Machine Learning Based Flood Prediction App

Sovan Mandal

25/01/25

Abstract

The global community is continuously working to minimize the impact of disasters through various actions, including earth surveying. For example, flood-prone areas must be identified appropriately, predicted, understood, and socialized. In that case, it will increase the risk of disaster impacts on the affected population in the form of death, property damage, and socio-economic losses.The data mining approach has had a significant influence on research related to flood prediction in recent years, namely its impact on researchers related to forecast, classification, and clustering. Floods can also be predicted using a time series approach used to predict the future, a type of data-driven prediction that has been developed and widely applied.
This project aims to apply these ideas to develop a flood prediction app.In addition to flood predictions, the app incorporates evacuation features that guide users through safe evacuation routes and emergency procedures, ensuring their safety in the event of a flood. By combining predictive analytics with actionable evacuation planning, the app aims to empower communities to take proactive measures, reduce risks, and minimize harm during flood events. The app serves a wide range of users, including residents, local authorities, and emergency responders, providing essential information for disaster preparedness and response.

Problem Statement

Flooding is one of the most devastating natural disasters, causing significant damage to infrastructure, ecosystems, and communities. Current flood prediction methods often rely on limited data sources and unreliable real-time simulations, localized insights, leaving many areas underprepared for sudden flood events. There is a need for an accessible, accurate, and timely flood prediction system that can integrate weather data to forecast potential floods. Such a

system would empower individuals, local authorities, and emergency responders to take proactive measures, minimize damage, and save lives.

Market Analysis

Flood forecasting and early warning systems are crucial for disaster management, particularly in flood-prone areas. With increasing urbanization, climate change, and unpredictable weather patterns, floods have become a growing concern globally. The demand for flood prediction apps is rising as governments, organizations, and citizens seek more reliable tools to manage flood risks and protect lives and property. The app market for such solutions is seeing growth, especially in flood-prone regions, as these tools help with preparedness and response.

Customer Segmentation

The potential market for a flood forecasting app is segmented into the following categories:

Government & Disaster Management Authorities: National, regional, and local governments need accurate flood forecasts to issue warnings, manage evacuation plans, and mitigate damage.

Farmers & Agricultural Sector: Floods can devastate crops and livestock. Farmers need accurate predictions to safeguard their land and resources.

Insurance Companies: Flood forecasting helps insurers assess risks and reduce claims related to flood damage by providing policyholders with timely alerts.

Urban Planners & Local Communities: City planners and local residents in flood-prone areas need real-time alerts and long-term forecasts to make informed decisions about construction and infrastructure development.

General Public: People living in areas at risk of floods would benefit from real-time notifications, making them more aware of potential threats and enabling better preparedness.

Core Functionality and Design

- Push Notifications: Send instant alerts to users when flooding is imminent or ongoing in their area.

Customizable Alerts: Allow users to set up alerts based on their location, flood risk level, or specific concerns (e.g., river overflows, heavy rainfall).

- Long-Term Forecasting: Provide flood predictions for the next few hours to several days, based on current weather forecasts and previous annual rainfall data.

- Flood Prediction Maps: Interactive maps that show flood-prone areas, with data visualizations like color-coded risk zones (low, moderate, high).

- Weather Data Integration: Display current and upcoming weather conditions that could contribute to flooding

- Risk Assessment: Show statistical likelihood of floods based on historical trends, weather forecasts, and environmental conditions.

- Flood preparedness guides: Providing practical tips on how to prepare for floods, create emergency kits, and safeguard homes and businesses.

Performance Requirements

- Speed and accuracy: The forecasting model will predict floods, find open shelters, evacuation routes with high speed and accuracy.

- Caching: Store commonly requested data like flood risk maps, real-time weather data, river levels temporarily on the server or a content delivery network (CDN) so that it can be quickly served to users without needing to fetch it from scratch every time. Caching reduces server load and ensures faster response times for users.

- Polling: The app can implement polling, where the app regularly checks for updates from data sources for every 5-10 minutes and pushes these updates to all users who need them.

Benchmarking

Existing Apps:

As compared to the following mentioned apps we will be focussing upon timely prediction ,faster data access and evacuation features.

App Name	Features
FloodWatchIndia	Real-time flood data, weather forecasting, flood risk maps, alerts
Flood Warning Information System (FWIS)	Flood warnings, river and rainfall data, emergency management tools
iRain	Rainfall data, flood warnings, urban flood monitoring

Exploration of methods:

Unsupervised Data Mining: The data mining goal is to find the internal hidden patterns inside the data, in an unsupervised data mining method, there is no training dataset, and the model is an algorithm that can directly be applied to the scoring datasets.

Autoregressive Integrated Moving Average(ARIMA):
This statistical method is used for time series forecasting.This method will be predicting the occurrence of flood from previous year's annual rainfall data.

Integration with Google Maps API:

Use real time flood data to create visualization for flood risks directly on to the map image and also to dynamically adjust the routes on the map, avoiding flooded roads and offering alternative safe routes.

How To's on safety measures during travel:

Provide guidance and rules on staying safe while traveling to a shelter, such as avoiding flooded areas, using vehicles safely, and staying informed through the app.

Safety and security:

The app will display emergency phone numbers medical services, and flood helplines, for users to quickly contact authorities in case of an emergency.

A quick-access emergency button that users can press if they are in immediate danger, sending an alert with their location to local authorities and close members.

Final Product Prototype

This app aims to integrate data from various sources, including weather forecasts, historical flood data, to create predictive models using machine learning and statistical techniques. By analyzing this data, the app can generate reliable forecasts of potential flood events, providing users with advance warnings. Additionally, it will offer evacuation routes, personalized notifications based on user locations, alerting them of impending risks and suggested precautionary measures.

User Signin using Google API: Since many users are using google sign in platform we will integrate this and ask permission for the localized language preferences to cater to diverse communities in flood-prone areas.

Algorithm:

The model will use a combination of Data mining techniques specifically KNN algorithm and Time Series Analysis to predict and classify flood prone zones with potential risks.
this model will predict the flood zones up-to 15 days prior.
After this process the flood risk zones icons will appear on google maps integrated into the app.

Core-Features:

Long-Term Forecasting: Provide flood predictions for the next few hours to several days, based on current weather forecasts and previous annual rainfall data.
Weather Data Integration: Display current and upcoming weather conditions that could contribute to flooding
Risk Assessment: Show statistical likelihood of floods based on historical trends, weather forecasts, and environmental conditions.

Interactive Evacuation Routes:

Real-time updates: The app provides dynamic, real-time updates about the best evacuation routes based on flood conditions and road closures. This feature would ensure that users are directed along the safest and most efficient paths to avoid flood-prone areas.
Detailed Maps: Incorporate maps showing multiple evacuation routes and their corresponding safety levels (such as high-risk and low-risk zones) so users can choose the best path depending on their current location.
Alternate Routes: Offer suggestions for alternate evacuation routes in case primary roads are blocked or flooded. The app could also take into account traffic congestion and provide real-time rerouting.

Live Traffic Updates: Integration with real-time traffic data to show which roads are blocked allowing users to avoid trouble spots.

Open Shelter Locations:

Nearest Shelters: The app could pinpoint nearby shelters where people can go in case of an evacuation. This might include government shelters, schools, churches, or any designated safe zones.
Shelter Capacity & Availability: Users could view the real-time status of shelters to check if they are full or accepting new evacuees, as overcrowding can be a concern during floods. This could be integrated with local authorities or community updates.

Emergency Contact Information:

Local Emergency Numbers: Display emergency phone numbers, such as police, fire services, medical services, and flood helplines, for users to quickly contact authorities in case of an emergency.
Helplines: Include access to national or regional flood management helplines for information or support on flood warnings, evacuations, and recovery resources.
SOS Button: A quick-access emergency button that users can press if they are in immediate danger, sending an alert with their location to local authorities and close members.

Instructions for Evacuation Procedures:

Evacuation Order Alerts: Push notifications about mandatory evacuation orders for specific areas and detailed instructions on how to safely leave the region.
Preparation Tips: Information on how to prepare for an evacuation, such as packing essentials (important documents, medications, emergency kits) and safety precautions (e.g., securing homes, moving vehicles to higher ground).
How to Stay Safe During Evacuation: Provide guidance on staying safe while traveling to a shelter, such as avoiding flooded areas, using vehicles safely, and staying informed through the app.

Push Notifications for Alerts:

Flood Warnings & Evacuation Orders: The app can send notifications about flood warnings, anticipated flood levels, or changes to evacuation orders. These alerts could be customizable based on location or the severity of the flood.
Reminder Alerts: Remind users to evacuate at specific times, check flood levels in their area, or remind them to move to a safer location if conditions worsen.

Local Emergency Services Integration:

Nearest Hospitals & Emergency Medical Assistance: In addition to shelters, the app could provide locations and directions to the nearest medical facilities, including hospitals or mobile emergency units, in case someone needs urgent care.

Search & Rescue Support: In cases where traditional evacuation routes are blocked, the app could provide info about search and rescue teams, their areas of operation, and how to contact them.

Language Support & Accessibility:

Multilingual Support: Offering information in multiple languages to cater to diverse communities in flood-prone areas.

Text-to-Speech & Audio Instructions: For users who are visually impaired or need help understanding the instructions, the app could offer audio-based directions for evacuation routes and emergency services.

Visual Aids & Icons: Clear icons and visual markers (such as flood zones, shelters, and road closures) would make navigation through the app simple, even for those with limited tech literacy.
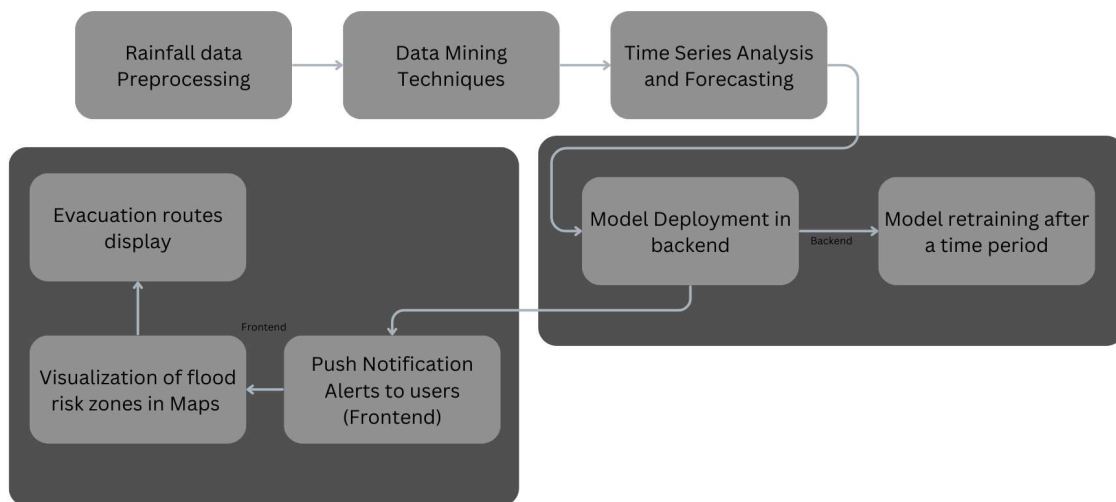
Applicable Constraints:

Payment Processing: Compliance with payment card industry (PCI) standards for secure payment processing. Ensuring secure and reliable payment processing for users

Applicable Regulations:

Consumer Protection Laws: Compliance with consumer protection laws, such as providing clear and accurate information about shelter services, risk zone, pricing, and terms and conditions, is essential to protect users' rights and interests.

Monetization

Affiliate Links: Integrate affiliate marketing by recommending products related to flood preparedness, such as emergency kits, water-resistant supplies, or insurance options. You can earn a commission whenever users purchase through your affiliate links.

Partnership with Insurance Companies: Partner with flood insurance providers to integrate their offerings directly into the app.commission for every user that purchases a policy via the app or through a referral.

in app advertisements
Location-Based Ads: Use geolocation features to display targeted ads for services relevant to the user's area. For example, ads for flood insurance, emergency kits, or local services (e.g., plumbing, roofing)

Conclusion:

The Flood Prediction App, with its advanced flood forecasting and evacuation features, is a critical tool for reducing the devastating impact of floods on communities. By providing real-time flood predictions, the app empowers users with the information they need to prepare for potential flooding events. Coupled with evacuation features, it ensures that individuals and families can make informed decisions, safely evacuate when necessary, and follow pre-planned routes with clear guidance.

The app not only alerts users to imminent risks but also offers practical evacuation routes, safety tips, and emergency contact information, ensuring that users have a comprehensive plan in place well before floodwaters rise. With this proactive approach, the app significantly enhances disaster preparedness, helping reduce casualties, property damage, and the strain on emergency services.

References and Resources:

W. V. Kambale, A. Deeb, T. Benarbia, M. Salem, F. A. Machot and K. Kyamakya, "Ensemble Transfer Learning for Time Series Forecasting: a Sensitivity Analysis Framework for a Shallow Neural Network," *2023 27th International Conference on Circuits, Systems, Communications and Computers (CSCC)*, Rhodes (Rodos) Island, Greece, 2023, pp. 205-211, doi: 10.1109/CSCC58962.2023.00040.

Amir-Behghadami M, Janati A. Reporting Systematic Review in Accordance With the PRISMA Statement Guidelines: An Emphasis on Methodological Quality. *Disaster Medicine and Public Health Preparedness*. 2021;15(5):544-545. doi:10.1017/dmp.2020.90

Book:Data Mining: Concepts and Techniques

Authors:Jiawei Han, Jian Pei, Hanghang Tong