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PROJECT PROPOSAL

Hot Issue

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EXECUTIVE SUMMARY

The Philippines is experiencing a new normal of more frequent and intense rainfall and typhoons. Recent tropical cyclones have affected over 10 million people, with thousands of families having to resort to evacuation centers. To reduce loss of life and confusion during floods, this project proposes a real-time, barangay-level evacuation dashboard for Quezon City that consolidates weather warnings, road-status information, and relief-center data into a single, easy-to-use source of truth for both residents and local authorities to use.

Using a flood vulnerability index and a flood-aware routing engine, the system recommends the safest, fastest routes and personalized departure times so people can reach nearby relief centers as soon as possible. By replacing fragmented information sources with a single operational dashboard, the project reduces evacuation confusion and delays, supports faster and more coordinated responses, and reveals gaps in relief-center coverage to guide resource placement in the future. A Streamlit prototype will integrate a decade of barangay data for route optimization and gap analysis. Scope limits include having it in Quezon City only, an English-language interface, and reliance on existing datasets.

KEYWORDS

flood evacuation dashboard, disaster risk reduction, flood vulnerability index, dynamic routing, barangay-level planning, weather integration, relief center accessibility, Quezon City, Streamlit app prototype

BACKGROUND

With the recent torrential rains and increased intensity of typhoons, the Philippines has faced a surge in flooding across the country, even in places that were considered safe or untouchable by floods. The harsh reality is that the country cannot merely rely on Filipino resiliency anymore to endure the repercussions of extreme weather. Thus, we have to accept that this is the new normal of intense rains and floods and we can no longer afford to allow these disasters to take more lives due to a lack of preparedness.

34 people were reported dead, 29 injured, and 7 missing due to the recent tropical cyclones Crising, Dante, and Emong, according to the National Disaster Risk Reduction and Management Council (NDRRMC) (2025). It was also estimated that a total of 10,078,298 people were affected by these consecutive typhoons, where 4,728 families were evacuated to 144 evacuation centers (National Disaster Risk Reduction and Management Council, 2025).

President Ferdinand Marcos addressed the aftermath of this: “This is not an extraordinary situation anymore… This will be our lives no matter what we do,” (Punzalan, 2025). Almost 10% of the country’s population was affected by the recent climate disasters, and we cannot simply surrender their chances of survival to the increasing frequency and intensities of these floods and allow nature to take its ruthless course. Therefore, the country urgently needs to create data-driven contingencies to ensure that the damage of these climate disasters are mitigated and the loss of human life is not tolerated.

THE PROBLEM

While there are numerous websites and datasets available for us to refer to in times of crisis, there is not a tool that consolidates all the necessary information needed to prepare to evacuate. Organizations such as Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) announce which areas are expected to be affected by rainfall, Local Government Units (LGUs) list down which evacuation centers citizens should go to, and the Metropolitan Manila Development Authority (MMDA) provides updates on which roads are affected by flooding.

It is imperative to have such vital information easily accessible during times of crisis for all citizens who would be potentially affected by the flooding. The average citizen cannot afford to waste time browsing through different sources of information to find out where and how to evacuate. Hence, the group proposes **a real-time dashboard that provides data during times of typhoon- and rainfall-induced floods on which relief operations centers to seek out, the optimal route to travel to these centers, as well as the most ideal time to start evacuating** in order to maximize preparedness and strengthen our resilience against climate disasters.

OBJECTIVES

- Address the core problem of citizens browsing multiple sources by creating a single source of truth.
- Develop a routing algorithm that provides citizens with the fastest, safest path to the nearest relief operations center while avoiding flooded roads.
- Create a real-time dashboard using data provided by relevant government agencies and other official sources.
- Provide insights on which areas are lacking in nearby relief operations centers and the most optimal locations to place them in, based on accessibility and susceptibility to floods.
- Develop an algorithm that provides routes for citizens to allow them to evacuate to a relief operation center within 2km and/or 30 minutes of their home.

SCOPE & LIMITATIONS

The dashboard will exclusively integrate barangay-level data from Quezon City, covering the period from 2015 to 2025. As such, its primary users are residents and stakeholders within the city.

The dashboard will visualize available routes to the nearest evacuation centers, along with estimated travel times. However, it will not display flood level measurements, nor will it address other natural disasters such as landslides.

It is also important to note that the road network and evacuation center data may be incomplete, outdated, or inaccurate. For the purposes of this project, these datasets are treated as truth, which may affect the reliability of the routes presented.

The prototype dashboard will be implemented using Streamlit, which requires an active internet connection for access and real-time updates. Additionally, it will only support the English language, which will limit accessibility for non-English-speaking users.

METHODOLOGY

Data Collection

Our project combines multiple sources to create a unified spatial database for evacuation planning. Geospatial components include OpenStreetMap (OSM) road networks processed through OSMnx, Philippine Statistics Authority (PSA) administrative boundaries at barangay-level granularity, relief and evacuation centers data gathered through OSM, and flood-prone areas identified through Project NOAH. Weather and environmental integration utilizes local weather station data for real-time conditions and historical rainfall patterns from 2015-present for statistical analysis. Demographic and infrastructure data encompasses PSA census population density for evacuation demand estimation and comprehensive critical infrastructure mapping including hospitals, schools, and government facilities with capacity and accessibility attributes for emergency operational planning.

Model Development

The model development framework is built upon three pillars that work to provide comprehensive evacuation guidance: flood vulnerability assessment for risk quantification, dynamic routing algorithms for optimal path selection, and evacuation timing models for critical departure recommendations.

First, a flood vulnerability assessment will be developed. The flood vulnerability assessment implements a weighted scoring system for road segments using the composite formula: FVI = w_1 x Historical_Flooding + w_2 x Elevation_Risk + w_3 x Proximity_to_Water + w_4 x Drainage_Capacity, where each w_i are weights calibrated through historical validation. Each component is normalized to a 0-1 scale enabling consistent risk comparison across the network.

From the flood vulnerability assessment, a passability threshold system can be established to aid in the road status classification for evacuation routing. In particular, the following system will be used:

A FVI <= 0.3 corresponds to a passable threshold, which indicates that roads remain fully accessible for all vehicle types including standard passenger cars, motorcycles, and emergency vehicles. A cautionary threshold flag will be raised if the FVI ranges from 0.3 to 0.5 inclusive, meaning that roads are still accessible but with increased travel time and heightened awareness required. Light flooding is possible during moderate rainfall events.

Moreover, a FVI between 0.5 and 0.7 inclusive refers to a restricted threshold. Here, roads are passable only for high-clearance vehicles and emergency responders with specialized equipment and significant flood risk during rainfall events exceeding 10mm/hour is to be expected. Standard passenger vehicles are strongly discouraged, pedestrian access dangerous. Finally, a FVI > 0.7 corresponds to an impassable flag. This threshold indicates that roads are closed to all civilian traffic due to high flood probability and safety risks. Access is limited to emergency responders with amphibious or specialized rescue vehicles. Alternative routing is mandatory for all evacuation plans.

Moreover, the project's routing system employs a modified Dijkstra's algorithm. Traditional shortest-path calculations are enhanced with dynamic edge weights reflecting current flood vulnerability: Adjusted_Travel_Time = Base_Time x (1 + FVI_route x Current_Risk_Multiplier). The algorithm continuously updates route recommendations as conditions change, providing alternative paths when primary routes become compromised. Real-time data integration enables route reallocation based on emerging flood conditions, traffic congestion, and facility capacity updates.

Finally, evacuation timing incorporates three critical components: preparation time (15-30 minutes for household readiness), travel time (calculated using flood-adjusted routing), and safety buffer. The critical evacuation time formula: CET = Flood_Onset_Time - (Preparation + Travel_Time x Traffic_Factor + Safety_Buffer) provides personalized departure recommendations. Evacuation priority scoring considers distance to relief centers and local flood risk levels to optimize resource allocation and reduce evacuation conflicts.

Project Implementation

Data processing follows an automated ETL pipeline. Feature engineering creates derived variables including road segment risk scores, network connectivity metrics, and facility accessibility indices. Model training utilizes historical flood events for supervised learning approaches, with cross-validation. The technical implementation utilizes Streamlit for rapid dashboard development with Pandas providing backend data processing capabilities. OSMnx and NetworkX handle network analysis computations including route optimization and connectivity assessment.

REFERENCES

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