Use of flow duration curves as input in river morphodynamic computations

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Challenge

Numerical models can be used to understand morphodynamic behavior and to forecast a river's future morphodynamic changes, for instance in light of the ongoing nourishments or climate change. Theoretically, there is no limit on the time span of such forecasts, yet for numerical simulations with a simulation window of more than a few years, the computation time will quickly become very large. It is desirable to reduce the computation time of such models as it may increase their value for daily practice.

Innovative components

The costliness of morphodynamic computations is a direct result of the presence of multiple time scales in river morphodynamic problems. Elimination of some of the less important time scales allows for more efficiency in computational models. We have eliminated fast hydrodynamic time scales by using a time-varying flow duration curve (i.e., time-varying flow statistics) instead of a hydrograph time series as model input.

This has enabled the development of a:

1. Space-marching morphodynamic equilibrium model, and a
2. Flow statistics based time-marching morphodynamic model.

For whom and where?

For all policy advisors that would like to use numerical models in their decisions.

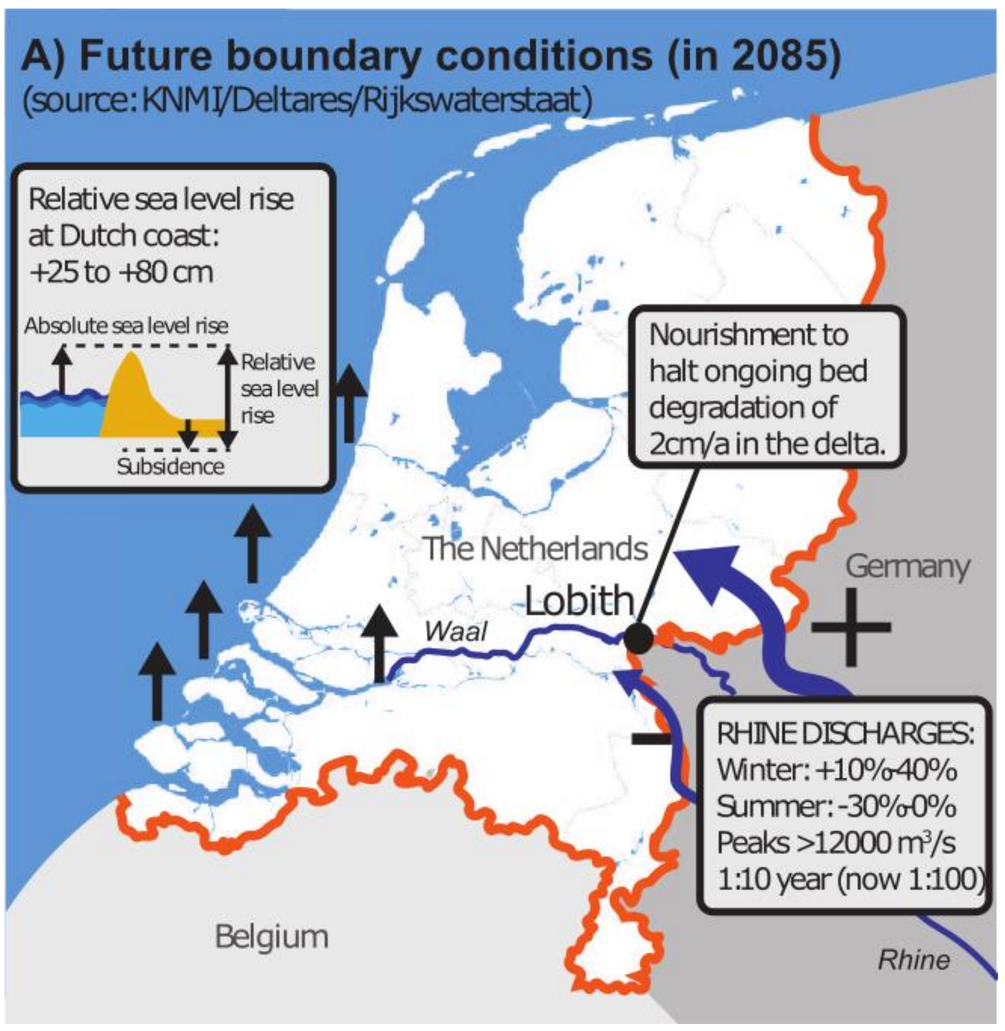
Application development and findings

We have applied the modelling concept to various test cases related to the Dutch Rhine system. We have learned that

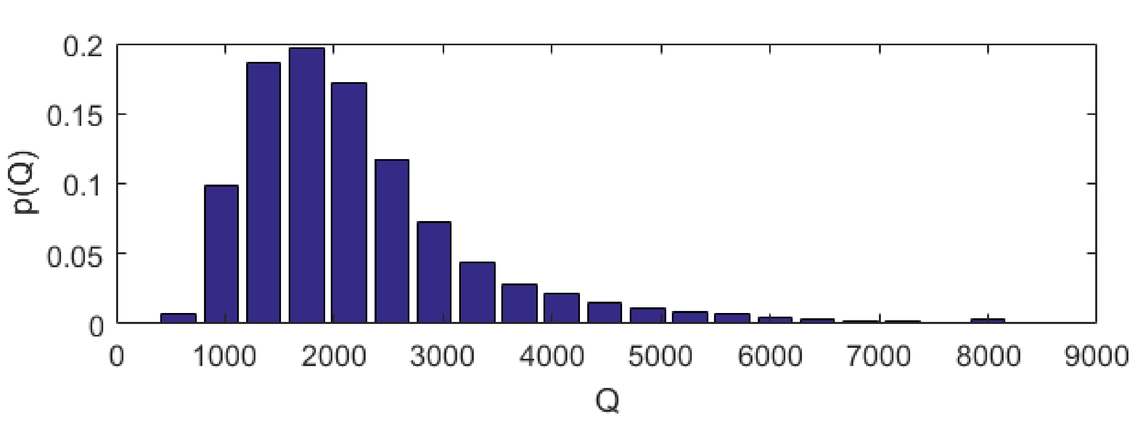
- The flow duration curve determines the trend in morphodynamic development, whereas the water discharge sequence governs the deviations from the trend.
- The variability of the flow rate is more important in a backwater reach than in the more upstream quasi-normal flow segment.
- Our new statistics-based morphodynamic model yields results similar to the mean of a Monte Carlo approach, yet in a computationally much more efficient manner.

Status for day-to-day practice

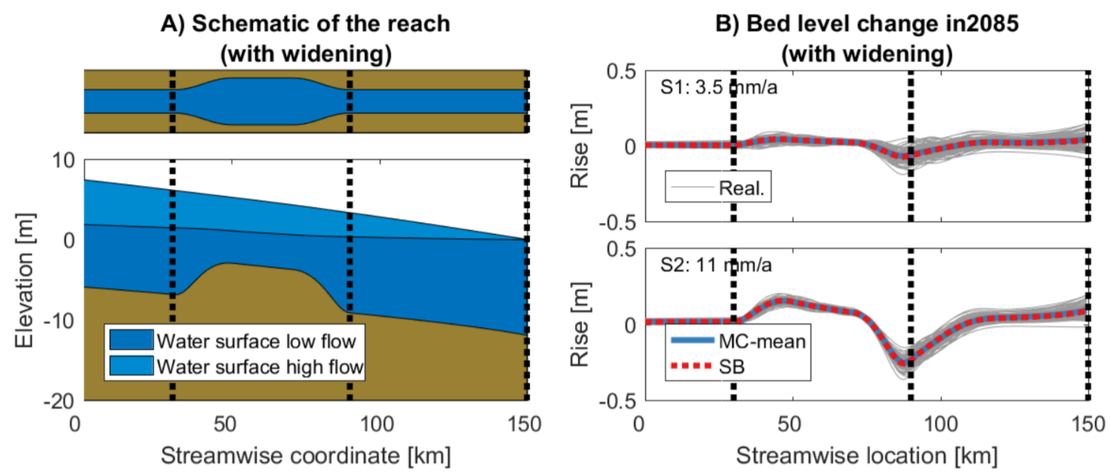
The results of this study are implemented in the research code ELV. Moreover, the concept of the methodology is generically derived and may therefore be implemented in other morphodynamic models also.



Slow, long-term variations in the forcing of the Dutch Rhine.



The new modelling concept uses flow statistics instead of daily time series. The statistics may be constant in time, or may vary due to climate change or human interventions.



Results for two scenarios of sea level rise. Flow statistics based time-marching model (SB) versus Monte Carlo (MC) simulations of a traditional time series hydrograph model.

Interested?

Email to: Astrid.blom@tudelft.nl
Explore more in the numerical morphodynamic modelling project description

D2 Project

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