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Review Paper for floodplain mapping with applications of HEC-HMS, HEC-RAS and ArcGIS softwares – A Remote Sensing and GIS Approach

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Abstract - *Floods have proven to be a serious disaster on a worldwide scale over time. Floodplain mapping is one of the key acts that must be conducted in order to determine, decide, and take action for flood risk management, given the significance and gravity of the effects of floods. This paper looks at the same subject from a geoinformatics perspective, using GIS software. GIS tools such as HEC-RAS, HEC-HMS, ArcGIS, and others are used to define floodplains. Many scholars have worked on this topic previously, and there is a wealth of information available. However, a new user learning the material for the first time may find things difficult and complex. There are many floodplain mapping approaches accessible, which may make it difficult for a new user to choose one for his own task. This paper attempts to assist a new user by categorizing previously examined studies (2000-2021) into three categories: Flood Frequency Analysis Methods, Digital Elevation Models (DEMs), and Softwares used.*

***Key Words*: Floodplain mapping, Software, Hec-HMS, Hec-RAS, ArcGIS, Remote Sensing**

1. INTRODUCTION

For a long time, India has been plagued by natural disasters. Floods, on the other hand, have become more common in recent years. These floods have wreaked havoc on people's lives and property. Hyderabad (2000), Ahmedabad (2001), Delhi (2002, 2003), Chennai (2004), Mumbai (2005), Surat (2006), Kolkata (2007), Jamshedpur (2008), Delhi (2009), Guwahati and Delhi (2010), Kedarnath (2013), Srinagar (2014), Gujarat, Chennai (2015), Assam, Hyderabad (2016), Gujarat (2017), Kerala (2018), Kerala, Madhya Pradesh, Karnataka, Maharashtra, Gujarat (all 2019), Assam, Hyderabad (2020) and the recent ones of Uttarakhand and Maharashtra- Mahad and Chiplun (2021) were the worst floods in the recent two decades. The regular occurrence of floods necessitated a thorough examination of the subject and the development of a solution to the challenges encountered. Floodplain mapping was one such solution. Floodplain mapping is a technique for identifying areas that are prone to recurring flooding from nearby rivers, lakes, streams, and the sea, as well as providing information on the spatial distribution of flood construction levels.For many years, numerous researchers have studied floodplain mapping. It has lately been coupled with tools like HEC-RAS and ArcGIS to conduct more in-depth research on the subject.

However, a user may be unsure about which technique to employ and how to apply it when pursuing a study in the subject for the first time. After reviewing prior research on floodplain mapping by a lot of scholars, this work has compiled and classified a few studies based on the methodology employed and presented them in a clear manner.

2. LITERATURE REVIEW

Numerous research papers in the last two decades were dedicated to the topic of floodplain mapping. The topic and its study however, became advanced with the time and the use of softwares facilitated the study of floodplain mapping. This paper tries to focus on the parameters of software, Digital Elevation Model (DEM) and Flood Frequency Analysis methods that have been majorly used to study floodplain mapping. Following is a brief look at the research papers that were studied:

2.1 Methods of Analysis

2.2 Digital Elevation Model

2.3 Softwares.

2.1 Methods of Analysis

The Normal Distribution, Gumbel Distribution, Log Pearson Type III, and Extreme Distribution methods are commonly used to forecast streamflow for up to 150 years. This review study uses this measure to separate the research papers under consideration.

Surendar Natarajan et al. (2019), discussed that floods are the deadliest natural calamity that has ever struck the world's metropolitan basins. Its negative consequences can be reduced by using suitable modelling, analysis, and management techniques. Such methodologies contribute to flood risk assessment, flood prediction, and emergency evacuation planning. The goal of this research was to create a rainfall–runoff simulation model by producing peak flow and volume from an exceptional rainfall event that occurred on November 22, 1999 in the ungauged Koraiyar basin south of Tiruchirappalli City in South India. To determine the optimum method to use in the research, hydrographs for the basin were made using the hyetograph and frequency storm method. HEC-HMS was used to analyze a digital elevation model generated with a geographic information system (GIS). Because of its simplicity and demand for a limited data strategy for modelling, the SCS method was chosen. The model's peak flow and volume are compared to the typical Nash–Sutcliffe values. The frequency storm approach was chosen as a better model for generating flood peak and volume for varied return periods in the basin because it had a Nash value of 0.7, which was greater than the value produced using the specified hyetograph procedure.

Hashemyan F., Khaleghi M.R. et al. (2015), simulated shift; residential and urban growth on floodplains and riverbanks, independent of hydrological and hydraulic conditions, increased the risk of flooding and, on the other hand, resulted in a loss of investment. This research employed the HEC-HMS hydrological and HEC-RAS hydraulic models to examine the behavior of the river's flood and how to enlarge its range in a Khoshke Rudan river reach in the Chaharmahal and Bakhtiari province. The HEC-HMS model was calibrated for the research region by measuring the river's cross sections with rain gauges and rainfall gauging stations from nearby basins. Using GIS extension in the GIS environment, flood zones related to precipitation with periods of 10, 20, 50, and 100 years were found. The findings of the survey validated the combined GIS and HEC-RAS models' high efficiency, demonstrated the model's potential, and advocated its use in residential and agricultural programme planning and management.

Cameron T. Ackerman et al. (2009), analyzed that the HEC-RAS is commonly used to compute water surface heights, with the data being analyzed using GIS to calculate flood extent and depth. New floodplain delineation tools in HEC-RAS generate inundation maps using water surface profile information and a ground surface model. This demarcation tool lets the modeler see the resultant floodplain right inside HEC-RAS, enabling hydraulic model refinement faster than using a GIS. Other modelling software can then be used to analyze floodplain impacts using the created floodplain boundaries and flood depths.

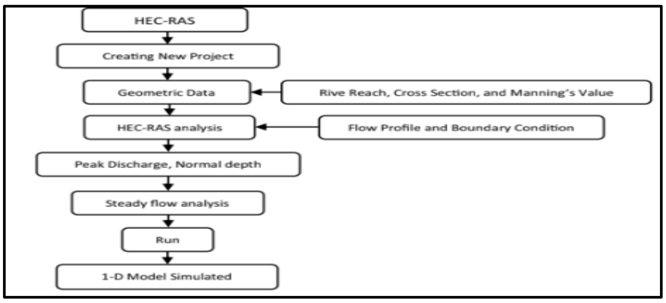

Fig-1: Methodology Flowchart for the Flood modelling for a data- scarce semi-arid region using 1-D hydrodynamic model.

(Source: https://doi.org/10.1007/s40808-021-01259-5)

Darshan J. Mehta et al. (2021), stated that because the research area was prone to flooding, a one-dimensional (1-D) hydrodynamic model was used to assess the geomorphic effectiveness of floods in the Ambica river basin in South Gujarat. Major floods occurred in 1981, 1984, 1994, 1997, 2001, 2003, 2004, 2006, 2013, and 2014. The purpose of this research was to evaluate the flood depth in the Ambica River basin's delta portion at Unai village using a 1-D hydrodynamic model. In this work, the HEC-RAS (6.0.0) programme was used to develop a 1-D hydrodynamic model using the geometry of the Ambica River, the Unai floodplain, and historical flood data. Fig-1 depicts the methodology of research. Stable flow analysis, flood conveyance, and uniform flow analysis were all evaluated using the model. The result of the model was calculated in terms of water depth and surface height. The findings suggested that the low-lying areas of Navsari city were vulnerable to flooding when the river discharge surpassed 6500 m3 /s. This research could be used to make judgments on disaster management, flood management, early warning systems, and infrastructure development.

Niraj Lamichhane et al. (2018), explained that the major goal of this research was to assess the inaccuracy associated with input data, such as various resolutions of elevation datasets and Manning's roughness for journey time computation and floodplain mapping, which was done using the HEC-RAS model on the test bed, the Grand River in Ohio, USA. The LiDAR combined with survey data results was compared to a 10-m DEM combined with survey data. These findings showed that a flood warning system may be built using a 10-m DEM in the channel and LiDAR data in the floodplain paired with survey data.

Surabhi Bhatt et al. (2014), explained that in this research, to assess the morphometric study, sophisticated technologies such as remote sensing and Geographic Information System (GIS) were employed to extract drainage networks utilizing Cartosat (DEM) for the Upper Krishna basin. Morphometric analysis is a mathematical and quantitative investigation of landforms. The catchments of the Krishna River, such as Krishna, Koyna, and Yerla, have a higher tendency to peak discharge in a short period of time. This is due to the high relief ratio (Rh), roughness number (R), and concentration duration (Tc). The greatest form factor, medium Dd, texture ratio, Rh, and period of concentration are found in the Dudhganga and Panchaganga catchments, causing modest effect on the major Krishna River. According to the findings of the research, GIS can give helpful information regarding watershed features for flood management.

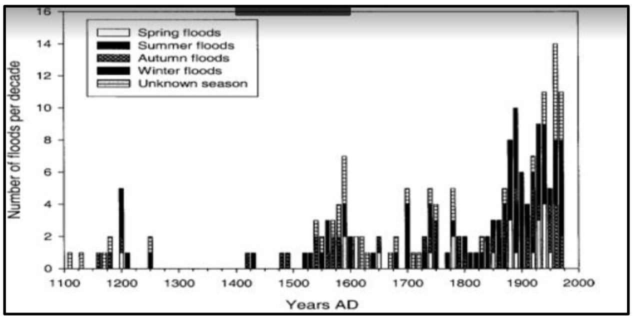

Fig-2: Temporal variability and seasonal distribution of the number of floods per decade recorded for the Tagus River Basin over the last 1000 years.

(Source: DOI:10.1023/A:1023417102053)

GERARDO BENITO et al. (2003), explained that flood frequency was highest in the years AD 1160–1210 (3%), 1540–1640 (11%) (Peak 1590–1610), 1730–1760 (5%), 1780–1810 (4%), 1870–1900 (19%), 1930–1950 (17%), and 1960–1980. (12 percent). Fig-2 gives an account of the temporal variability and seasonal distribution of the number of floods that occurred in the study area in the past 1000 years. At four localities along the Tagus River (Aranjuez, Toledo, Talavera, and Alcántara), the flood magnitudes of those documentary events were analyzed. Although the flood-producing processes in the Iberian Peninsula's Atlantic and Mediterranean basins are related to a variety of distinct weather patterns, most times of high flood frequency have a significant linkage. This demonstrates that, independent of the flood-producing mechanism; climatic variability has generated a reaction (positive or negative) in hydrological extremes during the previous millennium.

Surendar Natarajan et al. (2020), stated that flooding in urban basins is a severe natural disaster that results in numerous human and material casualties. Metro cities such as Tiruchirappalli and several towns were located in the semi-urbanized Koraiyar River basin in Tamil Nadu. Almost every decade, the basin is subjected to flooding. The objective of this work was to combine hydrological and hydraulic models with geospatial approaches to create a conceptual flood model in the Koraiyar River basin and to use HEC-RAS 5.0.7 to build a 2D model of the Koraiyar basin and to model flood scenarios for past, present, and future Land Use Land Cover (LULC) classes in the basin. To create floodplain and flood hazard maps for the Koraiyar basin in order to identify areas that are vulnerable to flooding. To create floodplain and flood hazard maps for the Koraiyar basin in order to identify regions in the basin that are at high risk of flooding and to propose appropriate flood mitigation measures. This investigation focused on the unmapped Koraiyar floodplains. At the spatial scale, flood hazard probabilities in the Koraiyar basin were calculated using a combination of GIS, remote sensing, hydrologic, and hydraulic modelling. The maximum flood flow was generated using the Hydrologic Engineering Centre Hydrologic Modelling System (HEC-HMS), the hydrologic model utilized in this investigation. For the 100-year return period of history to the expected future, the minimum flood depth was less than 1.2 m and the maximum was 4.7 m, according to the analysis. The simulated results showed that high hazard zones were detected in the middle of the basin in Tiruchirappalli city, with a maximum flood depth of 4.7 m and a flood danger area of 4.32 percent from 1986 to 2036.

S.S.Panhalkar et al. (2017), had evaluated the potential flood risk areas of Panchaganga river using GIS-based multicriteria decision analysis. RADARSAT SAR data from August 5, 2005 was used to model a flood scenario across the Panchaganga River (Kolhapur, Maharashtra). With the use of ERDAS envision software, the toposheets and digital satellite data collected from SOI for the research were geometrically rectified and georeferenced using the WGS 1984/UTM Zone 43 N projection system. Flood risk, according to the author, is mostly influenced by probability and effects. For sound urban and rural land planning and management, accurate flood inundation information is critical. It also provided the necessary baseline data for a full understanding of flood events.

Sadhan Malik et al. (2021) explained that the Dwarakeswar River, also known as Dhalkishore, is a prominent river in West Bengal's western region. Floods frequently damage the lower portions of the river that flows from West Bengal's western side. The goal of this research was to estimate and anticipate flood susceptibility in the context of climate change, which has become an alarming necessity for flood mitigation. The log-normal, Log-Pearson Type III (LPT-3), Gumbel's extreme value distribution (EV-I) and extreme value distribution-III (EV-III) models, as well as HEC RAS software, were used to evaluate historical and future flood frequency analysis and flood prone area mapping. The research concluded that statistically, Log-Pearson-Type-III was very helpful in dealing with FFA of the study area, whereas Weibull's method was very helpful for assessing the vulnerable areas.

Paulo Fernandez et al. (2015) used a geographic information system-based multicriteria decision analysis (GIS-MCDA) to study social vulnerability, which resulted in a better understanding and monitoring of social vulnerability over time, as well as the identification of 'hot spots' that require adaptation policies. According to the author, the paper's main research objectives were to present an approach to assessing social vulnerability to flood risk using GIS-MCDA that integrated multiple objectives and to integrate social vulnerability assessment findings to obtain scenarios and maps in support of risk mitigation and emergency management planning. The GIS-MCDA assisted in determining what was at danger and who was at risk, as well as where specific impact-reduction efforts should be adopted. The findings revealed the need of a city-scale strategy to urban flood risk management rather than a river basin size approach.

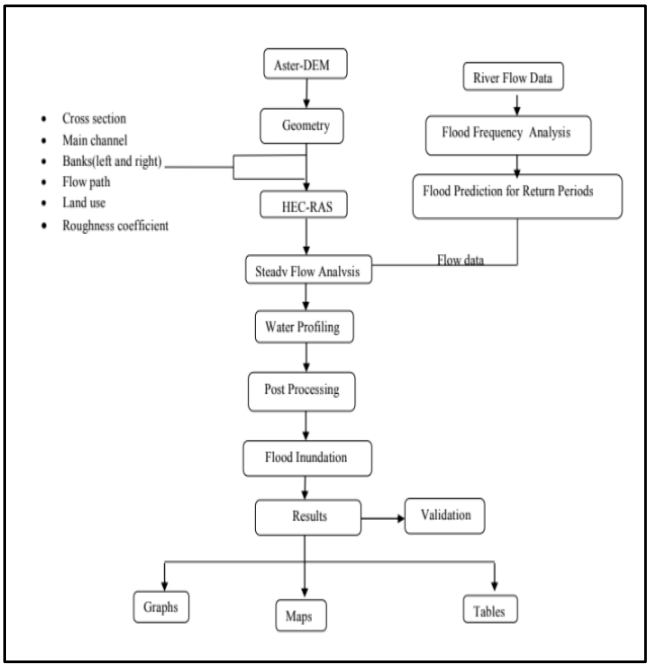

Fig-3: Flowchart showing the methodology for the Flood Submergence Study of the Shipra River Basin.

(Source: https://doi.org/10.37896/jxu15.10/035)

Parikshit Joshi et al. (2021) had evaluated flood mapping provides greater information to communities for improved flood risk management, and it could aid in damage mitigation by alerting relevant authorities. Floods in the Shipra River basin occurred on a regular basis. In this research, the submergence zone to be detected from flood occurrences was calculated using a GIS-based 1-D hydrodynamic model for various return durations. Fig - 3 shows a detailed methodology. According to the Steady Flow study performed in HEC-RAS, the results discussed the area under inundation in square kilometers with respect to the discharge in cubic meters.

2.2. Digital Elevation Model (DEM)

A DEM is a three-dimensional computer graphical representation of elevation data used to depict terrain on a planet, moon, or asteroids. The term "global DEM" refers to a discrete global grid. DEMs are the most common substrate for digitally produced relief maps and are widely used in GIS. A digital elevation model (DEM) is one of the most critical components of a flood inundation model. This section highlights and describes a few DEMs that are available for free download and use.

Brett F. Sanders (2007), analyzed that DEMs were utilized to parameterize a two-dimensional hydrodynamic flood simulation technique, and the results were compared to published flood maps and observed flood conditions. Because of the horizontal resolution, vertical precision (0.1 m), and capacity to identify bare-earth from man-made buildings and vegetation, DEMs based on airborne light detection and ranging (LiDAR) were favored. The goal of this research was to demonstrate the value of SRTM as a worldwide source of topography data for flood simulation. The sensitivity of flood model predictions to DEM type, resolution, and accuracy was investigated using DEMs to assign elevations to nodes of the computational grid. The preceding findings revealed significant utility in rather coarse online DEMs, one of which had worldwide coverage (3 s SRTM).

Muhammad Farooq et al. (2019), stated that flood hazard assessment is a non-structural technique for flood mitigation in addition to structural measures in the Swat valley in northern Pakistan, which is prone to regular floods and was badly damaged by the 2010 Flood. In this research, a 60-kilometer length of the River Swat (Khwazakhela Bridge–Chakdara Bridge) was modeled using the HEC-RAS 2D model and a high-resolution 12-m WorldDEM. Manning's 'n' values, flood stage at the Chakdara Bridge, and Flood2010-observed extent were used to calibrate and verify the model exclusively for historical maximum flood occurrences, notably Flood2010. The simulated maximum depths for the 12-m WorldDEM, 30-m SRTM, 30-m ALOS, and 30-m ASTER DEMs were 12,13, 14, and 25 meters, respectively. Simulated extents based on the 12-m WorldDEM were used to create flood hazard maps; land cover exposure to the simulated flood events revealed that agriculture, particularly orchards, was most likely to be damaged, with affected areas exceeding 55 sq km.

2.3 Softwares

In the various approaches tested, software such as Hydrological Engineering Centers River Analysis System (HEC-RAS), Hydraulic Modelling System (HEC-HMS), ArcGIS, Quantum Geographic Information System (QGIS), and others were employed. This section can be used for the research papers that have been studied.

Derdour Abdessamed et al. (2019), evaluated that the Ain Sefra (Algeria) watershed, which covers an area of 1957 km2 in Algeria's south-west, contains Ain Sefra city in its downstream half, where the Wadi Breidj and Tirkount meet. This confluence passes through totally urbanized regions and has been flooded multiple times, causing severe economic and human losses; these damages are the result of population growth and the encroachment of the city over this wadi's natural space. This research's methodological approach centered on hydrologic modelling using the HEC-HMS and hydraulic modelling with the HEC-RAS, which coupled the Watershed Modelling System model with the Geographic Information System. This research looked at how Ain Sefra city flooded during significant flood occurrences, both with and without concrete retaining walls built by local authorities. The research's findings revealed a protective proposal for assuring better flood passage in Ain Sefra, reducing danger and safeguarding the city from flooding.

M.R. Knebl, Z.-L. Yang et al. (2005), analyzed that the San Antonio River Basin in Central Texas, USA, was chosen as the research location because it is a region prone to severe flash flooding on a regular basis, and a big flood in the summer of 2002 was used to test the modelling framework. A rainfall–runoff model (HEC-HMS) translated surplus precipitation to overland flow and channel runoff, and a hydraulic model (HEC-RAS) approximated unsteady state flow across the river channel network based on the HEC-HMS produced hydrographs. The findings of this research will aid future modelling efforts by offering a tool for regional hydrological forecasts of floods. Despite being built for the San Antonio River Basin, the research claims that this regional scale model might be utilized as a prototype for model applications in other parts of the country.

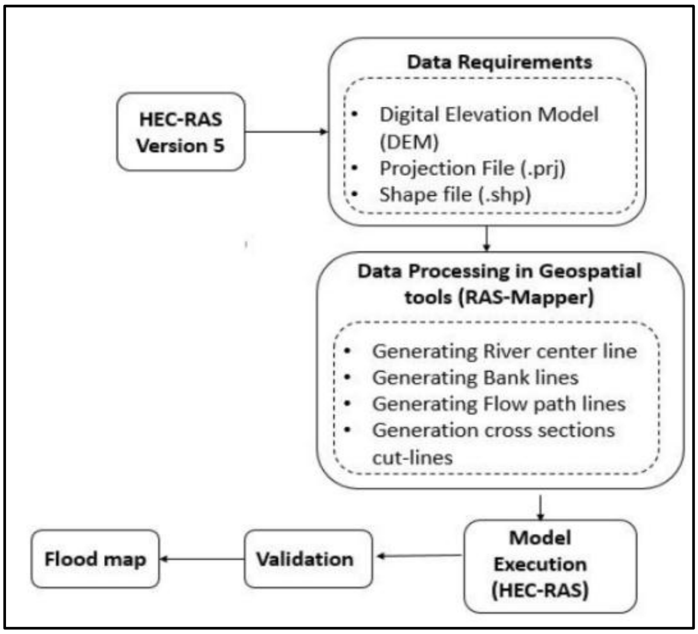

Fig-4: Methodology for the case study of the River Purna at Navsari.

(Source: https://doi.org/10.1007/s40808-020-00961-0)

Azazkhan I. Pathan et al. (2020), stated that decision-makers and disaster management authorities needed reliable data on flood depth, outflow, magnitude, and special datasets to mitigate and manage the impacts of such catastrophes. The goal of this research was to illustrate HEC-RAS v5's geographic analysis capabilities. River data such as bank lines, flow route lines, and cross-section cut lines were retrieved from the Cartosat-1 DEM for flood simulation (Digital Elevation Model). For the simulation of a 1D hydrodynamic model, steady flow analysis was used. The model produced a result in the form of water depth, which could be seen in the geospatial HEC-RAS mapper window. Figure 4 shows a brief methodology followed for this research. Flood depth maps for the floods of 2002 and 2004 were created, showing the low-lying sections of Navsari city. The results achieved in this research were in terms of water depths for the years 2002 and 2003, with discharges of 8836 m3/s and 5437 m3/s, respectively.

Surjit Singh Saini et al. (2016), stated that due to differences in land use and functional structure, floods in urban regions are more expensive and complex to manage than floods in rural areas. The city of Ambala in the state of Haryana has a lengthy history of severe flooding. On a watershed and city size, the current research tried to investigate natural and anthropogenic sources of flooding. Flood probability was calculated for a 2,5,10,and20 year return period using the Weibull plotting position formula, and the likely maximum discharge of 500, 1000, 1200, and 1500 m3 was used for flood extent prediction using Hydraulic Engineering Center-River Analysis System (HEC-RAS) software based on the Tangri River's past 21-year maximum discharge data. The spatial interpolation method was utilized to calculate flood depth using observed flood depth data. The model revealed flood inundation areas of 690, 1135, 1530, and 2300 hectares, respectively, with the anticipated impact on land use and population evaluated. Data from the most recent flood event, which occurred in July 2010, including remote sensing photography and a field survey, were used to validate the projected 5-year return flood extents. As a result, such outputs can be utilized by urban local bodies, town planners, and policymakers to support decision-making in risk-sensitive land use planning by incorporating climate change scenarios in order to limit the detrimental effects of floods in the urban environment.

K. Abdella et al. (2021), stated that flood is one of life-threatening events in different parts of Ethiopia. Floods can be caused by a variety of factors, including deforestation, agricultural expansion, urbanization, wetland drainage, climate change, river bed siltation, and a variety of other sorts of land use change. The goal of this research was to evaluate, examine, and develop appropriate river training works on the lower Kulfo river reach. Field investigation, including secondary data collecting, was conducted for the indicated 6 km reach in order to predict flood extent using a 1D hydrodynamic model, HEC RAS, and HEC GeoRAS. Flood depth and extent estimates aided in determining the dimensions of various river training structures. The maximum channel bed flood depth was 4.3 meters, while the flood plain flood depth was 2.3 meters, according to the modelling results.

Noor Suraya Romali et al. (2017), simulated a risk-based flood mitigation method that has received greater attention than the traditional flood control technique in terms of lowering flood impacts. The application of the HEC-RAS model to the construction of floodplain maps for an urban region in Malaysia is reported in this research. The Generalized Pareto is shown to be the optimal distribution for the Segamat River using the Kolmogorov-Smirnov (KS) test. The HEC-RAS model results were utilized in ArcGIS to create floodplain maps for various return times.

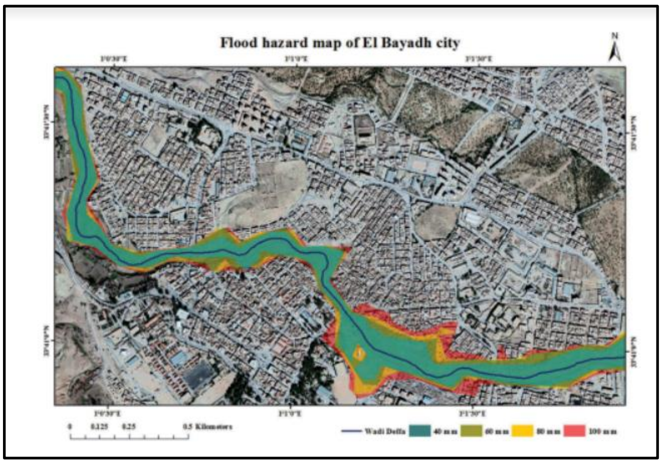

Fig-5: Flood hazard map for different amounts of rainfall in El Bayadh city.

(Source: https://doi.org/10.1080/1573062X.2020.1714671)

Mohammed Amin Hafnaoui et al. (2020), stated that the rising frequency of flash floods in Algeria's dry and semi-arid regions prompted a quest for practical and realistic remedies, with the use of mapping to demarcate floodplain zones being one of the options. On October 1, 2011, a major flood hit El Bayadh, causing massive damage to people and property. The objective of this research was to create a flood danger map for El Bayadh based on rainfall quantities. A flood danger map was created using four flooded locations and four precipitation values of 40 m, 60 m, 80 m, and 100 m. For the hydrological study required for this project, software such as ArcGIS and HEC-RAS were utilized. Figure 5 shows the flood hazard map for different amounts of rainfall in El Bayadh city. When combined with meteorological alerts supplied by the National Office of Meteorology, the flood hazard map generated thus far has shown to be beneficial.

Astite, S.W. et al. (2015), had evaluated the control of flood risk by the application of mapping of flood threats caused by overflowing rivers Modern simulation technologies, such as the hydraulic model (HEC-RAS) and the Geographic Information System, were used to create this map (ArcGIS). The research concentrated on the area around Oued El Harrach (Northern Algeria), which had seen several floods that had caused significant human and material damage. The research's cartography was a crucial tool for flood risk prevention, protection, and management decision-makers.

Surendar Natarajan et al. (2020), simulated that an unusual rise in rainfall volume, substantial man-made changes in land-use–land-cover patterns, and the resultant negative hydrological impacts were the main drivers of urban floods. The current study looked at the causes of urban floods before evaluating flood modelling approaches that may be applied successfully in urban catchments. The research need was found after discussing flood modelling methodologies used worldwide and nationally in big and medium-sized cities. The current study looked at all parts of a unique integrated flood modelling technique that might be applied for a medium-sized ungauged urban catchment region with a dendritic structure.

Neeraj Kumar et al. (2017), stated that floods have always been a natural calamity, and it is extremely difficult to prevent flood damage and take the necessary precautions without any advance warning. The goal of this work was to predict the water surface elevation (WSE) of the Yamuna River in Allahabad, Uttar Pradesh, India, using one of the most recent global flood monitoring tools (GFMS), which offers near real-time flow values for numerous streams across the world. Three stations were chosen for model calibration in this work; these stations are being used by various government agencies in India for river stage monitoring, as well as HEC-RAS and Global flood monitoring system (GFMS) modelling for 1D water surface elevation. The HEC-RAS model-based research utilizing Gumbel's distribution technique revealed that any structure design along the river Yamuna for the next 100 years should be at least 90 meters above sea level, based on current discharge data from 2001 to 2014.

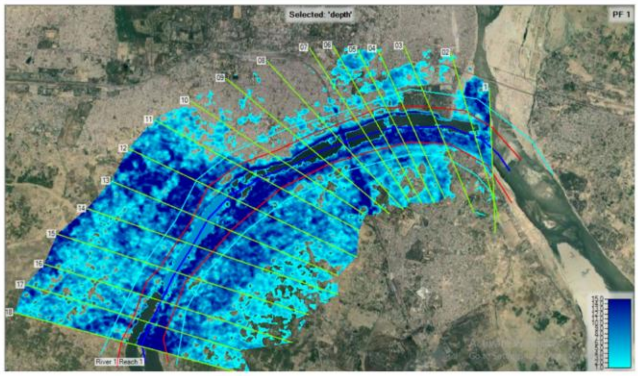

Fig. 5 Flood extent map of study area using HEC-RAS dated (26th August 2013)

Fig-6: Flood extent map of the study area created using HEC-RAS 2D (26 August 2013).

(Source: https://doi.org/10.1007/s40808-019-00687-8)

Neeraj Kumar et al. (2019), explained that Remote Sensing and GIS tools like world flood watching system (GFMS) and HEC-RAS model give the thought to research the flood analysis and their potential. The aim of this research was to model the water surface elevation (WSE) of stream Yamuna by victimization of one of the most recent world flood watching tools (GFMS) that has near real time discharge worth of various streams of the world. HEC-RAS second modelling was dispensed to figure out flood events or WSE/ HFL (High Flood Level) of the year 1978 and 2001–2014 and WSE level for coming 100, five hundred and one thousand years was calculable by Gumbel's distribution technique. Figure 6 denotes the area under inundation in the study area during the flood that occurred on 26 August 2013. The research's findings were conferred in four sections, with the sculptured and determined knowledge agreeing closely, showing that the HEC-RAS and GFSM data/tools were successfully used.

ANGELIKI MENTZAFOU et al. (2016) explained that the flood hazard map of the Evros transboundary watershed was created using a grid-based GIS modelling method that aggregated the main factors related to the development of floods: topography, land use, geology, slope, flow accumulation, and rainfall intensity, in order to meet the European Directive 2007/60/EC requirements for the development of flood risk management plans. The goal was to see how vulnerable each land use was to flooding. The method was validated by comparing the danger map produced with inundation maps derived through supervised classification of Landsat 5 and 7 satellite imageries of four flood occurrences that occurred near the Evros delta, a globally significant wetland. The model functioned satisfactorily when the output (high and very high flood hazard zones) was compared to the size of the inundated areas as mapped from satellite data. The findings confirmed the existence of a substantial association between land uses and flood hazard, suggesting the lowlands' and agricultural area's flood vulnerability. To comply with the Flood Directive's criteria for effective and coordinated flood risk reduction methods, a dynamic transboundary flood hazard management strategy should be prepared.

Jan Klimesˇ et al. (2013), explained that A glacial lake outburst flood (GLOF) along the Chucchun River in Peru's Cordillera Blanca was precipitated by an ice/rock fall into Lake 513 in April 2010. Using a 1D flood model created using HEC-RAS; this article reproduced the hydrological parameters of this event. The main model inputs came from detailed field examinations of surface features and topography within the river and over the adjacent floodplain; a total of 120 cross-sections were surveyed. Further geomorphological observations and eyewitness testimony helped to refine these inputs even more. Flood modelling allowed for the definition of the area of the water surface and its elevation at each cross-section in addition to determining the peak discharge (580 m3 s 1). These modelling results were in good accord with other flood-related facts, such as: flooded area; and the travel time from Lake 513 to the confluence with the Santa River.

3. OTHER VITAL RELAVANT LITERATURE PAPER REVIEWS IN REMOTE SENSING AND GIS DOMAIN

Shweta Panaskar et al. (2022), confirmed the Gravity Recovery and Climate Experiment (GRACE) Terrestrial Water Storage Dataset using Terra MODIS NDVI Anomaly. **Sahil Waqar Khan et al. (2022),** worked on a real-time project on risk assessment and problems in the decaying building's repairs and rehabilitation. **Mit J Kotecha et al. (2022),** used geospatial techniques to investigate the Urban Heat Island Effect in Rajkot City. **Vishal Ambad et al. (2021),** studied the impact of controlled permeable formwork liner against chloride penetration on concrete structures. The relevance of daylighting was recognised by **Amit Kumar Sharma et al. (2021),** who constructed a solar concentrator with optical fibre. **Rajnish Singh et al. (2021),** investigated several labour productivity factors in aluminium formwork systems. **M. P. Suryawanshi et al. (2021)**, focused on calculating the optimal cost for airport ground improvements in Navi Mumbai. **Pranav Andhyal et al. (2021),** explained the applicability of 5D CAD in routine construction for various billing using GIS through a case study. **Sonali Kadu et al. (2021),**developed an arithmetic approach for ranking factors that influence major infrastructure projects' timelines utilising the Relative Importance Index Method (RII) and the Important Index Method (IIM) (IMPI). Automatic Urban Road Extraction from High-Resolution Satellite Data Using Object-Based Image Analysis: **Divyashree Yadav et al. (2020),** employed a Fuzzy Classification Approach for the same. **Chirag Dhoble et al. (2020),** studied "Pressure-based Air Purification Lamp for Multifunctional Purpose,". **Dhondabai S Narayankar et al. (2020),** studied soil Erosion Modelling Using RUSLE and GIS of Dehrang Dam Watershed, Panvel, District Raigad, Maharashtra. **Shrenik Shah et al. (2020),** conducted research on the evaluation of urban utilities in Mumbai using 3D modelling techniques. **Tanvi Nijampurkar et al. (2020),** used RS and GIS to analyse sedimentation deposition in the Morbe Reservoir. Using the Swat Model and GIS, **Akshata Mestry et al. (2020),** conducted an in-depth study on the calculation of Water Balance components of Watersheds in the Manjira River Basin. **Panaskar S et al. (2019**), studied the Changes in LULC of Western Ghat by Comparing NDVI and NDWI. **Arya Vijayan et al. (2019),** studied about a real-time water leakage monitoring system based on IoT. **Vivek Kumar et al. (2019),** used GIS and SWAT to determine the Lower Godavari River Basin's Water Budget. **Priyanka S.Bhatkar et al. (2019**), researched about a Case Study on the Impact of Tar-Ball Pollution on the Alibaug Beaches (Maharashtra). **Biradar Shilpa et al. (2019),** made a research about E-Waste: An Alternative to Partial Replacement of Coarse Aggregate in Concrete was researched by The project of **Chowdary Mohanlal et al. (2019)**, is about using the 4D GIS Model in construction management. **Chhaya Zende et al. (2019),** tested a technique of producing Techniques of Sustainable Recyclable Formwork By A Smart Material Waste Composite Material (WCM) for Infrastructural Projects of Future Cities - A Swachh Bharat Abhiyan Initiative for Infrastructural Projects of Future Cities. **Mahesh S. Singh et al. (2019),** discussed and examined factors affecting brickwork labour productivity using the RII technique. **Reshma Kamble, et al. (2019),** carried out a Water Distribution Network Analysis for A Sawale Village Near Rasayani With the Application of Epanet Software - A GIS Approach. **Sanika Kandalekar et al. (2019),** investigated a Pervious Concrete Pavement: A Case Study of Karanjade Node, Panvel. **Pallavi Patil et al. (2019),** investigated resource management in infrastructure projects for future cities using the Re Modified Minimum Moment approach. **Shobana Jadhav et al. (2019),** conducted research on the best Feasible Transportation Route Analysis for Delivering Ready Mixed Concrete (RMC) - A Geographic Information System (GIS) Approach for delivering RMC. **Aditya Shatri et al (2019),** in their project, Integrated Land-Use Zoning, Using Topographical Data: Optimizing Vacant Space For Urbanization At Akole Taluka, Maharashtra, India, is about integrated land-use zoning. **Mihir Patilhande et al. (2017),** conducted a practical study project titled

"Rehabilitation and Cost-Effective House for Sustainable Rural Development: A Case Study of Landslide-Affected Dasgaon Village in Maharashtra.". **Sunilkumar Patel et al. (2017**), used Geographic Information System to highlight the importance of a long-term Smart Blue Roof Network System (GIS). **Karthik Nagarajan et al. (2016),** examined clever Modal Analysis of Multistory Buildings Considering the Effect of Infill Walls in great detail.

4. CONCLUSIONS

Floodplain mapping techniques have been used by many researchers for inundation mapping of floods that have occurred globally to date. Using non-spatial data such as rainfall and outflow as input, popular tools such as HEC-RAS, ArcGIS, HEC-HMS, and others have been utilized to construct precise flood inundation models of the floods. Digital elevation models (DEMs) from various sites such as SRTM, WorldDEM, and others were used to create the basic maps for the inundation models. Gumbel's Method, Multi-Criteria Decision Analysis, Kolmogorov-Smirnov (KS) test, Log-Pearson Method, and other approaches were used to calculate flood frequency in various research. A flood frequency analysis of roughly 100 years and more can be statistically calculated using these approaches. This article will help users by providing a quick reference to prior floodplain mapping studies. To summarize, it can be concluded that floodplain mapping may be studied using software by downloading DEM data, and flood frequency can be analyzed using a range of flood frequency analysis approaches after collecting, reading, and summarizing the papers for this study. Future floodplain mapping research will benefit greatly from this information.

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