

Title: Analyzing the robustness of flood risk systems to climate variability

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Flood risk managers need to take into account climate variability and climate change in their planning for the long term. Because of the natural variability in river discharges and storm surge levels, risk is considered the key concept for decision-making. Generally, risk reduction is weighted against investment costs in order to make a decision between policy alternatives. However, flood risk can be reduced in many ways. Flood probability reduction or consequence reduction may have a comparable effect on the flood risk, while other system characteristics may be affected differently. A decision between alternatives requires detailed insight into how the robustness of the system is affected.

In the context of climate change, the term robustness is gaining popularity in policy documents for water resources management. Because of its positive connotation of something being insensitive to varying circumstances, a robust system seems to be preferred. What this practically means is however unclear. This requires that the concept of robustness be made operational to support flood risk management.

This paper proposes a framework for the analysis of the robustness of flood risk systems. Robustness is considered a system characteristic that represents the ability (of a system) to cope with disturbances. Robustness is composed of three system characteristics that determine how a system responds to disturbances: resistance, sensitivity and resilience. Resistance is the ability to withstand disturbance, sensitivity is the ability to limit the impacts of a disturbance and resilience is the ability to recover from the impacts.

An application of the framework on an estuary in the southwest of the Netherlands shows that all three robustness components can be satisfactorily quantified. The degree of resistance is indicated by the maximum water level that does not cause flooding of the polders. The sensitivity is indicated by the increase of flood damage with increasing storm surge levels. The resilience is indicated by the financial, social and technical state of the system, which allows recovering quickly from the impact of flooding.

A system's robustness can be increased by improving one or all of the three capacities. When deciding between alternative policies, the key challenge is to consider all robustness capacities in a balanced way. Analysis of the system robustness gives insight into the degree of impact of a policy alternative on each capacity. As such, it supports a more subtle discussion among stakeholders in the process of decision making for flood risk management.