3MAP: Monitoring, Modelling and Mitigation of land subsidence in delta areas

Project Goal: The 3MAP project aims to address the global issue of land subsidence in delta regions, predominantly due to aquifer depletion to which sea level rise (SLR) superposes. The focus of the project is on enhancing our fundamental understanding of this phenomenon, providing reliable predictions, and contributing to the development of effective mitigation strategies to save deltas from drowning.

Research Description: Land subsidence is a global challenge that is especially concerning in delta regions due to their low elevation, dense population, and economic significance. It is crucial to acknowledge that despite climate change being a significant driver of SLR, most contemporary relative SLR (rSLR) is attributed to accelerated land subsidence due to groundwater overexploitation. This leads to environmental and socio-economic issues, including increased flood risk, infrastructural damage, saltwater intrusion, and ecosystem disruption. Several global cities in delta regions, such as New Orleans, Dhaka, Bangkok, Manila, Ho Chi Minh City, and Jakarta exemplify the scale and severity of this issue.

Our project will investigate land subsidence mechanisms, develop monitoring and modelling methods, and devise strategies to mitigate its effects. For the first time, we aim to map the three-dimensional land displacement field in deltas using long-term InSAR data and incorporating it into a three-dimensional integrated aquifer system compaction numerical model. This approach will unravel depth-dependent process interactions and spatiotemporal land subsidence patterns in the delta, forming the basis for creating effective mitigation strategies.

Reason for Research: Delta regions are inhabited by 500 million people. The total global cost of addressing rSLR-related damage in these areas surpasses tens of billions of euros. The threat of rSLR is expected to increase substantially in the coming decades due to population growth and climate change, putting deltaic regions at severe risk. Without intervention, the fallout could include extensive loss of fertile land, disruption to global food security, and potential displacement of millions of delta inhabitants worldwide.

Human-led mitigation could substantially reduce delta sinking, but this requires a detailed understanding of land subsidence mechanisms and better modelling approaches. Despite this, land subsidence remains critically under-quantified and is over-simplified in global analyses. The window for developing mitigation scenarios is rapidly closing, underscoring the need for immediate research efforts to address this issue.

Our research will focus on the Mekong Delta in Vietnam, the third largest delta in the world, home to approximately 18 million people, holding immense agricultural and economic importance. It experiences significant land subsidence, triggered by a complex array of drivers and processes. Therefore, this region is a prime example for studying other deltaic environments.

Expected Results: The project outcomes will contribute to various technical, natural, and social sciences, namely remote sensing, applied mathematics, geodesy, hydrogeology, hydrology, and geomorphology, as well as governance, and spatial planning, especially in delta environments.

This project pioneers the use of a three-dimensional land displacement field derived from InSAR in studying land subsidence in deltas, providing a novel perspective on aquifer system compaction studies. Furthermore, our research will innovate by enhancing and coupling existing numerical models, providing a comprehensive understanding of subsurface process interactions and delta system dynamics.

Our overall goal is to provide innovative scientific evidence to guide policy decisions to reduce groundwater extraction and mitigate the risk of delta regions sinking in future decades. Consequently, the outcomes of the project will be relevant for sustainable policymaking in the Vietnamese Mekong Delta and other rapidly subsiding coastal areas worldwide, particularly in light of global climate change.