Thesis Project Portfolio

FloodWatch: Enhancing Flood Prediction through Advanced Data Processing and Deep Learning

(Technical Report)

Assessing the Effectiveness of Government Policies on Flood Mitigation in Vulnerable Southeast Asian Developing Countries: A Case Study of Vietnam and Indonesia

(STS Research Paper)

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Executive Summary

Flooding remains a significant challenge in developing countries, particularly in Southeast Asia, where inadequate infrastructure and disaster management systems make communities more vulnerable to the devastating impacts of floods. In 2011, nearly 10 million people were affected, and 1,300 lives were lost due to floods in the region. Accurate flood prediction and warning systems are crucial for minimizing the consequences of such disasters. With this in mind, this coupled thesis focuses on two critical aspects of flood management: the role of government policies in mitigating the impacts of flooding in Southeast Asia and the development of a machine learning-based flood prediction system, called FloodWatch, specifically designed for Vietnam. The technical research project aims to implement FloodWatch, which utilizes advanced machine learning algorithms and real-time data to accurately predict flood risks across various locations in Vietnam. By developing a system that delivers timely and accurate flood warnings, communities can better prepare and respond to flood risks, ultimately reducing the social and economic impacts of these disasters. The STS study, on the other hand, will assess the effectiveness of government policies in reducing the social and economic impacts of flooding in the region. By examining and comparing various policies in different Southeast Asian countries, this research will identify best practices and recommend improvements for disaster risk reduction and adaptation strategies.

The FloodWatch project successfully developed a machine learning-based flood prediction system for Vietnam. In collaboration with Hanoi University and the University of the Cote d'Azur, the project team trained a flood prediction model using historical data, machine learning algorithms such as LSTM networks, and crowdsourced flood images. The model demonstrated accuracy and effectiveness in predicting flood risks across various locations in Vietnam. To facilitate data collection, the team employed multithreading and asynchronous IO

techniques to accelerate the collection of geographic locations, resulting in a 30-fold increase in data collection speed. Additionally, IoT-based weather condition collectors and humidity and water level sensors were deployed in major cities across the country, significantly enhancing the flood data available for the model. The project also successfully developed a real-time flood prediction cloud platform and the FloodWatch application for Vietnamese users. The application provided accurate, timely flood warnings, helping communities better prepare and respond to flood risks. The user interface was designed with a focus on fast response times, and GeoJSON encoding was used to efficiently communicate geographic data.

The STS research paper investigated the effectiveness of government policies in mitigating the social and economic impacts of flooding in Southeast Asian developing countries. Through a comparative analysis of government policies, the study identified the most effective measures for mitigating flood impacts and supported the development of disaster risk reduction and adaptation strategies in the region. The research findings indicated that common policy measures include early warning systems, flood control infrastructure, land-use planning, and community-based disaster risk reduction programs. Studies focused on specific aspects of flood management, such as the development of flash flood warning systems using machine learning and the implementation of community-based disaster risk reduction programs in Vietnam, demonstrated the potential for innovative solutions in reducing flood impacts. The paper also discussed the role of governance in managing disasters, highlighting the need for a shift from reactive to proactive approaches, from narrowly defined technocratic solutions to more integrated and inclusive approaches, and from fragmented and uncoordinated actions to more coherent and collaborative efforts. By providing a deeper understanding of the interplay between

government policies and the impacts of flooding, this study contributed to the broader literature on natural disasters and human development.

The coupled thesis projects contribute significantly to both the technical and socio-technical aspects of flood management in Southeast Asia. The successful development and implementation of the FloodWatch application demonstrate the potential of machine learning in enhancing flood prediction and data collection in Vietnam. Future research should focus on refining the AI models, incorporating additional data sources, and exploring the long-term effects of such systems on communities. The STS research paper provides essential information on the social and economic implications of floods and the role of prediction systems like FloodWatch in mitigating these effects. Policymakers and practitioners can use these findings to inform the development of appropriate disaster management policies and infrastructure investments. As a next step, researchers should examine the broader factors affecting flood management and risk reduction, such as community engagement, infrastructure development, and climate change adaptation strategies, to further enhance the region's resilience to floods.