Flood Location, Management and Solution(FLMS): A Flood Prediction and Management System for Kurla

Ambuj Pandey[1]
[1]Department of Computer Engineering
Don Bosco Institute of Technology
Mumbai, India
Ambujpandey4894@gmail.com

Shiab Patel [2]
[3]Department of Computer Engineering
Don Bosco Institute of Technology
Mumbai, India
shiabpatel123@gmail.com

Siddhanth Naidu [3]
[3]Department of Computer Engineering
Don Bosco Institute of Technology
Mumbai, India
siddhanth18112002@gmail.com

Kalpita Wagaskar[4]
[4]Department of Computer Engineering
Don Bosco Institute of Technology
Mumbai, India
kalpita@gmail.com

Amiya Kumar Tripathy [5]
5Department of Computer Engineering
Don Bosco Institute of Technology
Mumbai, India
Amiya.dbit@dbclmumbai.org

Dr. Sumit Sen[6]
[6]Department of Research
Indian Institute of Technology Bombay
Mumbai, India
sumitssen@gmail.com

***Abstract*— Flooding is a common problem in Kurla, a suburban area of Mumbai, India, with significant impacts on infrastructure, public health, and their livelihoods. This paper proposes FLMS, a Flood Location, Management, and Solution system designed to predict flood events in Kurla to assist in managing them. The FLMS system uses historical data on rainfall gathered from different sources, water levels, and other factors to develop a prediction model based on machine learning techniques. FLMS being a web bases application will allow its users to view alerts, contact the respective personnel and create awareness about the different stages of a disaster and ways to limit the losses caused by floods.**

Keywords—Flood prediction, flood management, machine learning, Kurla, Mumbai.

I. INTRODUCTION

Flooding is a common and serious issue in many parts of the world, especially in areas with poor infrastructure and dense populations. This problem is present throughout Mumbai, India, including the Kurla region. Significant property damage and alterations to daily life have been caused by flooding in recent years. We have created a solution called FLMS - Flood Location, Management, and System - to address this issue. By forecasting and managing floods in Kurla, FLMS hopes to lessen their effects on the city's infrastructure, general health, and way of life.

The FLMS system is made to gather and examine past data from different sources, such as details on rainfall and water levels of an area, in order to create a prediction model based on machine learning methods.

This work describes the creation, verification, and assessment of FLMS system. It outlines the data collection and analysis process, the machine learning methods used to create the prediction model, and the testing and evaluation findings. The effectiveness of FLMS system is contrasted with other flood prediction techniques, and the possibility for additional study and uses in this area are also highlighted. It also describes the architecture of the system, the use case and the stages of disaster. This paper aims at not only helping the local population by alerting them before the disaster strikes but also making sure they are aware about the steps to be taken while in the situation of a disaster.

To sum up. The FLMS system has the ability to lessen the impact of flooding on property, public health, and lives by offering current and accurate data on flood risk.

II. RELATED WORK

Many researchers have recently examined alternative methods for managing floods and assessing hazards using geospatial technology like geographic information systems (GIS) and remote sensing. [1] Kourgialas and Karatzas (2011), for instance, suggested a GIS modelling technique to evaluate flood-hazard areas utilizing information such as elevation, river network, and rainfall. To pinpoint regions having a high danger of flooding and create flood management plans, they created a map of the flood risk.

In a different work, [2] Liu et al. (2019) used Synthetic Aperture Radar (SAR) photos to create flood distance algorithms and fault concealed threat assessment for transmission line towers. They determined the flood distance for each transmission line tower after estimating the water depth using the backscattering coefficients of the SAR pictures. They identified the towers that were at risk of flooding by comparing the flood distance with the tower height, and they created fault management and prevention measures.

Even though these studies showed the GIS and remote sensing technologies' potential in flood control and hazard assessment, there are still a number of issues that need to be resolved. They include the need for increased data availability and quality, more simplified and effective modelling techniques, and improved stakeholder collaboration.

III. FLOOD MANAGEMENT STRATEGIES

Effective flood control necessitates the application of proper procedures in addition to the use of GIS and remote sensing technologies to forecast and monitor floods. Flood control involves a number of stages, each needing a unique strategy.

A. Risk Assessment

Risk assessment is the initial step. This entails determining and evaluating potential dangers related to floods and its effects on various places. The outcomes of this assessment are essential for creating successful flood management plans and for making wise judgements.

B. Preventive Action

Preventive action is the next phase. This entails taking steps to lessen the likelihood and effects of floods. Levees and dams are examples of structural mitigation techniques, whereas floodways and wetland restoration are examples of non-structural ones. Moreover, land use restrictions are frequently used to lessen the effects of flooding.

C. Preparedness

Preparedness is the third stage. This entails actions like training, emergency preparedness, and flood warning. The objective is to safeguard people and property while reducing the effects of floods.

The urgent activities conducted during and after a flood occurrence to protect lives and property make up the fourth The urgent activities conducted during and after a flood occurrence to protect lives and property make up the fourth stage, reaction. This can involve things like emergency repairs, search and rescue efforts, and evacuations.

D. Recovery

Recovery is the fifth and final stage. This entails the healing of the harmed parts and the restoration of normalcy. Typically, during this stage, labour-intensive tasks including debris clearance, damage assessment, and infrastructure reconstruction are used.

IV. GIS IN FLOOD MANAGEMENT

Flood management tactics have been significantly improved because to geographic information systems (GIS). GIS gives flood managers a thorough understanding of the flood-prone areas by analysing and visualising data through maps, empowering them to make wise decisions and create efficient mitigation plans [3][2].

To develop maps that depict areas susceptible to floods, GIS technology uses satellite photos, topographical data, and other geospatial information. Flood models, which simulate flood scenarios depending on many characteristics including rainfall, water levels, and drainage capacity, can also be made using GIS. These models offer useful information about the potential scope and severity of floods, allowing flood managers to evaluate the risks and make appropriate plans.

The capacity to give real-time data updates is one of the main benefits of GIS in flood management. GIS can give real-time information on flood events as they happen by fusing real-time data from sources including weather stations, river gauges, and satellite imagery. As a result, flood managers are better equipped to react to shifting conditions, allocate resources, and alert locals living in impacted areas.

The potential of GIS to promote coordination and communication among various stakeholders involved in flood management is another benefit. GIS aids in removing communication obstacles and facilitating collaboration between local authorities, emergency services, and other organisations involved in flood management by offering a common platform for sharing data and information.

V. PROPOSED SOLUTION

The Flood Location Management Solution system (FLMS) proposes a solution to improve flood management and prevention in the Kurla area. The technique entails creating a forecast model using data from previous floods. This model will employ statistical analysis to find patterns and trends that can improve flood prediction in the future and using GIS based maps to show the latest updates.

In order to make flood risk information more accessible to citizens, the FLMS system will also have a user-friendly web interface. To convey flood risk information in a simple and understandable manner, the website will feature interactive maps and visualisations. Residents will be better able to make decisions about their safety and wellbeing during potential flooding occurrences thanks to this.

The FLMS system will not only inform locals about their risk of flooding, but it will also advise the municipality and emergency services on the best ways to prevent and mitigate flooding. Based on the examination of the flood data, these suggestions will be updated when new information becomes available.

The suggested approach will assist government agencies and emergency services in improving their readiness for prospective flood occurrences and in taking proactive steps to lessen the effects of floods. The FLMS system seeks to provide a complete and efficient instrument for flood management and prevention in Kurla by utilising statistical analysis and historical flood data.

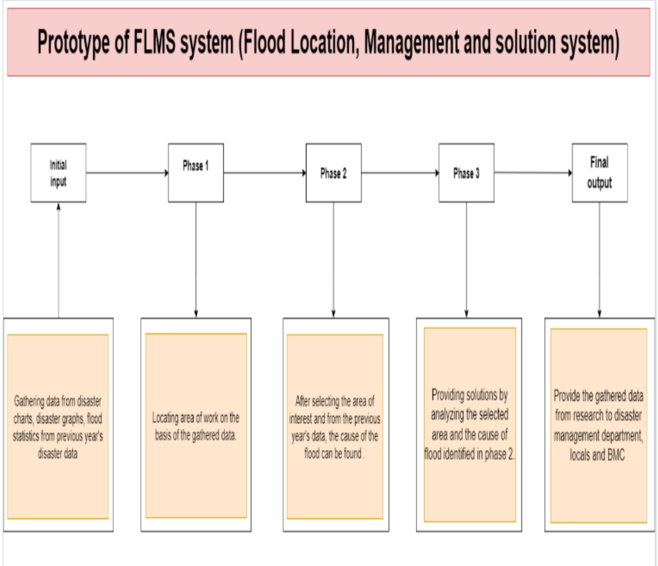

Figure 1 - Prototype

VI. USE CASE: FLOOD LOCATION, MANAGEMENT AND SOLUTION FOR KURLA

Purpose: To provide a flood alert and management system to help local public, municipal corporation, local authority, and nearby educational institutes prepare for and respond to flooding in the Kurla area.

A. *Actors*

1) *Local public:*

- Individuals who live or work in the Kurla area and may be affected by flooding.

2) *Municipal corporation:*

- Government agency responsible for managing public services in the Kurla area.

3) *Local authority:*

- Local government agency responsible for managing emergency response services in the Kurla area.

4) *Nearby educational institutes:*

- Schools, colleges, and other educational institutes located in the Kurla area.

B. *Steps:*

- Local public, municipal corporation, local authority, and nearby educational institutes register with the Flood Location, Management and Solution (FLMS) system.
- FLMS system gathers data from various sources, including historical flooding data and weather reports
- FLMS analyses the data to determine the likelihood of flooding in the Kurla area from historic and forecasted weather data.
- If a flood is imminent, FLMS sends alerts to all registered users, including local public, municipal corporation, local authority, and nearby educational institutes.
- Municipal corporation broadcasts warnings to the public via loudspeakers, social media, and other channels.
- Local authority sets up management teams to coordinate emergency response efforts.
- Nearby educational institutes receive alerts and use the information to decide whether to

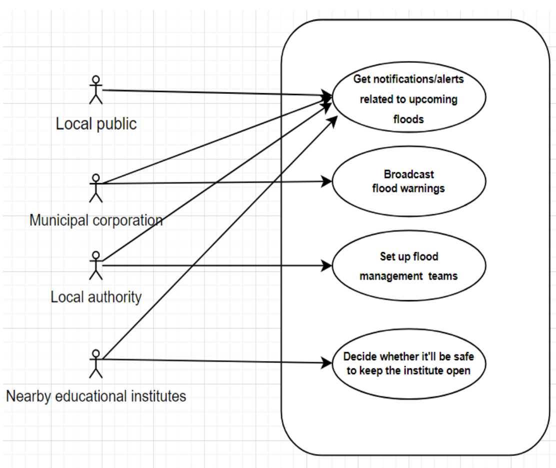

Figure 2-Use case Diagram

VII. Web Development Technologies and Frameworks Used

A web-based platform is used to implement the FLMS system, which stands for Flood Location, Management, and Solution. HTML, CSS, and Bootstrap are used to create the system's front end, which gives it a responsive interface. The Django web framework, which enables scalable and efficient development of complex online applications, is used to build the system's back end. The FLMS system is able to deliver an appealing and seamless user experience while also offering the essential capability to precisely predict and moderate floods in the Kurla region by utilising these technologies.

VIII. User Experience

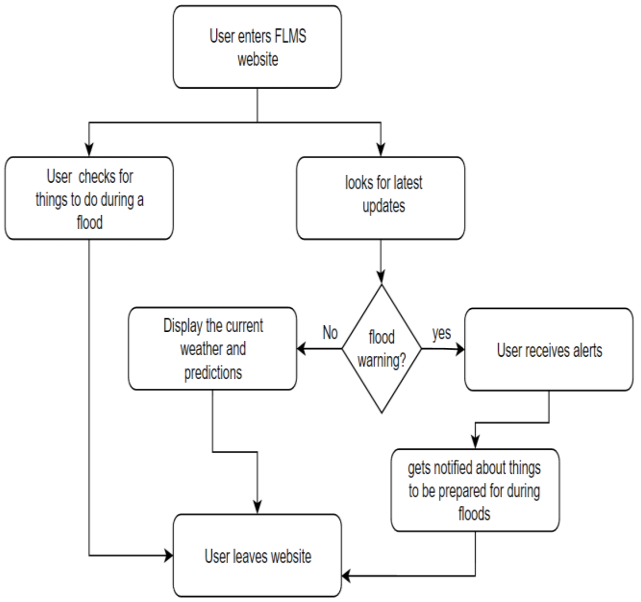

Figure 3 - FLMS system user interaction

On Upon visiting the website, users are presented with a landing page that provides an overview of the system and its capabilities. From there, they can navigate to different sections of the site, including the flood monitoring dashboard, the flood management section, and the flood solutions section.

The flood monitoring dashboard provides real-time information about current flood conditions, including water levels, rainfall, and other relevant data. Users can also view historical data and trends to help them better understand the nature of flooding in their area.

In the flood management section, users can access tools and resources to help them prepare for and respond to floods. This includes information on evacuation routes, flood shelters, and emergency contacts. Users can also report flooding in their area and receive alerts and notifications about flood risks and other relevant information.

The flood solutions section provides information on different solutions and strategies for managing and mitigating flood risks. This includes information on flood-resistant building design, flood barriers and levees, and other approaches to flood management.

Throughout the website, the user experience is designed to be intuitive and user-friendly, with clear and concise information presented in a way that is easy to understand. The goal is to empower users with the information and tools they need to better manage and respond to floods in their area.

IX. Problem Formulation

A. Initial State:

The current situation in the area which is prone to flooding is the system's original image. The weather, water levels, as well as other pertinent information are all included in this state.

B. Goal Test:

The system's objective is to lessen the region's exposure to flooding. The objective test is to determine whether or not platform's current status is equivalent with a flood-free situation.

C. Action:

The system's action component is taking measures to either prevent or lessen the effects of flooding on the area. This entails putting in place infrastructure upgrades, organising reaction teams, and setting up warning systems.

D. Transition:

The system's transition model predicts the state of the region in the future using information from the past, present, and future. Predicting water levels, probable flood zones, and the effects of flooding on infrastructure are all included in this.

E. Cost Function:

The system's total cost of maintaining flooding in the area serves as its cost function. This includes the value of flood-damaged property as well as the cost of emergency responders and equipment.

X. System Implementation

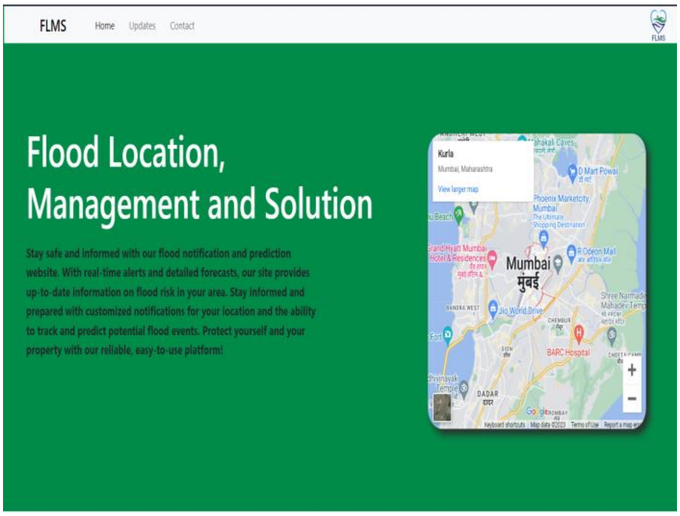

Figure 4 - Website Implementation

Figure 4 is a page from the FLMS website which aims at providing latest updates about floods to the people in Kurla.

In order to develop the Flood Location, Management and Solution (FLMS) system, a combination of HTML, CSS, Bootstrap, and the Django web framework was used. The website may be accessed from both desktop and mobile devices because it was made to be user-friendly and responsive. To store and handle data connected to floods, the system also makes use of a SQlite database.

A wide range of features and capabilities, such as flood alert, flood zone mapping, emergency preparedness planning, awareness related to flood, and others, are available to users through the FLMS system. This platform was also made to be modular, making it simple to integrate with other technologies and systems.

The website also provides links to various important contacts like the disaster management department and also a way for the people to directly send their issues from the website for being addressed by the concerned authorities.

There were a number of difficulties were faced during the design and implementation process of FLMS system , including problems with managing data and design of user interfaces. Yet, all these difficulties were overcome thanks to proper preparation and cooperation.

The goal is the improve to system's performance by taking more surveys form general population and making the interface as user friendly as possible.

XI. Research Outcomes and Significance

The possibility of flood-related damage and fatalities in the Kurla area could be significantly decreased because of the FLMS system. Local government officials and citizens can take the required actions to protect them and their property by receiving real-time flood warnings and flood danger assessments.

Flood forecasting and hazard mapping are made possible by the FLMS system's utilisation of GIS and historical flood data. Local government agencies and emergency personnel can use this information to better prepare for flood occurrences and respond to them when they happen.

The FLMS system can assist in lowering the financial expenditures related to floods. Local businesses can better anticipate for floods and perhaps reduce damages by offering more precise flood predictions and hazard mapping.

XII. Dataset

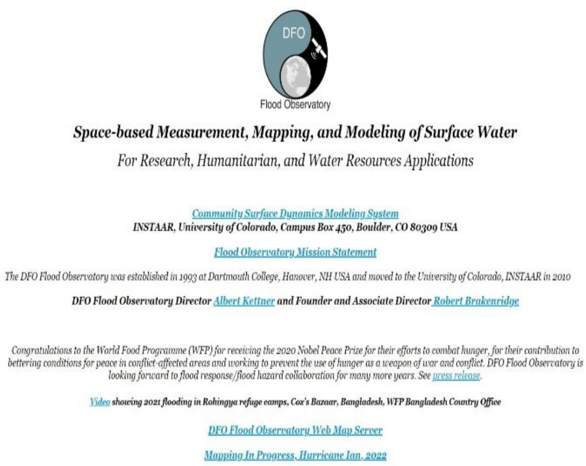

Figure 5 - dataset website

D	GlideNuml	Country	OtherCour	long	lat	Area	Began	Ended	Validation	Dead	Displaced	MainCause
27	0	India	0	75.0937	14.5398	254234.6	23-06-1985	27-06-1985	News	95	25000	Heavy rain
33	0	India	0	76.9103	32.8353	117441.2	18-07-1985	30-07-1985	News	340	20000	Heavy rain
53	0	India	0	82.8434	26.4816	89994.67	13-09-1985	15-10-1985	News	557	152000	Heavy Rain
61	0	India	0	86.7154	21.1495	46758.64	18-10-1985	20-10-1985	News	49	150000	Tropical cyclone
93	0	India		84.0726	25.6339	507167.4	15-06-1986	20-08-1986	News	258	3040000	Monsoonal rain
98	0	India	0	80.187	17.4331	107355.3	15-08-1986	22-08-1986	News	150	3000000	Monsoonal rain
106	0	India		89.4296	23.6547	231516.3	22-09-1986	10-10-1986	News	49	700000	Heavy rain
180	0	India		92.0622	26.4813	42285.99	23-05-1988	11-06-1988	News	76	43000	Monsoonal rain
190	0	India	0	92.926	26.988	70501.83	21-06-1988	14-07-1988	News	34	2000000	Heavy rain
196	0	India		80.7246	28.886	847737.3	04-07-1988	08-08-1988	News	233	500000	Monsoonal rain
203	0	India	0	71.1117	22.0189	76352.55	14-07-1988	27-07-1988	News	97	25000	Heavy rain
214	0	India	0	80.713	18.4311	94871.79	31-07-1988	02-08-1988	News	50	0	Heavy rain
228	0	India		86.5429	26.5037	626872.5	23-08-1988	15-09-1988	News	876	2000	Monsoonal rain
253	0	India		75.0459	30.9339	268528.6	21-09-1988	08-10-1988	News	731	1250000	Heavy rain
255	0	India	0	72.8962	19.1131	605.213	03-10-1988	04-10-1988	News	23	0	Heavy rain
330	0	India	0	76.4736	15.1816	905209.2	22-07-1989	31-07-1989	News	780	0	Monsoonal rain
334	0	India	0	92.8291	24.8678	112816.4	05-07-1989	10-08-1989	News	31	32000	Monsoonal rain
360	0	India	0	80.8611	26.4375	204979.4	03-09-1989	10-09-1989	News	7	0	Heavy rain

Figure 6 - dataset

This dataset [7] contains major floods that occurred in India and has a few entries of the area of Kurla.

XIII. LIMITATIONS

It is important to recognise the limitations of any study or endeavour. We also need to take into account some restrictions on our FLMS system. The fact that it depends on the accessibility and veracity of data sources like flood maps and weather reports is one of its key drawbacks. Inaccurate data can result in inaccurate evaluations and projections, which can have major ramifications for the management of floods.

Our platform's requirement for a particular degree of technical proficiency to manage and run is yet another drawback. For certain local governments or educational institutions, who might not have the means or expertise to operate the system successfully, this could be a problem.

Internet access may not be available in times of flood, hence the system also depends on its availability. This may reduce the system's usability and efficacy in those places.

It's also crucial to remember that while the system can help with flood control and offer useful information, it cannot totally remove the risk of flood or ensure the security of the impacted communities. It ought to be viewed as a planning and decision-making tool rather than as a conclusive answer to the flooding issue.

To ensure the FLMS system is implemented and used in an effective manner, these limitations must be taken into account and addressed.

XIV. FUTURE WORK

Although this research has shown that the FLMS system has the potential to offer efficient flood management solutions, there remains opportunity for further improvement and study. Further research on the efficacy of various flood management techniques, such as the use of green infrastructure and flood-resilient design, is one area for development.

Expanding the FLMS system to span a larger geographic area and integrating it with other current emergency management systems is yet another path for future study. To guarantee that the FLMS system is completely incorporated into current emergency response protocols, collaboration with local authorities and rescue workers may be necessary. Real-time sensor [4] data as well as other sorts of remote sensing data [6] can also be added with more effort.

A software system must include a user feedback process since it gives insight into user experience and aids in identifying any problems or potential development areas. In this study, we intend to gather user feedback in order to assess the FLMS system's efficacy in managing floods.

Feedback will be collected through surveys and interviews, where users will be asked to provide their opinions on the system's features, usability, and overall performance. We will also track user behaviours through website analytics to identify any areas that need improvement.

To determine areas that need improvement and to set goals for future development initiatives, the input that has been gathered will be examined. The platform will need to be changed as a result of the analysis' findings, in order to enhance user satisfaction.

XV. ACKNOWLEDGEMENT

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XVI. CONCLUSION

The development and implementation of a Flood Location, Management, and Solution (FLMS) are presented in this paper. The system enables various actors, such as the local public, municipal corporations, local authorities, and nearby educational institutions, to receive notifications and alerts. regarding impending floods, broadcast alerts, set up management teams, and make choices about whether to keep institutions open or not.

Technologies like HTML, CSS, Bootstrap, and Django have been used to implement the FLMS system. It is anticipated that the suggested approach will enhance the overall flood management procedure and lessen the damaging impacts of floods in sensitive locations.

There were several drawbacks discovered during system installation, nevertheless, such as the necessity for more precise and dependable flood detection algorithms and thorough flood management plans. Future work might include using more sophisticated flood detection algorithms and creating more potent flood management plans.

One of the additional areas where the FLMS system has to be improved in the future is user input. Overall, the FLMS system is a huge improvement in flood management and has the potential to be a significant help to places that are prone to flooding.

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