Flood Inundation Mapping and Damage Assessment on Kaziranga National Park Assam During Monsoon and Non-Monsoon Using GIS and Remote Sensing Data

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ABSTRACT

Natural disasters such as floods, earthquakes, landslides, cyclones, tsunamis, and volcanic eruptions are yearly phenomena that have devastating effect on infrastructure and property and in most cases results in the loss of human life. Floods are among the most prevalent natural disasters caused by meteorological phenomena. Mapping of inundated areas is crucial for determining the flood extent, deployment of emergency response teams and assessment of damage and casualties. The study investigates flood mapping using Sentinel-1A over the World Heritage site Kaziranga National Park, Assam. The main objective of the present study is to prepare flood maps and to assess the inundated area and the extent of damage under different land use or land cover. Flood mapping for a period of four years was carried out and from the results it was observed that the peak flood event occurred in the year 2020.

Keywords: Flood, Flood Extent, Submergence, Sentinel-1A, Kaziranga National Park

1. INTRODUCTION

Flooding is primarily the result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of river channels and streams. In many parts of the world, as much population is concentrated along the river valleys, flood is responsible for a greater number of damaging events than any other type of natural hazard. Flood events can occur due to a wide range of both natural and human induced factors. The damage caused by floods in terms of loss of life, property, and economic loss due to disruption of economic activity are all too well known. To minimize the damage due to flooding it is required to undertake various wide-ranging measures and activities related with prediction, prevention, warning, monitoring and relief along a flood plain. Flood management can have a significant impact on both natural and human environment and do not always offer a simple solution to the problem. Flood in Assam has been a common problem since early times. 2020 Assam floods refers to the significant flood event of the Brahmaputra River and coincided with the COVID-19 pandemic. In early days ground surveys method use to map and monitor floods with limitation of time and weather conditions. At present use of GIS has overcome those limitations for mitigation of floods. Especially use of GIS has really brought a revolution in mitigation of flood disaster. With advancement of technology in today's world, it is easier to reduce vulnerability of flood disaster that was not feasible in early days. The objective of the present study are: To prepare flood maps of Kaziranga National Park during the monsoon and non-monsoon using Sentinel-1A and Landsat 8 for a period of four years. To assess the inundated area and the extent of damage under different land use or land cover. To prepare graphs using rainfall data.

2. STUDY AREA

Kaziranga National Park lies in flood plain of mighty Brahmaputra and in Indo-Burma Bio-geographical region. Originally notified Kaziranga National Park lies between Latitudes 26° 34′ N to 26° 44′N and Longitudes 93° 08′ E to 93° 35′E. It is spread over the civil jurisdictions of Nagaon and Golaghat districts in Assam with mighty Brahmaputra River on the north and verdant Karbi Anglong hills on the south. The entire Kaziranga National Park area was

formed by the alluvial deposits of the Brahmaputra River and its smaller tributaries, which carry a great amount of silt during the rainy season every year. It is the place where the nature unwinds its pristine form in millions of hues, where wildlife roams fearlessly, where man and nature meet.

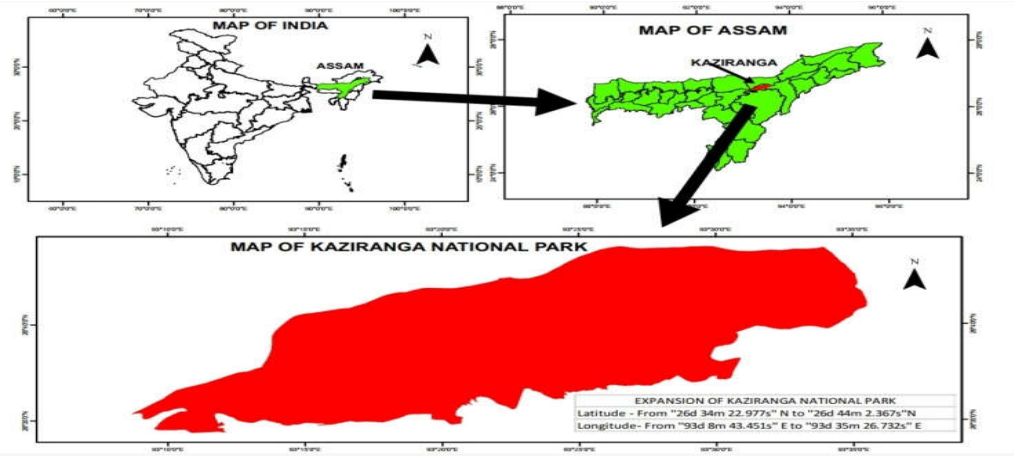


Figure 2.1: Location Map of Kaziranga National Park

(Source: Environment and Forest Department, Govt. of Assam)

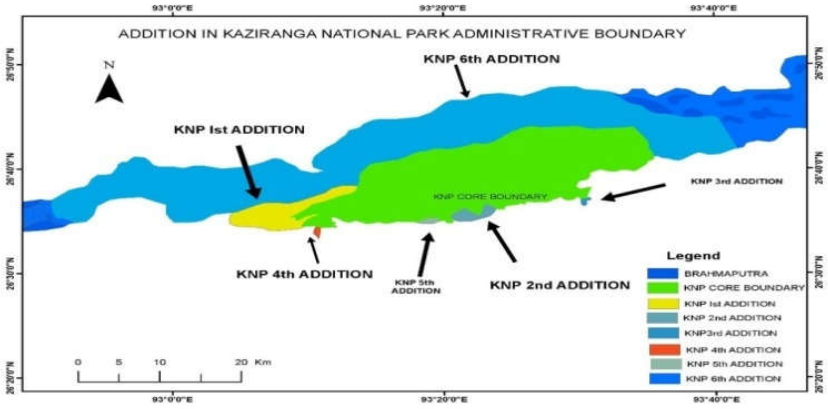


Figure 2.2: Addition in Kaziranga National Park Administrative boundary

(Source: Environment and Forest Department,Govt.of Assam)

3. METHODOLOGY

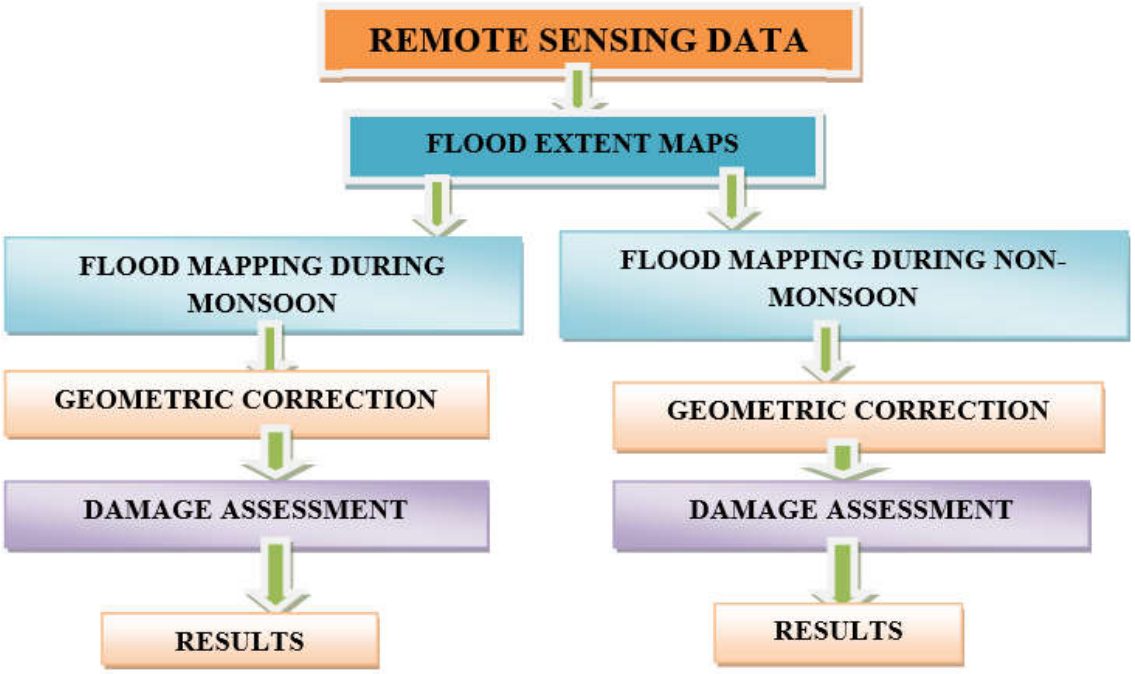


Figure 3.1: Scheme of Work

3.1 Data collection and processing

Table1: Table consist of data, source, and data type.

Data	Source	Data Type
DEM	Bhuvan	Raster
Flood Inundated Maps and Land cover (Monsoon)	Sentinel-1A	Raster
Rainfall (Precipitation)	Office of the Executive Engineer, Water Resource Department, Jorhat	Word
Flood Inundated Maps and Land cover (Non- monsoon)	Landsat 8	Raster

3.2 Digital elevation model

In this model Kaziranga National Park boundary is surrounded with hills and river in lower southern boundary which is roughly defined by the Mora Diphlu river. Further south are the hills of Barail and the Mikir. The Brahmaputra River on the upper northern boundary of the park is the biggest factor of huge amount of water which gets accumulated in Kaziranga lowlands along with the flood in river Brahmaputra. So, during monsoon season rising water level of river Brahmaputra and water flowing down from Karbi Anglong and Naga hills through various rivers and streams inundate the low-lying areas of Kaziranga National Park.

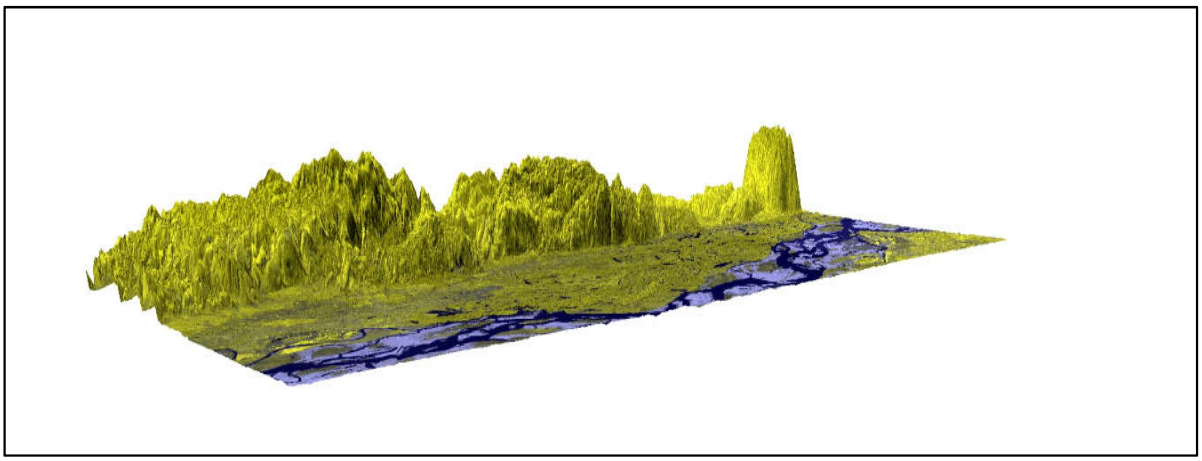
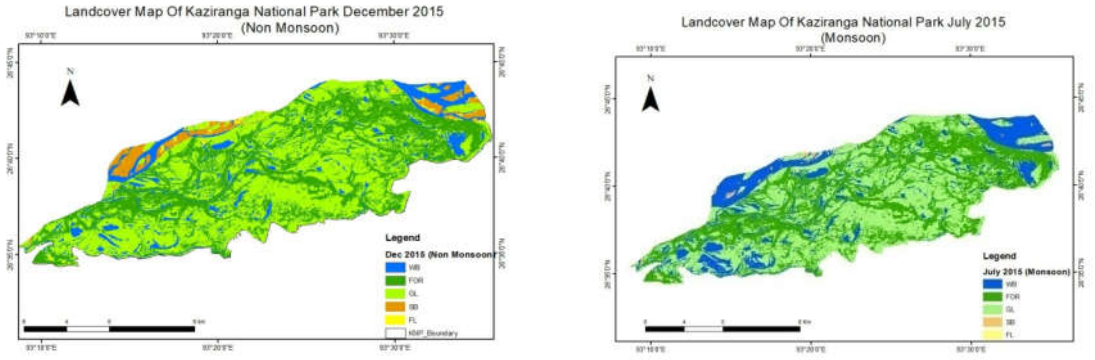


Figure 3.2.1: 3-D Model of Kaziranga National Park

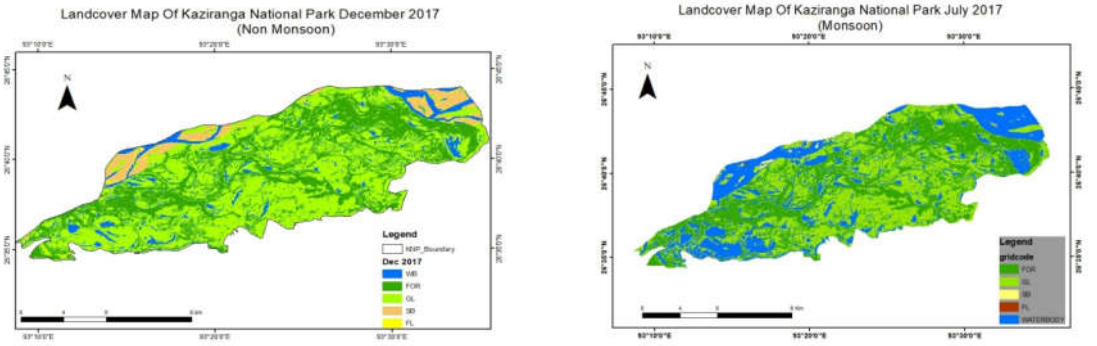
3.3 Land cover

Land cover maps represents spatial information on different types of physical coverage of Earth's surface. For e.g.- forests, grasslands, croplands, lakes, wetlands. Dynamic landcover maps include transitions of landcover classes over time and hence captures landcover changes. The landcover maps of monsoon and non-monsoon season of Kaziranga National Park of different four years has been shown below.



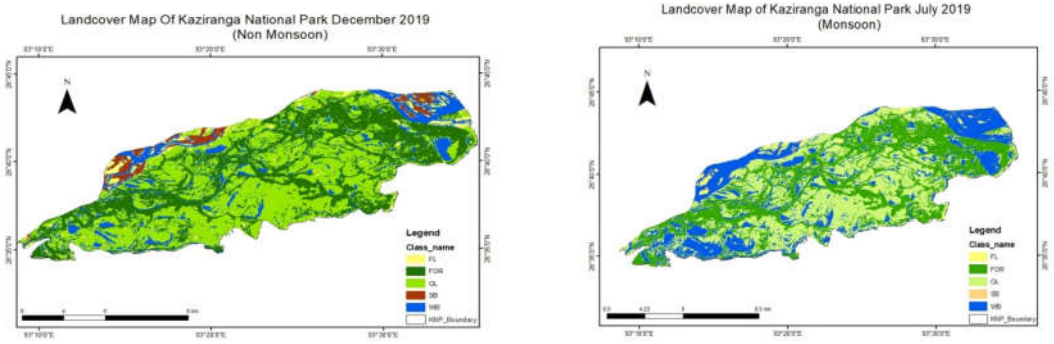
(a) (b)

Figure 3.3.1 (a): Landcover map of non-monsoon for the year 2015; (b) Landcover map of monsoon for the year 2015



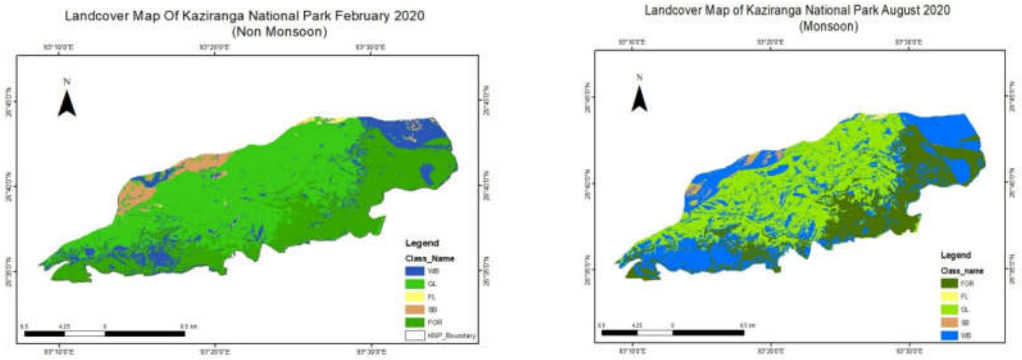
(a) (b)

Figure 3.3.2 (a): Landcover map of non-monsoon for the year 2017; (b) Landcover map of monsoon for the year 2017



(a) (b)

Figure 3.3.3 (a): Landcover map of non-monsoon for the year 2019; (b) Landcover map of monsoon for the year 2019

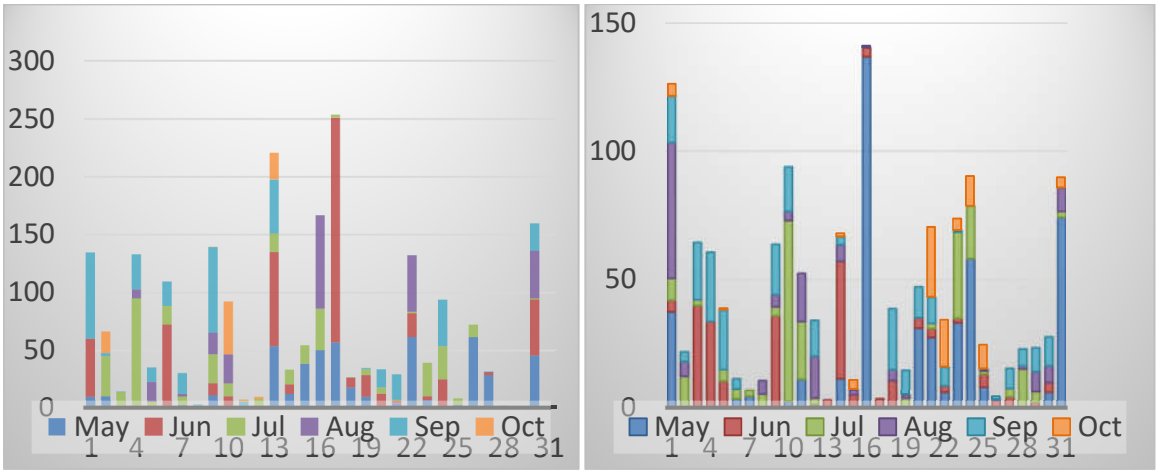


(a) (b)

Figure 3.3.4 (a): Landcover map of non-monsoon for the year 2020; (b) Landcover map of monsoon for the year 2020

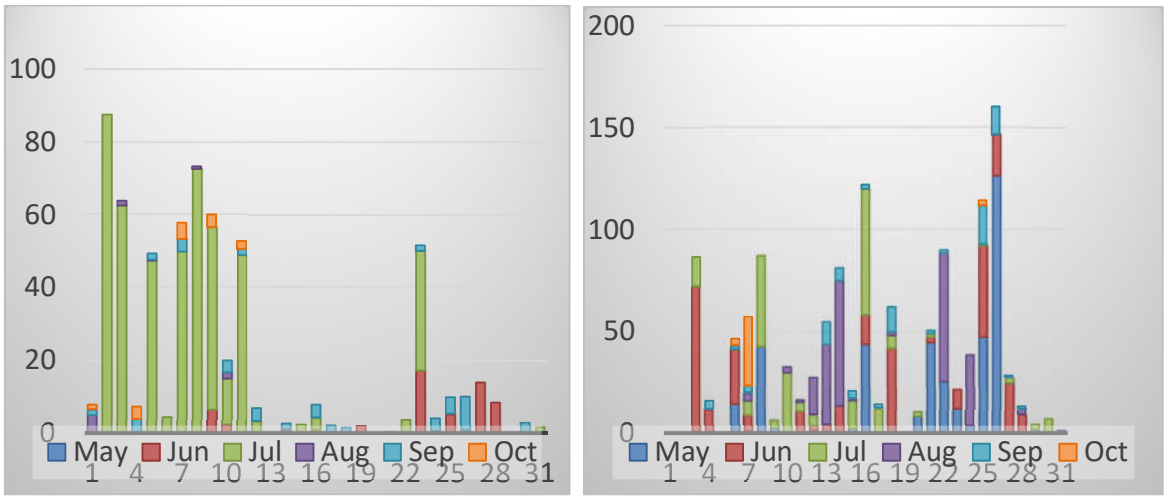
3.4 Rainfall precipitation

The amount of rainfall received over an area is an important factor in assessing availability of water to meet various demands for agriculture, industry, irrigation, generation of hydroelectricity and other human activities. The period between the months of May to October has been considered as the rainy season or monsoon period. Below are the graphs showing precipitation between the months from May to October for a period of four years of Bokakhat Rain gauge Station.



(a) (b)

Figure 3.4.1: Rainfall graph of Bokakhat rain gauge station for the year; (a) 2016 (b) 2017



(a) (b)

Figure 3.4.1: Rainfall graph of Bokakhat rain gauge station for the year; (a) 2019 (b) 2020

4. RESULTS

Flood adversely affected the different land cover of Kaziranga National Park. In the analysis, SAR images for a period of four years were used to detect the flood extent. Analyzing these four years, it was observed that the peak flood event occurred on 27th july 2020.It was clear that more area submerged on 19th july 2017 was 26.75% and 27th july 2020 was 33.36%. As a result of continuous raining the flood extent drastically increased, and the river Brahmaputra started to overflow. The flood water flowed over the lowland of the National Park which is the favourite gazing land of the animals which consists plenty of shorter grasses. On 18th july 2015 43.82% of the total grassland got submerged whereas in 19th july 2017 it was found 39.17%, 22nd july 2019 it was found 38.84% and 27th july 2020 it was found 40.08% of the total grassland got submerged. As a result, gazing animals had suffered shortage of food. The thick forest areas are comparatively on higher grounds hence on 18th july,2015 it was found that 36.4% of the total forest got submerged. But gradually it decreases on 19th July 2017, 22nd july 2019 and 27th july 2020 with 33.2%, 32.28% and 24.96% respectively. During these four years flood caused considerable damage to the roads, guard camps etc.

Table 2: Extent of flooded area for the year 2015 and 2017

	2015Area (Sqkm)		2017Area (SqKm)	
Classes	Dec	Jul	Dec	Jul
Waterbody	45.22	77.22	32.41	112
Forest	153.2	152.5	145.8	139.3
Grassland	196.7	183.44	211	164
Sandbar	16.76	2.39	22.8	0.9
Fallow land	6.71	3.05	6.6	2.48
Total	418.6	418.6	418.6	418.6

Table 3: Extent of flooded area for the year 2019 and 2020

	2019Area (Sqkm)		2020Area (SqKm)	
Classes	Dec	Jul	Feb	Jul
Waterbody	51.54	107.7	56.7	139
Forest	142.2	137.7	135.9	104
Grassland	194	162.6	204	167
Sandbar	12.34	1.5	17.51	5.2
Fallowland	18.58	9.1	2.54	1.4
Total	418.6	418.6	416.6	416.6

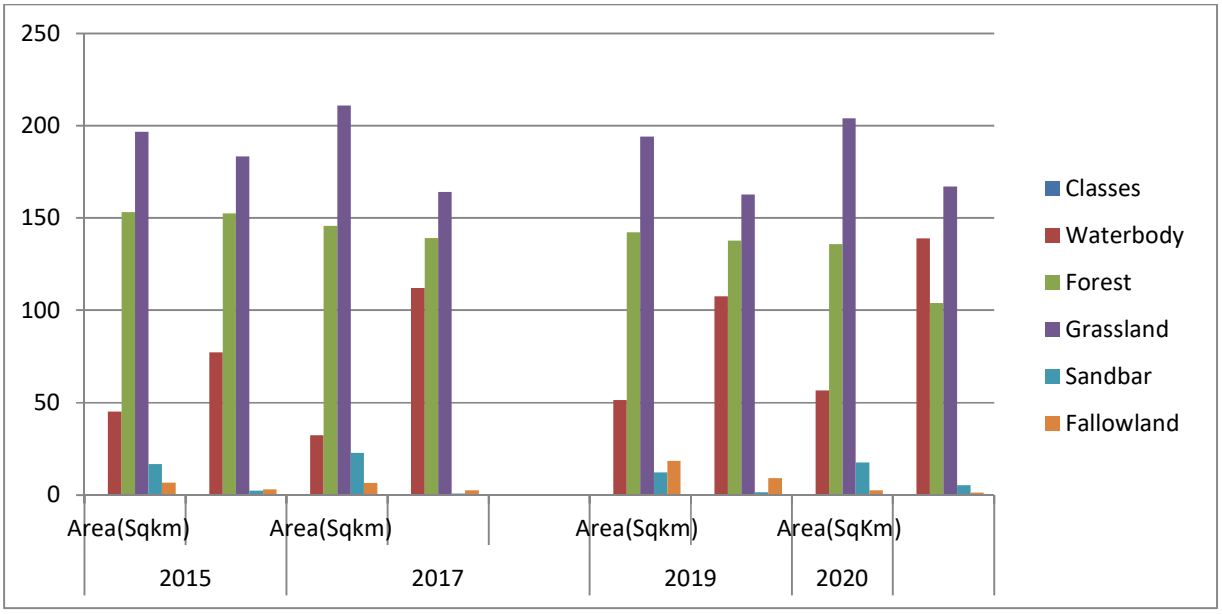
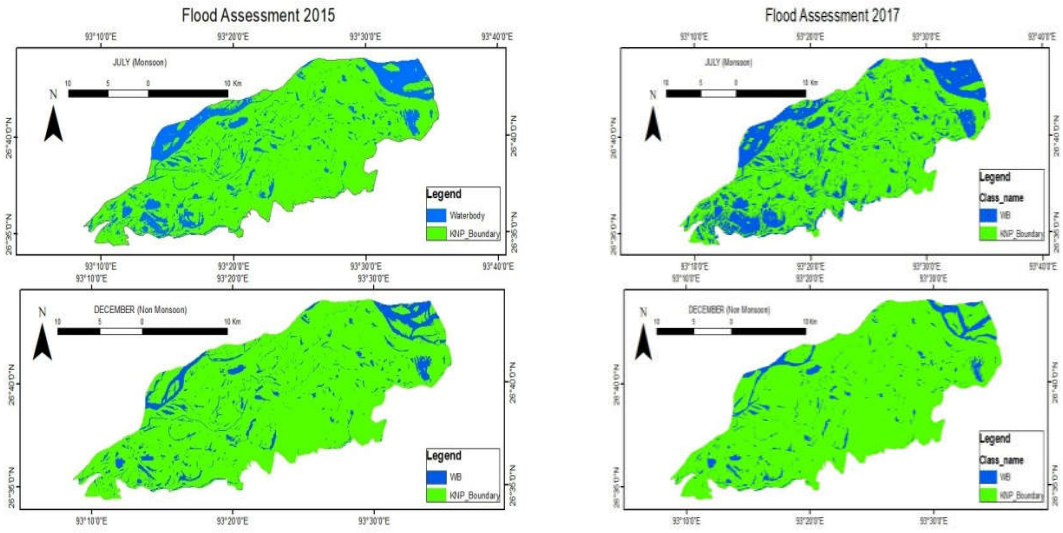
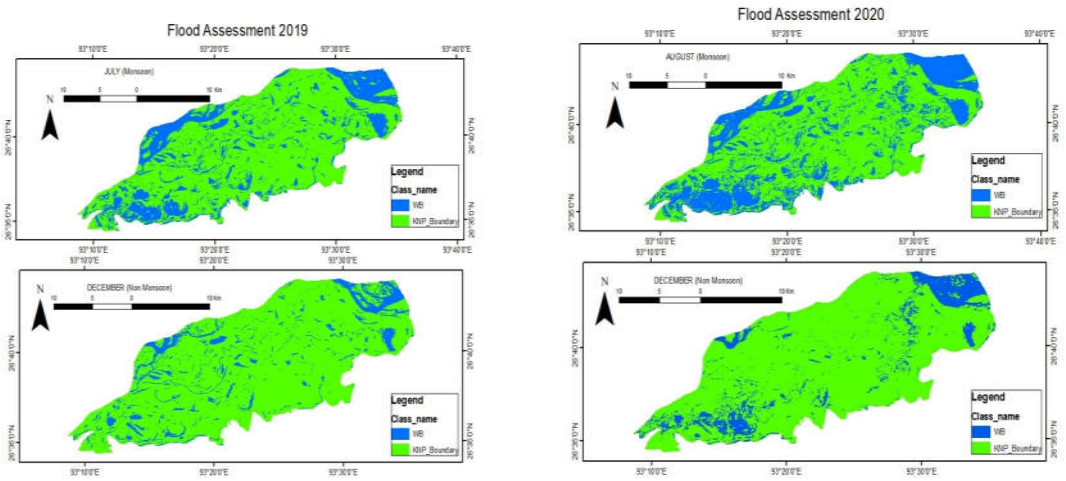


Figure 4.1: Graph showing the overall extent of flooded area.



(a) (b)

Figure 4.2 (a): Flood maps on 18-Jul-15(monsoon) and 23-Dec-15(non-monsoon); (b) Flood maps on 19- Jul-17(monsoon) and 28-Dec-17(non-monsoon)



(a) (b)

Figure 4.3 (a): Flood maps on 22-Jul-19(monsoon) and 18-Dec-19(non-monsoon); (b) Flood maps on 27-Jul-20(monsoon) and 20-Feb-20(non-monsoon)

5. CONCLUSION

In the present study timely and detailed analysis had been carried out using Remote Sensing & GIS tools for locating and identifying flooded areas along with land cover features. Flood monitoring using SAR data proved to be an effective method to get quick and precise overview of flooded areas. The basic objective was to show accurately and efficiently the flood extent maps of monsoon using Sentinel-1A. The peak flood event occurred in the year 2020 in which area submerged was 33.36%. Similarly, we found that the area submerged in 2015 was 18.44%, area submerged in 2017 was 26.75% and area submerged in 2019 was 25.72%. The study serves as a guide which contains necessary information regarding flood assessment during monsoon and non-monsoon season of Kaziranga National Park for a period of four years.

6. ACKNOWLEDGEMENT

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