QUANTIFYING THE HYDRODYNAMIC RESILIENCE OF SIMPLIFIED ATOLLS

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INTRODUCTION

In coastal hydrodynamics, the concept of resilience is mostly used by coastal managers with definitions closer to the field of risk assessment than to the study of dynamic systems (Masselink et al. 2019). This study proposes a new approach to quantify the hydrodynamical resilience closer to the ecological definition of Holling (1973) and is applied to the simplified case of small, circular, micro-tidal atolls.

METHODOLOGY

A simplified benchmark for atoll morphology and meteo-marine forcings (see Figure 1), is used to construct the simplified atolls. A set of 961 simplified atolls are randomly drawn from these parameters. A numerical model (Delft-3D) allows the computation of the wave setup, currents, and wave height for each of the atolls. An analysis of the resulting dataset describes the interplay between the various parameters and allows the selection of a set of characteristic state variables.

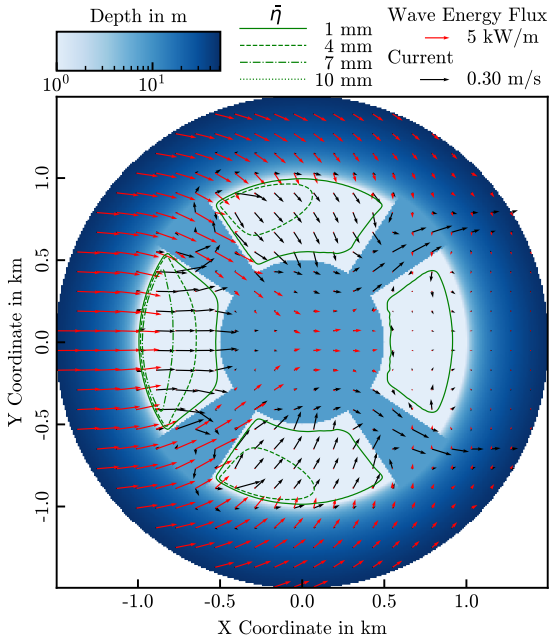

Figure 1 : Example of a simplified atoll hydrodynamical response to 1m offshore Hs

RESILIENCE

Following Holling (1973), stability represents the ability of a system to return to an equilibrium state after a temporary disturbance. Resilience is then a measure of the persistence of the system and its ability to absorb disturbances by maintaining the same relationships between the relevant state variables. To represent and quantify the resilience of a system, a potential is assigned to each possible state of the system, with domains of attraction (DOA) surrounding the stability equilibrium points of the lowest potential (SEP). The shape of the DOA measures the resilience (see Figure 2).

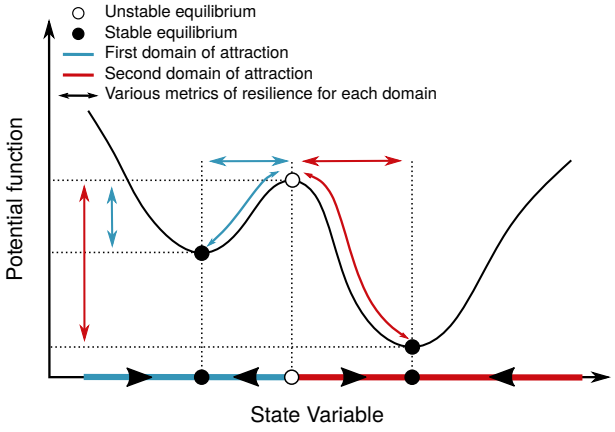

Figure 2 : Schematic view of resilience for a 1D System

The computation of the potential landscape is not always possible (Rodríguez-Sánchez et al. 2020), leading instead to the study of SEP modifications through qualitative analysis (Levins 1974) and the study of time trajectories of systems based on scenarios. By varying the previously defined reduced set of characteristics based on the IPCC scenarios, we obtain trajectories for future atoll hydrodynamics. These results are compared to the qualitatively expected effects through the definition of a signed digraph and corresponding community matrix (Dambacher et al. 2003).

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