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FLOOD ASSESSMENT OF WESTERN MAHARASHTRA REGION

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Abstract - *Flooding is a recurring natural hazard that poses significant risks to human lives, infrastructure, and the environment. Western Maharashtra, a region in India, has witnessed a history of devastating floods, leading to substantial socioeconomic losses. This study aims to provide a comprehensive flood assessment of the Western Maharashtra region, incorporating various factors such as rainfall patterns, hydrological characteristics, land use changes, and existing flood mitigation measures. The research employs a multi-disciplinary approach, integrating remote sensing and GIS techniques with hydrological modelling and statistical analysis. Historical rainfall data from meteorological stations and satellite-derived precipitation estimates are analysed to identify temporal and spatial patterns of extreme precipitation events. Hydrological characteristics, including river networks, catchment areas and flow rates are analysed using digital elevation models and hydrological modelling tools.*

Key Words: *flood assessment, Western Maharashtra, rainfall patterns, hydrological characteristics, land use changes, flood mitigation, remote sensing, GIS, hydrological modelling, risk management.*

1.INTRODUCTION

Floods occur when water overflows onto typically dry land, posing significant risks to agriculture, civil infrastructure, and public health. Human alterations to the environment, such as deforestation and changes in watercourses, often exacerbate flooding, along with larger issues like climate change and rising sea levels. Climate change intensifies rainfall and extreme weather events, heightening flood risks globally. Floods can cause widespread devastation, resulting in loss of life, property damage, and disruptions to critical infrastructure. Vulnerable populations living in floodplains or poorly constructed buildings without warning systems are particularly at risk. Floods historically leave long-term traumatic impacts on affected individuals. Climate change has increased the frequency and severity of floods worldwide. Western Maharashtra, known for its rich cultural heritage and varied terrain, faces flooding during the monsoon season due to heavy rainfall and low-lying areas. Flooding in this region can damage infrastructure, crops, and livelihoods, and in extreme cases, lead to loss of life.

1.1 Flood

A flood is a natural event where typically dry land suddenly becomes submerged. Some floods occur rapidly and recede quickly, while others build up over days or months before dissipating. Floodwaters in populated areas can carry away houses, bridges, vehicles, furniture, and even people, causing significant damage to farms, trees, and heavy objects.

General reasons for flooding are varied and include both human-induced and natural causes. Poorly designed infrastructure is a common human factor contributing to flooding, while natural reasons such as heavy rainfall also play a significant role.

Fig –Flood at Kolhapur.

Analysis of rainfall records in dam catchments, particularly in Sangli, Kolhapur, and Satara districts within the Upper and Middle Krishna sub-basin, reveals significant deviations from normal precipitation levels during heavy floods. Observed rainfall in these catchments can be as much as 5 to 19 times higher than normal, with an average actual rainfall approximately six times higher than normal. This abnormal rainfall pattern contributes to severe flooding in these regions.

The average actual rainfall in these catchments was approximately six times higher than the normal rainfall, leading to abnormal flooding downstream.

flood to downstream areas. X - Axis Y -Axis 2015 979.9 2016 1667.7 2017 1727.1 2018 1834.9 2019 3235.2 2020 2500 2021.

Analysis of rainfall records in the free catchments of Sangli, Kolhapur, and Satara districts revealed significant deviations from normal precipitation levels. During the peak 18-day period, rainfall was about 1.6 times higher than the previous 56 days. Actual rainfall during this event ranged from 13 to 29 times the normal amount, with an overall observed rainfall approximately 18 times higher than normal. This abnormal rainfall exacerbated floods in Sangli and Kolhapur districts. Regarding runoff, about 6630 Mm3 (234 TMC) yield was generated in all dams upstream of the state border. Of this, 2949 Mm3 (104 TMC) could be absorbed in dams, while the remaining 6381 Mm3 (130 TMC) had to be released downstream, generating 5663 Mm3 (200 TMC) runoff. Out of the total yield of 12,293 Mm3 (434 TMC) generated at the state border, only 2949 Mm3 (104 TMC) could be effectively mitigated. This led to a serious flood situation in the Krishna Valley in Maharashtra and further into Karnataka.

During the heavy rain spell in August 2019, many stations in Kolhapur district and the western part of Satara district exceeded their previous record of 7 days rainfall.

Table -1 Reach wise cross sections modeled

River	Reach	Length in (KM)	Surveyed cross sections	Interpolated cross sections	Total Cross sections	Year of survey
Krishna	Karad Bride to yerla Confluence at Bhramanai	95	48	44	92	2012
Krishna	Bramanal - warna - confluence at Haripur	12.6	18	8	26	2012
Krishna	Haripur-Rajapur	48	19	27	46	2012
Krishna	Rajapur To Almatti	211	31	189	220	2008
Yerala	Bramhanal	32.9	7	63	70	2012
Warna	National Haighw-ay Confluence at Haripur	58.5	20	36	56	2012
Pancha ganga	Kolhapur Confluence at Kurandwad	93.7	34	101	135	2012

This highlights the following issues contributing to flooding:

1. Inadequate land drainage systems in urban areas:

a) Poorly planned primary drainage systems result in stagnant floods throughout the city instead of efficient disposal.

b) Secondary drainage systems must maintain clear pathways for storm water to drain into natural watercourses, preventing blockages and facilitating quick drainage.

c) Tertiary drainage systems should effectively channel floodwater from tributaries and watercourses into main river channels. However, encroachments in river courses exacerbate flooding due to backwater effects and poor drainage.

2. Lack of flood absorption capabilities in reservoir planning:

a) Reservoirs are often not designed to absorb excess floodwater, with dead storage intended for silt accumulation and live storage fully utilized.

b) Reservoir operation schedules prioritize full storage by the end of the monsoon, without consideration for flood mitigation.

c) Ungated spillways and dams lacking manual control further exacerbate flooding.

3. Other contributing factors:

Debris accumulation on weirs, bridge piers, and parapets obstructs flow, temporarily raising flood levels. Regular maintenance of these structures is essential to prevent blockages.

2. OBJECTIVES

1) To study the different reason for flood situation.

2) To find reasons for the western Maharashtra flood.

3) To find a possible solution in avoidance of flood situation in western Maharashtra.

4) To study land topography using GIS technique.

3. METHODOLOGY

Analyse topography of western Maharashtra using various maps on GIS.To carry out various operations on the Toposheet mosaic image and insert various information so that the final project is well equipped with all the necessary data like elevation, contours, GIS Layering, etc.

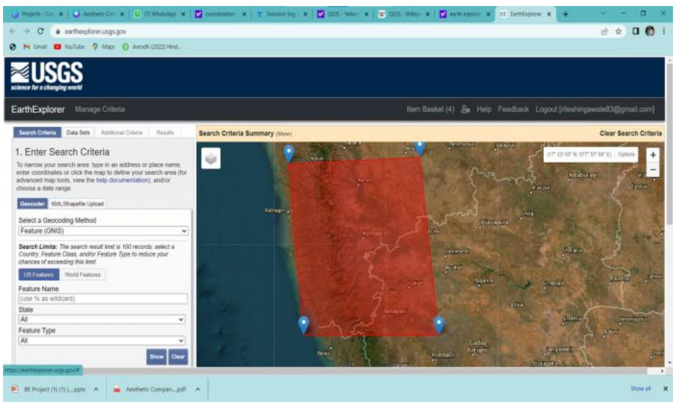
Examine climatic condition of western Maharashtra for past years. Maharashtra experiences a tropical wet and dry climate with hot, rainy, and cold weather seasons. Some areas more in land experience a hot semi arid climate, due to a rain shadow effect caused by the Western Ghats.

Study of Past flood Conditions In Western Maharashtra and their causes after severe drought in 1972 Krishna Basin has brought vast area under irrigation. Before 1972 age-old Krishna Canal was only available source for irrigation to the left side of Krishna River. It starts from Karad to Tasgaon in Sangli district. The Canal was drawn from Khodsi weir and constructed during the British regime. After 1972 Maharashtra government has introduced several major lift irrigation schemes in Satara, Sangli and Kolhapur districts. Similarly thousands of co-operative lift irrigation societies have also made available irrigation facilities at every village on both the sides of these rivers. These lift irrigation schemes have provided water to the area some 10 to 50 km away from the concerned river. At present more than 70% agricultural area on both sides of the river is permanently irrigated.Evaluate the problems faced by citizens after flood in the past by various case study.

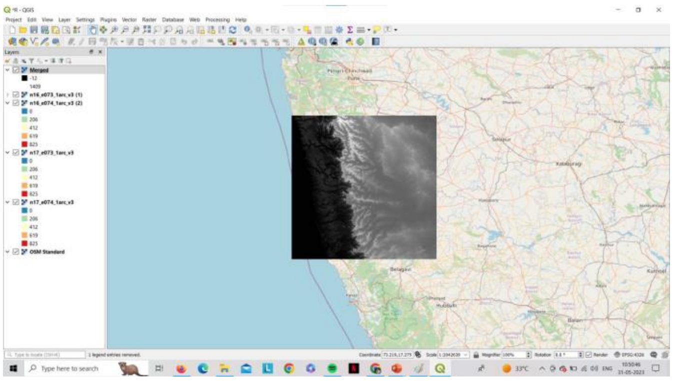
The relationship between flood risk awareness, worry and preparedness can affect the flood risk perception of society. Past experiences of floods influence the community perceptions of flood risks. Residents' low risk awareness and preparedness may hinder an effective response in case of flooding. Age, education, and monthly income levels differences affect flood risk perceptions. Respondents who live near rivers and other natural water resources have a higher flood risk perception.

3.1 Steps involved in creating Digital Elevation Model (2D):

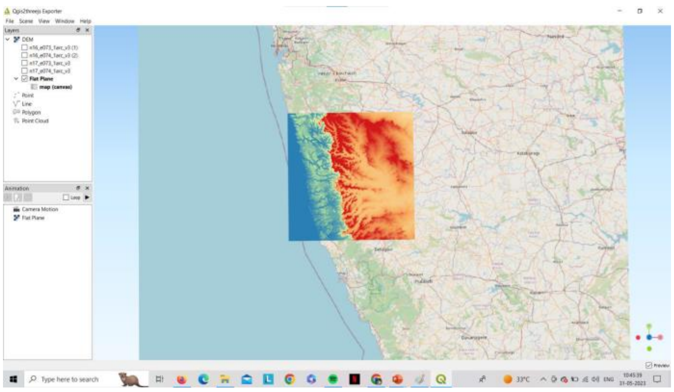
Step 1: Collecting Raw data from various sources.



Step 2: Import on QGIS, merge all tiles and add layers.

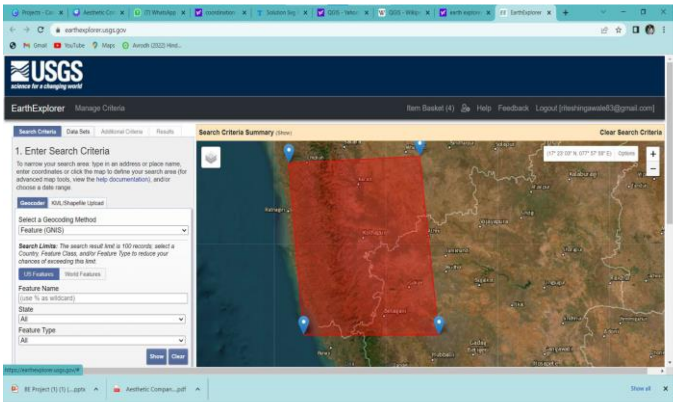


Step 3: Final digital elevation model of western Maharashtra region.

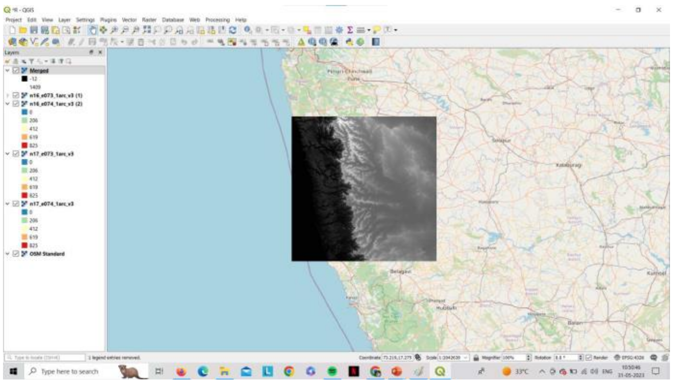


3.2 Steps involved in creating Digital Terrain Model (3D):

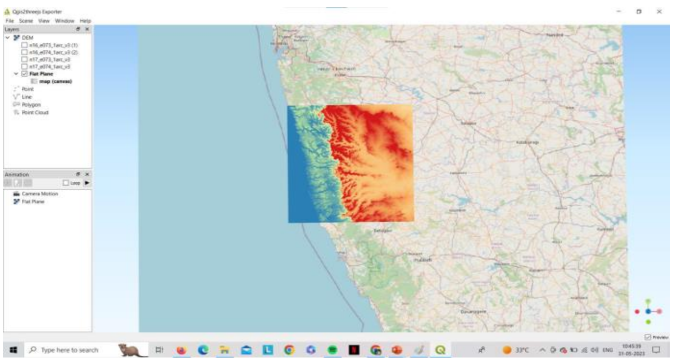
Step 1: Collecting Raw data from various sources.



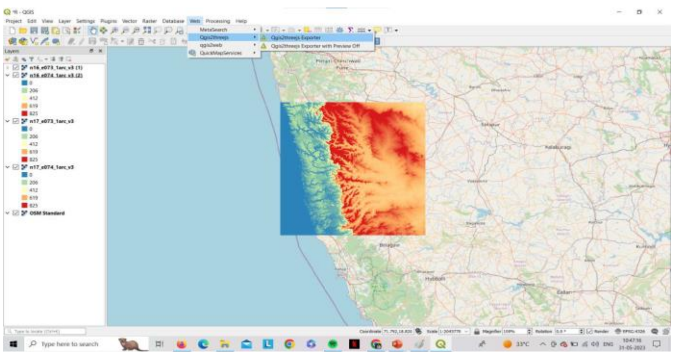
Step 2: Import on QGIS, merge all tiles and add layers.



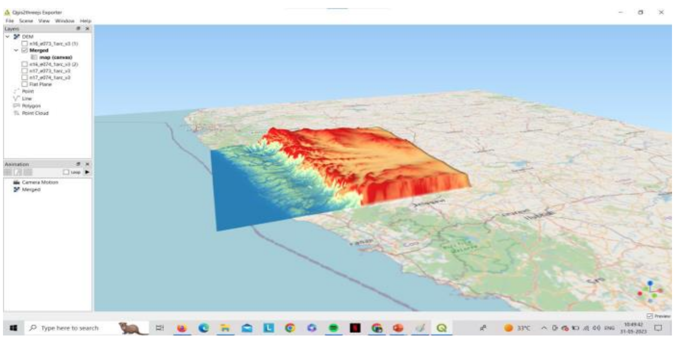
Step 3: Final Digital Elevation Model of Western Maharashtra Region.



Step 4: Add plug in Qgis2 three is and open it from web option



Step 5: Digital Terrain Model of Western Maharashtra Region



4. RESULT AND DISCUSSION

Geographical Information System A geographic information system (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). This provides a foundation for mapping and analysis that is used in science and almost every industry. GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision making. - Geographical Information System GIS Mapping Building Information Modelling (BIM), is again a very dynamic technology that gives a real-time view of the project development during its complete lifecycle right from its inception to its completion and subsequently during facility management. You conceive a plan, plot it on AutoCAD, export it to over Revit, develop a 3-dimensional facility from the imported AutoCAD plan, assign material with requisite properties to structural and non-structural members, while, at the same time keeping a record of their quantities which automatically done by Revit by feeding it with necessary settings. The tool is amazing, now using Navis Works Manage, you can perform simulation as per the work schedule prepared on primavera to come across any clash detection while the construction is being done virtually on screen. This encapsulates in brief about what BIM is all about. It is quite understandable, from above that both GIS and BIM are not merely a software, but a technology that is being enhanced by a multitude of software in combination with each via interoperability. Thus, if both GIS and BIM are synced and utilized for execution of any project, imagine the benefits, humungous benefits can be accrued. This combination of GIS and BIM has been referred to as GEOBIM.

Solutions and Flood Mitigation Measures After the detailed study and analysis by various experts, the various reasons responsible for this worst flood situation in the region were enumerated. All the natural and man-made issues have been considered. Those have been listed according to their most severity affecting for the cause. All these issues and findings have been discussed and formulated in the previous chapters in detail. Based on this, the Flood Mitigation Measures to be suggested were discussed. The measures suggested are sub-listed as short term (urgent) and long-term measures for every aspect. These are discussed below. The various aspects considered to suggest the important measures are

Advanced flood monitoring systems flood forecasting restoration of natural land drainage systems encroachments in natural waterways flood absorption measures disaster management units advanced flood monitoring systems.

5. CONCLUSIONS

In conclusion, the flood assessment in Western Maharashtra reveals the significant impact and challenges posed by flooding in the region. The analysis of the available data and information allows us to draw several key conclusions:

1.Frequency and intensity: Western Maharashtra experiences frequent and intense flooding events, especially during the monsoon season. These floods are often triggered by heavy rainfall and inadequate infrastructure to manage the excess water.

2.Vulnerable areas: The flood assessment has identified specific regions within Western Maharashtra that are more vulnerable to flooding. These areas include low-lying regions near rivers, densely populated urban areas, and poorly designed drainage systems.

3.Infrastructure shortcomings: The assessment highlights the inadequacy of existing infrastructure to effectively mitigate and manage floods. Insufficient drainage systems, outdated flood control measures, and encroachment on natural waterways exacerbate the impact of flooding.

4. Environmental impact: Flooding in Western Maharashtra has severe environmental consequences. It leads to soil erosion, contamination of water sources, destruction of natural habitats, and damage to agricultural lands. The long-term effects on biodiversity and ecosystem health are a cause for concern.

5. Socio-economic impact: Flooding disrupts the lives of local communities, causing displacement, loss of livelihoods, and damage to homes and infrastructure. The economic impact is substantial, with damage to agriculture, industries, and infrastructure leading to a significant setback in the region's development.

6. Need for proactive measures: The flood assessment emphasizes the urgent need for proactive measures to mitigate the impact of flooding in Western Maharashtra. These measures should include improved infrastructure planning, construction of effective drainage systems, early warning systems, and sustainable land management practices.

7. Collaboration and preparedness: Given the complexity of flood management, a collaborative approach involving government agencies, local communities, and experts is crucial. It is essential to enhance preparedness through capacity building, community awareness programs, and the implementation of effective disaster response plans.

8. Climate change adaptation: Climate change is likely to exacerbate the frequency and intensity of flooding in the future. Therefore, the flood assessment underscores the importance of integrating climate change adaptation strategies into flood management plans, including resilient infrastructure and nature-based solutions.

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