



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 6, June 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

Application of Remote Sensing and Geographic Information Systems in Flood monitoring

Sunkara Prem Kumar Reddy¹, Vellampalli Vishnu Sai¹, Aashi Agarwal², Dr. Zafar Ali Khan N³,

U.G. Student, Department of Computer Science Engineering, Presidency University, Bengaluru India¹

Assistant Professor, Department of Civil Engineering, Presidency University, Bengaluru, India²

Associate Professor, Department of Computer Science Engineering, Presidency University, Bengaluru, India³

ABSTRACT Flood frequency in India has significantly increased due to anthropogenic and climate factors. In this situation, it becomes crucial to monitor the disaster to develop better forecasting models and early warning systems. Remote sensing along with Geographic information systems has become a popular tool in vulnerability assessment and risk mapping. The high-resolution spatial information collected by satellites through remote sensing in the form of terrain images, digital elevation models etc. helps in generating flood hazard mapping and damage assessment. This paper reviews the work done by various researchers using GIS techniques for flood risk identification and management. It also discusses the various causes of floods and strategies such as early warning systems, flood shelter maps etc. adopted by the decision makers to mitigate the damage. The manuscript reveals that GIS can be integrated as a key tool towards flood management and mitigation.

KEYWORDS: Geographic Information Systems, Digital Elevation model, Flood risk maps.

I. INTRODUCTION

Flooding is a natural occurrence in which water overflows the boundary of a channel or a stream. It is the response of a basin to heavy rainfall. When the water flows beyond the capacity of the channel, the entire area gets inundated and it becomes destructive in nature for life and infrastructure. From past two decades, Asia has experienced maximum number of floods with a death toll of over 60,000 people. The present study focusses on flood management and monitoring using remote sensing and GIS. Flood monitoring involves the estimation of inundated area and depth of flood flow which is also significant for preparing flood maps and risk assessment. In recent times, Floods have also occurred in locations that were previously not thought to be flood prone. Flood is a physical feature of the environment and thus a vital part of the hydrological cycle. It is crucial to continuously monitor the flow rate in channels, natural streams or rivers to obtain timely information and develop early warning systems. Along with the flow rate, it is important to understand the parameters affecting the rate of flow such as change in the land use, rapid deforestation and urbanisation. Conversion of vegetated lands into built up areas in urban areas has resulted into increase in the magnitude of floods. Also, with the global warming and climate change, different components of hydrological cycle have been altered and frequency of floods has been increased. Therefore, Proper flood management includes not only the monitoring of flow rates but also to continuously monitor the land use changes. Remote sensing with Geographic information systems, GIS enables us to get information of various such parameters and help us to monitor the disasters in an organised manner. However, it is not a new concept. It has been evolved through many stages from optical remote sensing to radar remote sensing. Now-a-days, satellites are offering comprehensive, and multi-temporal images at regular intervals and with very high spatial resolution. Remote sensing makes use of electromagnetic radiation to interact with the various target features present on the surface of the earth. This has been proved to be one of the most efficient tool for flood mapping and suitability analysis and can be useful for emergency response and disaster preparedness. Remote sensing data has been widely used right

from quantity estimation to monitoring water quality, from estimating water depths to monitoring river channel changes and aquatic habitat. Earth observation satellites allow continuous monitoring of atmospheric and surface elements which is correlated to floods. It also provides a comprehensive, synoptic, and multi-temporal and multi-spatial coverage of wide areas in real time and at regular intervals. GIS users can easily use the flood hazard and flood shelters model developed in ArcGIS Model Builder or QGIS model or any other GIS platform as per the user requirement. Geostationary satellites offer continuous and synoptic weather observations over broad regions containing both big and small river basins, have proven to be excellent for mapping, monitoring, and research.

II. REVIEW OF LITERATURE

K.C. Mondal et al applied GIS for flood assessment in two blocks of West Bengal, both of which are located in the lower Ajay River basin and the Ausgram II. With the rapid development of the human population, communities are progressively encroaching on river valley flood plains, increasing the danger factor. Aushgram-II and Nanoor blocks (Maps of India) were geo-referenced in GIS platform for analysis of the subject region. The Ajay River basin was delineated, and channel extraction was performed using SRTM DEM data (90 m, 4.1 version) (CGIAR-CSI 2004). They have also estimated the flood-affected area and identification of flood-prone areas. The risk has been calculated based on the height of the flood, the extent of the flood, and the number of individuals that will be affected. In the GIS platform, a probable suitable site for flood shelter has been determined based on a detailed study of flood risk and hazards. Using the same, the flood area was calculated using the primary danger level (PDL) (Irrigation & Water Ways Directorate 2013) as a benchmark and changing the water level by 1 m from the PDL. Villages that were impacted by the PDL are thought to be the most vulnerable. The village-point height was extracted, and flood height was measured at several stages of flood to determine the strength of the flood. The results showed that flood pattern and extension are strongly linked to topographic factors. The risk threshold was set at 1.5 meters of flood height. The spatial distribution of flood was detected using these topography and flood models. The study shows that geospatial-based technology is a powerful and comprehensive tool for determining the appropriate flood-protection zone. Four factors were evaluated while determining the greatest probable flood shelter location-accessibility, school location, ground slope and proximity to flood-affected area are all factors to consider. The optimum potential site zone was found based on these four parameters and proportional weight age value.

Kabir Uddin et al have investigated the flood hazard area and flood shelter places for Sindh Province. In Pakistan, floods have been categorized as a significant natural calamity. Flooding from the Indus River and its tributaries has a long history in Pakistan, as evidenced by floods in 1928, 1929, 1955, 1957, 1959, 1973, 1976, 1988, 1992, 1995, 1996, and 1997. Seven districts of Sindh province, in Nepal's south-eastern region, are chosen as the study area in this literature. NDVI was used to construct an NDVI picture in the pre-processing step, with NDVI indices values ranging from -1.0 to 1.0, with non-vegetation regions having negative values and vegetation areas having positive values. Rivers' Euclidean distances were calculated, and the flood hazard of short disease from rivers was graded. Then, on a standard scale of 1 to 5, reclassify data sets. Several '1' indicates the greatest danger of flooding, while a value of '5' suggests the least risk. The flood swamped a total area of 7579 km² in Sindh province. The estimated result indicated a very high hazard region out of Sindh province's total size of 46,138 km² (6216 km²). A total of 1363 km² was shown to be less prone to flooding.

PawarAmol D et al conducted flood management studies in Lonavla, a town and hill station in the Pune district of Maharashtra, India, with a Municipal Council. Khopoli, on the upstream side of the river from the colony, has a dam for power generation. Because of its proximity to the river, this region is especially vulnerable to flooding. The techniques used are Google Maps was used to create the picture, Ground Control Points (GCPs) were then obtained on the field using a Global Positioning System GPS hand held device (GARMIN GPS INDIA), in Quantum GIS programme, the image was registered using the georeferenced tool, Then, using the line feature to digitize the image, a shape file for Road, River was created For the River Indrayani, a buffer study was performed at 10m, 25m, 35m, and 50m, Depending on the intensity of the flood, this information can be used to determine whether or not people should be evacuated the area's. Primitive buffer operations such as point, line, and polygon buffer operations are

used to shift data around. Buffer Point and Buffer Line are the things taken into consideration while the study. The buffer study shows that the 35 m and 50 m will result in severe submergence in the area. For these levels, proper planning for the evacuation of the populace is required.

JiraponSunkpho et al developed a system for real-time monitoring of water conditions, such as water level, flow, and precipitation level, for flood monitoring in Thailand's southern province of Nakhon Si Thammarat. Flooding is a common occurrence in Nakhon Si Thammarat, a province in southern Thailand, affecting the whole province, particularly the urban area. In the Nakhon Si Thammarat metropolitan region alone, the flash flood in November 2002 took the lives of roughly ten million Thai baht. Throughout the years, floods have been studied using a variety of methodologies and considerations, including wireless sensor networks (Chang, 2006; Hughes, 2006; DeRoure, 2005), embedded systems with middleware (Hughes, 2006; Chen, 1990), Internet-based real-time data acquisition (Chang, 2002), and flood modelling and forecasting (Hughes, 2006; Chen, 1990). In addition to sensor technologies, space and satellite data technologies have been used to improve accuracy (Manusthiparom, 2005; Veijonen, 2006; Louhisuo, 2004). One of the most often used infrastructures for establishing a flood monitoring and warning system is an ad-hoc wireless sensor network (Chang, 2006; Hughes, 2006; DeRoure, 2005). This research presents a revolutionary tailored wireless sensor network. The three main components of the constructed system are the sensor network, data transmission and processing, and database and application server/computer. In the case of a flood, the system will track crucial flood-related data (water level, flow, and precipitation) and send out timely flood alerts to local stakeholders through SMS, FAX, and email. They employed a UNIDATA ultrasonic Doppler device with a 128K data recorder to detect water level and velocity in the monitoring sensor module, Fischer's precipitation sensor (MetoClima 2007), which monitors the volume and intensity of rain. The main goal of this paper was to do real-time flood monitoring for the study area.

Arshad Ameen A et al worked towards creating flood maps and land use maps for flood analysis in Kalady, a town in the Angamaly district of Kerala, India. The panchayat has a total size of 16.44 hectares. Flood maps were developed to assist non-technical users in determining how flood hazard zones may affect different types of facilities. The KaladyPanchayat provided the research region's border map, which was used to construct a flood map. This border was digitized using Google Earth Pro. In each of the Panchayat's 17 wards, latitude, longitude, and estimated water levels were recorded. The True Compass app was used to track water levels and acquire latitude and longitude. After that, the data is transferred to Excel sheets. A shape file of the research area is created using ArcGIS 10.3 software, and all of the surveyed points are added to the shape file of the boundary using the add data tool. The Kriging tool in ArcGIS software is used to interpolate the points and a flood map is created. In order to evaluate the impact of land use on floods, a land use map is created by using a Landsat image and further image classification was done. The application overlays the produced flood map and land use map to create the flood effect map.

Mr.PakornPetchprayoon et al monitored and analyzed the floods in Thailand in 2002 by collecting data from RADARSAT 1, LANDSAT 7 ETM+, IRS 1C, 1D, and higher resolution satellite images such as IKONOS and QuickBird. The RADARSAT 1 data, yielded a comprehensive set of physical data that may be utilized to analyze the flood disaster's consequences on the transportation network, agricultural, and urban areas. The data fusion of RADARSAT 1 and LANDSAT 7 was done and shown in artificial colour. Blue was used to represent flooded areas, while red was used to represent the forest. A GIS was used to combine the image with geographical and attribute data. The study of flood-related damages, such as those to transportation networks, agriculture, and urban areas, was improved by this combination. Flooding occurred in several watersheds, according to satellite data obtained in 2002, which was beneficial for combining with hydrological and meteorological data and models, resulting in flood catastrophe prevention and mitigation approaches. Remote sensing and Geographic Information System technologies, in addition to traditional damage assessment and mapping methods, can provide accurate and timely information for disaster monitoring. The insights gathered by this method might be useful in both land use planning and catastrophe management.

Irimescu et al. have worked on flood prevention using flood mapping for Romania. The Danube is Europe's second-longest river, stretching 2,857 kilometres and passing through Romania for 1,075 kilometers (38 percent). The six

most impacted places along the Romanian section of the Danube are Ghidici – Macesu de Jos, Bechet – Corabia, Oltenita – Calarasi, BaltaIalomitei, Insula Mare a Brailei, and the Danube Delta. The largest flow on the Danube in the preceding 100 years, 15,800 m³ /s, was produced by heavy rains and melting snow over Central and Eastern Europe towards the end of winter and the beginning of spring (Meteorological bulletins, 2006). Topographic maps have been used to extract several types of information layers, including administrative aspects, natural characteristics, and communication networks. Flood mapping in satellite pictures was done using MODIS (Moderate Resolution Imaging Spectroradiometer) data. Flood mapping was carried out with the use of FORMOSAT 2 and SPOT data. In flood-affected areas, the CORINE LAND COVER 2000 software was utilized to determine land cover/use classes, with the LANDSAT 7 ETM+ mosaic serving as the thematic background. As part of the NATO SfP Project, a method for extracting flood-affected zones in the Danube's Romanian half was created (Brakenridge et al., 2003). Image geo-referencing, NDVI computation, separation of water from other cover classes, extraction of the water mask, validation, economic damages, and data distribution are the processes in the processing chain for quick mapping. End-users benefit from rapid mapping tools since they are easy to use and comprehend. Every year, floods in various parts of Romania, like in many other countries, cause significant damage across large territories, resulting in human lives and economic implications.

Mathur DK, et al has conducted a study on natural hazard assessment, vulnerability assessment and risk assessment for flood affected villages in Gujarat's Anand district. An appropriate flood mitigation/evacuation strategy was also proposed under the study. The study area comprised of three villages in the Anand district were chosen for this study: Rajupura, Vaherakhadi, and Anklawadi. Study area location is given by the following coordinate locations: 22° 27' 17.60" North 73° 03' 17.80" East latitude and 22° 31' 2.57" North 73° 04' 11.6" east longitude define the research area.

Download satellite images from the Bhuvan site. Flood evacuation planning is demonstrated using QGIS source software. The study area is digitized using GIS software. QGIS is used to identify and digitize various sites such as shelters, hospitals, and road networks. GIS and remote sensing were used to create flood susceptibility map, determine potential shelter places based on available resources and the best escape route. Vasad, the neighboringhamlet, is used as a shelter site for these three communities. The PHC hospital in Vasad is equipped with contemporary emergency care facilities. Vasad is at a greater height than the well-defined road network of these three communities.

Flood hazard mapping was studied by SwarupJyotiBaishya et al. Baralia-Nona River Basin in Assam, India was chosen as the case study location. The Baralia-Nona River basin spans 26°19'N to 26°50'N latitude and 91°28' to 91° 41'E longitude, with a catchment area of approximately 558.71 km². The study's main goals are to investigate the basin's climatic characteristics, determine the basin's sensitivity to flood dangers, create a flood hazard zonation map using a composite flood hazard index, and make recommendations for hazard reduction and planning in the research area using a composite flood hazard index. The study used the Survey of India's topographic sheets (1:50,000) No.78 N/7, 8, 10, 11, which were registered to UTM projection. Drainage lines from a topographic map were digitized in a GIS environment to establish the drainage network of the Baralia-Nona basin. At several sites, topographic maps and SRTM photos were utilized to derive contours. The 2011 Indian Census provided village-level population data, and GIS was used to estimate village-level area and population density. Rainfall, temperature, the history of floods in the study area, the production of land use maps, flood risk mapping elevation maps, population density maps, proximity to the Baralia and Nona Rivers, the number of homes, and agriculture are all considered. The Flood Hazard Index model's hazard categories were considered.

Argaz, et al did a study employing remote sensing and GIS tools to map flood hazards. They chose the Souss River Basin, which is in western Morocco, as their research region. The Anti-Atlas Mountains are to the south, while the High Atlas Mountains are to the north, as shown by the coordinates 9.6 and 7.47 degrees west longitude and 29.70 and 31.11 degrees north latitude. The Souss river basin was separated into five zones with varied degrees of flood danger to assess flood-hazard areas (very high, high, moderate, low, and very low). This categorization is accomplished by giving relative weights to the components that generate and impact flooding. This is done in a Geographic Information System (GIS) environment, and for each parameter, themed maps are created. Seven

thematic-layer parameters were constructed using a GIS ArcMap environment: flow accumulation, slope, elevation, rainfall intensity, land use, geology, and distance from the drainage network. Rainfall intensity, elevation and slope, land use, flow accumulation, geology, and distance from drainage network are among the parameters discovered. Finally, utilizing ABHSM data from earlier floods in the basin, the modelled output maps, such as the flood danger map and the validation map, were validated.

The study on spatial evaluation of flood vulnerability was undertaken by Hiba Mohammad et al. The coastal zone of Syria was chosen for the case study because it spans 4200 km² and is divided into two governments: Lattakia in the north (2300 km²; 9981311 residents) and Tartous in the south (1900 km² ; 333188 inhabitants). The digital elevation model (DEM) was extracted from the interpolation of the elevation data by the triangular irregular network using the contour map received from the General Organization of Remote Sensing (GORS) in Lattakia (TIN). They used a supervised analysis on a LANDSAT L7 ETM+ satellite image to produce a land use map. Aspects to consider include water depth, height and slope, and water accumulation. Vulnerability zones (villages, city Centre, and industrial zone) must be assessed to determine exposure according to the three water levels. Based on the lessons learned in this case study, the following recommendations for river flood zone management in general might be developed: Include this assessment in river zone management plans as a tool for determining the degree of vulnerability of Syria's river flood plains, allowing for improved decision-making. Install flood defences in high-risk locations and provide equipment for measuring hydrographic networks.

By combining GIS and remote sensing data such as soil type, slope, rainfall data from the imaging satellite Himawari 8, land cover data from Landsat 8 OLI, and observation data from catastrophic events over the last five years, Y Berkati et al were able to determine the level of flood disaster prone area in Semarang. In visible light, Himawari-8 has a pixel resolution of 0.5 and 1 kilometre, 2 kilometre in the infrared channel, 1 and 2 kilometre in the infrared channel, and 4 kilometres for cloud data. Semarang, the capital of Central Java, was the site of the study. Semarang is one of the most populated cities in Indonesia. Himawari-8 can capture global observations every 10 minutes and customized observations every 2.5 minutes. The United States launched the Landsat-8 imaging satellite on February 11, 2013. The onboard Operational Land Imager (OLI) sensor and the Thermal Infrared Sensor are both 11-band sensors on Landsat-8 (TIRS). The OLI sensor simulates the effects of stress on items on Earth by using visible, near infrared (NIR), and short-wave infrared (SWIR) radiation. Rainfall, land cover, soil analysis, slope analysis, flooding events, and flood prone areas in Semarang were studied. In this work, remote sensing and GIS techniques were used to identify the character of locations and flood susceptibility zones in Semarang. Physical variables impacted the frequency and severity of floods. Landsat 8 pictures classified just 30% of the land cover as forest, according to multiple studies, potentially reducing water runoff to aquatic bodies and land. The integration of remote sensing data and GIS has been able and practical to grasp flood-prone zones by researching the physical character and history of floods.

A.F. Sunar et al have monitored floods in Maritsa river basin using Landsat 8 OLI MSI and Sentinel 2 MSI images. Ancillary data, such as weather data and flow measurements, were used in the study in this case. Precipitation and flow data were given by the Edirne Meteorological Station and five different flow monitoring stations. NDWI which is a regularly used remote sensing-derived metric for monitoring changes in water content in bodies of water, for calibration were used to evaluate the flooding occurrence and mapping in this work. Google Earth Engine (GEE) was used to analyse and understand geographic data for a range of applications. In this study, the water and non-water zones were clearly distinguished and the images were confirmed by comparing them to data on the Turkish Disaster and Emergency Management Authority website. This effort aims to demonstrate a rapid risk assessment for prospective damage assessment by automatically analysing optical and active satellite image data on the GEE platform. Flood response and damage assessment have shown to be particularly effective in cloud-based computing environments, such as the GEE platform. It is possible to infer that geo-information technologies, such as remote sensing, provide timely information for flood disaster management in cross-border areas such as the Maritsa River basin.

III. METHODOLOGY

The general methodology for flood assessment is discussed in the figure 1. Various maps such as rainfall data points, Slope, LULC, and Soil etc. are generated. These maps can be used as an input to GIS where further analysis can be done to determine the flood hazard mapping and risk assessment.

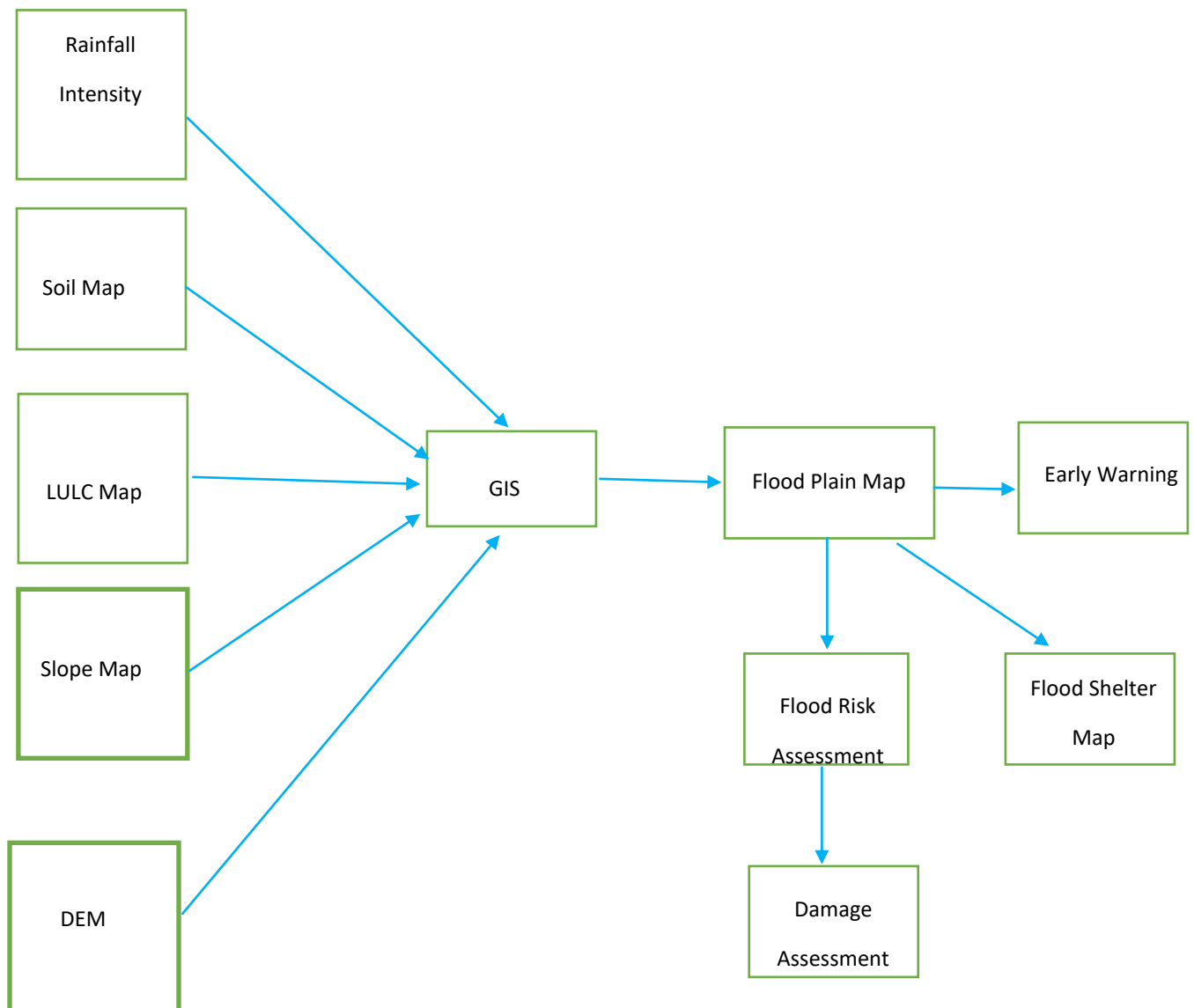


Fig 1 – General Methodology for Flood Assessment



IV. FUTURE SCOPE

Flood monitoring studies can be further extended for regional scale. Integration of Remote sensing and GIS can be further explored to develop better early warning systems. In most of the literature review, the satellite images used can be taken with an improvement over resolution to get true representation of the hazard. Flood hazard mapping and damage control mapping must be done to mitigate the effects of the disaster.

V CONCLUSION

The above review paper summarises the research work done in the field of flood management and monitoring by using GIS technology. Natural disasters such as floods are very devastating in nature. However, the impact multiplies under the impact of climate change. In order to mitigate the loss, hazard monitoring becomes crucial. Also, with the advancement of technology, remote sensing and GIS have proved to be an essential monitoring tool. As discussed in the paper, flood mapping with the use of high temporal-spatial resolution remote sensing images, the area under submergence can be assessed and the risk map can be generated. Based on the availability of space and resources, flood shelter maps can also be prepared which can help in faster recovery from the disaster.

REFERENCES

- [1] Snehangwar, 2013, International Journal of Environmental Science: Development and Monitoring (IJESDM) ISSN No. 2231-1289, Volume 4 No. 2
- [2] Kartick Chandra Mondal et al, 2020, Application of Remote Sensing and GIS in Flood Vulnerability Assessment -A Case Study of Lower Ajay Basin, India, DOI: 10.1007/978-981-32-9527-8_10
- [3] Kabir Uddin et al, 2013, Application of Remote Sensing and GIS in Flood Hazard Management: A Case Study from Sindh Province, Pakistan, DOI: 10.5923/j.ajgis.20130201.01
- [4] Pawar Amol Det al, Application of GIS and RS for Flood Evacuation Planning: A Lonavala Case Study
- [5] Jirapon Sunkpho et al, 2011, Real-time flood monitoring and warning system, J. Sci. Technol. 33 (2), 227-235, 2011
- [6] Arshad Ameen A. A et al, 2019, Flood Mapping and Impact Analysis using GIS, ISSN: 2278-0181 IJERTV8IS050522 Vol. 8 Issue 05, May-2019.
- [7] Pakorn Petchprayoon et al, Application of Remote Sensing and GIS to Flood Monitoring and Mitigation.
- [8] Anisoara Irimescu et al, 2010, Remote sensing and GIS techniques for flood monitoring and damage assessment. Study case in Romania
- [9] Mathur DK, et al. Application of Remote Sensing and GIS For Flood Vulnerability and Mitigation: A Case Study of Flood Affected Villages of Mahi River, Arch Phys Res, 2017, 8 (2):07-11
- [10] Swarup Jyoti Baishya et al. Application of Remote Sensing and GIS for Flood Hazard Mapping: A Case Study at Baralia-Nona River Basin, Assam, India, Volume 5 Issue 3 || March. 2017 || PP-58-70
- [11] A. Argaz et al, 2019, Flood Hazard Mapping Using remote sensing and GIS Tools: A case study of Souss Watershed, J. Mater. Environ. Sci., 2019, Volume 10, Issue 2, Page 170-181
- [12] Hiba Mohammad, 2021, Spatial Assessment of Flood vulnerability in Lattakia Governorate Area Using GIS and Remote sensing, Conference Paper · May 2021
- [13] Y Berkati et al, Flood Prone Analysis Using GIS and Remote Sensing Data; Case Study in Semarang, Central Java, doi:10.1088/1755-1315/874/1/012004
- [14] A. F. Sunar et al, Flood Analysis With Remote Sensing Data – A Case Study: Maritsa River, Edirne, Volume XLII-3/W8, 2019 Gi4DM 2019



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details