Dynamic Assessment of Coastal Vulnerability to Sea-level Rise: When and Where to Adapt?

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Most infrastructure, settlements and facilities are located near the coast and are highly vulnerable to sea-level rise (SLR), coastal erosion and storms. Continued population growth in low-lying coastal areas will increase vulnerability to these hazards.

At the projected rates, SLR may not pose an immediate threat to coastal areas; nevertheless, a higher sea level will provide a higher base for storm surges to build upon and diminish the draining rate of low-lying areas, thereby increasing the risk of flooding from rainstorms.

Due to uncertainty in climate change predictions, coastal vulnerability assessments (VA) and most town planning activities are based on an assumption that sea level will remain constant in the future. However, climate change is undeniable and the resulting SLR is a reality that coastal communities will face in the coming decades. Thus, it is essential to consider coastal dynamics in assessing the impacts of SLR under various scenarios when preparing our cities for the future.

Currently, the number of regional-scale VA studies is limited. They are, however, required by local stakeholders to design adaptation strategies at a local level. Therefore, the knowledge gaps with respect to how coastal areas can adapt to climate change must be filled. The dilemmas confronting decision makers are: when and where to adapt to SLR.

By considering the complex and dynamic nature of coastal systems interacting and changing over time and addressing these dilemmas, this research intends to provide a dynamic model for a VA of coastal areas to assist decision makers to identify and evaluate effective adaptation alternatives for reducing climate change impacts.

The research models coastal inundation to make predictions about what might happen with different actions addressing a range of SLR scenarios. Under these scenarios, the extent and timing of coastal inundation and its impacts will be assessed in terms of a range of indicators; for example, impacted population numbers, impacted properties and socio-economic characteristics of impacted regions. The research examines natural and socio-economic systems already vulnerable to current climate variability by firstly analysing their current conditions, to provide a reference map to compare future conditions. It then analyses the systems under various scenarios to identify how climate change affects the already troubled systems over time.

Traditional modelling approaches focus on either temporal or spatial variations, but not both. However, it is the space-time integration that provides the explanatory power to understand and predict reality. Accordingly, they must be examined together for modelling the environment. Therefore, the research concentrates on the concurrent modelling of temporal and spatial variations of coastal processes. To achieve this outcome, two modelling techniques are combined: (1) System Dynamics, and (2) Geographical Information Systems.

A combination of these approaches would provide the potential to address temporal and spatial problems concurrently. Owing to the model's flexible structure, any other elements such as population growth and economic scenarios effecting coastal systems, can be integrated as needed. Users can change values of the model variables during the simulation process to test impacts of various scenarios.