

Abstract

Steering Coastal Resilience to Extreme Events Through Multiple Adaptive What-If Scenarios Using Coupled Modeling and Artificial Intelligence

Coastal zones undergo continuous transformations driven by climatic and anthropogenic drivers across a range of spatial and temporal scales. In this dynamic and changeable environment, efficient resilience must extend beyond preparation for a single scenario. Adaptive scenarios should be guided by robust, process-based models enhanced with artificial intelligence. What-If scenarios enable the systematic exploration of diverse risk pathways and impact permutations under both climate change and direct human interventions. In this project, **Steering Coastal Resilience to Extreme Events Through Multiple Adaptive What-If Scenarios Using Coupled Modeling and Artificial Intelligence**, scientific workflows will be designed using coupled coastal models, whose results will be used to develop AI-based emulators. The Geesthacht Coupled cOAstal model SysTem (GCOAST) will serve as the main coupled model to simulate the What-If scenarios. GCOAST has been widely used in studies investigating coastal impacts through the coupling of hydrodynamic, wave, and sediment modules, proving to be a reliable modeling tool for coastal processes. This project will engage in further development of improved workflows to apply GCOAST and AI-based emulators, scaling their application to efficiently perform assessments of multiple scenarios, which is an essential requirement for coastal management and the exploration of What-If scenarios. Through this integration, the research will yield highly adaptable and customized scenarios of extreme events. Subsequently, the project will apply these approaches to coastal zones of the European Union, with a primary focus on the marginal seas of the German Bight and the Western Black Sea, aiming to advance the scalability of models for coastal processes and related impacts.