there are two types of data set such as spatial and attribute data. Data measurements used in Geographic Information System are associated with locations and, therefore, can be placed on the map. Using locational data, we can know both what is present, where it is and why. The real world data, feature data, can be stored by the coordinate systems. The issues of what the researcher are analyzing influences how it is best represented. Moreover, what is at each location can be attached – this information is referred to as attributes.
In GIS each dataset is managed as a layer and can be graphically combined using analytical operators (called overlay analysis). To explore important questions and find answers to those questions, GIS enables the researcher to work with these layers by combining them.

The foundational concept of spatial analysis is the idea of stacking layers containing different kinds of data and comparing them with each other on the basis of where things are located. The layers join in the sense that they are all georeferenced to true geographic space.

In addition to locational and attribute information, spatial data inherently contains geometric and topological properties. Geometric properties include position and measurements, such as length of the roads and railway lines, direction of the mountain ranges, area of residential lands, and volume of flooding areas. Topological properties represent spatial relationships such as connectivity of the road network, inclusion, and adjacency to a river. Using these spatial properties, the researcher can ask more types of questions of the data to gain deeper insights.

3.3. Anatomy of an Overlay Analysis

GIS analysis can be used to answer questions like: why the area is affected by the natural disaster, flooding? Many of seemingly unrelated factors – land cover, relative slope, distance to existing rivers and mountain ranges – can be displayed as layers, and then analyzed together using weighted overlay such as population data and elevation data (Figure 5, 6 and 7)

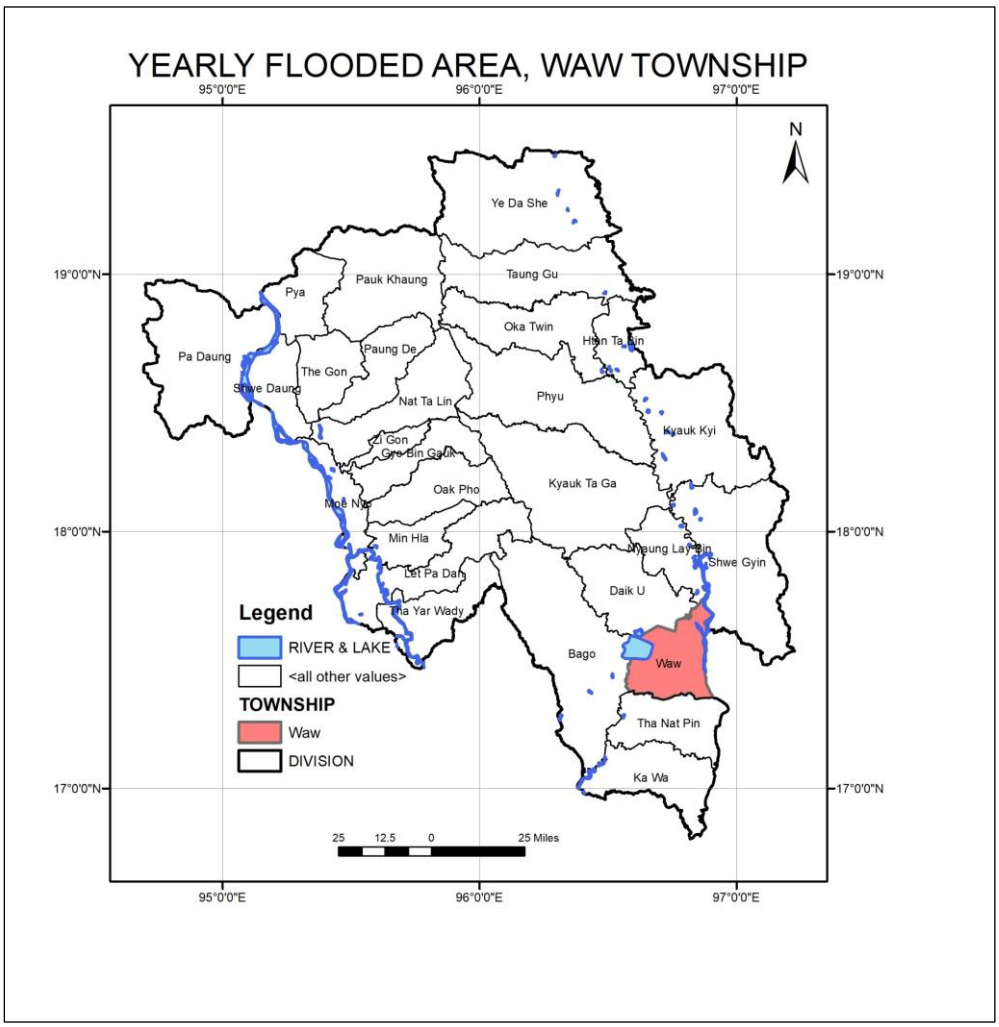


Figure 5 Yearly flooded area, Waw Township in Bago Region

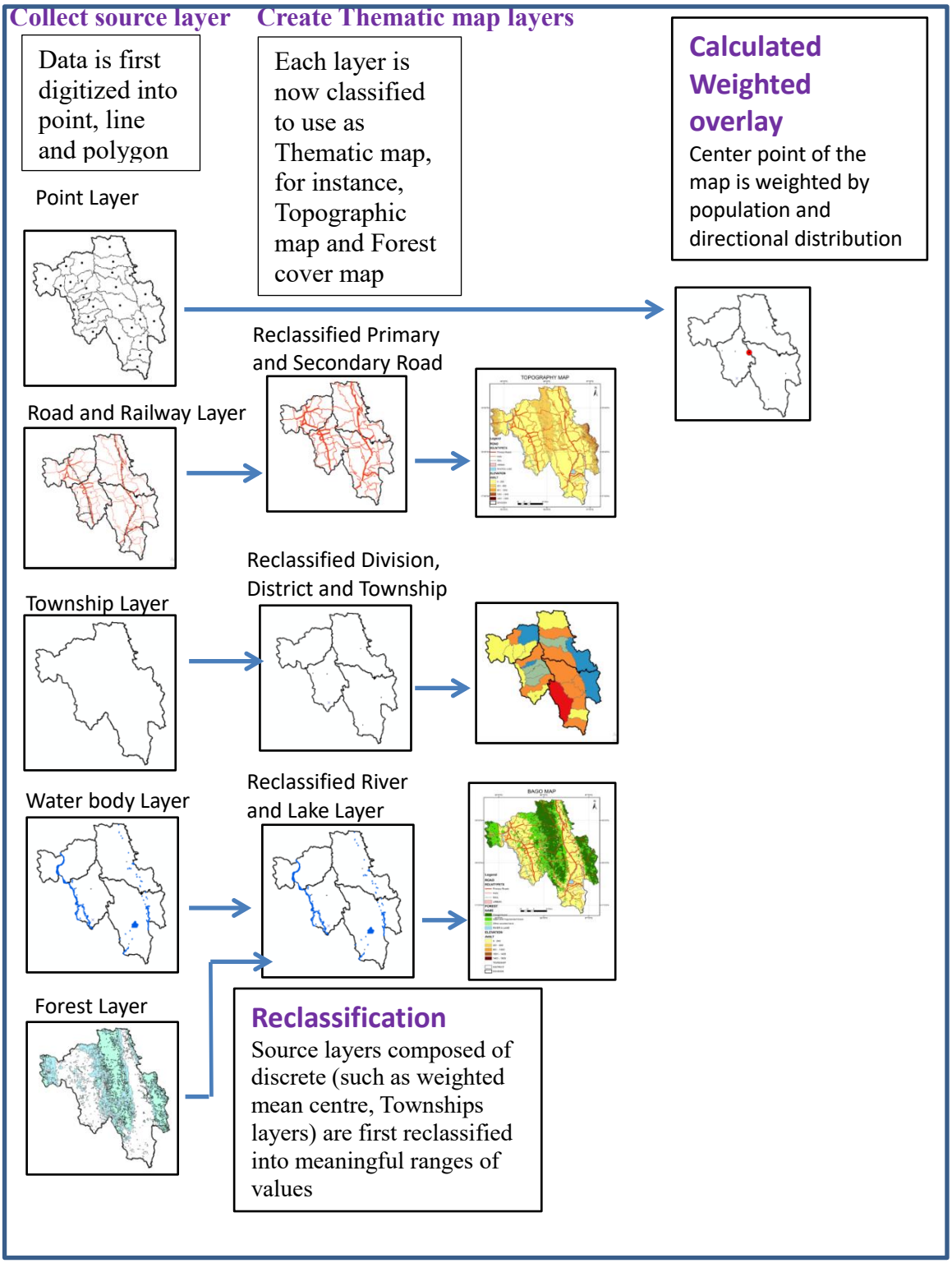
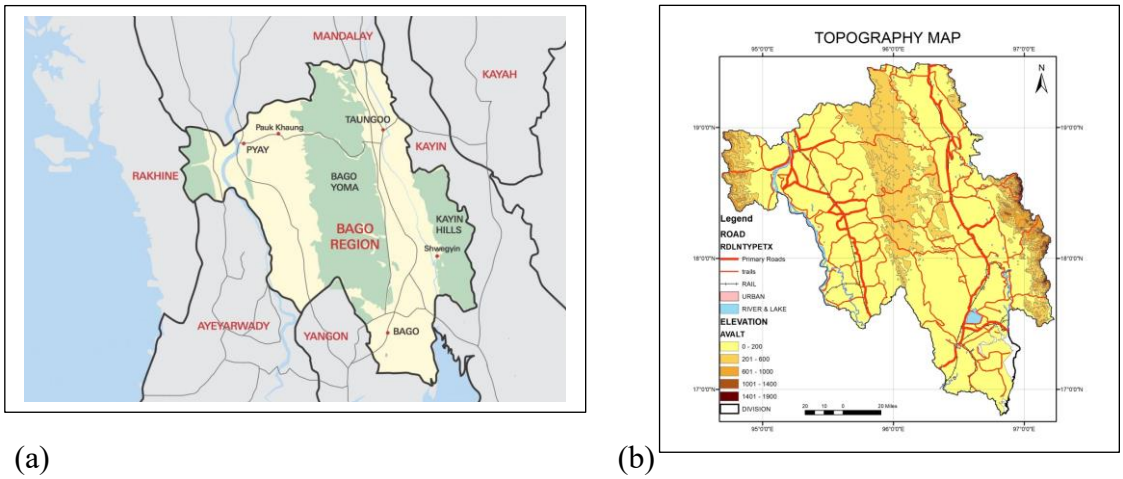


Figure 6 Overlay Analysis to Examine Flood Affected Area
Source: The Researcher's study, 2019

Figure 7: Location of Bago-Sittaung River Basin, Myanmar
Source: RHDHV, 2014



(a) (b)

Figure 8: Townships located in narrow strips of low-lying land, yellow area in the map
Source: [8] disaster flood 2018 /YCDC Data

There are many reasons for Bago Region is affected by flood – it is a river basin area, it is low-lying area between ranges and hill, its main economy is timber extraction, farming and another reason is mining (Figure 8 and 9).

3.4. Vulnerability Factors of Flooded Area

The low-lying area

The land near Sittaung river basin in Bago (East) and the land near lower Ayeyarwady river basin in Bago (West) have an elevation of less than 200 meters. These flat lands are inundated areas in rainy season yearly. They are shown as yellow colour in figure 9.

Location and Dimension of river basin area

The Bago-Sittaung floodplain exists of two river basins: the Bago river basin and the Sittaung river basin. Bago river flows in southern part of Myanmar and it is the main river. It arises in the hills of Bago County and flows for 331 kilometres towards Yangon with a catchment area of 5348 km^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 150 m upstream to 2200 m downstream (Win, 2014).

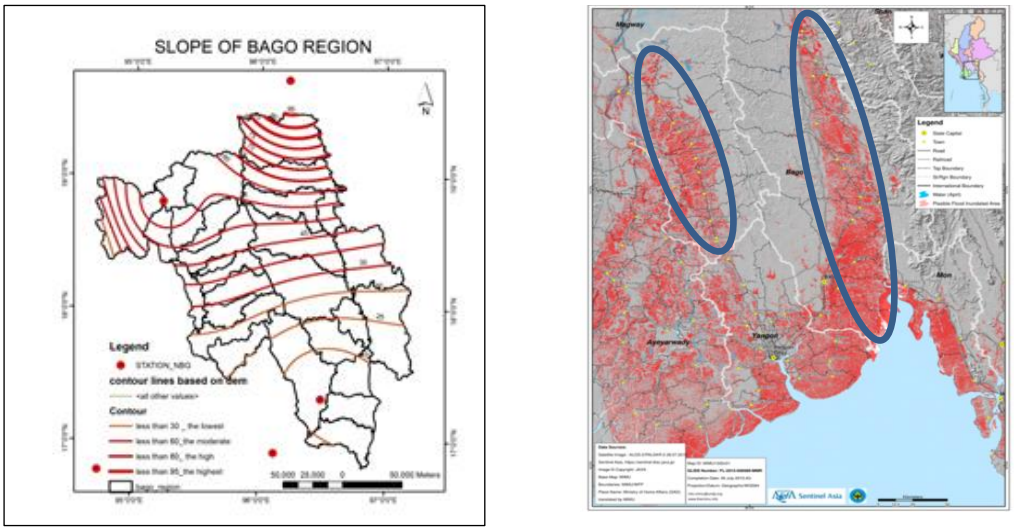


Figure 9: Map showing relationship between Slope and Flooding in Bago Region
Source: (a) Researcher's study and (b) MIMU in 2015

The Sittaung river basin is located in central-south Myanmar and contains the Sittaung River. Rising northeast of Yamethin on the edge of the Shan Plateau and flowing south with a catchment area of 48100 km^2 for 420 km (van Rest, 2015) to empty into the Gulf of Martaban of the Andaman Sea. The broad Sittaung River valley lies between the forested Bago Mountains on the west and the steep Shan Plateau on the east. The Sittaung River is navigable for 40 km year-round and for 90 km during three rain months. Transport is used to float timber, particularly teak, south for export. Its lower course is linked by canal to Bago River, which makes the basins during the wet season very inter related. This canal, built to bypass the tidal bore that afflicted the mouth of the Sittaung, once provided the only route from Yangon to Taungoo (Myanmar, 2015).

The rivers almost have the same size, but the catchment area of the Sittaung river basin is almost ten times bigger than the Bago river basin. The tributaries contributing to the Sittaung River have a way larger surface than the tributaries flowing in the Bago River. This is the natural cause of higher velocity speeds, water depths and thus discharges in the Sittaung River (Figrue10).

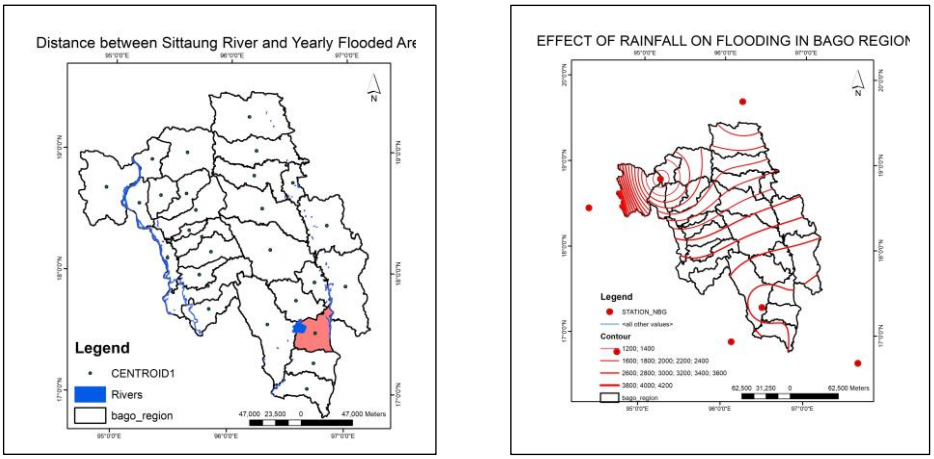


Figure 10: Map showing relationship between Distance from Sittaung River and Effect of Rainfall on Flooding
Source: Researcher's study

Timber extraction

The division's economy is strongly dependent on the timber trade. Taungoo, in the northern end of the Bago Region, is bordered by mountain ranges, home to teak and other hardwoods. Closed forest, open and fragmented land and other wood land are shown in Figure 11.

From 2010 to 2015, Myanmar lost more than 1.3 million acres of forest on average each year, according to a report last year by the UN's Food and Agriculture Organization. While forests covered an estimated 65 percent of the country in 2000, that number had been reduced to 45 percent in 2015, according to the FAO assessment.

It needs to tackle illegal timber – a huge issue in Bago Region, home to the teak-rich Bago Yoma mountain range.

The regional government would typically seize between 1,000 to 2,000 tonnes of illegal timber a year. This number rose to about 6,000 tonnes in 2016-17 and 5,000 tonnes in the first nine months of 2017-18, with seizures particularly high around Pyay and Pauk Khaung townships in western Bago Region.

However, local people said that illegal logging was still rampant in Bago Region, particularly in Pauk Khaung. The seizure figures represented just a fraction of what was being smuggled. 50 to 60 tonnes of illegal timber from the Bago Yoma are coming into Pauk Khaung every day. Illegal loggers have close relationships with the regional government.

Photo: The remains of burned teak trees in Bago Region in 2014

On the other hand, four types of farms will span 350,000 acres. Farms oriented toward the business side of forest management will grow trees like teak and padauk. The others will focus on trees' role in water resource management and flood mitigation; community forestry, for forest-dependent village populations; and mangroves.

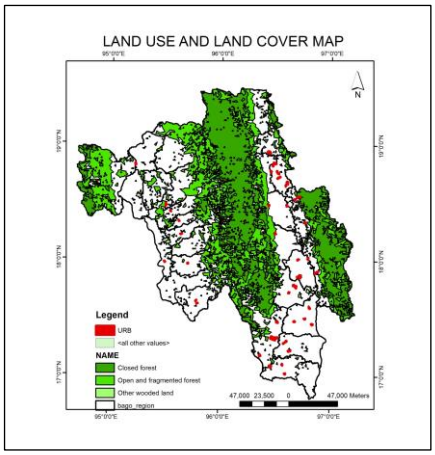


Figure 11: Land Use and Land Cover Map in Bago Region

Farming

There are over 650,000 acres (2630 sq.km) of rice cultivation in Bago Region. The major crop is rice, which occupies over two-thirds of the available agricultural land. Other major crops include

betel nut, sugarcane, maize, gourndnut, sesamum, sunflower, beans and pulses cotton, jute, rubber, tobacco, tapioca and banana.
The division has a small livestock breeding and fisheries sector. In 2005, it had over 4 million farm animals; nearly 1,200 hectares (3,000 acres) of fish and prawn farms.

4. CONCLUSION

Heavy seasonal monsoon causes increased water levels in Sittaung and Bago rivers and makes a spillway of the Swar Chaung Dam broke and consequently, sudden flooding in Yedashe Township, Bago Region. Major economy, the extraction of teak makes worse the disaster.
Being Flat land areas between Kachin Hill, Bago Yoma and Rakhine Yoma is the most important vulnerable factor. Villages located in the eastern part of the region are more affected area than that of the western part.
The low-lying areas are the place of settlement and farming land, especially Waw Township, a focal point of major economy of the region, is affected by flooding yearly. Damage caused by the flooding makes considerable impacts on health and food security. Therefore, government needs to solve the disaster which is occurring yearly in Bago Region.
Vulnerability Factors of flooded area can be clearly seen by overlay analysis in which dissimilar inputs to create an integrated analysis such as elevation of the area, forest types, river and lakes and transportation routes.

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