ENVIRONMENTAL QUALITY ANALYSIS OF GROUND WATER USING GIS IN MAHARASHTRA

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ABSTRACT

This phase of the project focuses on leveraging ArcGIS software for the comprehensive analysis of the Krishna River basin in Maharashtra, India, with a primary objective of developing effective flood control measures. The study employs a multidimensional approach that involves the collection and analysis of topographical data, historical flood records, and digital elevation models (DEMs). The first objective is to systematically collect and analyze topographical data of the Krishna River basin using ArcGIS. By examining past flood events and understanding the basin's elevation variations, potential flood-prone zones are delineated. This phase sets the foundation for targeted interventions to mitigate the impact of floods in the region. The third objective involves the development of flood inundation maps using ArcGIS. These maps serve as a critical tool for visualizing the extent of flood-prone areas, enabling a comprehensive assessment of the potential impact of flooding. This visual representation is instrumental in making informed decisions about flood control strategies. With a clear understanding of the flood- prone areas, the fourth objective is to propose suitable flood control measures. Recommendations will be based on the analysis conducted using ArcGIS, taking into consideration the unique characteristics of the Krishna River basin. Proposed measures aim to minimize the impact of flooding and enhance the region's resilience against future flood events. The final objective is to evaluate the effectiveness of the proposed flood control measures using ArcGIS. Through simulation and modeling, the project aims to assess the anticipated impact of the recommended interventions on reducing flood vulnerability in the Krishna River basin. This phase of the project sets the groundwork for subsequent analyses and interventions, laying the foundation for a comprehensive approach to flood control in the Krishna River basin. The integration of GIS technology ensures a robust and data-driven methodology, facilitating informed decision-making for sustainable environmental management.

Keywords - Environmental quality, Groundwater, GIS (Geographic Information System), Maharashtra,

1. INTRODUCTION

1.1 Background of the Study

The Krishna River is one of the major River s in India and flows through the states of Maharashtra, Karnataka, Telangana, and Andhra Pradesh before emptying into the Bay of Bengal. The River Bank is home to millions of people who depend on it for their livelihoods, and it is also a vital source of water for agriculture, industries, and hydropower generation. However, the Krishna River is prone to floods, especially during the monsoon season, which can cause extensive damage to property and infrastructure, displacement of people, and loss of lives. The floods in 2005 and 2009 in the Krishna Bank were particularly devastating, causing severe damage to crops and infrastructure, and resulting in the loss of hundreds of lives. In response to the recurring floods, the Indian government and the state governments of Maharashtra, Karnataka, Telangana, and Andhra Pradesh have implemented various flood control measures to mitigate the impact of floods in the Krishna Bank.
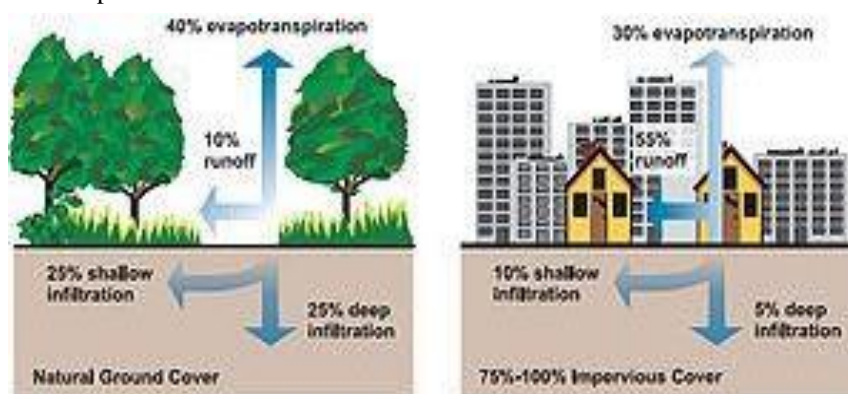

Fig.1 Flood Control

The society and the economy of any country suffer in many ways after a flood with the loss of lives, vegetation, properties and infrastructure, which means there will be fewer people on the labor force, less agriculture available for locals and for exporting and less businesses to contribute to the country's economy development. There will be mass displacement of people, many of whom may be left homeless and jobless. In order to fill this gap, the government will have to spend at a higher level. The country may have to look for international assistance to supply food and materials to clean and rebuild its infrastructure. While some countries will support voluntarily, other will charge for their efforts, putting the assisted country in debt and at an economic loss.

This study is of great importance, because flooding damages properties and endangers humans and all other living things' lives. This study is justified because floods are among the most frequent natural disasters that cause greater economic losses and difficulties to human activities. About 90% of the damages caused by natural disasters (excluding droughts) are caused by floods and associated water flows. The floods are responsible for the death of almost twice the amount of people as tornadoes and hurricanes put together. The water-related disasters account for 90% of all disasters in numbers of people affected. Social and economic costs of floods have risen in recent decades and the trend is to continue to rise if an action is not taken. By 2017, natural disasters related to water caused worldwide losses of US$ 306 billion. Between 1980 and 2016, 90% of natural disasters were climate-related. In 2016, 31% of global losses were due to storms, 32% attributed to flooding and 10% to extreme temperatures. In addition, this study is justified as there is the prospect that climate change may contribute to increase flooding resulting from rising sea levels and heavy rains in certain regions of the planet.

The Krishna River is one of the major River Banks in India and is prone to frequent floods, causing extensive damage to property, infrastructure, and loss of human lives. The River Bank covers parts of Maharashtra, Karnataka, and Andhra Pradesh, and is home to a large population. Floods in the Krishna River are mainly caused by heavy rainfall, inadequate drainage systems, and encroachment of floodplains.
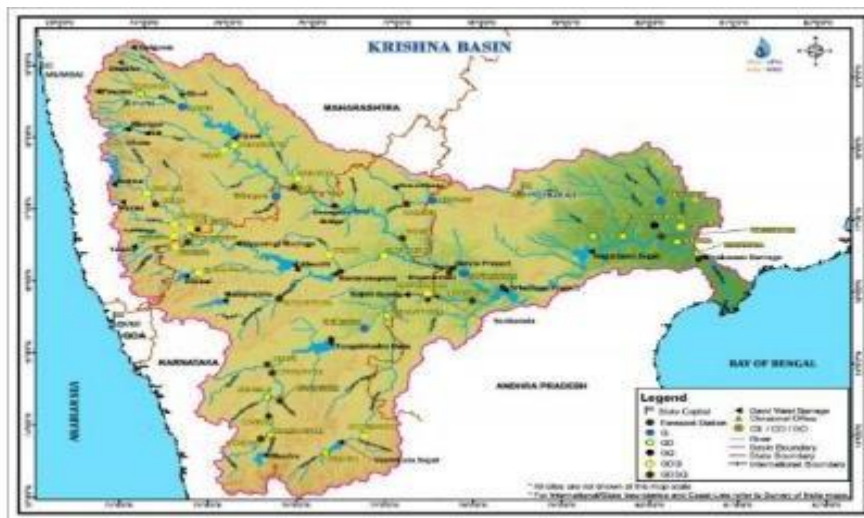

Fig. 2 Krishna River Map

To mitigate the impact of floods in the Krishna River, Kasbe Digraj Bank, various flood control measures have been implemented over the years. However, the effectiveness of these measures is still a matter of debate, and there is a need for continuous monitoring and evaluation of their impact. The problem statement, therefore, is to identify the most effective flood control measures for the Krishna River and to develop a comprehensive strategy for their implementation.

The scope of a study on flood control measures for the Krishna River would typically include a comprehensive assessment of the various factors that contribute to flooding in the region, as well as an evaluation of the potential solutions and strategies that could be implemented to mitigate the impact of floods. The study would likely begin with an analysis of the physical characteristics of the Krishna River, Kasbe Digraj Bank, including its topography, geology, hydrology, and climate patterns, as well as the historical flood records and data that are available for the area. This information would help to identify the primary causes and sources of flooding in the region, such as heavy rainfall, River in flooding, flash floods, and other natural hazards. The study would also assess the existing flood control infrastructure and systems in the region, including dams, levees, channels, and other structures that are designed to manage and regulate the flow of water in the Bank. This would involve an evaluation of the effectiveness of these systems in mitigating flood risks and protecting local communities and infrastructure. The scope of a study on flood

control measures for the Krishna River would be quite broad, encompassing a range of technical, environmental, and social factors that are critical to understanding and addressing flood risks in the region. The goal of such a study would be to develop a comprehensive flood management plan that can help to protect local communities and infrastructure, minimize the impact of future floods, and promote sustainable development and resilience in the Bank. The objective of the study is to collect and analyze topographical data of the Krishna River using ArcGIS.

2. LITERATURE REVIEW

2.1 General

A review of the literature revealed to this topic by various authors in researchpapers, text books etc. summarized here which are unique and are based on research.So it is essential to study the past work done on similar fields which would help further work to be different and specific.

B Jagadeesh et.al (2021) Conducted research on "Flood Plain Modelling of Krishna Lower Bank Using ARCGIS, HEC- GEORAS and HEC-RAS"

A flood is an overflow of water that submerges land which is usually dry. Floods can also occur in River s when the flow rate exceeds the capacity of the River channel, particularly at bends or meanders in the waterway. This results in causing damage to human and property if they are in the natural flood plains of River s or settled on the banks of River s. To facilitate the appropriate measures for effective flood mitigation in advance, there is a need to model the flood plain which facilitates to locate the flood plain and its extent for effective flood mitigation measures.

By understanding the extent of flooding and floodwater inundation, decision makers are able to make choices about how to best allocate resources to prepare for emergencies and to generally improve the quality of life. This research presents a straightforward approach for processing output of the HEC-RAS hydraulic model, to enable two and three dimensional floodplain mapping and analysis in the ArcView geographic information system. The methodology is applied to a stretch of River Krishna from downstream of Nagarjuna Sagar project to Kummaripalem which is located on upstream of Prakasam Barrage. The flood plain maps are developed for the flows corresponding to 2, 10, 25, 50 and 100 year return periods. The resulting surface model provides a good representation of the general landscape and contains additional detail within the stream channel. Overall, the results of the research indicate that GIS is an effective environment for floodplain mapping and analysis.

Akshata R. Kotahale (2021) Conducted research on "Critical Analysis of Krishna Sub-Bank Flood 2019"

The present research work includes the details of Krishna sub Bank also the study of flood events of Krishna Bank 2019.The capacity of reservoir & rainfall pattern of Krishna Bank was studied. The data of flood prone area was collected & Analysis of flood 2019 in Sangli District, Kasbe Digraj was done by various Organizations like Indian Metrological Department (IMD) & IITM Pune, Water Resources Department (WRD), Central Water Commission New Delhi (CWC) & Maharashtra Remote Sensing Application Centre & also suggested existing floods mitigation in infrastructure in Krishna Bank. The solutions were suggested from the reasons studied. This project provides information about situation of flood in 2019 and what are the critical analysis of Krishna sub Bank flood cannot be absolutely controlled flood can only be managed to reduce flood losses. What are the main reasons behind the earlier flood and hydrological parameter of Krishna Bank? The worst affected districts noticed were Sangli and Kolhapur (Krishna and Panchaganga sub Bank). 5. Suggesting different solutions for flood controlling or managing.

S. B. Kore et.al (2022) Conducted research on "Flood Risk Analysis of Upper Krishna Sub-Bank using GIS"

Floods are the most and repeatedly occurring destructive natural disaster due to an overflow of water submerges land which is basically dry. Generally, floods are occurring due to heavy rainfall or cloud bursting or manmade disturbance to nature, fast snowmelt, global warming or tropical cyclone or tsunami. In 2019, the Krishna River, Kasbe Digraj has faced very heavy rainfall and major floods which took the lives of approximately 500 people and nearly isolating 350 villages and leaving millions homeless. Here we studied the previous? Flood disaster at the Bank of the Krishna River, Kasbe Digraj and processed the GIS environment using software tools. This facilitates exploring the data and methods that are mostly unexplored, and areas that have not lightened in the? field of? flood studies in Krishna Bank. It is impossible to avoid? floods and risk associated with flood, however it is possible to work on the flood reduction. Flood hazard mapping is to identify comparatively safe sites in high elevation with low risk is one of the powerful tools for this purpose. Flood hazard mapping? ash? flood will be beneficial for risk assessment. Management and emergency services during flood events. The objective of this paper is to generate flood hazard zonation maps of Upper Krishna sub-Bank using GIS tools and satellite images. To do so, we use spatial data and SRTM DEMs with accuracy assessment is achieved by using check points, obtained by GPS observations. Runoff,

surface slope, drainage density, distance to main channel and land use were considered causative factors. All used data are processed and integrated in an ArcMap and QGIS to prepare a final flood hazard map for Upper Krishna sub-Bank. The areas in high risk flood zones are obtained by overlaying the flood hazard index map with the zone boundaries layer.

Mohit Prakash Mohanty et.al (2022) Conducted research on "Flood management in India: A focused review on the current status and future challenges"

Despite massive investments and continuous flood-control efforts in India, the socio-economic damages and death toll continue to remain high. Undoubtedly, the process of flood management in India is very complex due to the influence of several socio-hydro climatological factors, such as climate change, sea level rise, and socioeconomic dynamics. While these factors influence the intensity and frequency of flood events, factors explicitly related to the process of flood management, such as the improper execution of traditional structural measures, the lack of the proper implementation of schemes, lackadaisical execution of traditional structural measures and end-to-end management of the flood management programs/practices, ensure only partial protection. This review article identifies the region-specific flood problems in India and discusses the initiatives undertaken by major Indian flood management agencies, with an emphasis on the current ongoing flood management practices. The effectiveness of these practices in the long term is discussed, and specific gaps are identified. The recommendations provided in this article may be useful to guide stakeholders and policymakers in formulating and implementing sustainable flood management plans for improved flood resilience.

While the literature provides valuable insights into various aspects of water resource management, flood control measures, and flood risk analysis in different geographical contexts, there is a noticeable research gap in the specific area of environmental quality analysis of groundwater using GIS in Maharashtra. The existing literature primarily focuses on river basin planning and management, flood risk analysis in urban areas, flood disaster and control measures, economic analysis of flood control measures, simulation of floods in specific river segments, flash floods in hilly regions, and mapping flooded rice paddies. However, there is limited research addressing the environmental quality of groundwater in Maharashtra using GIS techniques. The identified literature does not directly address the comprehensive analysis of the groundwater quality in the context of Maharashtra, a state in India facing various environmental challenges. Maharashtra has a diverse geographic and hydrogeological landscape, and understanding the groundwater quality is crucial for sustainable water resource management, agricultural practices, and public health. The absence of research in this specific domain hinders the development of a holistic understanding of the environmental quality of groundwater in the region. Furthermore, the literature review lacks a focus on the integration of GIS technology in analyzing and visualizing groundwater quality data. GIS offers a powerful tool for spatial analysis, mapping, and decision-making in environmental studies. Given the increasing importance of GIS in water resource management, there is a research gap in exploring its application in assessing and managing

groundwater quality in Maharashtra. Therefore, the identified research gap suggests the need for studies that specifically investigate the environmental quality of groundwater in Maharashtra using GIS techniques. Such research could contribute significantly to the sustainable management of water resources in the region and provide valuable insights for policymakers, water resource managers, and researchers working in the field of environmental science and geography.

3 RESEARCH METHODOLOGY

3.1 General

The flood risk map of Krishna Bank has been generated by considering different thematic layers of the factors controlling the flood. These thematic layers were prepared using remote sensing data (LISS-IV, Landsat-VII), Topographic maps, Block level boundary maps, population data, SRTM DEM data, and rainfall data. The different data sets were analyzed for information generation like geomorphic features, population density, landuse landcover etc. The SRTM DEM was analyzed for the generation of slope map. All the data / thematic layers derived from different sources were converted to grid format which will be used in GIS analysis. Finally, all data was integrated in a GIS environment using multi-criteria decision tools for preparation of flood hazard, vulnerability and flood risk maps. Details of the data used for this study and the methods employed were elaborated in below section.
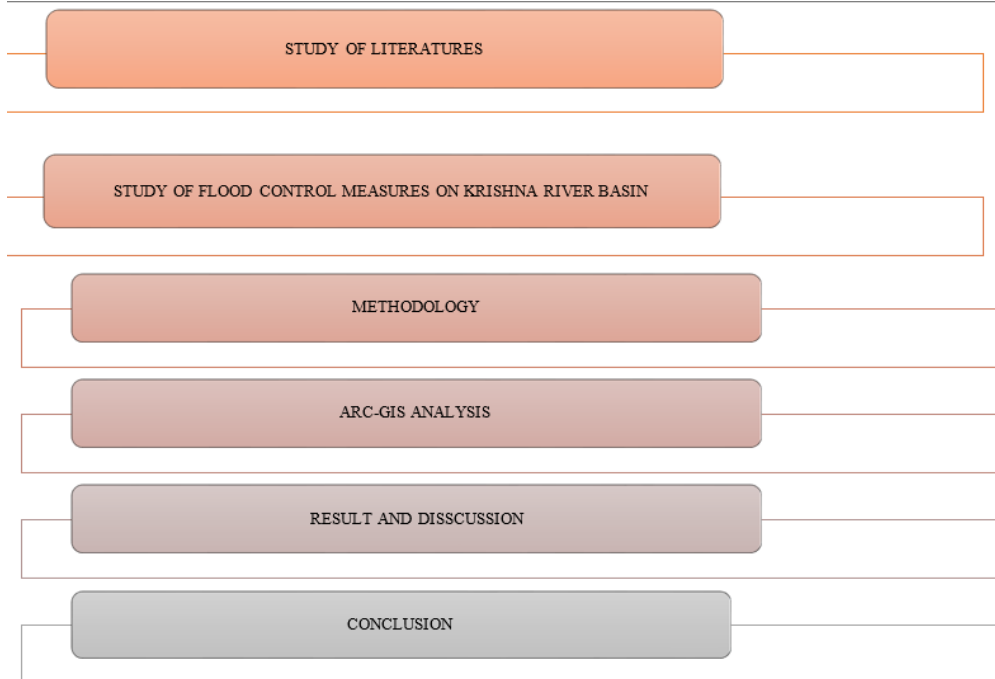
Fig.3 Methodology Flowchart

3.2 Data used

An extensive use of satellite based remote sensing data for mapping and topographic analysis was made for the study of flood risk assessment in the part of Krishna Bank. Table 3.1 and Table listed below shows the details of various data sets used.

Table 1 Lists of satellite data used for analysis

Data type				Month/Year of Acquisition	Ground Resolution/ Scale
Satellites	Sensors	Path/Row	Spectral Resolution (µm)		
Landsat–7	TM	140/42	B1: 0.45–0.52 B2: 0.52–0.60 B3: 0.63–0.69 B4: 0.76–0.90 B5: 1.55–1.75 B6: 10.4–12.5	December 2009	30 m for bands 1,2,3,4,5 and 7 120m for band 6 resampled to 30 meters
				B7: 2.08–2.35	
IRS–P6	LISS–4	102/35 102/36,102/37 102/41,102/42,102/43 102/6,102/7,102/8	B1: 0.52–0.59 B2: 0.62–0.68 B3: 0.77–0.86	January 2022, February 2022 and 2021	5.8m for bands 1,2,3
Digital Elevation Map (DEM)	Surface Radar Terrain Mapper (SRTM)	Elevation in 1m pixel precision, ±7m vertical accuracy		2022	90m

3.3 Rainfall Data

The rainfall data used for the Risk analysis is from "The Tropical Rainfall Measuring Mission (TRMM)". This is a joint mission between National Aeronautics and Space Administration (NASA) and the India Aerospace Exploration Agency (IAXA) designed to monitor and study tropical rainfall. A combined Precipitation Radar (PR) / TRMM Microwave Imager (TMI) rain- rate product with path-integrated attenuation at 4 km horizontal and 250 m vertical resolutions. TRMM data (2b31) are available at a nearly global scale for the past 12 years (2008 to 2022). It has been designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation, which is responsible for shaping both global weather and climate.

3.4 Census Data

The Latest Census data for the year 2022 has been procured from "The LandScan global population" which has approximately 1 km resolution (30" X 30"). LandScan Global is the finest resolution global population distribution data available and represents an ambient population (average over 24 hours). LandScan population distribution models are matched with the data conditions and geographical nature of each individual country and region. The LandScan data for India and Nepal has been used for the purpose of risk analysis in my study area.

3.5 Field data

An extensive field visit for the collection of topographic points and ground validation was done during May 2023. For the geomorphologic mapping, various features have been mapped and validated with the ground during field visit. Also, the data for road River intersection points have been collected throughout the study area, which is being used as one of the supporting parameter for the analysis of the vulnerability of the area to risk, which was classified accordingly to various classes. The avulsion channel has been mapped using Differential Global Positioning

System (DGPS). For River profiling the continuous topographic point were collectedand for the land profile, the discrete profiling was done.

4 RESULTS AND DISCUSSION

General

On the basis of a comprehension of the causes of flooding in the study area, various sources of available data sets were utilized to generate thematic layers. Analysis at a block level has been chosen as the unit of investigation for the current study. Using a combination of flood 'hazard' and 'vulnerability' maps, the final flood 'risk' map was created. For the hazard analysis, seven factors were considered: geomorphic features, population density, slope, distance to the active channel, rainfall, and Road-River intersection frequency and the number of people of the study area for the susceptibility analysis, which pertains to the loss of material, emotional, and architectural integrity.

Table 2 The Parameters Used For The Flood Measure Analysis

Flood Hazard Analysis	Vulnerability Analysis
1. Geomorphology	1. Population density
2. Rainfall	2. Landuse-landcover
3. Slope	3. Road River interaction
4. Distance to active channel	

Krishna River water diverted

Flood control measures on the Krishna River bank in the Kasbe Digraj area of Sangli are crucial for safeguarding the region from the devastating impacts of flooding. One of the key strategies in flood control is the diversion of water to prevent overflow and inundation in vulnerable areas. This process involves redirecting excess water to alternative channels or storage areas, effectively managing the water flow and mitigating potential flood risks.

In the context of Kasbe Digraj, the use of Q-GIS software can play a pivotal role in identifying suitable locations for water diversion. Q-GIS (Quantum Geographic Information System) is a powerful tool for spatial analysis, allowing for the visualization and interpretation of geospatial data. In the case of flood control, Q-GIS can aid in mapping out the topography, hydrology, and land use patterns in the area, helping planners make informed decisions about where water diversion is most effective. As Shown in Fig. No.5.8

Identification of Low-Lying Areas: Q-GIS can be utilized to analyze elevation data and identify low-lying areas prone to flooding. By understanding the topography of the region, planners can pinpoint locations where water tends to accumulate during heavy rainfall or when the river water level rises. These areas can be designated as potential sites for water diversion.

- **Hydrological Analysis:** Q-GIS can incorporate hydrological data, including river flow rates, precipitation patterns, and soil permeability. Analyzing these factors helps in determining the volume of water that needs to be diverted and the most effective locations for diversion points along the Krishna River.

- **Land Use Mapping:** Understanding the existing land use patterns is essential for effective flood control. Q-GIS can assist in creating land use maps, identifying areas with minimal human settlements and agricultural activities where water can be safely diverted without causing significant damage to infrastructure or crops.

- **Creation of Alternative Water Channels:** Q-GIS allows planners to design and simulate the creation of alternative water channels for diverting excess water. By considering factors such as slope, terrain, and existing

infrastructure, the software can help optimize the layout of diversion channels to ensure efficient water flow away from vulnerable areas.

- **Integration with Remote Sensing Data:** Q-GIS can integrate remote sensing data, such as satellite imagery, to provide real-time information on the current state of the river and surrounding areas. This helps in monitoring changes and making dynamic decisions on water diversion based on the evolving flood situation.

- **Community Engagement:** Q-GIS can be used to map out areas with high population density or critical infrastructure. This information is valuable for engaging with local communities and stakeholders to ensure that proposed water diversion measures are in line with the overall development goals of the region.

  The use of Q-GIS software in flood control measures on the Krishna River bank in Kasbe Digraj, Sangli, is instrumental in identifying suitable locations for water diversion. Through comprehensive spatial analysis, planners can make informed decisions to safeguard the community from the adverse impacts of flooding while promoting sustainable development in the region.

Amount of excess water gathered during floods

The amount of excess water gathered during floods in the Kasbe Digraj area along the Krishna River bank is a critical aspect of flood control measures. To understand this, various factors such as land use/land cover (LULC), population density, and road-river intersection density have been analyzed using Q-GIS software.

The LULC analysis indicates that a significant portion (48%) of the area is covered by moist sand areas, which includes small water patches and waterlogged areas. This makes the region susceptible to flooding, as water has limited infiltration capacity in such areas. Additionally, the dry sand areas resulting from a previous avulsion contribute to 9% of the total area. These factors contribute to the overall vulnerability of the region during floods.

Population density is a crucial factor in assessing the potential impact of floods. The population at risk is determined by evaluating the density of economic assets in the flood-prone areas. The population density map generated from the 2021 census data reveals the distribution of people in the region. The high population density in certain blocks indicates the potential risk to human lives and economic assets during flooding.

Furthermore, the analysis of road-river intersection density provides insights into the vulnerability of infrastructure. The road network is essential for the community's connectivity, and damage to roads during floods can isolate towns and villages, hindering relief efforts. The classification of blocks based on intersection density shows that some areas are more prone to road damage during floods, posing challenges for evacuation and aid distribution.

To quantify the excess water gathered during floods, it is essential to consider the elevation, slope, and topography of the region. Low-lying areas and those with gentle slopes are more likely to accumulate excess water during floods. The road-river intersection density map also highlights areas where road damage may contribute to flooding by impeding the natural flow of water.

In conclusion, the amount of excess water gathered during floods in the Kasbe Digraj area is influenced by various factors such as land use, population density, and road-river intersection density. The analysis using Q-GIS software provides valuable insights for implementing flood control measures, including the identification of vulnerable areas and the need for infrastructure improvements to mitigate the impact of floods.
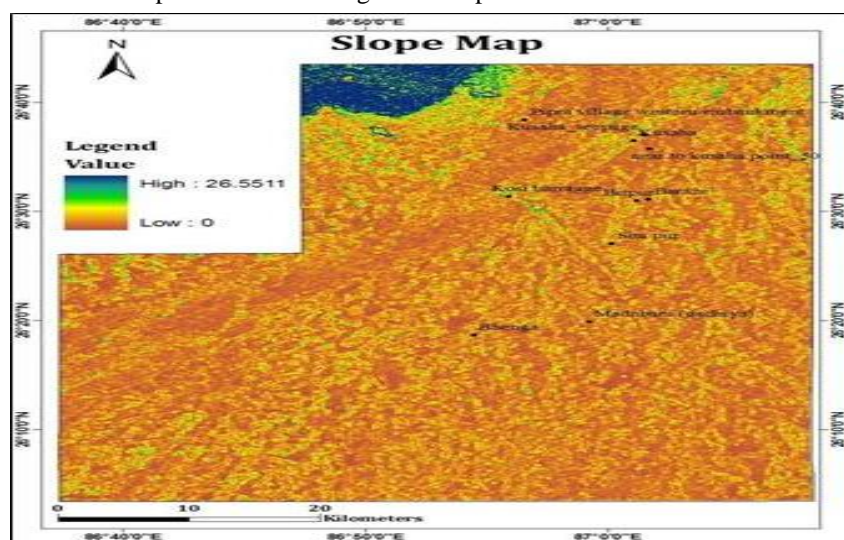

Fig. 4 SRTM DEM Map

Fig. 5 Classified Slope Map

Fig 6 Active Channel Map

Generation of flood risk map

Flood hazard map and the vulnerability map were multiplied to generate the final risk map of the study area in the model builder. The risk analysis was carried out block wise basis. The final Flood risk map is showing the FRI range from 1.584 to 21.1707, which has been shownin the figure. For the classification of the Flood Risk Index (FRI) we need to have a rangeto define the risk, for different categories such as very low, low, moderate, high, very high, thus histogram has been used to classify risk map into five major classes which are shown in the table below.

Table 3 Flood Risk Index with their value range

Range	Flood risk Index(FRI)
1.589 – 2.791	Very Low Risk
2.792–5.524	Low Risk
2.525–8.798	Moderate Risk
8.790–12.346	High Risk
12.347–21.170	Very High Risk

5 DISCUSSION

For the study of risk analysis 75 blocks including both Maharashtra (India) have been analyzed with the total area of 3286 sq.km. The final risk map was generated with the multiplication of both maps (Hazard *vulnerability). Here each parameter has been assigned different weightage factors using Saaty 9-point scale to define the relative importance, which decides the dominance of the factors over the other. The final risk map is represented with the graduated color map which was further categorize to assign the values to each block using histogram into different Flood Risk Index range.

From the analysis it has been investigated that due to the change in the River dynamics, there ischange in the geomorphology of the area, the formation of vast stretch of sand sheets and swamps and marches, rejuvenation of palaeochannels, formation of flood plains along the new channels, formation of channel bars due to high sedimentation load which has been markedout during field visit. The vast stretch of sand sheets has turn agricultural land into barren landof no use as the thickness of the sand deposition is very deep. The risk map in general depicts the environment form, the concern and the vulnerability of the population in the area that is prone to the hazard; hence the risk map takes into account thepopulation, the areas of human activities like towns and settlements, roads River linkage, the cultivated areas, that are delimited and arranged into order of importance for the management priority. The final flood risk map obtained by the integration of the different thematic layers in GIS environment has been validated with the MODIS Dartmouth flood inundation map of October12-13, 2009 for the study area. This inundation map showing flooded areas from period 1999 to 2009, which has been serving as the latest information source for the validation of the map. When risk map is compared with the flood inundation map of 2009, the areas which fall in the category of high to very high risk index are the regions coincide withthe areas that was inundated during flooding. It supports the fact that the avulsion zone falls within these blocks, and risk in those areas are due to the high population density ie.1483 – 2043 persons /sq.km. The block of Sangli, Satara, Kolhapur (India), fall in the moderate risk zone although they are not showing any inundation as verified from the MODIS inundation map, has attributed to high degree of road River intersections of small channels which cause backwater logging and poor drainage condition. Low slope along with the marshes andswamps as derived in the geomorphology map from satellite image of LISS-4 makes

the condition more worst.

6 CONCLUSION

The implementation of flood control measures on the Krishna River bank has been critical in mitigating the impact of floods in the region. The construction of dams, levees, and other infrastructure projects have provided a significant level of protection to the people, property, and agricultural lands in the Bank. The use of modern technology for forecasting and monitoring weather conditions and River flows has enabled early warning systems, improving the response time to potential flood events. However, it is important to note that the success of flood control measures depends on a multi-faceted approach, which includes effective land use management, watershed management, and community participation.

The long-term sustainability of flood control measures will depend on the effective coordination between government agencies, local communities, and stakeholders in the region. The Risk analysis conducted in this thesis is based on an efficient methodology with an objective to delineate the flood hazard areas, flood vulnerability area, and finally produced the combined risk areas in the upper Krishna River Bank. The risk analysis of the study area represents an exploratory methodology based on morphological, topographical, demographicaldata which can be ultimately used for the delineation of the risk areas affected by the different parameters like population, Slope, Rainfall, Land-use.

This analysis has finally focused on the identification of the factors that controls the flood hazard and vulnerability in the study area. A combination of different data sets such as remote sensing images, population data (Landscan Global), topographic maps (Survey of India, Texas Library), block boundary maps available from different regional centers. Geomorphic mapping for different time period was carried out with the aid of satellite / remote sensing images for prior and Post Avulsion Period to understand the evolution of the landforms in the Alluvial fan and predict the connectivity of the pale channels.

The different geomorphic units namely active channel belt, active flood plains inactive flood plain, minor active channel deposits, channel bar deposits, and the fan surface. The decision factors identified are rainfall, population Density, distance to active channel, land use land cover, slope of the area, geomorphic features. Thematic maps were prepared using several image processing techniques and GIS operation at different scale. Each of the thematic layers (Classified data sets) were brought to same scale.

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