Title of dissertation				
Quantifying the Impact of Salinity Intrusion on Agricultural Livelihoods in Coastal Communities of the Vietnamese Mekong Delta: A Multi-Model Approach for Impact Assessment and Adaptation Strategy Development				
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Salinity intrusion has a significant and wide-ranging impact on agriculture and livelihoods, particularly in coastal communities. In regions with economies heavily reliant on natural conditions, such as Soc Trang in the Vietnamese Mekong Delta, salinity intrusion in 2016 and 2020 caused considerable damage (GSO, 2020).

Based on the collected data, salinity intrusion since 2016 has significantly impacted the socio-economic life of people in the Mekong Delta, particularly in Soc Trang province, with clear effects on agricultural livelihoods. Livelihoods refer to activities people undertake to earn a living using various resources (human, natural, material, financial, and social) under the management of organizations, institutions, and policies. Agricultural livelihoods in the context of salinity intrusion have become increasingly critical and need protection as communities face growing challenges from this phenomenon. This study assessed the vulnerability and adaptive capacity of coastal communities in the Mekong Delta to the impacts of saltwater intrusion on livelihoods. A multidisciplinary approach was applied, including entropy, field surveys, GIS, and interviews. LVI and LVI-IPCC indices were used to calculate vulnerability levels based on survey data from 457 households in 12 communes of Soc Trang Province, with weights determined using Shannon's entropy method. The results revealed that Lich Hoi Thuong commune had the highest vulnerability index (0.608), followed by Tran De (0.443) and Dai An 2 (0.435), while Phu Huu (0.389) and Lieu Tu (0.224) had lower vulnerability levels. Although differences were not significant, each district exhibited unique characteristics requiring specific attention.

As salinity intrusion becomes more unpredictable, developing early and accurate forecasting methods is essential for policymakers. This allows for the creation of timely response strategies and provides valuable information to local communities. This study developed machine learning models to predict salinity intrusion in the target area. The machine learning models were designed to forecast short-term salinity intrusion in the coastal areas of the Mekong Delta, Vietnam, with capabilities to predict both hourly and daily salinity levels.

For hourly predictions, this study utilized algorithms such as Random Forest Regression (RFR), Support Vector Regression (SVR), Long Short-Term Memory (LSTM), Artificial Neural Networks (ANN), Extreme Gradient Boosting (XGBoost), and Ridge Regression (RR). Input data included salinity measurements from Tran De, Long Phu, Dai Ngai, An Lac Tay, and Soc Trang stations, water levels from Tran De station, and discharge data from the Can Tho

hydrological station. The results indicated that these models were highly effective in forecasting short-term salinity, achieving accuracy up to 16 hours in advance.

For daily salinity intrusion, this study developed additional machine learning models to provide a comprehensive analysis of machine learning applications in salinity forecasting. It also emphasized the importance of meteorological factors in improving forecast accuracy. Daily input data were collected from Tran De, Long Phu, Dai Ngai, and Soc Trang stations, along with water level and discharge data from the Can Tho hydrological station. The results showed that models such as Decision Tree, Ridge Regression, Bayesian Ridge Regression, XGBoost, Gradient Boosting, Support Vector Regression (SVR), Random Forest, Long Short-Term Memory (LSTM), and Artificial Neural Networks (ANN) performed consistently well across five different research scenarios using various combinations of input variables. Notably, incorporating meteorological factors into the analysis significantly enhanced forecast performance, providing a robust scientific foundation for managing and responding to salinity intrusion in the region.

To mitigate vulnerability, our study recommends improving education and vocational training for local people, as well as encouraging farming households to join social organizations to receive timely support. The implementation of effective agricultural development policies integrated with strategies to respond to saltwater intrusion is also critical. Moreover, to adopt a more practical approach, this study applied technology and science to sustainable agricultural production, focusing on optimizing nitrogen fertilizer use in rice cultivation. This approach aims to minimize environmental impacts and adapt to increasing salinity intrusion caused by climate change. Using the DSSAT – CERES -Rice model, this study conducted experiments with five nitrogen fertilizer rates: 0 kg ha^{-1} (no fertilization – N0); 150 kg ha^{-1} (current nitrogen application - N100); 127.5 kg ha^{-1} (85% of the current nitrogen application - N85); 105 kg ha^{-1} (70% of the current nitrogen application - N70) and 75 kg ha^{-1} (50% of the current nitrogen application - N50). The results demonstrated that 127.5 kg ha^{-1} was the most effective rate for rice cultivation. This rate optimized nitrogen use, minimized the negative impacts of salinity intrusion, reduced fertilizer costs, and improved productivity while mitigating environmental impact.

Based on the research findings, this study has answered the research questions and achieved the initial research objectives. Using an interdisciplinary approach, the study clarified the potential of machine learning models in predicting salinity intrusion in the Vietnamese Mekong Delta, providing valuable information for policymakers and proposing effective adaptation strategies. This research also provides a scientific foundation for efficient fertilizer management and the application of technology in sustainable agricultural production.

Photos

Graduation Ceremony

RONPAKU Fellow and supervisor