



# URBAN FLOOD- A CASE STUDY OF GUWAHATI CITY, KAMRUP (METROPOLITAN), ASSAM

## OPEN ACCESS

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## Abstract

*In the present study, the researcher aims to study the factors responsible for flood inundation and water-logging in the city and to identify the flood-prone areas and mapping and the Social and administrative measures to reduce the impact of the flood. A set of secondary data had been collected through various sources for the study in the selected area. Various GIS software has been used in preparing the Guwahati satellite image. First of all, we downloaded the satellite imagery of Guwahati from 1st January 2018 to 1st January 2019 using the USGS Earth Explorer, using data set as Landsat Collection1, followed by Landsat Collection 1 Level 1 using Landsat 8 Satellite with OLI/TIRS C1 Level1 Sensors having 30 metres resolution. From the study it has been found that the major factors responsible for the flood are Water Logging: Heavy rainfall triggered water logging in several parts of the city. Areas such as Zoo Road, Chandmari, Ambari, Ulubari, Hatigaon, Dispur, Gandhi Mandap, Kalapahar, and Christian Basti came along with visuals of waterlogged areas. Rapid Urbanization: Unplanned urban growth of the city. Increasing of Urbanization in the city from 80.23% in 2001 to 82.9% in 2011 according to the percentage of the urban population in 2011 census. Change in Land Use Land Cover: Natural and semi-natural vegetated areas and artificial and natural water bodies decreased while the built-up area increased, cultivated and managed areas, natural and semi-natural non-vegetated areas increased.*

**Keywords:** Urban flood; Inundation; Water-logging; Vegetation; GIS

## Introduction

Floods are the unfailing feature of the State. Almost every year the State experiences floods. Added with a flood, the problem of erosion assumes serious proportions. Insurance against floods requires local action as well as national coordination. It is realized that floods and their negative consequences can only be

managed, they cannot be controlled of natural resources and agricultural state. Above 80% of people depends on agriculture but for more than 60 years Assam has been facing huge river erosion problems, which is closely related to flood problem. Erosion along with flood has destroyed lots of agricultural production and other fruits and house land of the people.

“River erosion means a current of river or wave of water of the river broken the banks of the rivers which accumulates huge mud and siltation in the river bed and holding capacity of water decline in the river and creates flood and erosion Assam” The city of Guwahati experiences inundation and water logging problem after every medium to a heavy shower. Rapid urbanization with increased housing and construction activities in the city has led to more rooftops, driveways, streets, and other impervious or hard surfaces. This has resulted in decreasing land capacity to soak up and carry excess water. Moreover, the unplanned expansion of the city to accumulate increasing population has to lead to severe encroachment in the wetlands, low-lying areas, hills and shrinkage of forest cover these denuded hills and loss of wetlands thus lead to artificial floods and water logging.

### Objectives

- To examine the factors responsible for flood inundation and water-logging in the city
- To identify the flood-prone areas and mapping
- Social and administrative measures to reduce the impact of flood

### Methodology

The methodology involved field-based observations and the final integration of collected data in a GIS environment. A set of secondary data had been collected through various sources for the study in the selected area. The secondary sources were integrated using GIS techniques. While integrating the data in GIS environment registration of all the collected maps from different sources.

Various GIS software has been used in preparing the Guwahati satellite image. First of all, we downloaded the satellite imagery of Guwahati from 1<sup>st</sup> January 2018 to 1<sup>st</sup> January 2019 using the USGS Earth Explorer, using data set as Landsat Collection1, followed by Landsat Collection 1 Level 1 using Landsat 8 Satellite with OLI/TIRS C1 Level1 Sensors having 30 metres resolution

Use of various GIS platforms in downloading the maps and creating map layout was used. Such as the use of DIVA-GIS for downloading administrative boundary maps, use of GEOFABRIKS software to download the natural as well as cultural feature map of INDIA.

With the help of Erdas 2015, the satellite imagery was layer stacked and the AOI layer for the the study area was created using the clipping method.

Immediately after every downpour the city drains get silted up with silts coming with storm water running down the hills flooding the streets. The wetlands also cannot accumulate the excess storm water of the city. The seasonal floods in the State are largely a consequence of the concentration of heavy rainfall within a period of a few days/weeks during the

monsoon months and low flows.

### Study Area

Guwahati, the area where the study has been conducted is located in the state of Assam in southern bank of the river Brahmaputra. The city lies within 26°5’ N to 26°12’ N latitudes and 91°34’ E to 91°51’E longitudes (Fig 1). According to the 2001 census, the total population within the GMC area is 8, 09,895 with a population density of 3750 persons/sq km. It is subdivided into 60 wards.

Guwahati lies between the banks of the Brahmaputra River and the foothills of the Shillong plateau, with LGBI International Airport to the west and the town of Narengi to the east. Guwahati Metropolitan Development Authority (GMDA) is the planning and development body of the greater Guwahati Metropolitan Area. Guwahati is the largest city in Northeast India.

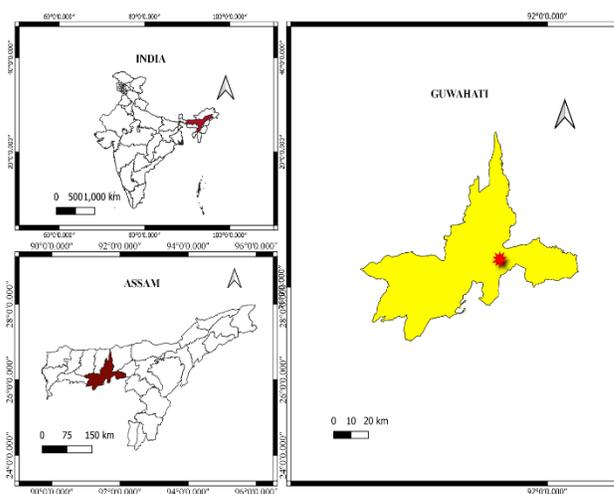


Fig. 1. Location Map of Guwahati

### Delimitation

- The study is limited only to the geographic area of the state of Assam.
- This study is limited to the urban flood of Guwahati.
- The study is done only for the dissertation purpose and the findings may not be transferable to other situations or cases.

### Review of Literature

Keeping in view the specific necessity for the State of Assam, the inter-State water disputes, the State Water Policy has a specific importance. The Policy envisages a long-term water resource management program designed to develop a critical mass of indigenous productivity with the requisite

technical, economic and sociocultural means for sustainable development and has tried to highlight the flood problems of Assam and also the Cause and Remedies of flood hazard. The geographical distribution of different rivers in different parts of the state along with its tributaries is discussed here. The flowing and catchment area of the rivers along with the source and end of the rivers are mentioned in this article. The main key points are The State of Assam comprised of two valleys namely the Brahmaputra and Barak Valley.

With the help of QGIS software, AOI parts were highlighted and clipped using geoprocessing tools, and the location map of the study area was created.

### Data Collection and Observation

Identified Flood Prone Roads and Settlement Areas the major roads and areas severely affected f flood inundation problem were identified based on field observation and can be listed as follows:

Table 1. GMDA 2015

Sl. No	Flood prone areas	Sl. No	Flood prone areas
1	Geetanagar / Hatigaon Chariali up to Narengi	11	Rukminigaon , Mathura Nagar and some low-lying area in Beltola
2	G.N.B Road from Guwahati Club to Noonmati (Except New Guwahati Area )	12	Some areas on the A.T Road
3	R.G Baruah Road	13	Santipur – Bharalumukh area
4	Maligaon / Durga sarobar	14	Fatasil Ambari
5	Guwahati College approach road	15	B.Borooah Road
6	Nabagraha Road and its nearby areas	16	Hedayatpur
7	Along the Kanwachal road , particularly the southern part	17	Lamb Road , Ambari
8	Nabin Nagar / Anil Nagar /Ambikagiri Nagar / Tarun Nagar /Lachit Nagar upto Bhangagarh	18	Gandhibasti area
9	Srimantapur	19	B.K Kakati Road
10	Christianbasti area of G.S Road	20	Kachari Garigaon

The above graph is prepared to show the flood inundated area of Guwahati city. We have downloaded the metadata of the flood Inundated area of the city from the Bhuvan web portal. It gives an average data of Guwahati from 2011-2019. As we can see in the above-mentioned pie graph the percentage of rarely inundated zone is 44%, the percentage

Table 2. Flood Indulated Diagram Of Guwahati

Sl.No	Zone	Flood Indulation (%)
1.	Indulated Free Zone	14%
2.	Rarely Indulated zone	44%
3.	Chronically Indulated zone	31%
4.	High Indulated Zone	11%

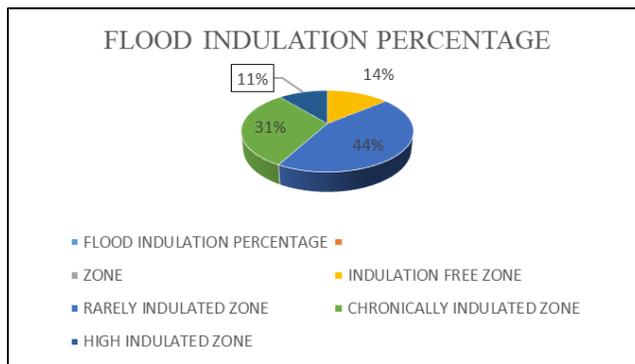


Fig. 2. Flood Indulation %

of Indulated free zone is 14%, the percentage of chronically inundated zone is 31% and the highly inundated zone covers a percentage of 11% on average.

### Results and Discussion

The rain period of the year lasts for 9.6 months from January 30<sup>th</sup> to November 17<sup>th</sup> with a sliding 31-day rainfall of at least 0.5 inches. The most rainfalls during 31 days centered on July 1<sup>st</sup> with an average total accumulation of 13.0 inches.

### Factors Responsible for Urban Flood in the City:

#### Rainfall

Table 3. Average Rainfall (mm) in Guwahati from 2010-2019

Sl No.	Year	Average Rainfall in mm
1	2010	233.74
2	2011	246.66
3	2012	332.37
4	2013	356.36
5	2014	212.35
6	2015	434.78
7	2016	396.83
8	2017	417.87
9	2018	313.14
10	2019	1172.6

Source: IMD Guwahati



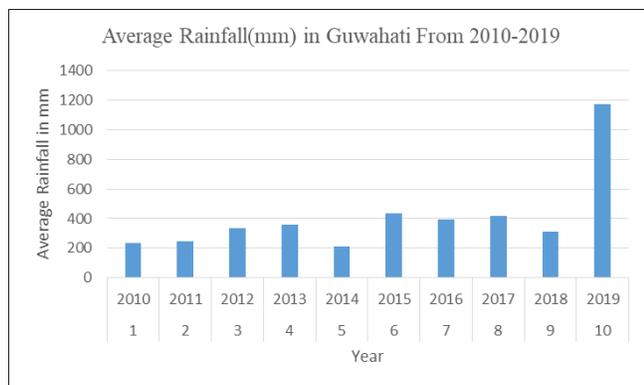


Fig. 3. Average Rainfall (mm) in Guwahati From 2010-2019

Change in land use and land cover from 2011-2012 to 2015-2016

Table 4. Category Wise Distribution of Land Use/ Land Cover in Kamrup District 2011-2012

Level 1	Distribution (km <sup>2</sup> )
Agriculture	1490.77
Barren/ Uncultivable/ Wastelands	36.696
Built-Up	196.13
Forest	2095.71
Wet Land	173.287
/ Water Bodies	293.46

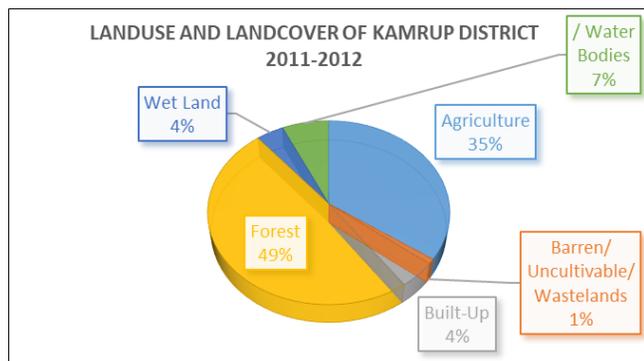


Fig. 4. Land use and land cover of kamrup DISTRICT 2011-2012

The LULC (Land use and Landover Map) of Kamrup (Metro) District Guwahati is downloaded from Bhuvan Web Portal. The LULC map belongs to the year 2011-2012 and 2015-2016. As we can see Change in Land use and Landover is the most dominant factor responsible for rapid urban floods in the city. With the growth of rapid urbanization, the land use and land cover of the city changes in the past years. As we have taken 5 years, we have observed several changes in the LULC pattern. The cropland increased from 1350 sq km

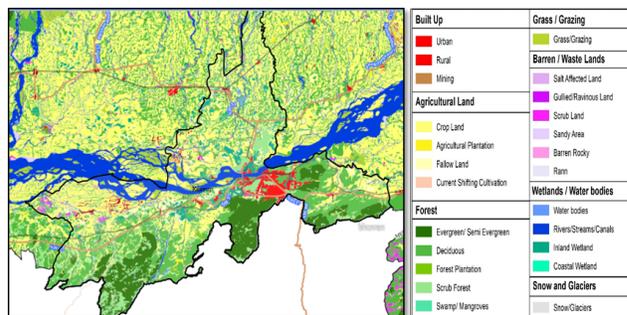


Fig. 5.

Table 5. Category Wise Distribution of Land Use/ LandCover in Kamrup District (2015-2016)

Level 1	Distribution (km <sup>2</sup> )
Agriculture	1529.27
Barren/ Uncultivable/ Wastelands	119.6
Built-Up	234.31
Forest	1957.49
Wet Land	141.85
Water Bodies	292.02

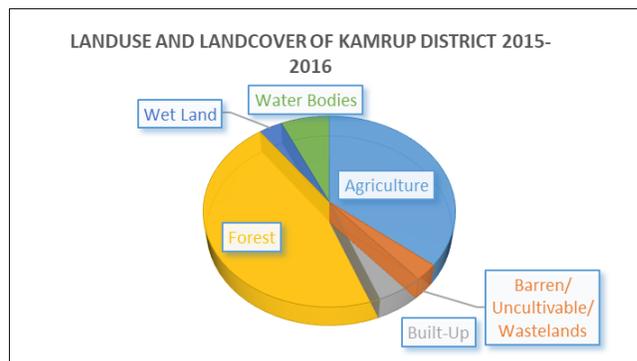


Fig. 6. LandUse/ Land Cover in Kamrup District (2015-2016)

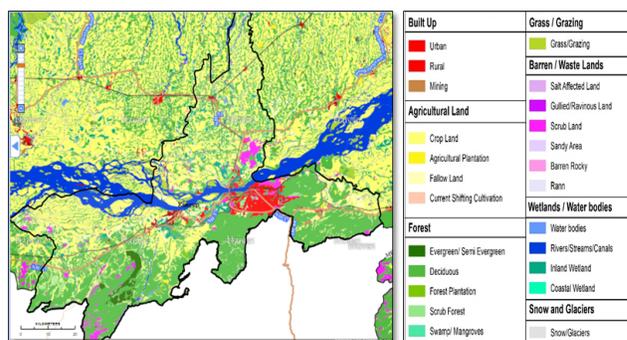


Fig. 7.



in 2011-2012 to 13.87.82 sq km in 2015-2016. The Scrubland increased from 32.505 in 2011-2012 to 119.22sq km in 2015-2016. The mining area increased from 10.960 sq km to 21.57 sq km, urban cover changed from 128.862 sq km to 157.14 sq km in 2015-2016. Scrub. Forest decreased from 218.038sq km in 2011-2012 to 47.98 in 2015-2016.

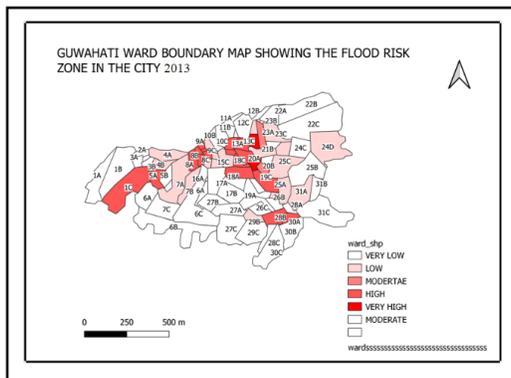


Fig. 8.

The Flood Risk zone of Guwahati City showing the 30 wards (ABC) 2013, where we have classified the ward map into Flood risk zone of Very low, Low, Moderate, High, Very High based on a percentage of the flood area. The above data is collected from the GMDA (Guwahati Municipality Development Authority) board of Guwahati. ward no 20A Bhangagarh, Tarun Nagar, and Nabin Nagar, 21C Zoo Tinali belongs to High-Risk Zone.

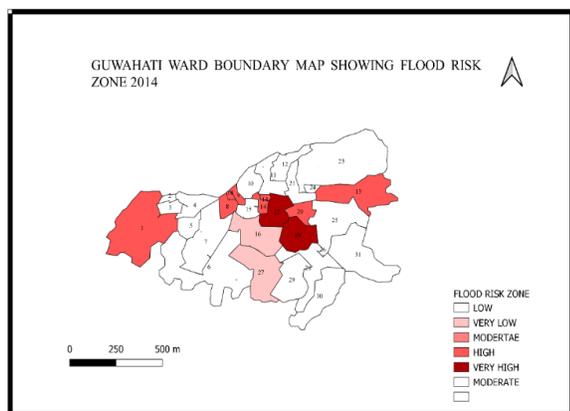


Fig. 9.

The Flood Risk zone of Guwahati City showing the 30 wards 2014, where we have classified the ward map into Flood risk zone of Very low, Low, Moderate, High, Very High based on a percentage of the flood area. The above data is collected from the GMDA (Guwahati Municipality

Development Authority) board of Guwahati. ward no 17 and 19 belongs to a very high-risk zone. ward no 1, 8, 9, 13, 14, 18, 20, belongs to high-risk zone. The ward no 2,3,5,6,10,11,12,22,23,24,25,26,28,29 and 30 belongs to moderate risk zone. ward no 4, 7,15,21,31 belong to Low-risk zone. The ward no 16 and 27 belongs to very low risk or no risk zone.

## Effects and Damages Caused by The Urban Flood in Guwahati

Brahmaputra Basin and with Special Provisions for Guwahati City:

### Damages caused by flood in the city

- Water logging:** the city of Guwahati experiences recurrent flood inundation and severe water logging in the occurrence of storm
- Traffic jam:** the swirling floodwaters submerged homes and fields in many parts of the city water has entered several houses in those areas and the heavy waterlogging on the roads also caused severe traffic jams. Cars, buses, bikes, and vehicles of every sort were found stranded on almost all the major roads. The districts that continued to be affected by the floods are Anil Nagar, Tarun Nagar, VIP Road, Rajgarh, Bhetapara, Jorabat, R G Baruah Road areas, GS Road, and much more were waterlogged. Traffic movement was slow in many areas following heavy waterlogging on the roads.
- Electricity cut off for a long time:** after the event during the clean-up process when the floodwaters have dispersed, there are yet further risks as there are serious possibilities of electrocution from water damaged appliances, so the electricity is cut off for a long time.
- Damages to the household's properties:** immediate impacts of flooding can include loss of human life, damage to property and infrastructure, and destruction of crops and livestock. The psychological effects of loss of life, displacement, and property damage can be long lasting. The prone area in the city. If the Bharalu River fails to drain rainwater, the entire drainage system of the city collapses. Usually, low laying residential and commercial areas face acute problems of waterlogging. Over 40% of the GMC area is vulnerable to flood damage. Bharalu basin is the most flood.
- Diseases:** Flood can potentially increase the transmission of the following communicable disease. Water-borne diseases such as typhoid station at Bondajan to facilitate dewatering when the sluice gate is closed. fever, cholera, leptospirosis and hepatitis A. Vector-borne disease such as malaria, dengue and dengue

haemorrhagic fever, yellow fever, Japanese encephalitis.

6. **Sanitation problems:** people lose their homes and often also lose their source of food and water. If the drinking water supply and sanitation system are already inadequate, flooding poses a further major health threat. The commuters alleged that the gutters were blocked and no adequate measures were taken by the Guwahati municipal corporation causing a flash flood in Guwahati. The rain that lashed the city also snapped road links in several places putting motorists and pedestrians in trouble due to waterlogging. The **urban floods** in the **city** causes great amount of destruction and inconvenience; cause heavy traffic jam due to street waterlogging, paralyzes day to day activities, damage the **urban** infrastructure viz, roads, bridges, electric poles, etc causing severe economic damage

## Conclusion

Currently, Guwahati city heavily relies on the natural drainage system, and there is no proper drainage plan to cater to the needs of the city. The existing natural drain channels need to be cleared from garbage and keep it clean for the movement of stormwater during monsoon season. The rivulet channels should be kept clear of any waste disposal, and all the drains falling in them should be relocated. The interconnectivity of these natural drains can be handy in directing out the floodwater from the city in quick time; hence the encroachments over the drain channels should be removed. Also, a systematic stormwater drainage system should be planned along with the other infrastructure services. After all the analysis it is clear that water coming down from the hills in Guwahati is the major prime reason behind the bowls or the plains in the city core getting flood inundated,

thus urban planning schemes of watershed management in hills can be planned by using GIS and calculating the slopes.

## Suggestions

1. To improve the drainage system of Guwahati city to avoid waterlogging.
2. The flow of confinement by Embankments.
3. Anti-Erosion Measures and river training works.
4. Pro-siltation devices.
5. Sluice Gate should be constructed.
6. Proper maintenance of the manholes in the streets.
7. Disposal of household sewages and garbage properly.

## Causes of the problems

On the south bank of the Brahmaputra, the Bharula, Khanajan, and Bondajan, rivers eventually meet the Brahmaputra river. Due to blockage in the drainage system through Bharalu, Khanajan, and Bondajan, backflow of the water from the Brahmaputra river cause frequent floods in the city during every summer.

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