IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
IJARSCT
Impact Factor: 6.252
Volume 2, Issue 8, May 2022

Disaster Management of Panchaganga Flood Near Kolhapur Region

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Abstract: *In India most of the disasters are caused by floods, about 60% of the landmass is prone to earthquakes of various intensities, over 40 million hectares is prone to floods, about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. The main aim of the present study was to evaluate its management, the potential flood risk areas of Panchaganga river and Krishna River using GIS and diverging flood water through underground tunnel from Panchaganga ghat to Gandhinagar. The flood scenario across the Panchaganga river was analyzed using data of August 2019 by segregating flooded areas. Factors considered for evaluation of the flood risk analysis were flood layers, evaluation, river basin and land cover analysis by AHP Method. This management was used to compute by using GIS and sensors, to access flood risk of Panchaganga river.*

Keywords: Disaster Management, Flood risk, GIS Technique, AHP Method, Sensors, Flood, Fire, etc.

I. INTRODUCTION

Maharashtra is not known for being flood-prone, however recent frequent flooding & consequent losses make it necessary to acquire better technical knowledge by using modernized flood mitigation techniques. During the month of July & August 2019, Maharashtra was afflicted with heavy floods as a result of intense rainfall. Kolhapur district in Panchaganga basin was hit especially hard by extreme floods A heavy loss of life, property, and crops had been reported. Divergent opinions had been expressed at various levels regarding these flood events. Past flooding in Kolhapur districts has been severe and the floods of 2005 & 2006 have been particularly noteworthy. However, the flood of 2019 was comparatively much more severe as it lasted over a week and caused a much higher level of damage.

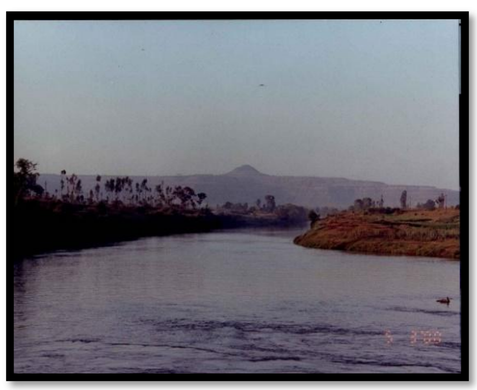

Figure 1: Panchaganga River

The Panchganga River, as it is called today, winds eastward for about thirty miles before it enters the Krishna River at Kurundvad. In the thirty miles of its course, to the east of Kolhapur the Panchganga River receives only one considerable stream the Hatkalangale or Kabnur which, rising from the Alta hills and passing Hatkalangale and Korochi joins the Panchganga near Kabnur about fifteen miles below Kolhapur.

From Shiroli to its junction with the Krishna near Narsobawadi, it has an extensive Alaviya floor bordered by the large worn-out stumps of the Alta portion of the Panhala in the north and the Hupari part of the Phonda Sangaon range in the south. A characteristic feature of this basin is the contrast between the rounded worn-out features locally known as Mals and the general entrenched nature of all the streams.

A further noteworthy aspect is the deeply incised course of the Panchganga itself. From Mangaon, the river flows in a deep bed that is well below 40 feet from the surrounding plain. Further downstream it develops an incised meander-core which includes the Narsobawadi area.

Advantages of Flood Management:

- Habitat creation, biodiversity and conservation.
- Improving water quality and reducing erosion.
- Agricultural management.

Disadvantages of Flood Management:

- Very expensive.
- Dams trap sediment which means the reservoir can hold less water.
- Habitats are flooded often leading to rotting vegetation. This releases methane which is a greenhouse gas.

II. LITERATURE REVIEW

1. Sachin Panhalkar and Amol Jarag published paper on a flood river GIS technique in Flood Risk Assesment of Panchganga River,2017, Flood hazard causes great loss to lives and properties leading to disturbance in human society. Flood is the single most hydrometeorological hazard causing substantial losses.

2. Shubhendu S. Shukla presented a paper on Disaster Management: Managing the Risk of Environmental Calamity in volume 1, Issue 1, pp. 12-18, September 2013. Describes severe damage to ecology and economy of a region due to disaster. With installation of new technologies and by adopting space technology as INSAT and IRS series of satellites, India has developed an operational mechanism for disaster warning especially cyclone and drought, and their monitoring and mitigation.

3. Pramod Patil (2012) publishes a paper on Disaster Management in India in Volume 2, issue 1, pp 1-4, Feburary 2012.Highlighted disaster profile of India and Disaster Management in India. He concluded that there are some points on which we have to focus like effective warning system and effective communication system etc.

4. Chen-Huei Chou et al (2013) presented a paper on International Journal of Business Continuity and Risk Management in Volume 4, No.1, pp. 75 – 91, 2013. Presented we focus on identifying the contents of a web-based disaster management system from the perspectives of multiple stakeholders the needs the system should meet, and crisis behaviors that the system should anticipate. We propose two conceptual models to investigate how these categories of web-design elements could enhance victims' coping mechanisms and reduce impacts of natural disasters on individuals and businesses Extending the theories of task-technology fit and self-efficacy, we propose the concepts of need-web element fit, behavior-web element fit, and disaster self- efficacy

5. Dr. Priyanka Banerji (2013) publishes a paper on Comparative Analysis of Disaster Management between Japan & India in Volume 13, Issue 6, October 2013, Pages 62-74**.** Studied a comparison between Disaster Management in India and Japan and concluded that There is fast recovery growth in Japan after disaster as compare to India.

6. Vicky Walters et al (2014) presented a paper on Disaster risk at the margins: Homelessness in vulnerability and hazards, pp. 211-219, 2014.Presented focuses on the linkages between the multi-faceted marginalisation of homeless people and their various vulnerabilities to disaster associated with both everyday small-scale hazards and large-scale natural hazards. Highlighting the complexity and acute vulnerability of homeless people to disaster from a multitude of man-made and natural hazards at different scales, it argues for more attention and integration of homeless people's needs and everyday hazards in disaster research and policy.

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7. Ben Wisner (2015) publishes a paper on A review of the international literature on disaster social work and case management (2015) In his paper presented the challenges during disaster. There have been key events that have motivated people to seek IDRIM such as the Indian Ocean Tsunami and Haitian earthquake and their aftermaths. New institutions have been created that have the potential to move us toward IDRIM such as UN-ISDR. Finally, a series of concepts have emerged from many reports, evaluations, and research.

8. Scott Manning et al (2016) presented a paper on International Journal of Emergency Management in Volume 12, No.3, pp. 241 – 262, 2016.Presented a review of the international literature on disaster social work and case management was conducted. These results shed light on the roles and processes of social work, the use of psychosocial interventions, and the barriers to service delivery in the international disaster context.

9. Shohid Mohammad Saidul Huq (2016) publish a paper on Community based disaster management strategy in Bangladesh: present status, future prospects and challenges in Volume 4, No. 2, 216, pp. 22-35Presented analysis on the disaster management by grassroots community. Participation in Bangladesh and concluded that the people should be participated for disaster management. To aware people the social workers should provide training and seminars to the people time to time.

10. Deeptha V Thattai et. al. (2017) presented a paper on Natural disaster management in India with focus on floods and cyclones in2017.Researches about two case studies cyclones and floods are taken up for comparison of disaster management strategies adopted in the country.

III. METHODOLOGY

1. **Rainfall**

During 25 July to 13 August 2019, the flood-effected districts of Satara, Sangli, and Kolhapur continuously received excess to large amounts of rainfallDuring the first week of August starting on 1st August, Satara, Sangli and Kolhapur received large amounts of rain, with departures of +431%, +406% and +344% from their long-term averages, respectively. While rainfall intensity decreased in the second week, these districts continued to receive excess rainfall with +89% of its normal over +152% over Kolhapur, +89% over Satara and +59% over Sangli districts.

Land Cover Analysis

Based on the LandCover analysis, the settlement covers an area of 84.95 square kilometerswhile miles, while the area of agriculture is 383 sq. miles. There are 136 square feet of barren land and 39 square feet of grass land remaining.

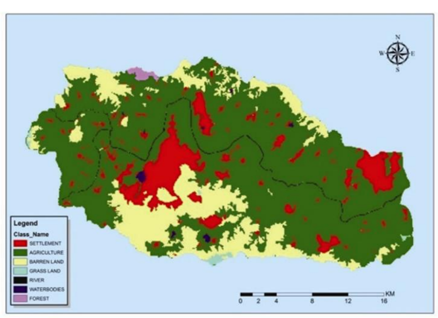

Figure 2: Land Cover Analysis

Water bodies havean area about 7.57 sq. km. Infrastructure like major and other roads plays an important role in mitigation during flood period. This infrastructure data was generated from LISS-IV images.

2. **Flood Damage**

Between August 2nd and August 15th, Kolhapur districts were hit hard by heavy rains. Between the 5th and 14th of August, there was a major flood in Sangli, which reached dangerous levels. Between the 3rd and 14th of August, a similar situation occurred in Kolhapur Town, with flood levels above the danger level. Maximum submergence (inundation) occurred in town and adjacent tahsils on August 9th.

Water Resources Impacts

Increased rainfall in the form of heavy precipitation events is expected to enhance river discharge. Surface runoff is likely to increase in some catchments, for example, sub-catchments of the Godavari are expected to have enhanced runoff in July. In south central Maharashtra, an increase in the number of low rainfall days suggests that the region is experiencing dry spells, which will have an influence on water supplies and agricultural patterns.

3. Flood Prone Area

The river system that includes the Krishna River from Karad to Almatti, as well as its three tributaries Yerala, Warna, and Panchganga, is being modelled. The river system is being built one reach at a time. In order to map flooding, the river system is geo-referenced. The total length of the river system in question is 544.59 kilometres.

4. AHP Method

AHP is widely used in MCDA to obtain the requiredweights for different criteria. It has been successfullyemployed in GIS-based MCDA since the early 1990s.Preference structure of decision makers can be easily defined through pairwise comparison approach. This isthe biggest advantage of this method. The present approach is helpful to identify and evaluate potential floodrisk areas of Panchganga river. The weightage was obtained by pairwise comparisons and the consistency was evaluated among their relationship.

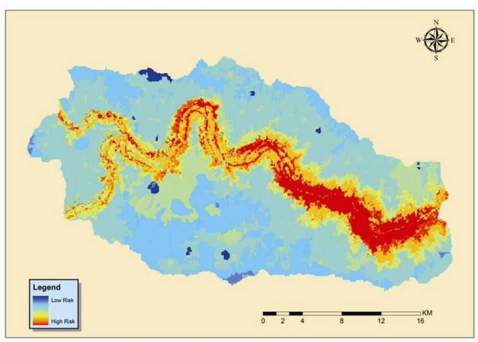

Figure 3. Flood Risk map Based on AHP Method

AHP method is much more accurate and reliable for flood risk analysis for the present study. National highways (Mumbai–Bangalore and Ratanagiri) and three state highways. Sixteen district roads and some village roads were included in high flood risk zone.

However, according to the result obtained from AHP, 154 sq. km area has moderate flood risk area. Moderate flood risk area includes nearly 127 sq. km agricultural land of 31 villages. Major national highways, state high- ways, district roads and some village roads were also included in moderate flood risk zone.

All the above-mentioned infrastructure, agriculture and settlement areas are located in high flood risk zone, which immediately requires proper zonation and planning to avoid the various kinds of losses during a flood.

In this study, ranking, rating and AHP method were compared with each other. These form a promising and powerful tool, but an equally important ingredient of decision-making process is the ability of the decision maker to select and combine in the most appro- priate way the several criteria, depending on the nature of the objective[26].

The three methods have been assessed through GPS based field techniques and ancillary data of previous events. A total of thirty-four points were collected from the study region by applying stratified random technique and each point categorized as high, moderate and low flood risk point as per geo-spatial conditions. Finally, accuracy assessment was performed in Erdas imagine software. The result shows that the overall accuracy of AHP method is

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quite higher with 79.36% as compared to other methods like rating and ranking. Therefore, analysis reveals that AHP method is much more accurate and reliable for flood risk analysis for the present study.

5. GIS Technique

In hazard management, GIS are incredibly valuable and effective tools. Satellite data can provide more accurate hazard footprints, which can be valuable for measuring or monitoring the impact of a hazard and mitigating flood-related activities. Remote sensing data (optical and microwave) can be utilised to swiftly analyse the severity and impact of flooding damage. Various studies have been carried out employing remote sensing data to assess and detect flood inundation zones, as well as to assess the dynamics of floods, throughout the last two decades.

GIS and multicriteria decision making (MCDM), two independent areas of research, can benefit from one other. Through automating, managing, and analysing spatial data for decision-making, GIS techniques and procedures play an essential role in the analysis of MCDM challenges. making. The MCDM approach includes a number of approaches and methodologies for analysing end-user preferences and incorporating them into GIS-based decision-making. RADARSAT-SAR pictures were utilised by Otsubo et al. to map waterlogged areas around the Lower Mekong basin, photos of flood hydrologic regimes and areal extent of flooding Sharma et al.8 used multi-temporal satellite data to create a village-by-village flood risk index map for Assam's Naogaon district. Flood hazard was combined with data on land use/land cover, infrastructure, and population by assigning weights to individual classes and using villages as a reference unit. According to the findings, the GIS environment is capable of producing flood risk maps.

To quantify flood risk in the Kosi River basin, Sinha et al.9 employed a multi-parametric technique of the analytical hierarchy process (AHP). The basin's hydrological analysis was combined with GIS-based flood risk mapping. To create a flood risk index, parameters such as land cover, topography, social (people density), and geomorphological were combined with an analytical hierarchy approach (FRI). Finally, long-term inundation maps were used to validate the flood risk map.

6. Sensors

Hundreds of coastal tide gauge platforms have ultrasonic sensors that offer tsunami and tropical storm surge warning data. They're also used on similar platforms to keep an eye on flooding along various rivers. The most up-to-date flood warning system is being used to keep an eye on flooding on city streets. The Flood Sensor is functional works by detecting water from the two metal prongs at the bottom of the sensor. If these two metal prongs get wet, an alarm signal is sent to the control panel. The Flood Sensor will float if there is enough water to flood the surface it sits on.

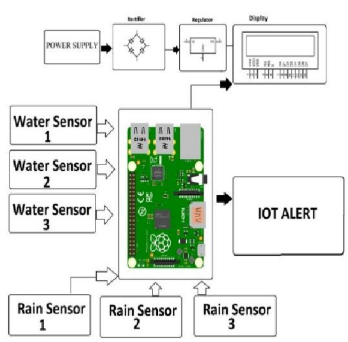

Figure 4. Sensor Technique

In the past several years, many satellite techniques that use optical sensors have been proposed to detect flood inundation, including **National Oceanic and Atmospheric Administration (NOAA)/advanced very high-resolution radiometer (AVHRR)** (Jain et al. 2006. 2006. Flood inundation mapping using NOAA AVHRR data.

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IV. RESULRT AND DISCUSSION

1. **Flood monitoring system that monitors the water level of the rivers using ultrasonic sensor:**
   The researchers used a model to test the generated prototype's usability and dependability. It was first tested in a prototype environment created by the researchers, which was used to complete the study. The test determined whether it satisfies the client's requirements. The prototype is assembled and the various hardware components are connected in the diagram below.
   The solar panel is connected to a regulator in the upper deck, as shown in the diagram. To guard against over-voltage, the regulator charges the battery and prevents overcharging. The Arduino microcontroller, topped by the GSM Module and the Ultrasonic sensor looking down, detects the distance of the water on the lowest deck.
   A script created in the Arduino programming language was first uploaded to the Arduino microcontroller board in order for the produced prototype to function properly. The script was tried in a temporary setting with the Arduino Integrated Development Environment (IDE) to see if it produced the expected results.

Figure 5: The Different Components of the Proposed Prototype

2. **Prototype Monitoring System Testing:**
   The researchers put the prototype to the test in a makeshift basin to see how much water it could hold. To obtain reliable data, the inputs have multiple sub-parameters. The water level in the planned prototype is measured in inches. There are four options to evaluate in the input. A notification message comprising the level of water and the alert level will be delivered to the computer when the water level exceeds the threshold value set in the script that was uploaded in the Arduino Micro-controller server. The table below shows the different option as input for the monitoring system.

Water Level (Feet)	Alert Level	SMS Notification Delivery
10’ and below	Normal	10 minutes interval
10’-20’	Moderate	5 minutes interval
20’-30’	Critical	1 minute interval
30’ and above	Emergency	1 minute interval

Design and develop an early warning system using Web and SMS

3. The researchers created two platforms for conveying information to concerned stakeholders in the case of a flood. One example would be real-time monitoring via a web-based system accessible over the Internet. Another is the Isabela province's SMS notification system, which allows for automatic contact between the system and local communities and other concerned entities.
4. The web-based monitoring system was created in the PHP programming language, with MySQL serving as the back-end for storing data from the SMS notification system. The web-based flood monitoring system also includes other flood-related data, such as water level, alert level, flood warning status, affected areas, and update logs. When fresh information was uploaded, the online application was also automatically updated.

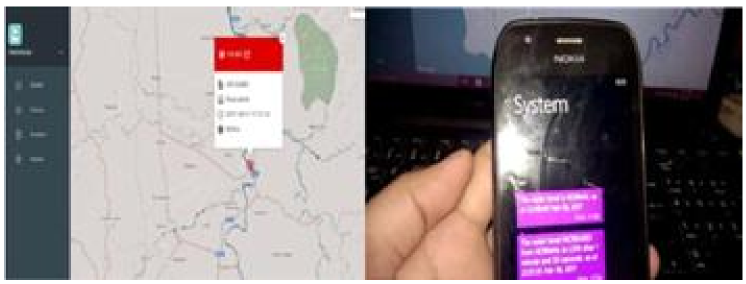

Figure 6. SMS Alert and Web-based Interface

The developed SMS application serves as the system's brain. It is responsible for processing data sent by the water level monitoring system, uploading an update for web-based monitoring, sending notifications to concerned stakeholders, and responding to requests for updates via keywords. In order to provide notifications, the SMS application uses a fuzzy logic algorithm. The application can deliver a warning status as an output based on the alert level received as input. Concerned folks can also use the built SMS application to inquire about the present state of a prospective flood disaster. The system will send a return message detailing the alert level, flood warning status, and flood-affected locations if you send a message with the keywords "Flood Status.". By this feature it allows the system to perform two-way communication between the system and the community in general.

V. CONCLUSION

1) AHP Method:

- According to AHP analysis, high flood risk area includes nearly 17 villages. In the case of agricultural land, about 42 sq. km is flood vulnerable area.
- Also, some major roads in the study area come under the high flood risk zone. All the above-mentioned infrastructure, agriculture and settlement areas are located in high flood risk zone and it immediately requires proper attention to avoid socio-economic losses.
- The theoretical base of ranking leads to inaccurate weights but rating method required little effort. For more precise results, pairwise comparison method is the ideal option.

2) GIS Technique:

- It is clear that with the help of GIS and multi criterion techniques, useful information for flood risk analysis can be acquired.
- Comparative analysis shows that the area under high and moderate risk increases in AHP as compared to other methods.

3) Sensors:

- The project contributes towards economy and the citizens. It envisions a safe, prepared and less casualty community before, during and after typhoon devastation.
- The model also promotes the use of real-timemonitoring system through the developed web-based application

DOI: 10.48175/IJARSCT-4496

and SMS notification system as aneasy medium in disseminating information particularly in the remote areas.

- By allowing the system intwo-way communication, it gives more flexibility in providing important information to the community.

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