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Observation of Flood Hazard using Geospatial Technology

Surya Deb Chakraborty[1], Mayuri Bhattacharyya[2], Chandan Bhadra[3]
Environmental System Research Institute (ESRI, India)

Abstract: Flood, one of the most important natural disasters, affects human civilization in many ways. Present age geographical information system (GIS) is used to observe the extent of flood to consider the risk of disaster. The objective of this study is to observe before and after flood condition created by Titli Cyclone using geospatial technology. Here we use sentinel data to estimate flood condition. NDWI (Normalized differential Water Indices) is calculated before and after images of sentinel data using ArcGIS Pro software in 2.2 version then we did unsupervised classification to estimate flooded area. The study area is Asika Town situated in between 2 rivers namely Rushikulya River and Badanadi River in southern Odisha. This town was flooded during Titli Cyclone on 18th October 2018. To monitor the effects of flood was used the unsupervised classification of two sentinel images acquired on 2018 when a severe flood was affected the above-mentioned area. This research offers a very fast and affordable method of flood monitoring that could be very useful for the emergency management plan of local authorities.

Keywords: Sentinel, NDWI, Unsupervised Image Classification, Flood Map, Flood monitoring, Coastal Hazards, Odisha

Introduction

The physical cover of the earth including Vegetation and non-vegetation parts is known as land cover. To get solution for planning in context of agriculture, urban and natural conservation a detail knowledge of land cover can give solution (Huth et al., 2012). Using satellite imagery observing land cover is widely-used tool for large area environmental monitoring to understand the changes (Cihlar, 2000).

Flood is considered to be the most common natural disaster worldwide during the past years, creating many environmental and socio-economic significances within the affected flood plain. The impact of flood hugely affected on human life as well as economic dimensions. Floods directly caused 9500 fatalities and losses assessed at 70 billion euro 20th century in the Europe (Dysarz et al., 2015). For the planning to monitor the future growth of the city and identifying the flood-affected area flood hazards maps are very useful. Geospatial technology mainly remote sensing and GIS contribute significantly for flood hazard monitoring.

A severe cyclonic storm named Titly packing heavy winds and widespread rains hit the eastern part of the India 12th Oct on Thursday, in Andhra Pradesh and in Odisha. Aska Town in Ganjam District resembled a water world 13th Oct on Friday. The whole town was flooded under 11 feet water level as Badanadi and Rushikulya Rivers wreaked havoc in the region in the aftermath of cyclone Titli. Many people together with author1 himself was stuck in that flood for 2 days in Asika Town. This study is mainly to understand the situation after flood condition as well as victim's experience sharing using geospatial technology.

Study Area

The study area is Aska Town in Ganjam District, which is mainly in between of Badanadi and Rushikulyac Rivers. Asika is located at 19.6°N 84.65°E. It has an average elevation of 30 meters (98 feet). It is situated at a distance of 40 km from Brahmapur on South, 35 km from Bhanjanagar on the North at the confluence of Rivers Rushikulya and Badanadi (Bara River). NH-59 (Gopalpur-Ahmedabad) passes through this city.

Aska falling in Ganjum District, which is characterized, by an equitable temperature all through the year, particularly in the coastal regions.

The average annual rainfall of the district is 129.60cms (source IMD). The rainfall generally increases from the coast towards the interior hilly tracks of the district. The relative humidity is high throughout the year specifically in coastal areas. Winds are fairly strong particularly in coastal regions in summer and monsoon months.

The geographical area in Ganjum District has cultivated lands. Paddy is the Principal crop in Kharif, while pulses are the main crops in Rabi. Red sandy soils, red loamy soils, lateritic soils, coastal alluvial soils and coastal sandy soils, are the main soil types occurring in the district.

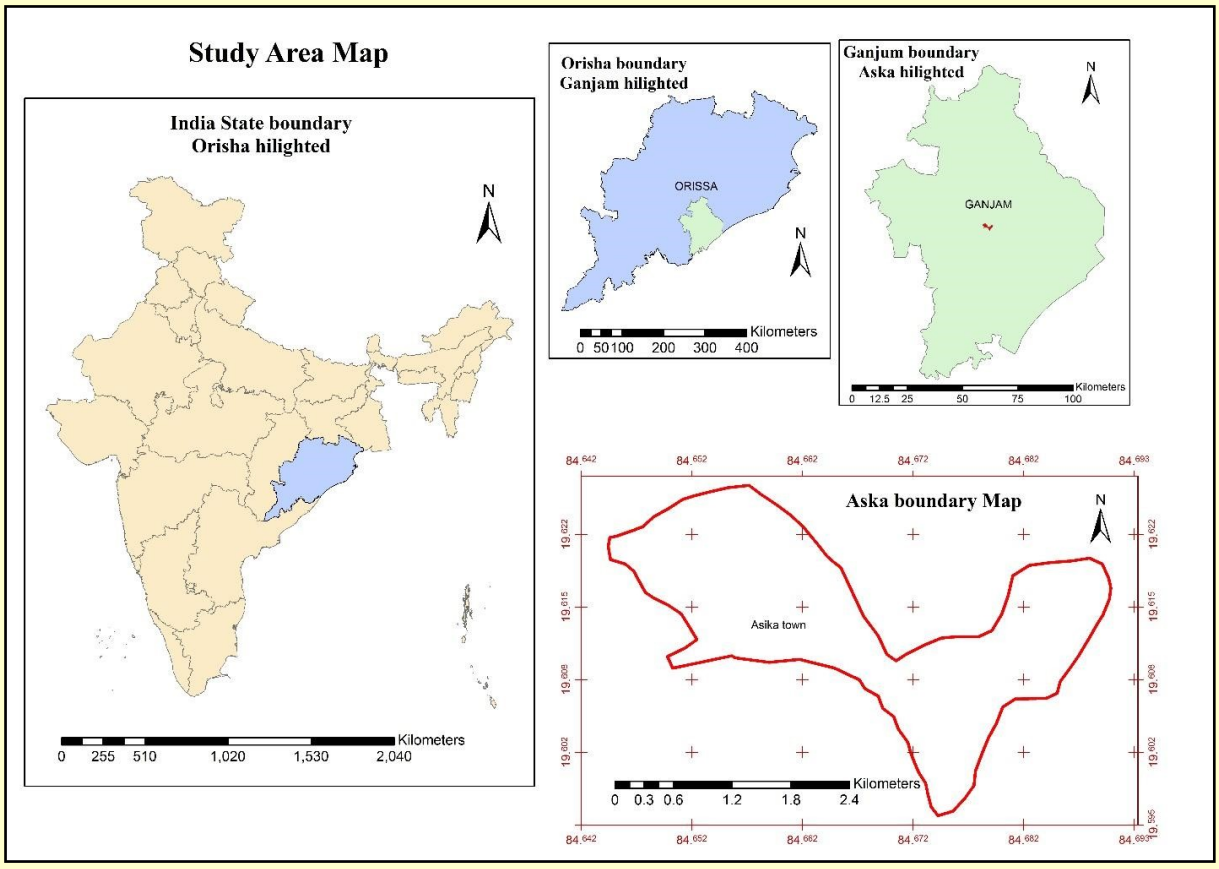

Figure 1. Study area map

Methodology

The Normalized Difference water Index (NDWI) was estimated over Granjum District Area. Sentinel datasets of before and after flood are used for preparation of Flood change maps.

Table 1: The following datasets were used to compute Flood change analysis

Data Used	5^{th} Oct 2018	10^{th} Oct 2018
	Sentinel 2B	Sentinel 2B

Water Indices: $NDWI = \frac{\text{Green}-\text{NIR}}{\text{Green}+\text{NIR}}$

In this part using green and NIR bands of sentinel images we estimated NDWI for both dates. Then using unsupervised isodata method we classified it in 4 classes. After that we reclassified that unsupervised image in 2 classes one should be water another should be non-waterbody. Then we convert reclassified image in shape file. Once it's converted in shape file we just extract the waterbody from that shape file. In this way we easily differentiate before and after flood river condition.

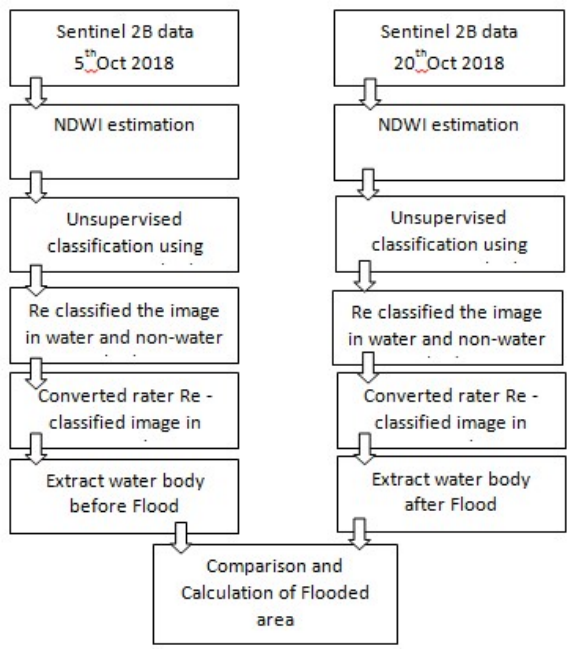

Figure 2. Workflow of the main phases of Flood analysis

Results and discussions

Unsupervised Classification- ISOdata method over Sentinel 2b NDWI Datasets for 5th and 20th Oct 2018 was carried out by taking four classes. Then datasets was re-classifying using the classes and created in 2 classes, one is waterbody another one is non-waterbody. An overall accuracy of 88.74% (Kappa Coefficient: 0.8480) for 5th Oct 2018 datasets and 87.15% (Kappa Coefficient: 0.8275) for 20th Oct 2018 datasets was obtained during the accuracy assessment of the LU/LC classification. Before and after flood water bodies are extracted from classified images of Gunjam District.

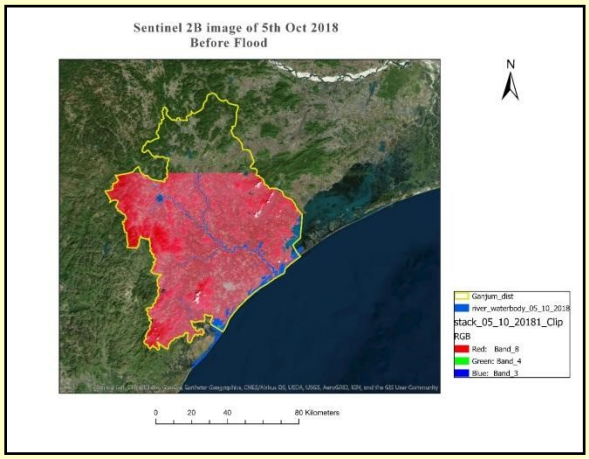

Figure 3. Before Flood condition of Ganjum district, Odisha

Here in figure 3 we observed the image of 5th Oct 2018 before flood sentinel image. We extracted the total water covered area in Ganjum District which approximately is 17839.93 hector. This water body mainly shows rivers, dams and few waterlogged area due to agriculture. But after Flood there is huge change in water covered area which can easily marked on after Flood 20th Oct images.

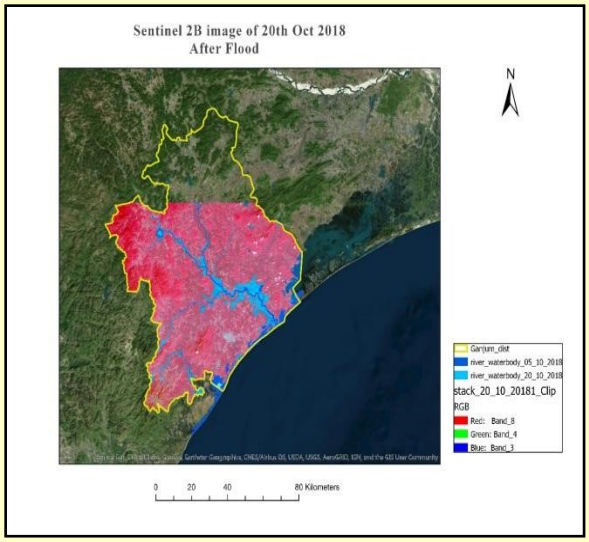

Figure 4. Before Flood condition of Ganjum district, Odisha

Here in figure 4 we observed the image of 20th Oct 2018 after flood sentinel image. It was observed that a huge increased level in water covered area in Gunjum District as post-flood scenario. It almost covers 40113.65 hector area. If we subtract before and after flooded water area then we can get an approximately the area under water due to flood which is almost 22273.72 hector area.

In this study we focus on Aska Town, where the author1 was stuck during the time of flood. Aska Town is in Ganjam District, which is mainly in a river confluence of Badanadi and Rushikulya. That town was flooded on 13th Oct due to the effect of cyclone Titly. The rain was started from evening 3.30 pm on 13th Oct and at 14th Oct night 2.30 am water was started entering into the town and by morning the water level also reached 12th feet. Below we try to focus on Asika Town before and after flood condition.

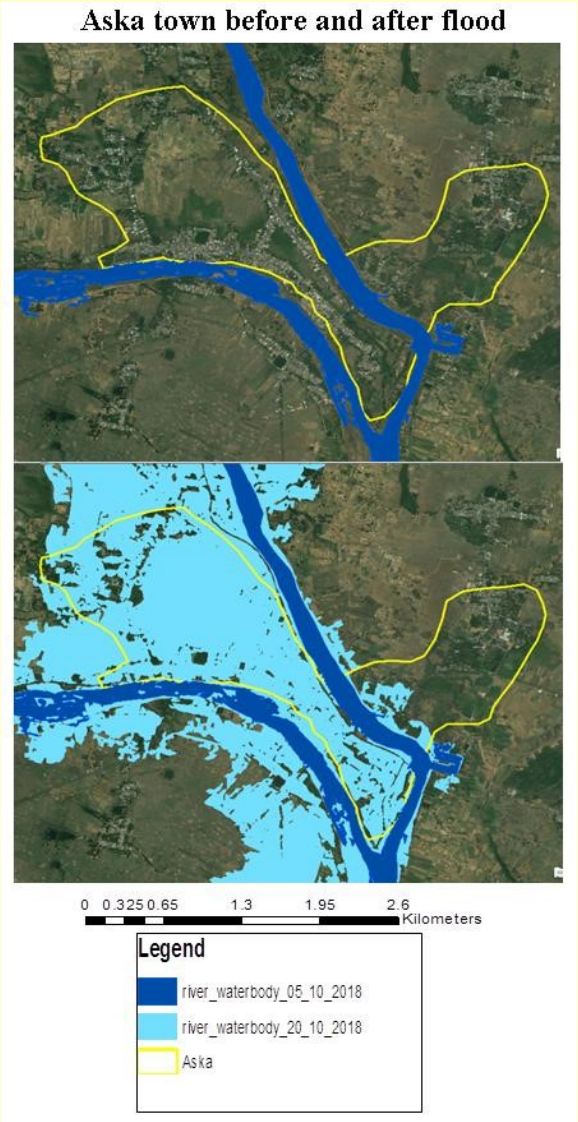

Figure 5. Before and after Flood condition of Aska town

We observed that total area of Aska town is 571.88 Hector approximately, but just after flood on 20th Oct 2018 images, we observed 350.80 Hector approximately area of Aska town was under water. Almost 62% of total town area was under water. The land in between badanadi and Rushikulya totally under water only the eastern part that is opposite side of Badanadi was not flooded. Few pictures was collected during flood was given below.

Figure 6. Few pictures of flooded Aska town on Oct 13th, 2018

Flood monitoring and damage assessment in the domain of remote sensing and GIS is very useful technique. Remote sensing is capable to study recent and past event as well as it helps to predict hazards due to flood and landslide events. Remote sensing provide us real time data of flood situation where it was impossible to reach during flood hazards.

Here we presented a flood extent scenario in an efficient and simple way. Here we mapped flooded and non-flooded area, which also verified with the data collected during flood. Here we compared the reflectance feature of water versus non water surface on a pair of Sentinel 2 B images (data acquired before and after during the flood event).

The total flooded area derived from the satellite images, on 20th Oct 2018 for Aska Town was 350.80 hector or approximately 62% of total city area covered with water.

Here we demonstrated the ability sentinel 2b images and the potentiality of geospatial technology for flood damage assessment. For the state and national disaster agencies are required satellite derived flood inundation maps for disaster monitoring and relief efforts. Here we can suggest more integration of data like elevation data, river network data etc. are required for more develop algorithms for flood assessment which is the further scope of this study.

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