A multiscale analysis of the stability of Caribbean coastal ecosystems through the biogeomorphic modelling of its complex bays and inlets

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The Dutch Caribbean consists of two island groups, the Leeward Antilles off the Venezuelan coast separated from the Windward Islands east of Puerto Rico over distances of the scale of the Caribbean Sea itself. Climate change in the Caribbean Sea is predicted to lead to rising sea levels, warming waters and changing eddy fields. Warming waters lead to an increase in the intensity and occurrence of tropical storms and hurricanes, and are linked to an increased risk of surge flooding. Changing eddy fields are likely to affect the path of storm tracks. All of which further influence the environment of the Caribbean, and hence the stability of its ecosystems.

Climate change will potentially have a significant effect on the biogeomorphological development of bays and lagoons here. It is a challenge to predict the consequences of such extreme events, as well as of more gradual changes due to climate change and their impact on the islands of the Dutch Caribbean, and their marine ecosystems.

To analyze the effect of the resultant stressors, including changes in regional sea level, wave climate, flushing of bays and lagoons, warming and biogeomorphic feedbacks, we apply a novel strategy: downscaling from climate simulations, to a regional ocean model including waves, to biogeomorphodynamic modelling at the scale of the local bays and lagoons. These effects are driven by global scale processes, yet have a regional impact at the scale of the entire Caribbean Sea, as well as at the scale of the individual bays and lagoons.

The wide range of spatial and temporal scales linking the large global-scale dynamics down to the local effects on Caribbean ecosystems demands a multiscale modelling approach. In this presentation we will detail how this challenge is being tackled by an international multi-disciplinary team — lead by the three Dutch institutes: TU Delft, IMAU and NIOZ — in order to establish a connection between global climate changes and local ecosystem effects, and evaluate the impact to ecosystems in small-scale lagoons and bays.