A Synopsis of Project on

SAFER: System for Disaster Assessment and Forecasting of Emergency Risks using Geo-Spatial Data

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Computer Science and Engineering Data Science

by

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Approval Sheet

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Disaster management in Northeast India faces significant challenges due to frequent natural disasters such as floods, landslides, earthquakes, and cyclones. Critical issues include poor infrastructure, insufficient real-time data, and unreliable communication systems. The region also faces resource constraints, with inadequate emergency services and preparedness plans. The "System for Disaster Assessment and Forecasting of Emergency Risks using Geo-Spatial Data" (SAFER) aims to revolutionize disaster management in Northeast India, specifically targeting flood and landslide management by addressing limitations such as non-intuitive interfaces, inadequate data integration, and lack of real-time information distribution. Utilizing advanced geospatial technologies and intelligent systems, SAFER leverages raster and vector spatial data for precise disaster assessment and forecasting, enabling proactive measures and efficient resource allocation. A standout feature of SAFER is its voice-controlled user interface for geospatial maps, enabling users to interact with and navigate the maps through voice commands. The system provides real-time information distribution, enhancing timely updates for responders and the public. It includes an Intelligent Ambulance Booking System, supporting multiple languages and live location sharing, and a simulation component for disaster evacuation planning. This integrated approach promises to significantly improve emergency preparedness and response outcomes through real-time alerts, detailed reports, analytics, and statistics.

Keywords: ***SAFER***, ***Geo-Spatial Data***, ***Disaster Management***, ***Northeast India***, ***Floods***, ***Landslides***.

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List of Abbreviations

SAFER: System for Disaster Assessment and Forecasting of Emergency Risks using Geo-Spatial Data
API: Application Programming Interface
MODIS: Moderate Resolution Imaging Spectroradiometer
GPS: Global Positioning System
GEE: Google Earth Engine
SAR: Synthetic-aperture radar
TTS: Text-to-Speech
STT: Speech-to-Text
GIS: Geographic Information System
LSTM: Long Short-Term Memory

Chapter 1

Introduction

The Northeastern region of India is highly disaster-prone, frequently experiencing floods, landslides, earthquakes, and cyclones. These natural calamities significantly affect the population, economy, and infrastructure, resulting in loss of life and extensive property damage. The region's hilly terrain, complex river systems, dense forests, and heavy rainfall exacerbate the severity of these disasters. A primary concern is the annual monsoon season, which triggers floods and landslides. States like Assam and Arunachal Pradesh often face massive floods, displacing thousands and destroying homes, crops, and infrastructure. Landslides threaten hilly areas, where unstable soil erodes during heavy rains, blocking roads and isolating communities, complicating aid delivery.

Climate change is worsening the situation, leading to erratic weather patterns and increasing the frequency and intensity of disasters. This emphasizes the urgent need for effective disaster management strategies. Inadequate infrastructure in remote areas poses challenges for disaster preparedness and recovery. To address these issues, there is a growing demand for technology-driven solutions for prediction, assessment, and management. An integrated system can reduce risks by utilizing real-time data, predictive analytics, and early warning systems.

Our proposed system, "System for Disaster Assessment and Forecasting of Emergency Risks (SAFER)," offers an advanced solution by integrating geospatial data for accurate disaster assessment and forecasting. It features a voice-controlled map interface, real-time alerts, and an intelligent ambulance booking system, enhancing disaster preparedness and response through precise data analysis and real-time information sharing.

1.1 Motivation

The frequent occurrence of disasters in Northeast India, characterized by floods, landslides, and earthquakes, presents significant challenges that demand urgent attention. These natural calamities have not only caused extensive damage but have also highlighted the inadequacies in the existing disaster management frameworks. For instance, recent events have demonstrated that rescue operations are often hindered by poor communication systems, a lack of real-time data, and inefficient ambulance dispatch mechanisms. Such delays can be life-threatening, making it critical to address these shortcomings with innovative solutions.

Furthermore, the region faces unique challenges related to digital literacy. Many individuals in affected areas may not possess the technical skills required to navigate complex systems. Therefore, there is an urgent need for intuitive interfaces that can be easily understood and used by non-expert users. By simplifying access to vital information and services, we can empower communities to better prepare for emergencies and respond more effectively when disasters strike.

The potential for technology to enhance emergency preparedness is immense. By integrating real-time data analytics, advanced communication tools, and efficient resource allocation systems, we can significantly reduce response times. These improvements not only increase the chances of successful rescue operations but also play a crucial role in saving lives.

Inspired by these challenges and opportunities, the development of SAFER aims to create a comprehensive solution that addresses the pressing needs of disaster management in Northeast India. SAFER seeks to leverage technology to bridge gaps in communication and information dissemination, ultimately enhancing the resilience of communities in the face of natural disasters. Through this project, we aspire to foster a safer environment, improve emergency preparedness, and contribute to the well-being of the affected populations.

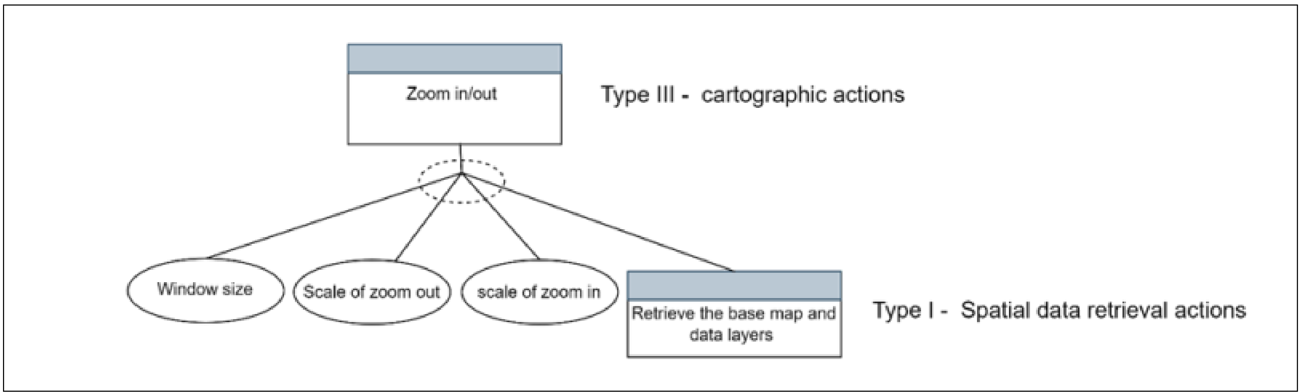

Figure 1.1: System Architechture proposed by Mahmoudi et al. (2023) [10]

The existing system, as represented by the Figure 1.1, focuses primarily on basic map interaction tasks, such as zooming in and out and retrieving spatial data layers. While these functions are essential for navigation and visualization, they are limited in scope and do not fully address the needs of users in critical situations. For instance, in emergencies, users may require quick access to vital information, such as the nearest hospital, police station, or their current location, which the existing system cannot provide. These limitations, particularly the lack of advanced, real-time service integrations and interactive capabilities, motivated us to expand the system's functionality.

Our project addresses these gaps by introducing multiple voice commands that go beyond simple cartographic actions. We integrated location-based services to allow users to find nearby essential facilities, such as hospitals and police stations, and added the ability to track the user's location. Additionally, we included real-time service features like ambulance booking. By combining these features with natural language processing for voice commands, our system is designed to be more responsive and user-friendly, especially in emergency scenarios where time and ease of use are critical. This expansion overcomes the drawbacks of the old system, making it more versatile and practical for real-world applications.

1.2 Problem Statement

This section highlights important issues that make disaster preparedness and response difficult. These include problems with accurate disaster assessment and forecasting, complicated user interfaces, delays in sharing real-time information, and limited connections between emergency services. By looking closely at these challenges, we aim to show the obstacles that stop us from fully using available technologies and data, emphasizing the need for new and innovative solutions within the SAFER framework.

Inaccurate disaster assessment and forecasting arise from poor integration of spatial data types, such as raster and vector data. This fragmentation leads to unreliable predictions, especially in high-risk areas prone to natural disasters. Many disaster management platforms has complex, non-intuitive interfaces, which are not easy to use for users, including emergency responders and local authorities. This complexity makes it difficult for them to access critical information quickly, hindering their ability to make informed decisions under pressure.

Delayed real-time information further complicates the situation. When emergency responders do not receive timely updates on changing conditions or new data, their decision-making processes suffer. This can result in increased damage and longer recovery times for affected communities, as opportunities for timely intervention are lost.

Additionally, the lack of integration among emergency services creates significant coordination challenges during disasters. When different services, such as ambulances, fire departments, and rescue teams, cannot share real-time information effectively, it leads to confusion and delays in response times. This inefficiency compromises the overall effectiveness of rescue operations and can put lives at risk.

Overall, these challenges highlight the urgent need for improved accuracy in disaster forecasting, user-friendly interfaces that simplify data access, timely dissemination of critical information, and enhanced integration among emergency services. Addressing these issues is vital for better managing disaster responses, ensuring swift action, and ultimately protecting the communities during emergencies.

1.3 Objectives

The key objectives of the SAFER project focus on improving disaster management in Northeast India by integrating advanced technologies. These include the use of machine learning for disaster assessment and prediction, creating voice-controlled interfaces for easier interaction with geospatial maps, generate report and statistics of disasters and developing an intelligent ambulance booking system. Each objective targets specific challenges in disaster preparedness and response, contributing to a more efficient and comprehensive emergency management framework.

- **To Integrate Disaster Assessment and Prediction in Northeast India**: This objective focuses on combining disaster assessment and prediction in Northeast India by utilizing an LSTM (Long Short-Term Memory) network. This advanced machine learning approach will analyze historical and real-time data to forecast potential disasters more accurately. By incorporating both raster data, which includes pixel-based information like satellite imagery, and vector data, which represents geographical features like roads and boundaries, we can create a comprehensive understanding of the region. This integration aims to enhance the accuracy of disaster forecasts and assessments, empowering local authorities and emergency responders to make informed decisions and implement timely interventions to protect communities at risk.

- **To Generate Comprehensive Reports and Statistics Based on Analysis**: This objective aims to produce detailed reports and statistical insights by analyzing data related to disaster scenarios. By collecting and processing information from various sources, such as past disaster events, evacuation procedures, and resource allocations, we can create clear and informative reports. These reports will summarize key findings and trends, helping local governments, emergency responders, and community organizations understand the effectiveness of their current strategies. Additionally, the statistics generated will provide valuable insights into areas that need improvement, guiding future planning and resource distribution to enhance overall disaster preparedness and response efforts.

- **To Provide a Voice-Controlled Interface for Seamless Interaction with Geospatial Maps**: This objective focuses on developing a user-friendly voice-controlled interface that allows individuals to interact effortlessly with geospatial maps. By using the Web Speech API, Flutter TTS, and STT, the interface will enable users to navigate maps, query information, and execute commands simply by speaking. Users will be able to:

  - **Locate Nearest Hospitals**: The interface will allow users to ask for the nearest hospitals, providing real-time directions and distance information, ensuring quick access to medical facilities in emergencies.
  - **Request Ambulance Services**: Users can issue voice commands to request nearby ambulance services, enabling rapid response during critical situations.
  - **Show My Location**: The interface will provide users with their current location on the map, assisting in navigation and situational awareness, particularly beneficial in unfamiliar areas.
  - **Access Emergency Resources**: Users can query information about essential services such as fire stations, police stations, or shelters, helping them make informed decisions during crises.

  This approach is particularly beneficial for users who may have difficulty using traditional interfaces or for those in emergency situations where hands-free operation is crucial. By making geospatial data more accessible through voice commands, we aim to empower emergency responders, local authorities, and the general public to quickly access vital information during critical moments.

- **To Integrate an Intelligent Ambulance Booking System with Real-Time GPS Tracking and a Voice-Controlled First Aid Assistant**: This objective aims to create an advanced ambulance booking system that includes real-time GPS tracking and a voice-controlled first aid assistant. The system will allow users to quickly request an ambulance with just a few voice commands, ensuring a fast response during emergencies. By incorporating GPS tracking, the system will enable emergency responders to locate and dispatch ambulances efficiently, reducing wait times for those in need. Additionally, the voice-controlled first aid assistant will provide users with immediate guidance on basic first aid procedures while they wait for help to arrive. This integration seeks to improve the overall efficiency of emergency response efforts and enhance the safety and well-being of individuals during critical situations.

1.4 Scope

This section defines the scope of the SAFER project, focusing on enhancing disaster management in Northeast India. Key areas include providing real-time disaster information to emergency responders, assisting local governments with resource planning, improving emergency dispatch systems, ensuring public access to forecasts and evacuation plans, and supporting disaster management authorities with advanced predictive models. Together, these efforts aim to create a more effective approach to disaster preparedness and response.

- **Real-Time Disaster Information for Emergency Responders**: Emergency responders play a crucial role in managing disaster situations, and providing them with real-time disaster information and predictions is essential for enhancing their effectiveness. By delivering accurate and timely data about ongoing and potential disasters, responders can make informed decisions, prioritize their actions, and allocate resources efficiently. Access to real-time information not only improves situational awareness but also allows for proactive planning and swift response strategies, ultimately contributing to the safety and well-being of affected communities. This integration of real-time data and predictive analytics empowers emergency responders to navigate complex disaster scenarios with greater confidence and efficiency.

- **Resource Planning for Local Governments**: Assisting local governments in planning and allocating resources for disaster preparedness is vital to ensuring a proactive and organized response to emergencies. By providing them with accurate data and insights into potential disaster scenarios, local authorities can better assess risks and prioritize resource allocation effectively. This support enables governments to develop comprehensive disaster preparedness plans that include infrastructure improvements, emergency response training, and community engagement initiatives. Additionally, having access to real-time information allows for informed decision-making regarding the deployment of personnel and equipment during emergencies, ensuring that resources are utilized efficiently. Ultimately, this collaboration fosters a resilient community that is better equipped to handle disasters, minimizing their impact and safeguarding public safety.

- **Efficient Emergency Dispatch Systems**: Enhancing dispatch efficiency through smart ambulance booking and alerting emergency rescue teams is crucial for improving response times during critical situations. An intelligent ambulance booking system optimizes resource allocation by quickly identifying the nearest available ambulance based on real-time data, such as location and traffic conditions. This system can also automatically alert emergency rescue teams, providing them with essential information about the emergency and the quickest routes to the scene. By streamlining the dispatch process and fostering collaboration among responders, communities can significantly improve their emergency medical services, leading to better outcomes for those in need of urgent assistance.

- **Public Access to Disaster Forecasts**: Allowing the general public to access disaster forecasts and evacuation plans is essential for promoting better preparedness and ensuring timely evacuations during emergencies. By providing accessible information on potential disaster scenarios, including weather forecasts, seismic activity, and other relevant data, communities can empower individuals to make informed decisions about their safety. Public access to well-defined evacuation plans enables residents to understand the safest routes and procedures to follow in the event of a disaster, reducing confusion and anxiety during critical situations. This proactive approach not only enhances community resilience but also fosters a culture of preparedness, encouraging individuals to take personal responsibility for their safety and that of their families. Ultimately, by keeping the public informed and prepared, we can minimize the impact of disasters and ensure more effective responses when emergencies arise.

- **Support for Disaster Management Authorities**: Helping disaster management authorities make informed decisions through advanced predictive models and analytics is essential for effective disaster risk assessment and mitigation. By utilizing data analysis techniques and machine learning algorithms, authorities can gain insights into potential disaster scenarios and their impacts. These predictive models analyze historical data and current conditions to identify high-risk areas and forecast the likelihood of disasters. This information enables authorities to prioritize resources, develop targeted mitigation strategies, and implement preventive measures tailored to specific risks. Ultimately, equipping decision-makers with accurate, data-driven insights enhances their ability to protect communities and minimize the overall impact of disasters.

Chapter 2

Literature Review

Recent advancements in disaster management have increasingly leveraged geospatial data and machine learning, particularly for flood and landslide prediction systems. These innovations, while promising, face challenges such as data inaccuracy, integration complexities, and high computational demands. This literature review examines key research addressing these issues, with a focus on the SAFER framework. SAFER integrates high-resolution geospatial data, machine learning algorithms, and accessible technologies to enhance real-time disaster prediction, assessment, and response. Comparative analysis highlights challenges like data accuracy in prediction and the lack of timely information for decision-makers, which are addressed through solutions such as frequently updated geospatial data and ArcGIS dashboards for instant reporting. Additionally, innovations like voice-controlled geospatial maps for visually impaired users and SMS-based ambulance booking systems aim to improve accessibility during emergencies. This review identifies gaps in current approaches and suggests future research directions to enhance both prediction accuracy and emergency response effectiveness.

2.1 Comparative Analysis of Recent Study

The section represents a comparative analysis of for addressing key challenges in disaster management using the SAFER system. It identifies problems like data inaccuracy, complexity in disaster prediction, and lack of real-time information, offering solutions such as high-resolution data, voice-enabled navigation, and SMS-based ambulance booking. This approach aims to improve real-time response and accessibility in critical situations.

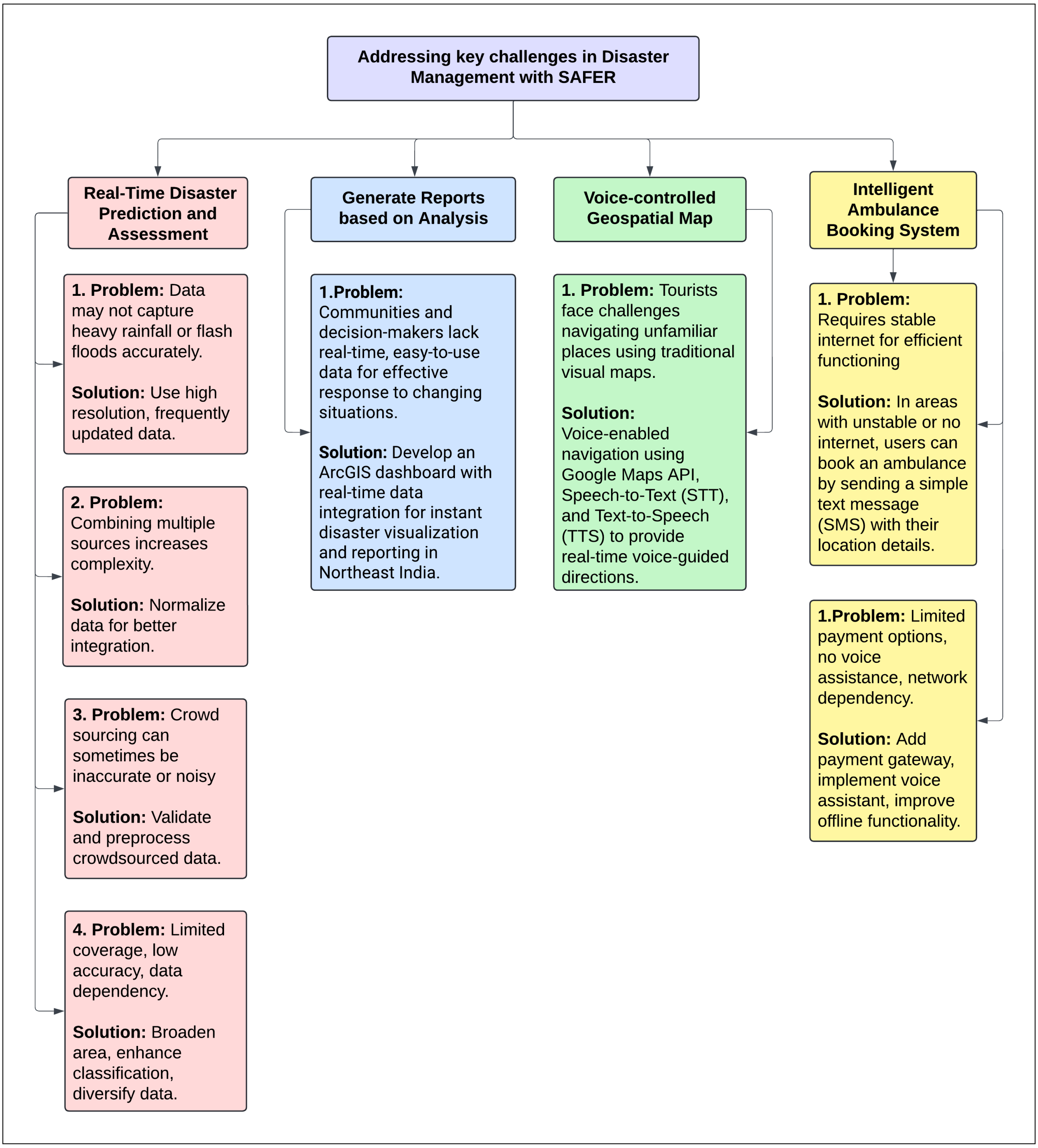

Figure 2.1: SAFER Literature Review Analysis

The paper "The Ambulance Booking and Tracking System" by Anbarasu P et al. (2024)[1] introduces a digital solution designed to enhance the efficiency of requesting and dispatching emergency medical services. The Ambulance Booking System (ABS) offers an intuitive platform accessible via web and mobile applications, enabling users to quickly request an ambulance, provide essential patient information, and track the ambulance's location in real-time. The methodology incorporates GPS technology to pinpoint the client's location and nearby ambulances on a map, facilitating efficient booking and timely responses during emergencies. By streamlining communication between emergency services and the public, the ABS ensures a more effective response to medical emergencies, ultimately improving access to emergency healthcare.

R. Jyothsingh et al. (2024)[8] presents a comprehensive platform designed to enhance emergency response processes by facilitating seamless communication among patients, ambulance drivers, and hospitals through a user-friendly website interface. The system allows patients to register and log in to book ambulances based on availability and proximity to hospitals while accessing detailed ambulance listings. Ambulance drivers can view and accept patient requests, updating their status upon completion of a service. The methodology focuses on efficiently managing multiple requests, displaying remaining patient needs when a driver is on duty, and marking accepted requests for clarity. Additionally, hospitals can maintain driver records, improving coordination within the emergency response network. By streamlining the booking process and enhancing real-time communication, the proposed system aims to improve the overall efficiency of emergency medical services.

The study titled "Landslide Detection in Uttarakhand Region Using Active Remote Sensing" by Vivek Chamoli et al. (2024)[2] focuses on detecting landslides in the Tota Ghati region of Uttarakhand using Sentinel-1 satellite data. It applies both unsupervised and supervised classification techniques to satellite images to identify changes before and after the August 2021 landslide, with image processing done in ERDAS Imagine software. The study achieved an accuracy of 92.12% pre-landslide and 94.75% post-landslide but faced challenges such as location specificity, low Kappa coefficient for certain classifications, and dependency on Sentinel-1 data availability.

The "Ambulo Mobile Application for Online Ambulance Booking" by Seema Redekar et al.(2024)[13] offers a solution to reduce delays in ambulance services by enabling real-time booking and tracking. The app integrates Google Maps API, along with Dijkstra's and A* algorithms, to optimize ambulance routes based on traffic conditions. Users can select the nearest hospital or specific ambulance types such as Basic Life Support, Advanced Life Support, or Mortuary Ambulance. The application includes dedicated modules for users, drivers, and administrators, ensuring efficient communication and real-time updates. However, the app is currently limited by cash-only payment options, lacks voice assistance for special needs users, and depends on network connectivity, which may impact its functionality in areas with poor internet coverage.

Addressing the issue of road accident casualties, the paper "Optimal Ambulance Positioning for Road Accidents With Deep Embedded Clustering"[4] proposes a novel approach to ambulance positioning that emphasizes pre-positioning over reactive dispatch. The methodology involves using Deep Embedded Clustering to optimize ambulance locations for quick responses to road accidents. By analyzing historical data, the system clusters accident-prone areas and strategically positions ambulances in those regions, significantly reducing response times. The study employs a new deep-learning model, Cat2Vec, to capture complex patterns and relationships in the data and compares this approach with traditional clustering algorithms such as K-means, Gaussian Mixture Models (GMM), and Agglomerative clustering. Furthermore, a novel scoring function is introduced to evaluate real-time response time and distance, enhancing the framework's effectiveness.

Ghorbanzadeh et al.(2022) take an advanced approach in "Landslide Detection Using Deep Learning" [7] by merging a ResU-Net deep learning model with Object-Based Image Analysis (OBIA) for improved landslide detection using Sentinel-2 satellite imagery. The study compares three methods: ResU-Net, OBIA, and an integrated ResU-Net-OBIA approach. The integrated model shows significant improvements, yielding higher f1-scores and accuracy, especially by reducing false positives. The proposed method refines the results of pixel-based models by incorporating object-based classification.

In their 2022 paper, Collini et al.[3] introduces a machine learning-based short-term prediction model for landslide events, using explainable AI to improve interpretability. The study focuses on rainfall-induced landslides in the Metropolitan City of Florence, analyzing real-time features such as rainfall, temperature, and water levels. The XGBoost model proved most effective, outperforming traditional models like SIGMA in terms of accuracy and false alarm reduction. The use of explainable AI, specifically SHAP, allowed for understanding the relevance of features in both local and global predictions. The model aims to assist early warning systems for landslide-prone areas.

A notable contribution from Arizona State University, "Building Community Resilience Through Geospatial Dashboards"[11], showcases a toolkit that integrates and visualizes multi-agency data, aiding decision-making by providing real-time insights into local challenges. Dashboards focus on economic resilience, mobility disruptions, and poverty tracking, offering data in a user-friendly manner. They allow communities to track issues like unemployment, economic impacts, and behavioral responses to events like COVID-19. The goal is to empower communities with tools to understand evolving challenges and develop targeted responses efficiently.

Jinyang Du et al.(2021)[5] explores the use of satellite data for flood monitoring and forecasting, focusing on Cyclone Idai in southeast Africa. Using SMAP and Landsat data, the study applied a machine learning-based Classification and Regression Trees (CART) model for 30-meter resolution flood mapping. The model achieved a high correlation ($R = 0.87$) with observed data and effectively captured the flood's spatial and temporal dynamics. The study emphasizes the value of satellite data and machine learning for flood forecasting, especially in data-scarce regions.

Supattra Puttinaovarat and Paramate Horkaew (2020) take flood forecasting to a new level by integrating meteorological, hydrological, geospatial, and crowdsourced data with machine learning techniques[12]. Using models like Decision Trees, Random Forest, and Artificial Neural Networks, the system achieves high accuracy in predicting floods, with the MLP ANN model performing best, showing a classification accuracy of 97.93% and a Kappa score of 0.89. The integration of crowdsourced data enhances real-time flood predictions, providing a valuable tool for flood preparedness and response.

The paper "An Interactive Voice Assistant System for Guiding Tourists in Historical Places"[9] presents a voice-enabled navigation system that enhances the tourist experience at historical sites through Human-Machine interaction, utilizing speech recognition and Text-to-Speech technologies for accurate guidance. By employing the Google Map API, the system offers cost-effective, self-governing navigation, especially for local users unfamiliar with specific areas. It processes user auditory input, matches it with keywords in its database, and provides pre-stored voice messages for navigation. Integrated GPS technology enables precise directional guidance via audio cues, making the system beneficial for visually impaired individuals and those less adept with technology, thus enhancing accessibility for all visitors.

Kuldeep et al.(2016)[6] uses geospatial techniques for flood mapping in river islands in India. The study uses a texture-based classification approach with satellite data from Indian Remote Sensing Satellites (LISS-III and Cartosat-1) to identify land use/cover categories such as water, sand, and islands. The HEC-GeoRas model within a GIS environment is employed for flood inundation mapping, helping to identify river islands less vulnerable to flooding, which can be used for eco-tourism projects.

Key Challenges in Disaster Management with SAFER

The SAFER project addresses key challenges in disaster management by proposing innovative solutions. It enhances Real-Time Prediction and Assessment through high-resolution data integration, implements ArcGIS dashboards for timely report generation, and improves accessibility with a voice-controlled map using the Web Speech API. Additionally, it enables ambulance booking and SMS service to assist the users with limited internet access during emergencies.

- **Real-Time Prediction and Assessment**: Data accuracy issues arise when capturing short-term events and integrating multiple sources, such as weather data and sensor readings.
  Solution: Use high-resolution, frequently updated data and normalize inputs for better integration, enhancing the reliability of predictions.

- **Report Generation**: The generation of comprehensive reports on historical disasters is crucial for informed decision-making and future preparedness.
  Solution: Statistical reports that include in-depth analyses, along with graphs and charts, can provide valuable insights into historical disaster patterns. This visual representation of data enhances understanding, enabling authorities to make more informed decisions.

- **Voice-Controlled Map**: Visually impaired users struggle with navigating mobile applications that rely heavily on visual elements.
  Solution: This solution integrates the Web Speech API with Flutter's Text-to-Speech (TTS) and Speech-to-Text (STT) functionalities, enabling users to navigate maps and execute commands through voice input, thereby enhancing accessibility.

- **Ambulance Booking System**: Limited internet access can affect emergency bookings, leaving vulnerable populations without essential services during disasters.
  Solution: Enable SMS-based ambulance booking, ensuring better accessibility for users in low-network areas, allowing them to request emergency assistance via text messages.

The Table 2.1 summarizes various existing systems and methodologies relevant to the SAFER project, focusing on ambulance booking systems, landslide detection, and related technologies. Each entry highlights the key aspects, methodologies, and potential drawbacks of the reviewed literature.

Table 2.1: SAFER Literature Review

Sr. No	Year	Title	Author(s)	Methodology	Drawback
1	2024	The Ambulance Booking and Tracking System	Anbarasu P, Arunkumar S, Gowtham R, Deepak S, Latha M (Professor)	A mobile app enables users to book and track ambulances in real time, with a server processing requests, matching ambulances, and sending arrival updates, while storing data in a database.	1. Accuracy depends on data resolution but an increase in accuracy will need more computational power. 2. Short-term events (heavy rainfall for 1hr or flash floods) may not be captured accurately if the data is not updated frequently enough.
2	2024	Ambulance Booking System	R. Jyothsingh (Assistant Professor, SRK Institute of Technology) Thota Swathi, Kareti Lepakshi, Pulivarthi Akash, Puvvaladasu Hemanth	The Ambulance Booking System uses a mobile app for users to request ambulances, processing requests, matching them with available units, and providing real-time tracking and notifications.	1. Internet Reliance: Depends on stable internet for functionality. 2. Limited Features: May lack advanced features compared to more comprehensive systems
3	2024	Landslide Detection in Uttarakhand Region Using Active Remote Sensing	Vivek Chamoli, Rishi Prakash, Rishabh Bahuguna, Anurag Vidyarthi, R. Gowri, Ved Prakash Dubey	Detects landslides in Uttarakhand's Tota Ghati using Sentinel-1 data and ERDAS Imagine classification.	1. Limited locations– Focuses only on Tota Ghati, making results hard to generalize to other areas. 2. Classification issues– The Kappa coefficient for landslide areas was low (0.5498), indicating classification difficulties. 3. Data reliance- Dependency on Sentinel-1 data limits the study if that data is unavailable.
4	2024	Ambulo Mobile Application for Online Ambulance Booking	Seema Redekar, Saloni Kharat, Chirag Gupta, Tarun Iyer, Sneha Baital	Ambulo provides real-time ambulance booking and tracking using optimized routing algorithms to enhance emergency response.	1. Limited payment methods – Currently supports only cash payments, with plans for payment gateway integration. 2. No voice assistance yet – Special needs users may encounter difficulties until voice functionality is added. 3. Reliance on network connectivity – App performance may be affected in areas with poor internet coverage.

5	2023	Optimal Ambulance Positioning for Road Accidents with Deep Embedded Clustering	Dhyal Desai Dhyani, Joyeeta Dey, Sandeep Kumar Satapathy, Shruti Mishra, Sachi Nandan Mohanty, Pallavi Mishra, Sandeep Kumar Panda	The study suggests using Deep Embedded Clustering to optimize ambulance positioning based on historical data of accident-prone areas, reducing response times.	1. Data Dependency: Requires extensive and accurate historical accident data.
6	2022	Landslide Detection Using Deep Learning and Object-Based Image Analysis	Omid Ghorbanzadeh, Hejar Shahabi, Alessandro Crivellari, Saeid Homayouni, Thomas Blaschke, and Pedram Ghamisi	The paper integrates Deep Learning (ResU-Net) and Object-Based Image Analysis (OBIA) for landslide detection using Sentinel-2 imagery.	1. Pixel-based Deep Learning (DL) models can struggle to differentiate between similar-looking features (e.g., riverbeds vs. landslides).This limitation often leads to false positives in the landslide detection process.
7	2022	Predicting and Understanding Landslide Events With Explainable AI	Enrico Collini, L. A. Ipsaro Palesi, Paolo Nesi, Gianni Pantaleo, Nicola Nocentini, Ascanio Rosi.	The paper introduces a 1-day landslide prediction model using XGBoost and Explainable AI, leveraging static and real-time features, with data managed through Snap4City and validated with 2013-2019 data from Florence.	1.While the model achieves better prediction accuracy than previous approaches, its implementation is computationally expensive due to the large dataset and the heterogeneity of the input data.
8	2022	Building community resilience through geospatial information dashboards	S. Praharaj, E. Wentz	The methodology involved collecting local data via APIs, integrating it with GeoNode and R, and creating a multi-view web dashboard for interactive community response.	1. Lack of Granular Data: Dashboards often lack sub-group data, limiting insights into the unequal impacts of crises. 2. Complex Navigation: Poor design, limited data options, and unclear narratives reduce user engagement and decision-making effectiveness.

9	2021	Satellite Flood Inundation Assessment and Forecast Using SMAP and Landsat	Jinyang Du, John S. Kimball, Senior Member, Justin Sheffield, Ming Pan Colby K. Fisher, Hylke E. Beck, and Eric F. Wood	A flood prediction model using rainfall, soil moisture, and satellite data forecasts events up to 3 days with a Classification and Regression Trees (CART) model.	1. Accuracy Depends on data resolution but increase in accuracy will need more computational power. 2. Short-term events (heavy rainfall for 1hr or flash floods) may not be captured accurately if the data is not updated frequently enough.
10	2020	Flood Forecasting System Based on Integrated Big and Crowdsource Data by Using Machine Learning Techniques	Supattra Puttinaovarat, Paramate Horikawa	Develop a flood forecasting system that uses real-time and crowdsourced data with machine learning for accurate and timely predictions.	1. Accuracy depends on data quality 2. Combining multiple data sources increases complexity . 3. Crowdsourcing can sometimes be inaccurate or noisy .
11	2020	An Interactive Voice Assistant System for guiding the Tourists in Historical places	R. Keerthana, Dr. T. Ananth Kumar, P. Manjubala, M. Pavithra	The methodology features a voice assistant that converts commands to text and provides real-time navigation with audio instructions using Text-to-Speech (TTS) technology.	1. Internet and Language Limitations: The system's reliance on a stable internet connection and limited language support restricts its usability in areas with poor connectivity and for non-English speakers. 2. Accuracy and Privacy Concerns: Speech recognition may face challenges in noisy environments or with different accents, and the use of location data raises potential privacy issues if not securely managed.
12	2016	Geospatial techniques for flood inundation mapping	Kuldeep, P. K. Garg, R. D. Garg	A framework identifies river islands for eco-friendly tourism by analyzing satellite data and flood risks to ensure flood resistance.	1. Accuracy of flood modeling and land classification depends on the resolution. 2. HEC-RAS is Resource Demanding.

Chapter 3

Project Design

The project design phase is crucial for transforming conceptual ideas into practical solutions. For the SAFER system, this design process involves a careful examination of system architecture, user interfaces, and data management strategies. This ensures that all components work together effectively to achieve the project's goals. The system integrates various technologies and data sources, creating an efficient platform focused on real-time data processing, predictive analytics, and user-friendly interfaces. By highlighting the roles of different data layers, the architecture facilitates a smooth transition from data acquisition to actionable insights, allowing users to respond quickly and effectively during disasters.

Key components of the SAFER system include the collection and analysis of geospatial and weather data. By leveraging real-time monitoring, machine learning models, and interactive interfaces, the system enhances situational awareness for users. A data flow diagram (DFD) illustrates how information is exchanged among different users, such as local authorities, emergency responders, and the public. Additionally, a use case diagram outlines user interactions, clarifying the distinct roles of various user groups in disaster management. For example, local authorities may focus on high-level predictions and resource allocation, while emergency responders utilize real-time data for navigation and situational updates.

Overall, this chapter provides a comprehensive overview of the SAFER system's design. It showcases its potential to enhance the efficiency and accuracy of disaster responses. By emphasizing a user-centric approach, the SAFER system aims to empower all stakeholders involved in disaster management, ensuring that they have the tools and information necessary to act effectively in emergencies.

3.1 Proposed System Architecture

The Figure 3.1 illustrates the architecture of the **SAFER** system, which integrates various layers for effective disaster management. Each layer serves a specific purpose, contributing to a comprehensive approach that includes data collection, integration, processing, analysis, and real-time operations.

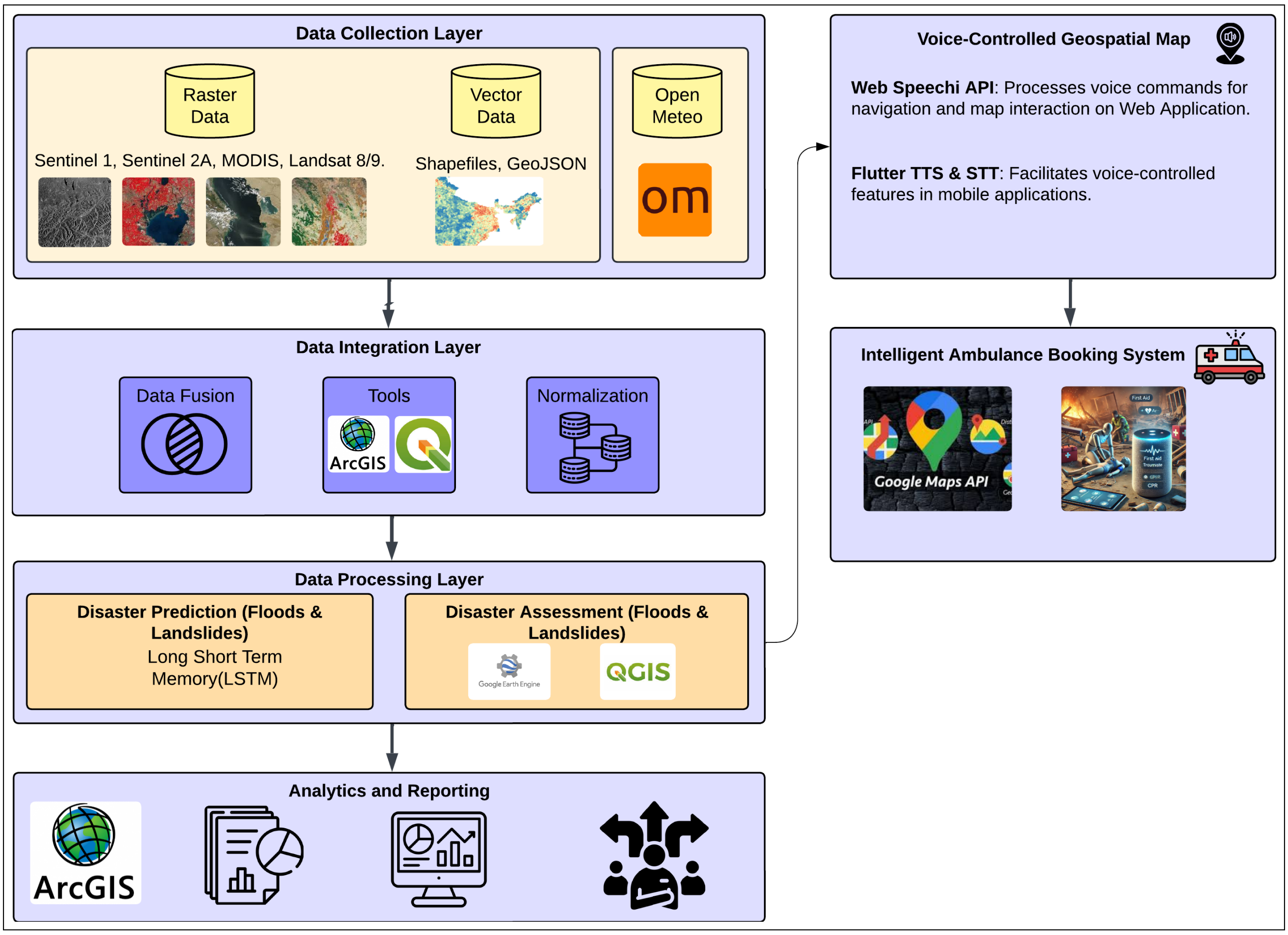

Figure 3.1: SAFER System Architecture

1. Data Collection Layer

This layer forms the backbone of the system by aggregating various geospatial and weather data. It combines both raster and vector data:

- **Raster Data**: Satellite imagery from sources like **Sentinel 1**, **Sentinel 2A**, **MODIS**, and **Landsat 8/9**. These high-resolution images are crucial for environmental monitoring, disaster identification and temporal analysis.
  - **Sentinel 1**: Provides radar imaging, which is useful for detecting changes in land surface, especially for flood monitoring, even in cloudy conditions.
  - **MODIS and Landsat**: Capture multispectral images that help in identifying different land cover types, vegetation health, and water bodies.
- **Vector Data**: This includes **Shapefiles** and **GeoJSON** formats that provide geographic features like administrative boundaries, infrastructure (roads, hospitals), and disaster zones. Vector data is fundamental for precise map overlays and localization.
- **Open Meteo Data**: This service integrates weather information such as precipitation, temperature, and wind forecasts. Timely weather updates are crucial in predicting events like floods or cyclones.

Purpose: The data collection layer ensures that diverse types of spatial and weather data are gathered and prepared for analysis. By combining multiple satellite sources with weather data, this layer forms a comprehensive real-time and historical dataset.

2. Data Integration Layer

Once data is collected, it needs to be harmonized and fused for further analysis. This layer is responsible for:

- **Data Fusion**: The combination of raster and vector datasets helps in creating a unified view. For example, satellite images (raster) can be overlaid with infrastructure data (vector) to assess the impact of disasters on buildings and roads.
- **Tools (ArcGIS & QGIS)**: These are the primary Geographic Information System (GIS) tools used to process, analyze, and visualize spatial data. ArcGIS offers advanced spatial analytics, while QGIS is an open-source alternative, ensuring accessibility for different users.
- **Normalization**: Data normalization ensures that inputs from various sources are in a compatible format and scale. This allows for seamless integration and analysis, ensuring the accuracy and comparability of the datasets.

Purpose: The integration layer is essential for preparing data in a usable format, combining multiple sources into a unified geospatial framework. This allows for accurate predictions and assessments in subsequent layers.

3. Data Processing Layer

The processed data from the integration layer is now ready for deeper analysis:

- **Disaster Prediction**: Using **Long Short-Term Memory (LSTM)**, a deep learning model, this component forecasts future disaster events like floods and landslides. LSTM is particularly suited for time-series data (such as weather data) and can model dependencies over long periods, making it ideal for disaster prediction based on historical patterns and real-time inputs.
- **Disaster Assessment**: Post-disaster, tools like **Google Earth Engine** and **QGIS** assess the extent and impact of the disaster. These assessments help identify affected areas, quantify damage, and plan for resource allocation.
  - **Google Earth Engine**: Cloud-based platform that performs large-scale geospatial analysis, ideal for monitoring and assessing changes over vast regions.

Purpose: The data processing layer transforms raw data into actionable insights, providing predictive and post-event analyses. This helps authorities prepare for disasters and respond quickly when they occur.

4. Analytics and Reporting

- **ArcGIS & Reporting Tools**: The results of the analysis are visualized and reported using GIS tools. This layer creates maps, reports, and dashboards that can be shared with decision-makers.
- The data processed in this step supports strategic decisions, such as disaster response strategies, evacuation planning, and resource distribution.

Purpose: This layer ensures that the processed data is converted into user-friendly formats, enabling stakeholders to make informed decisions.

5. Voice-Controlled Geospatial Map

- **Web Speech API**: Enables voice-based interactions with geospatial data on a web-based platform. For example, users can give commands like "show flood zones" or "zoom to affected areas" using voice commands, making the interface more accessible, especially in emergency situations.
- **Flutter TTS & STT**: For mobile applications, Text-to-Speech (TTS) and Speech-to-Text (STT) functions are implemented using Flutter to provide a voice-activated navigation experience. This can be useful for emergency responders who need hands-free access to maps while on the move.

Purpose: The voice-controlled functionality makes the system highly user-friendly, especially during emergencies where quick, hands-free access is critical.

6. Intelligent Ambulance Booking System

- **Google Maps API**: Provides real-time routing and location services. By integrating geospatial data and real-time traffic or disaster zone information, the system can direct ambulances to avoid blocked roads and reach affected individuals faster.
- **Mobile Control Systems**: These provide emergency responders with real-time situational updates, helping them navigate effectively in disaster scenarios.

Purpose: This system is designed to optimize emergency response time, ensuring that medical help reaches victims in the shortest possible time, even in complex disaster situations.

3.2 Data Flow Diagrams(DFD)

The Figure 3.2 demonstrates how users interact with and navigate through the system to access disaster-related information and services.

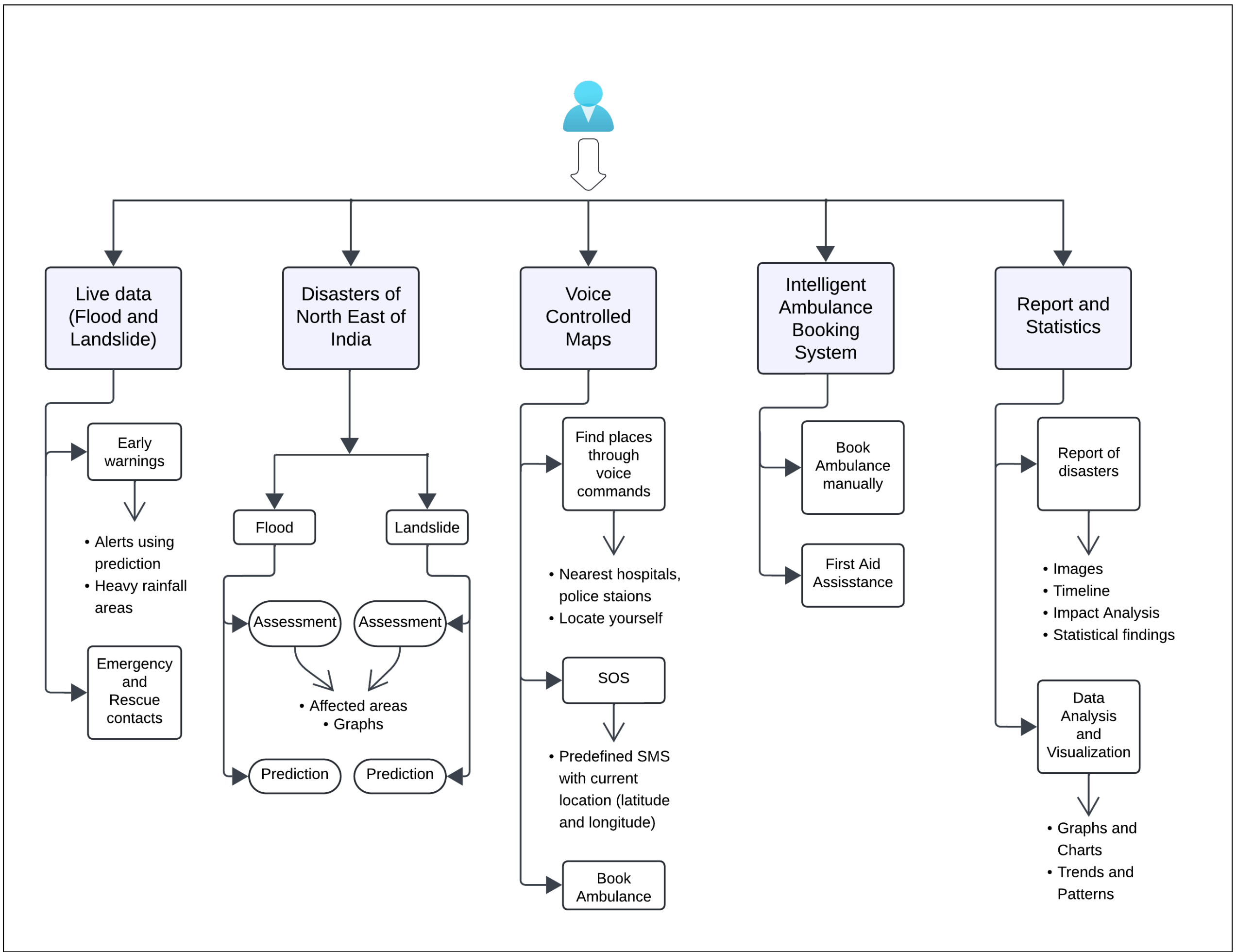

Figure 3.2: SAFER Data Flow Diagram

- **Main User Interaction:**
  The user is central to the system's operations, with multiple modules interacting directly with them. These modules provide various functionalities, including data access, voice commands, and emergency services.

- **Live Data (Flood and Landslide):**
  This module handles real-time data related to flood and landslide conditions.

  - **Early Warnings:** The system uses this live data to provide early warnings to the users, allowing them to prepare for possible disasters.
  - **Emergency and Rescue Contacts:** If an immediate threat is detected, this module also provides contact information for emergency services and rescue operations.

- **Disasters of North East of India:**
  This focuses on disaster assessment and prediction specifically in Northeast India.

  - **Assessment:** Both floods and landslides assessment is done to find the affected areas of the historical disasters and also the rainfall graph in that respective month.

- **Prediction:** Using the live data, the system predicts the likelihood and severity of future occurrences, helping in proactive disaster response.

- **Voice-Controlled Maps:**
  This module allows users to interact with geospatial maps using voice commands.
  - **Find Places through Voice Commands:** Users can locate areas or access data by speaking commands, simplifying navigation through complex geographical data.
  - **SOS Functionality:** In case of emergencies, users can activate SOS through which the user can directly send the SMS of their location during emergencies.
  - **Book Ambulance:** The voice interface can also facilitate ambulance booking directly through spoken requests, improving the speed of response.

- **Intelligent Ambulance Booking System:**
  This system provides a seamless method for users to access emergency transportation during disaster events.
  - **Book Ambulance Manually:** Users have the option to book an ambulance manually through the system.
  - **First Aid Assistance:** The system can provide guidance on first aid, helping users manage injuries or health issues while awaiting professional medical assistance.

- **Report and Statistics:**
  This module deals with compiling and analyzing disaster data.
  - **Report of Disasters:** The system generates detailed reports about disasters, including their impact and response.
  - **Data Analysis and Visualization:** Collected data is processed for analytical purposes, offering insights through visualization tools. This helps in better understanding disaster patterns and improving preparedness for future events.

The SAFER system combines real-time data, predictive analytics, voice-controlled interfaces, and emergency management tools to create a comprehensive disaster management platform. By focusing on Northeast India and leveraging technologies like voice commands and geospatial data, it aims to enhance response times and improve outcomes during floods and landslides. The system also offers detailed reports and statistics to help authorities for better future disaster management.

3.3 Use Case Diagrams

The Figure 3.3 shows interactions between four user types—Local Authorities, Emergency Responders, Public Users, and Ambulance Drivers and the system's components.Here's a brief explanation of each component:

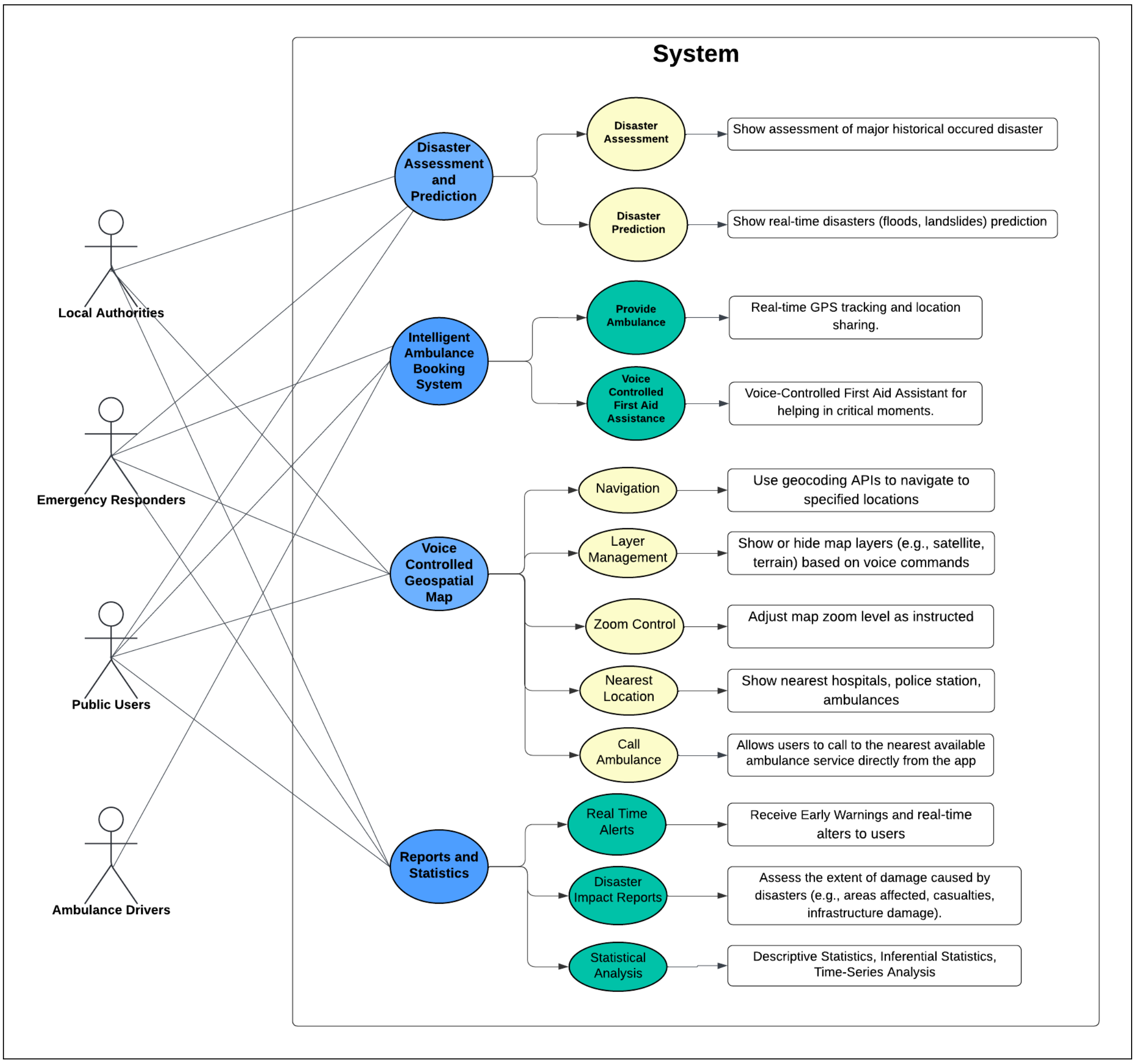

Figure 3.3: SAFER Use Case Diagram

Actors:

The SAFER system involves several key actors, each playing a crucial role in disaster management and response. These actors interact with the system's various components to ensure efficient coordination, timely assistance, and accurate dissemination of information.

- **Local Authorities**: They might include government officials, disaster management agencies, and police. They can access features related to disaster assessment, prediction, and emergency coordination.
- **Emergency Responders**: These include paramedics, rescue teams, and others who are directly involved in on-ground response efforts. They use functionalities such as navigation, geospatial maps, and real-time information.
- **Public Users**: This group consists of civilians who might need real-time alerts, assistance during disasters, or ambulance services.

- **Ambulance Drivers**: They are specifically involved in providing ambulance services and may use GPS tracking and location-sharing features to reach people in need quickly.

Use Case Components:

The SAFER system is composed of several key use case components designed to enhance disaster preparedness, response, and coordination. Each component serves a specific function, providing users with the tools and information necessary to effectively manage emergencies.

- **Disaster Assessment and Prediction**:
  - **Disaster Assessment**: This shows the assessment of past major disasters to help with planning.
  - **Disaster Prediction**: It provides real-time predictions for events like floods or landslides.
- **Intelligent Ambulance Booking System**:
  - **Provide Ambulance**: Enables real-time GPS tracking and location sharing for effective ambulance dispatch.
  - **Voice-Controlled First Aid Assistance**: Provides voice-guided assistance for basic first aid during emergencies.
- **Voice-Controlled Geospatial Map**:
  - **Navigation**: Uses geocoding APIs for guiding emergency responders or users to specified locations.
  - **Layer Management**: Allows users to toggle map views (e.g., satellite or terrain) through voice commands.
  - **Zoom Control**: Adjusts the map view based on user instructions.
  - **Nearest Location**: Displays nearby critical services such as hospitals, police stations, and ambulances.
  - **Call Ambulance**: Allows users to directly request ambulance services.
- **Reports and Statistics**:
  - **Real-Time Alerts**: Provides early warnings about disasters or emergencies.
  - **Disaster Impact Reports**: Assesses the damage caused by disasters, such as affected areas and casualties.
  - **Statistical Analysis**: Offers descriptive and inferential statistics, along with time-series analysis to understand trends.

This diagram provides a clear picture of how different users interact with various functions of the system to enhance disaster preparedness, response, and coordination. It aims to improve the efficiency of disaster management efforts and ensure quicker response times in emergencies.

Chapter 4

Project Implementation

The implementation of this project focuses on building a comprehensive disaster assessment and forecasting system, specifically designed to support real-time decision-making during natural disasters such as floods and landslides. This chapter outlines the various stages of the project development, detailing the tools, technologies, and methodologies employed to achieve the project objectives. From the initial planning phase to the deployment of interactive maps and voice-controlled geospatial systems, the project integrates predictive analytics, real-time monitoring, and user-friendly interfaces to enhance disaster response and preparedness. The following sections delve into the timeline, key features, and capabilities of the system, demonstrating its effectiveness in providing critical information and support during emergencies.

4.1 Timeline Sem VII

The Figure 4.1 provides a detailed overview of a major project focused on disaster assessment and forecasting systems. This Gantt chart outlines the phases, tasks, and responsibilities, mapping out the progress of the project across multiple weeks. By breaking down the tasks, it shows both completed and ongoing activities. It also highlights task owners, due dates, and progress percentages, offering a clear roadmap for project development. With the timeline structure, it becomes easier to monitor the workload, track the duration of tasks, and ensure that key deliverables are met within the planned deadlines.

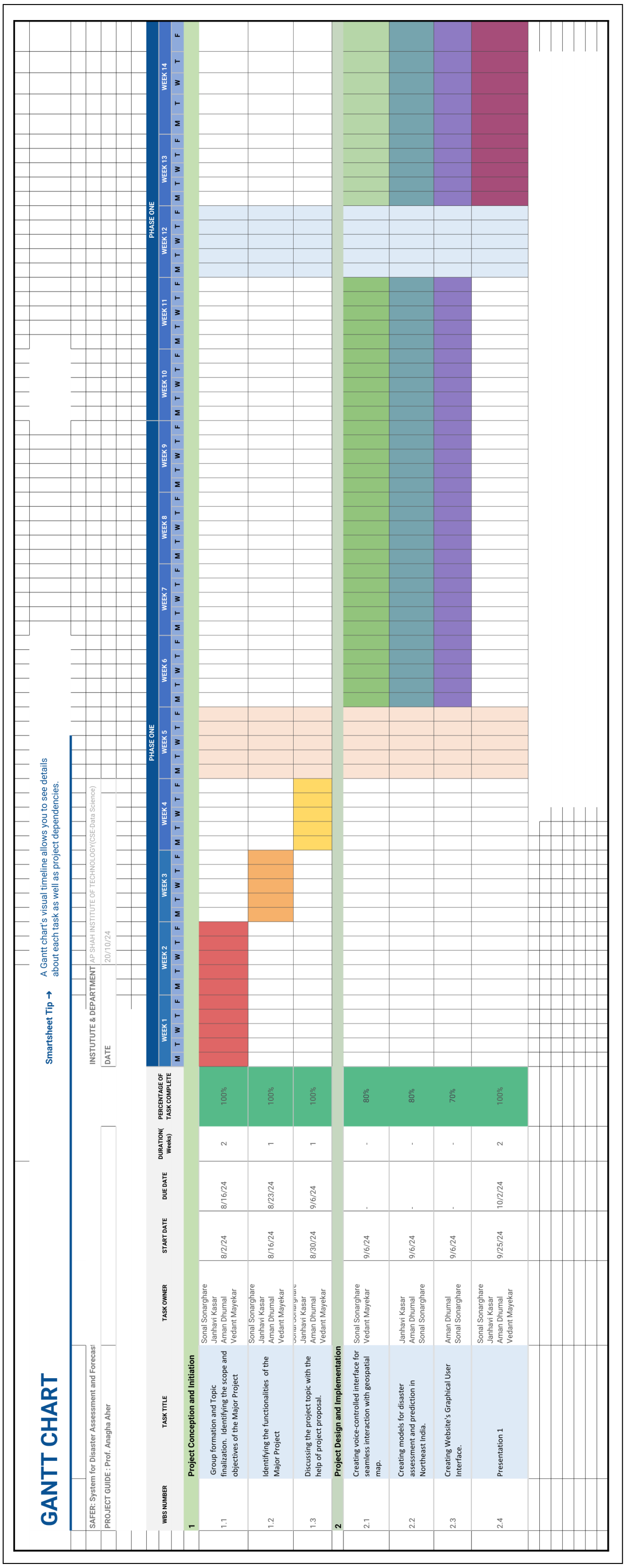

Figure 4.1: Gantt Chart for Timeline of Phase 1

4.2 System Prototype

This section covers the development SAFER, focusing on key features like disaster assessment, predictive analytics, voice-controlled geospatial maps, and emergency services. Each component was designed to provide users with critical information during disasters, ensuring quick access to resources and support. The following pages outline the technical process and core functionalities that make the system effective and user-friendly.

Figure 4.2: SAFER Areas of Support

The Figure 4.2 illustrates the various disaster response capabilities provided by the SAFER system, which are presented in the five areas of support are designed to offer specialized assistance during disasters. Here's what each area does:

- **Floods:**
  - Offers assessments of historically affected districts during major flood events.
  - Provides real-time monitoring, predictive analytics, and updates on flood conditions.
- **Landslides:**
  - Offers assessments of historically affected districts during major landslide events.
  - Offers early detection, real-time monitoring of landslide-prone areas and provides alerts about blocked roads, unsafe zones.
- **Voice-Controlled GeoSpatial Map:**
  - A voice-activated map interface that provides disaster data, location-based updates, and directions.
  - Allows users to locate hospitals, shelters, and other critical resources using voice commands during emergencies.

- **Ambulance:**
  - Enables users to book ambulances through voice commands and track their real-time location.
  - Offers quick access to emergency medical services, ensuring timely help during disasters.
- **Voice-Controlled First Aid Assistant:**
  - Provides step-by-step voice-guided first aid instructions for various medical emergencies.
  - Ensures that even untrained individuals can administer essential care while waiting for professional help.

Together, these areas support disaster preparedness, emergency response, and real-time assistance.

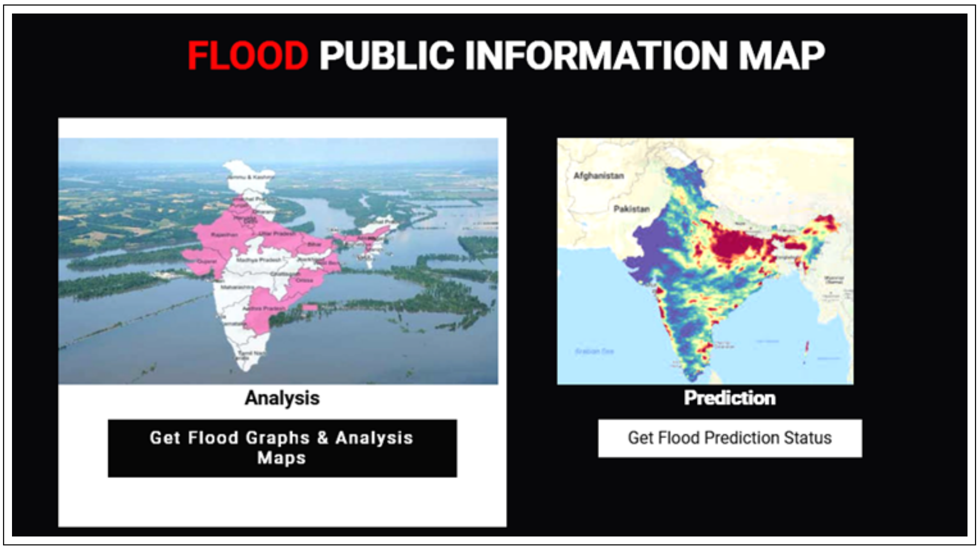

Figure 4.3: SAFER Flood Public Information Map

The Flood Public Information Map as shown in Figure 4.3 consists of two interactive components:

- **Analysis**: This component displays historical and current disaster assessments, including severity maps and graphical representations that illustrate the impact of floods across various regions.
- **Prediction**: This component provides flood predictions, offering real-time forecasts of potential flood-prone areas to enhance preparedness for imminent risks.

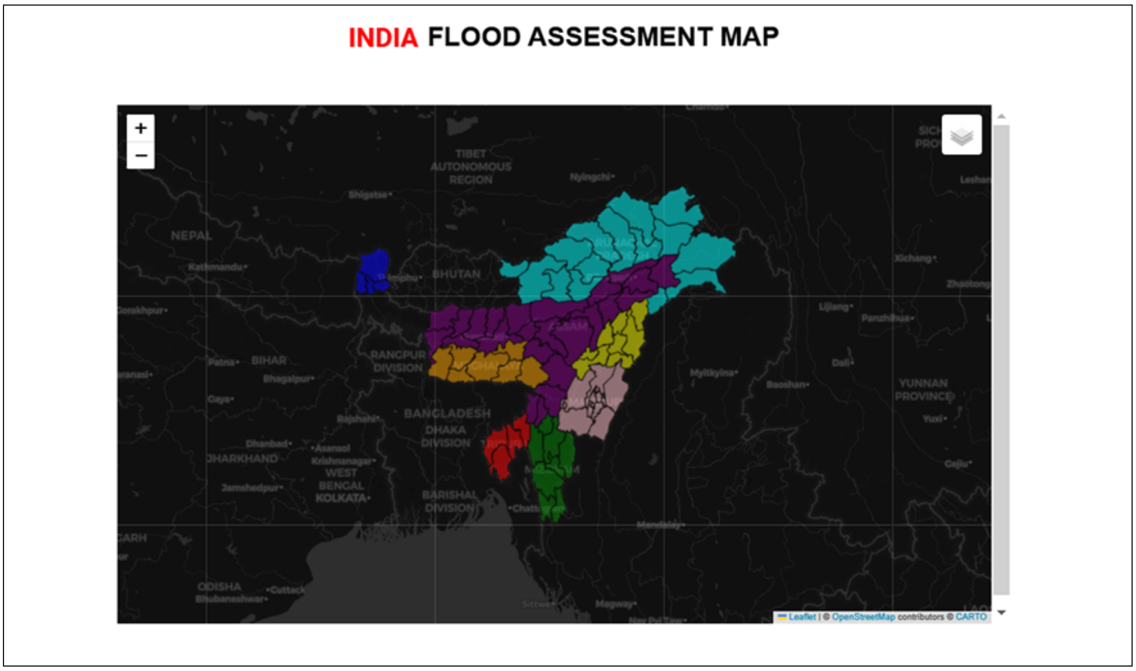

Figure 4.4: SAFER Flood Assessment Map

The Figure 4.4 is a flood assessment map of India, specifically highlighting the northeastern states. Each state is marked in different colors, indicating areas of interest for flood assessment. The map is interactive, allowing users to click on a state to view detailed information about the majorly affected districts and historical data on past disasters. This type of map is useful for understanding flood impacts and preparing for future events.

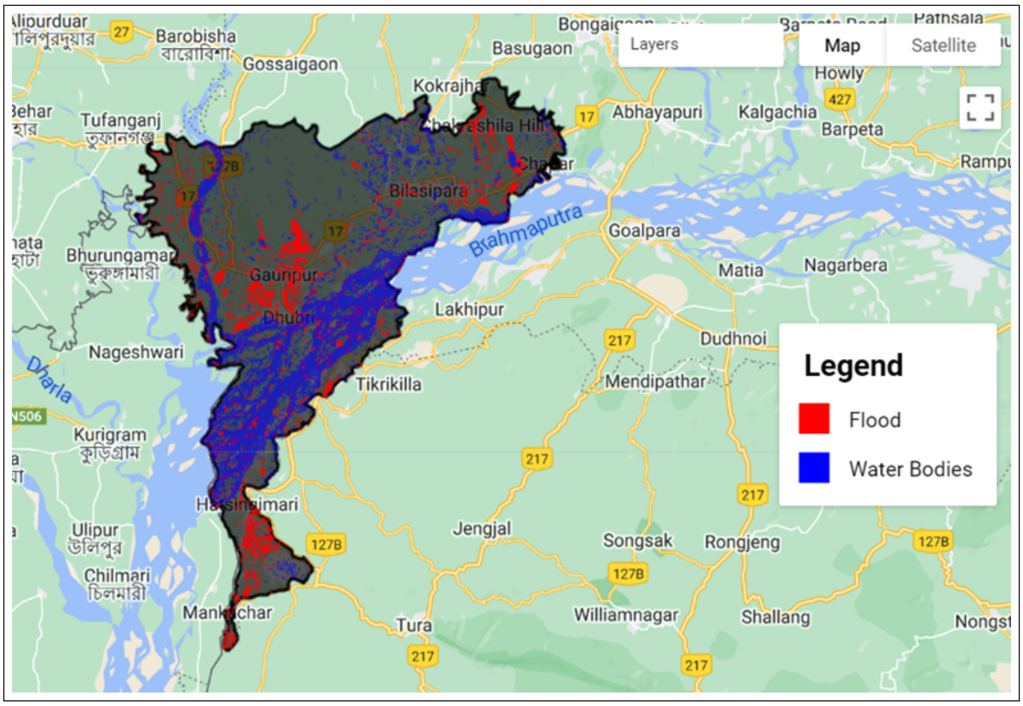

Figure 4.5: Flood Assessment Map of Dhuburi, Assam (May-July 2024)

The Figure 4.5 shows a flood assessment map of Dhuburi district of Assam (May-July 2024), the affected area can be visualized in red color on the map, while water bodies such as rivers, lakes, and ponds are represented in blue color. This color scheme helps in easily identifying the impacted regions and distinguishing them from natural water bodies on the map.

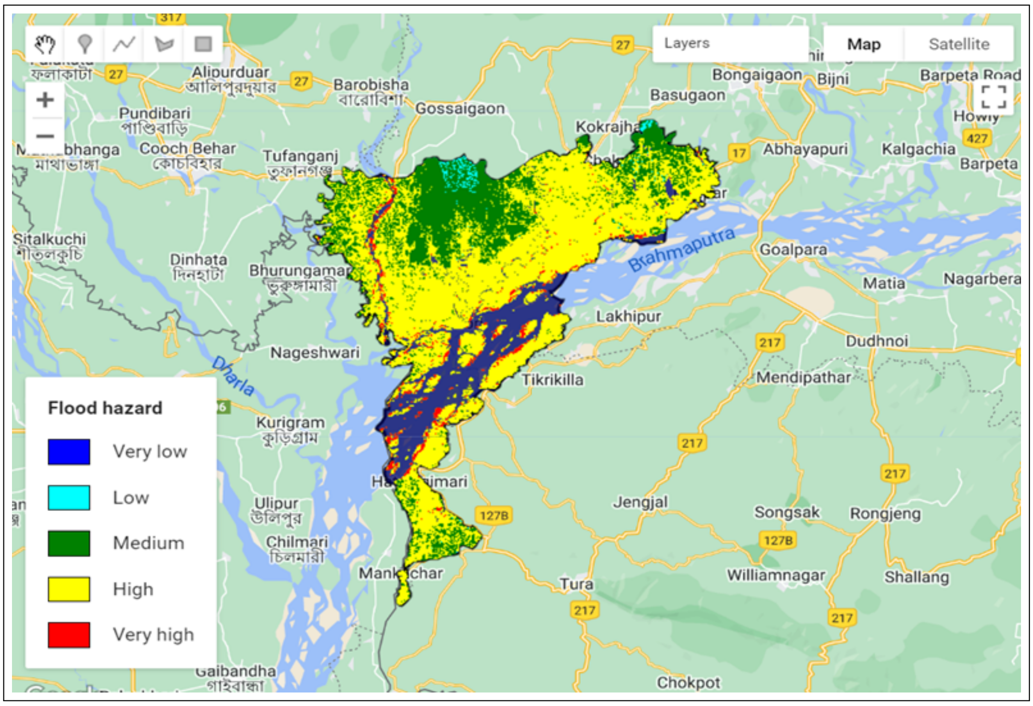

Figure 4.6: Flood Risk Assessment in Dhuburi District, Assam (May-July 2024)

The Figure 4.6 assesses flood risk in the Dhuburi district of Assam (May-July 2024) by analyzing various environmental factors. It calculates distances from water sources, assigns hazard scores based on these distances, and incorporates elevation data to evaluate terrain effects. It also examines the health of the vegetation and the moisture levels in the area using images from the Sentinel-2 satellite. This information contributes to creating an overall flood hazard score, which is shown on the map.

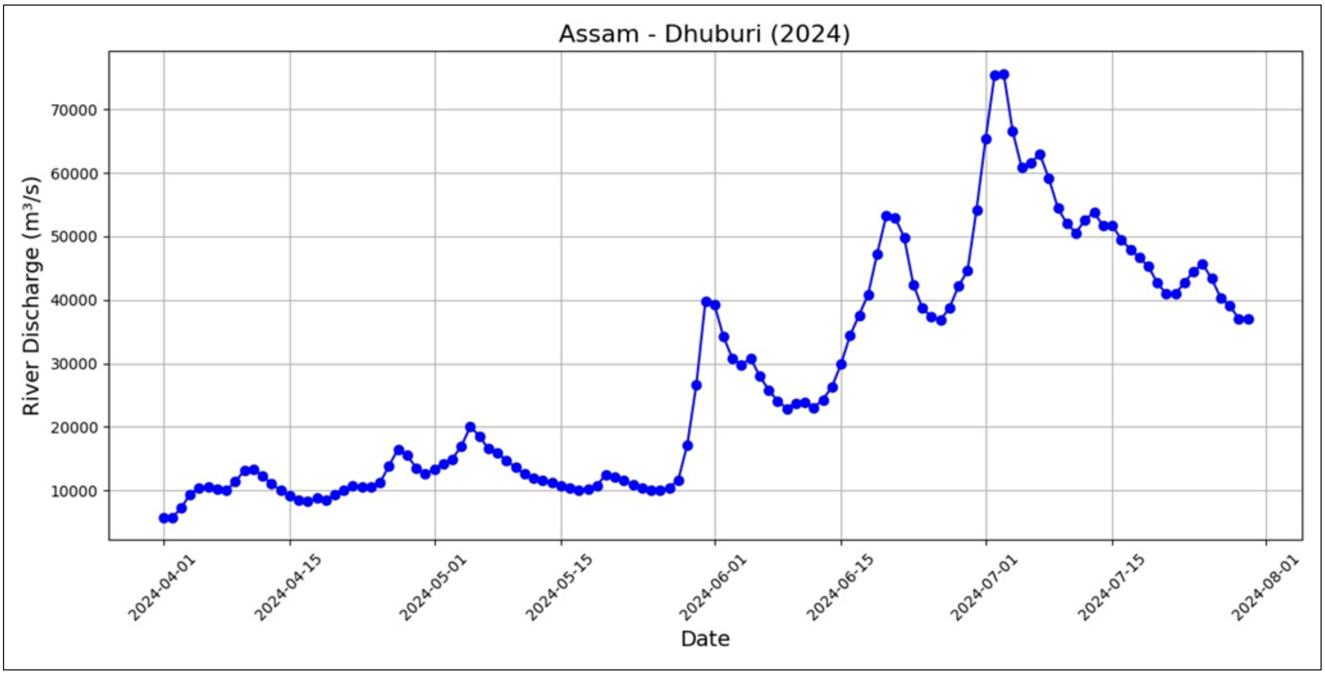

Figure 4.7: River Discharge in Dhuburi, Assam (2024)

The Figure 4.7 is a line graph showing river discharge (in cubic meters per second) over time for the Dhuburi region of Assam in 2024. The horizontal axis represents dates from early August to late October, while the vertical axis measures river discharge from 0 to 70,000 cubic meters per second. The graph shows fluctuations with a peak around mid-September, indicating a significant increase in water flow. This data, sourced from Open Meteo, helps in understanding seasonal changes and potential flooding events in the region.

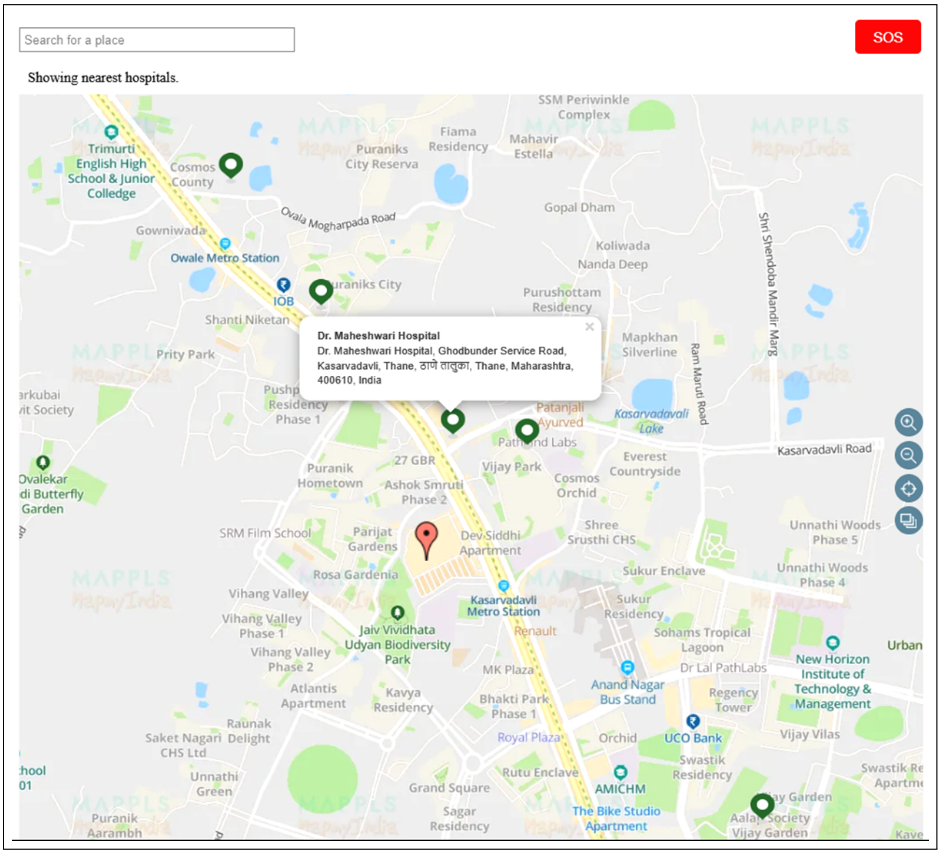

Figure 4.8: Voice-Controlled Map Website: Locate Nearest Hospital

The Figure 4.8 shows a voice-controlled geospatial map interface on a website. The map displays various location markers, with a red pin indicating "Dr. Maheshwari Hospital." At the top, there's a search bar with a microphone icon, suggesting voice command functionality. The text above the search bar reads "Showing nearest hospitals," indicating that the command "show nearest hospital" has been used to display the nearest hospitals from the user's location. This feature helps users quickly find medical facilities by using voice commands.

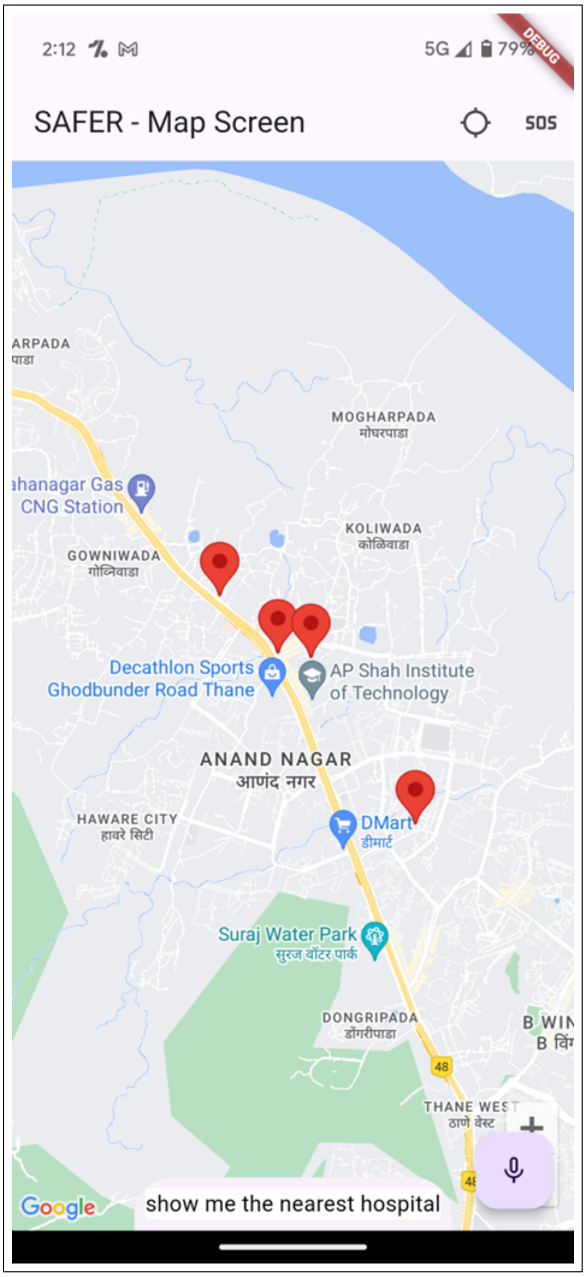

Figure 4.9: Voice-Controlled Map App: Find Nearest Hospital

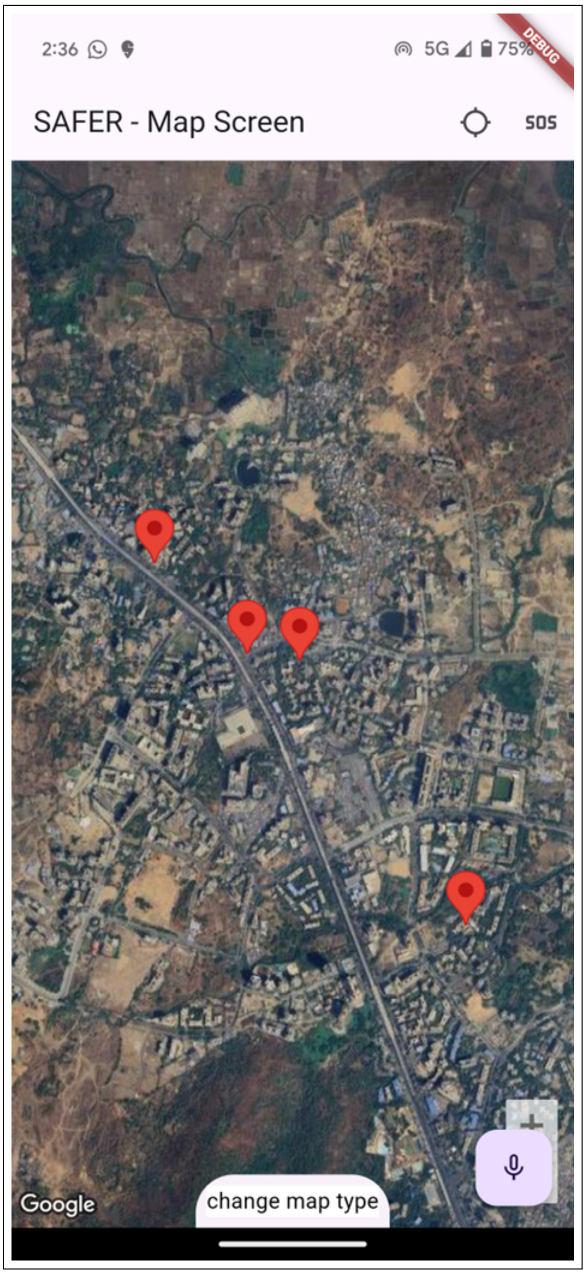

Figure 4.10: Voice-Controlled Map App: Layer Change Feature

The Figure 4.9 shows a voice-controlled geospatial map in an application. The map displays various location markers, with a blue marker indicating a hospital. At the top, there's a search bar with a microphone icon, suggesting voice command functionality. The text at the bottom reads "show me the nearest hospital," indicating that this command has been used to display the nearest hospital from the user's location. This feature helps users quickly find medical facilities by using voice commands.

The Figure 4.10 shows a geospatial map application on a mobile device. The map displays an aerial view with various location markers. At the bottom of the screen, there is text box that indicates the interpreted command spoken by the user.

Figure 4.11: SOS Button: Send Location to Emergency Contacts

When the SOS button is clicked in the application, an automatic message is sent to the distress number as shown in Figure 4.11. This message includes the user's current location, providing the latitude and longitude coordinates to help the contact quickly locate the user in an emergency.

Chapter 5

Summary

The SAFER project aims to significantly enhance disaster management in Northeast India by leveraging geo-spatial technologies and intelligent systems. This report outlines the progress made during this semester, focusing on two primary areas: Flood Assessment and the Voice-Controlled Interface for geospatial maps. Here's a more detailed explanation of the work completed:

Flood Assessment: Flood assessment plays a crucial role in disaster management, providing valuable insights into the extent and impact of flood events. Using Sentinel-1 SAR satellite imagery from Google Earth Engine (GEE), it enables detailed analysis of historical floods. This helps authorities evaluate affected areas, assess the severity of events, and make informed decisions for future flood preparedness and disaster management efforts.

- A comprehensive overview assessment of regions impacted by historical flood events has been conducted using Sentinel-1 satellite images from Google Earth Engine. This assessment focuses on identifying districts with most affected areas.

- A detailed assessment framework has been developed to evaluate areas with varying levels of vulnerability, categorized as low, medium, and high risk based on the severity and frequency of past flooding incidents. This approach allows for more informed decision-making and deeper analysis.

Voice-Controlled Interface: The development of a voice-controlled user interface for geospatial maps facilitates user interaction through voice commands, enhancing accessibility and usability during emergencies. It is designed to streamline navigation and send SMS during emergencies.

In conclusion, the SAFER project has made significant progress in advancing disaster management in Northeast India through the integration of advanced technologies and intelligent systems. The completed components have successfully laid the groundwork for improved disaster preparedness and response, leveraging satellite data, innovative interfaces, and detailed assessments.

The recent developments have not only tackled current challenges but also laid a solid groundwork for future improvements. Key outcomes include the enhancement of disaster assessments through the integration of Sentinel-1 satellite imagery via Google Earth Engine, which has greatly improved the accuracy and reliability of flood evaluations, enabling better forecasting. The user-centric design of a voice-controlled interface has made geospatial maps more accessible, particularly during emergencies. Data-driven decision-making has been supported by detailed flood assessments, aiding disaster management and resource allocation. Moreover, the completed work paves the way for future advancements like disaster prediction models and integration with emergency response systems.

The significant advancements achieved through the SAFER project not only strengthen the current disaster management framework in Northeast India but also establish a solid foundation for future innovations of substantial importance. By effectively leveraging advanced technologies and data-driven methodologies, this initiative aims to enhance resilience in the face of disasters, enabling communities to respond more efficiently and effectively to emergencies. The insights and systems developed through this project will serve as essential resources for authorities, ultimately contributing to a safer and more sustainable environment for all.

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