FLOOD INNUNDATION MAPPING IN JEHLUM RIVER AND ITS IMPACT ASSESSMENT USING REMOTE SENSING AND GIS TECHNIQUES FOR THE YEAR 2014.

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ABSTRACT: *This research is executed to map flood inundation zone in River Jhelum occurred in 2014. The main purpose of the research was to investigate the destruction caused by flood and the rehabilitation cost flood using geographical information system (GIS) and remote sensing (RS) techniques. It also aimed to identify the impact assessment of flood on the socio economic life of locals. GIS and RS techniques helped to assess flood affected areas and provided further risk management policy. We identified the percentage of land use across our study area as agricultural land was about 40%, bare soil was 29%, buildup area was 16% and water body was 12% at normal water flow before flood. In post flood conditions, the water body increased up to 33% and buildup area degraded 10%. We identified the exact losses using this emerging technology of RS and GIS.*

Keywords: LULC (Land use and Land cover) mapping, Change detection, Spatiotemporal analysis, GIS, GPS, Remote Sensing.

1. INTRODUCTION

Flood is an overflow of water that submerges land which is usually dry. It is a natural phenomenon that emerges due to heavy rainfall, tsunami, coastal hazards and earthquake. Some manmade activities like deforestation, mismanaged dam system and mud based water preservation system create venerable areas for flood. It is documented that flood occurring phenomenon has increased over the past years due to global warming around the world's largest rivers. The results of flood seem most destructive and vulnerable, because it destroys the overall social and economic setting on regional scales [1]. Besides this, Flood also changes the position of the land that creates direct impact on topography in case of flood vulnerable plains. Socially, the primary impact of flood is in case of loss of many precious lives, livelihood and pet animals of residents which are eaten by flood with no time limits. Residential areas, commercial markets, industry, recreational areas, road infrastructure, sanitation facility, drainage network and railway lines are badly hit and destroyed by flood which are commonly known as economical losses on regional scales that takes years for rehabilitation. So it is difficult for man to cope with the destructions caused by the flood. The secondary impact of flood is the decline in tourism including destruction of historical buildings and places of enjoyment.[2]. There are many types of floods e.g. flash flood is a local flood which happens in a very short period of time. It occurs in mountainous regions that become most destructive due to dam's failure. It is caused by heavy rain and overflow of water and melting of snow. Strom surge flooding is a phenomenon of rising water. It is also called coastal flood or tsunami [3]. It is the high level of water on the surface of banks of a streams or rivers. It occurs due to timing and depth among different locations. Such kind of floods can last for larger time because of slow moving water. Pluvial flood is caused when heavy rain fall occurs. Pluvial flood with heavy rainfall creates overflowing of water body[4]. A kind of flood mainly happens in urban areas and it happens in those areas which are above coastal and river flood plains. Coastal flood takes place due to low lying land. The level of coastal flood is a function of the elevation [5]. Flood waters penetrate into the land that is normally controlled by the structure of the coastal land.

Positive impacts of flooding

Flooding is also a positive stance for the soil. It is beneficial because the flood will drain the old and useless soil. It will make the level of production high. [3].

Objective of the research

- To measure the impacts of flood on socio economic life
- To apply remote sensing (RS) technique to identify the flood porn areas and geographic information (GIS) technique to map flood inundation.
- To suggest safety measurement for proper management of flood.

2. Study Area

The starting point of the Jhelum River is Verinag Spring adjacent to PirPanjal which is situated in south eastern kashmir's valley in India. Before entering to territory of Pakistan it has to pass from Srinagar and after this through stony barriers of Wular-Lake. River Jhelum flows near to district Jhelum and it is located in the west bank of punjab's river. River Jhelum's lenth is 772 Km. Alexander discovered Jhelum in 325 BC when he came in Punjab. It flows throughout south of Pakistan's hills and In west of kashmir's valley[6]. The drains belonging to this river have length of 2300 square miles located in Kashmir. The main source of water for this river are glaciers of Kashmir.In spring season when snow melts then its flow is almost controlled[7]. Its flow is also controlled in the month of June and September in the beginning of the monsoon season which causes heavy flow of water in Jhelum River. Sometimes its flow speeds exceeds to 1,000,000 cubic per second which is highest. In winter season rainfall is a minor source of water for it. In jehlum River level of water is normally high in summer and low in winter. Through Jehlum district it enters into Punjab province. Then its flow is towards the plain areas of Punjab province and its boundary prolonged to sagar doab and chaj. The convergence of this river to Chenab is at Trimmu head located in district Jhang. Mithankot is the only spot where all five rivers of Punjab falls in river Sindh[8].

In Pakistan's territory the main cities from which it passes are Jhelum, Muzaffarabad, Jhang, MandiBahauddin, Malakwal,

Khushab, Sahiwal, Multan and Muzaffargarh[9]. By combining daily average flows of the river, the annual average flow can be calculated. Its annual average flow is about 11.85 MAF i.e. 8.2 MAF in Kharif season and 3.65 MAF in Rabi season[10].

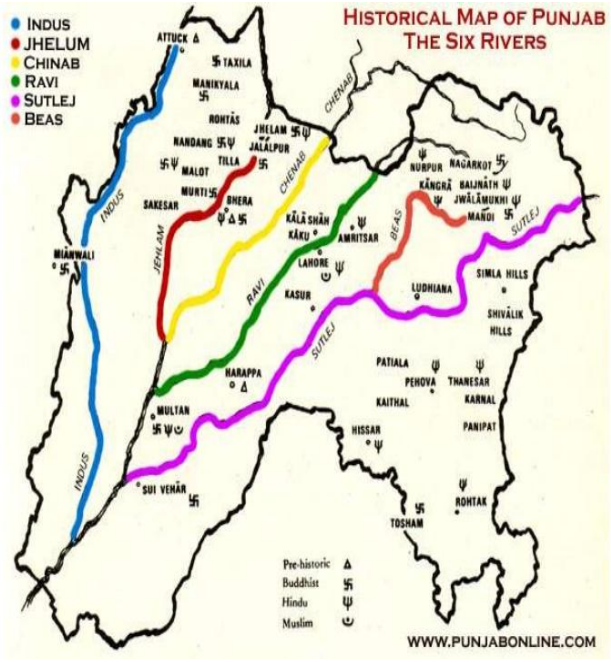


Fig No.1 Jehlum Rive and it's Outskirts.

3. Methodolgy

3.1 Image Acquisition

Landsat 8 flood related images were acquired from USGS website which were freely available to download. We downloaded two Landsat 8 data sets to estimate flood inundation for the dates 25-Aug-2014 (before the flood) and 10-Sep-2014(after the flood).

3.2 Band Stacking.

The images downloaded were a composite of 11 layers. These layers were tied up using layer stack algorithm in Erdas Imagine 9.2.

3.3 Geometric distortion classification

Geometric distortions created by fluctuations in sensor's functionality were checked and removed in Erdas Image 9.2 to process error free data and fruitful results.

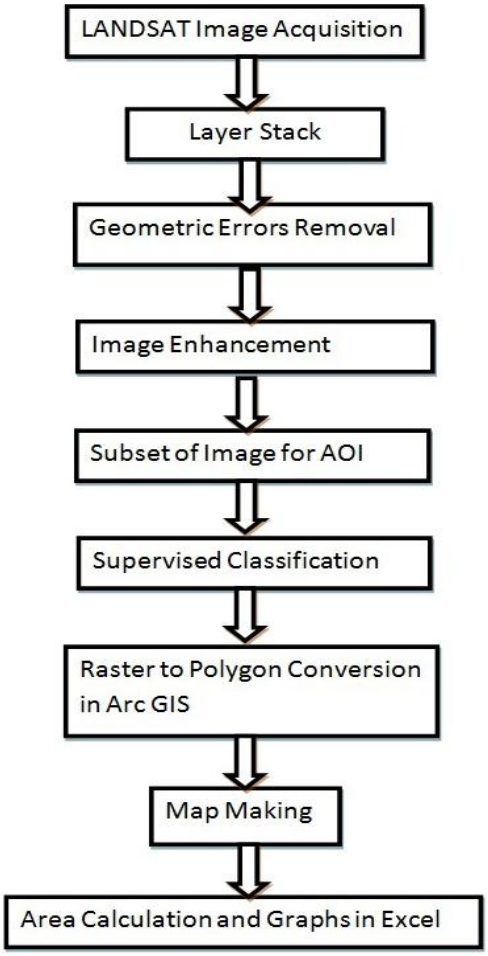
3.4 Image classification

The alogorithm of supervised classification was applied to rectified satellite images to see spatial distribution features in the images. In this step we classified the images into major classes named as water body, bare soil and the buildup area.

3.5 Subsetting.

In this step we extracted out areas of interest form the complete dataset using extract by mask algrithm in Arc GIS 10.1. Sub setting is a good method of extraction of our desired area to enhance processing speed otherwise system may take longer time in processing.

3.5 Raster Analysis in Arc GIS



We opened classified images in Arc GIS 10.1 and converted them into polygons to measure the actual extent of regular flow of water verses the extent of flood water inundation. We computed the areas and found the following results.

4 RESULTS AND DISCUSSION

We classified images into major classes including agricultural area, build up area and Bare soil. Build up area included the residential structures of locals e.g houses, commercial markets, educational institutes and public buildings etc. Agricultural area included the major crops plants across the fields and the bare soil was the type of soil that remain wet into the bed of river.

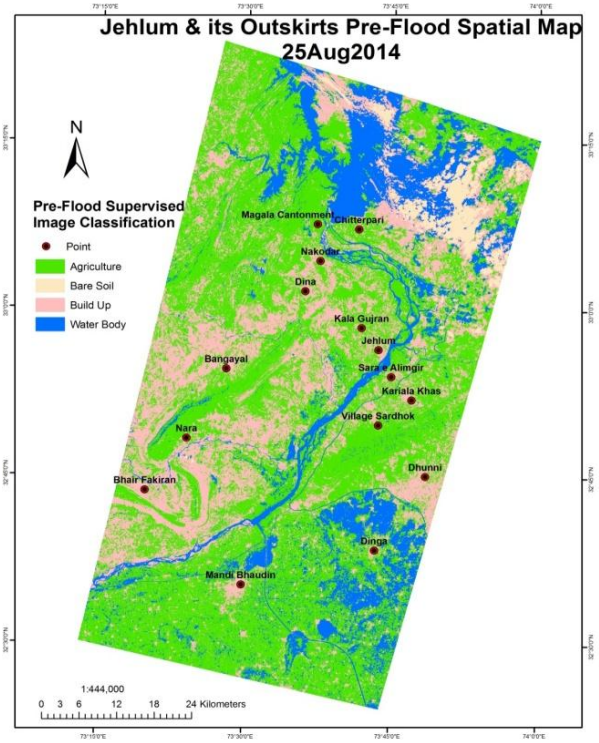


Fig No. 2 Classified map of River Jhelum before Flood.

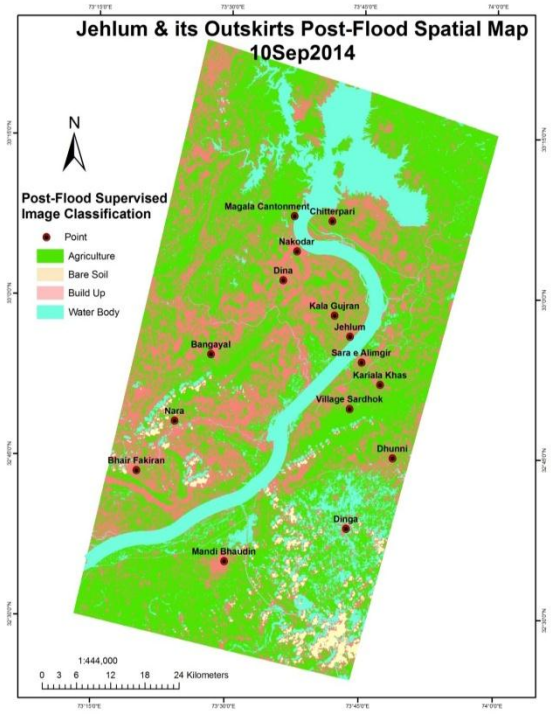


Fig No.3 Classified map of River Jehlum after Flood.

Table No 1. Land use Area of river Jhelum and its outskirts before flood

Agriculture	Bare soil	Build up area	Water body
2724 Sq Km (43%)	1461 Sq Km (28%)	819 Sq Km (17%)	193 Sq Km (12%)

Table 2 Land use Area of river Jhelum and its outskirts after flood

Agriculture	Bare soil	Build up area	Water body
2511 Sq Km (31%)	1325 Sq Km (25%)	409 Sq Km (10%)	1193 Sq Km (33.3%)

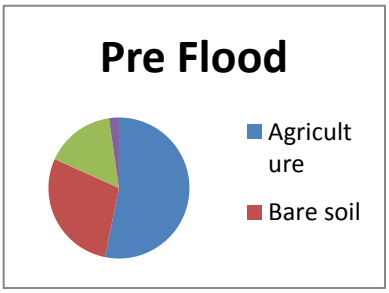


Fig 4.2 Graph of pre Flood Area

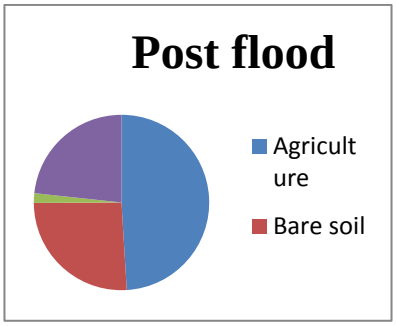


Fig 4.3 Graph of pre Flood Area

The result showed that agricultural land was found about 40% and the bare soil was 29%. The build up area was about 16% and water body was noted 12%.

The post flood classified image is shown below.

After the classification of the post flood areas, it was clear that, build up and agriculture area is destroyed by the flood water.

4.1 Pre and post flood analysis

We superimposed pre and post flood classified images to map flood inundation and found the following results. By this superimposition we found that agricultural area was decreased by 31% as it was 43% before the flood, water body increased up to 33% as it was just 12% in normal flow, build up area was also decrease to 10% and bare soil 25%.

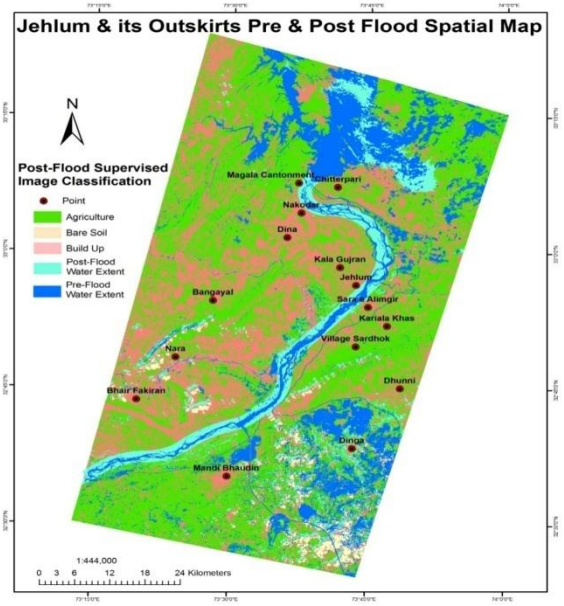


Fig No 4 Pre and Post Flood Classified image.

4.2.1 Economic Impact of Flood

We found that flood, a natural disaster, that has hit the areas indiscriminately. Whole geography of the flood affected region was disturbed badly. It had a clear impact on socio-economic conditions, as it takes a massive amount for rehabilitation of built up areas that affected the economy badly.

Environmental impacts

Additionally, the target of our study was the environmental area affected by the flood. The hazardous substances and chemicals are transported by the flux of flood. When the flood ends up, these hazardous elements become a cause of various diseases. At the same time flood killed the insects and animals by destroying the ecological balance.

Effect of flood on road infrastructure

According to our observations, the flood destroyed the transportation system in the study area. It also collapsed the structures of schools, factories, roads, bridge railway line and sanitation facilities.

Social impacts of flood

Flooding brought vulnerability for the people that resulted in loss of life (human death), property (live stock) and livelihood. There were also psychosocial effects of flooding which damaged the growth of economic development. In addition, the flooding also resulted in the mass migration**.**

5. CONCLUSION

Remote sensing and GIS techniques proved very useful to identify the flood vulnerable areas. It became very easy to demarcate the flood water extent and to estimate the rehabilitation cost using this emerging technology. RS and GIS techniques enabled us to analyses the areas that were not approachable physically. These techniques increased the spatial and temporal resolution.

ACKNOWLEDGEMENT.

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6. REFERENCES

[1] Victoria state emergency service Report ‘’flood and its types ‘’ (2010).

[2] Werritty, A., Houston, D., Ball, T., Tavendale, A., & Black, A. (2007). Exploring the social impacts of flood risk and flooding in Scotland. Edinburgh: Scottish Executive

[4] Asgary, A., Anjum, M. I., & Azimi, N. (2012). Disaster recovery and business continuity after the 2010 flood in Pakistan: Case of small businesses. International journal of disaster risk reduction, 2, 46-56.

[5] Aparna, N., Ramani, A. V., & Nagaraja, R. (2014). Risk management support through India Remote Sensing Satellites. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 40(8), 1.

[6] Joaquim Jose Furtado1*, Zhihua Cai1 & Liu Xiaobo1 1 China University of Geosciences, 388 LuMo road, Wuhan, Hubei, P.R. China. Zip code 430074

[7] PCI Image classification Lillesand and Kiefer (1994)

[8] Zerger, A., & Smith, D. I. (2003). Impediments to using GIS for real-time disaster decision support. Computers, environment and urban systems,27(2), 123-141.

[9] Schaerer, P. (1989). The avalanche-hazard index. National Research Council Canada, Institute for Research in Construction.

[10] Khan, M. Y., Mir Shabeer, Imtiyaz A. Raja, and Nazir A. Wani. Physico-chemical analysis of River Jehlum (Kashmir). Global Journal of Science Frontier Research 12, no. 1-E (2012).