Confidence in real-time forecasting of morphological storm impacts

Fedor Baart and Pieter van Gelder and Mark van Koningsveld

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Introduction

Fedor Baart

PhD thesis: Confidence in morpological forecasts

Links

http://citg.tudelft.nl http://www.deltares.nl
http://www.openearth.nl http://www.micore.eu

1 Coastal safety along the Dutch coast

2 Days ahead

3 Confidence

Outline

1 Coastal safety along the Dutch coast

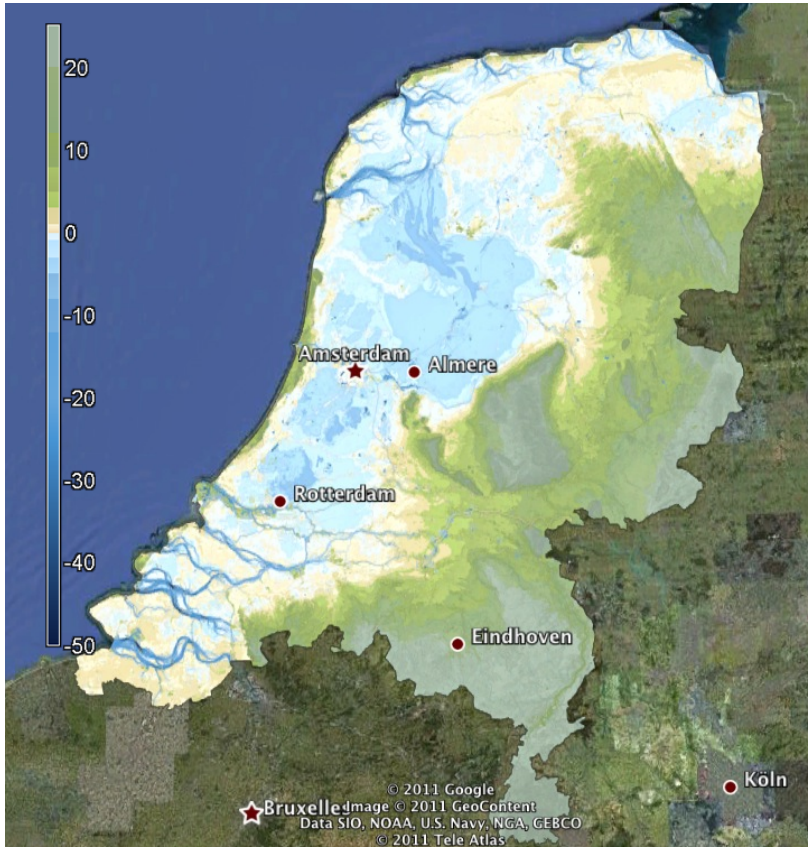
2 Days ahead

3 Confidence

The Netherlands below sea level

Elevation

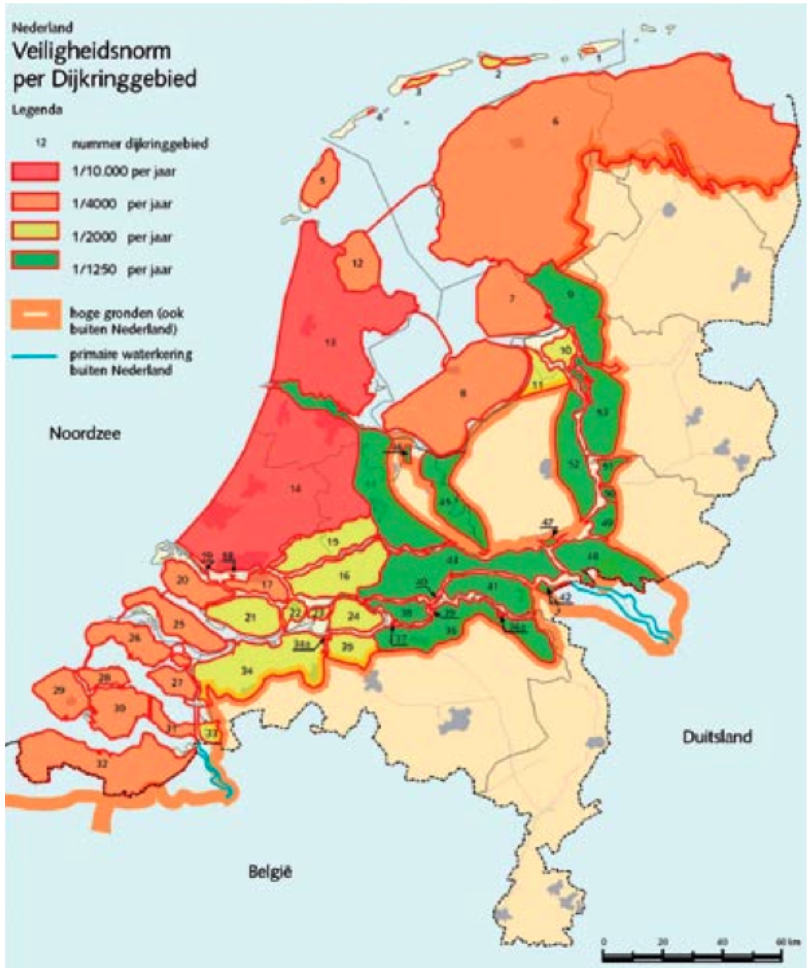
40% Of the Netherlands is below sea level.



How safe should it be?

Norm

Dutch safety standard of $^1/_{10000}$ (exceedance probability for the Holland Coast per year) is based on economic evaluation of the hinterland.



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Operational modelling

Forecasts

Predicting coastal changes 3 days ahead.

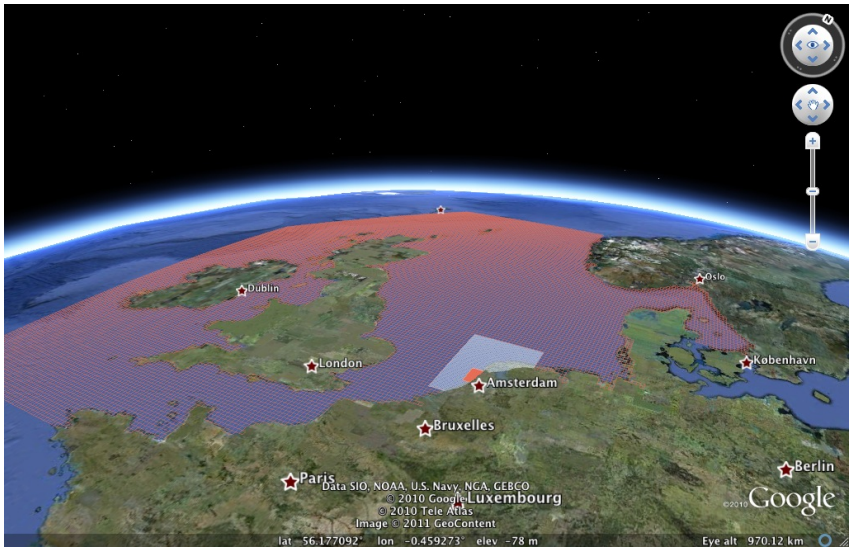


Figure: Operational model for coastal morphology (Baart et al 2009)

Operational modelling

Forecasts

Improvements to several aspects of the operational coastal morphological model.

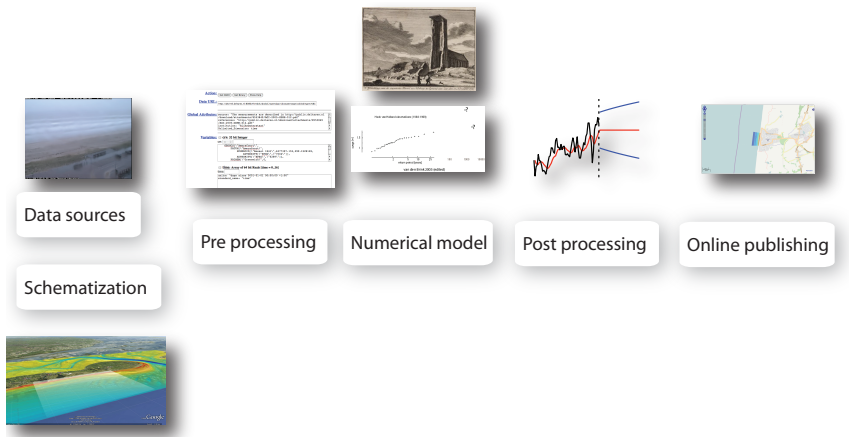
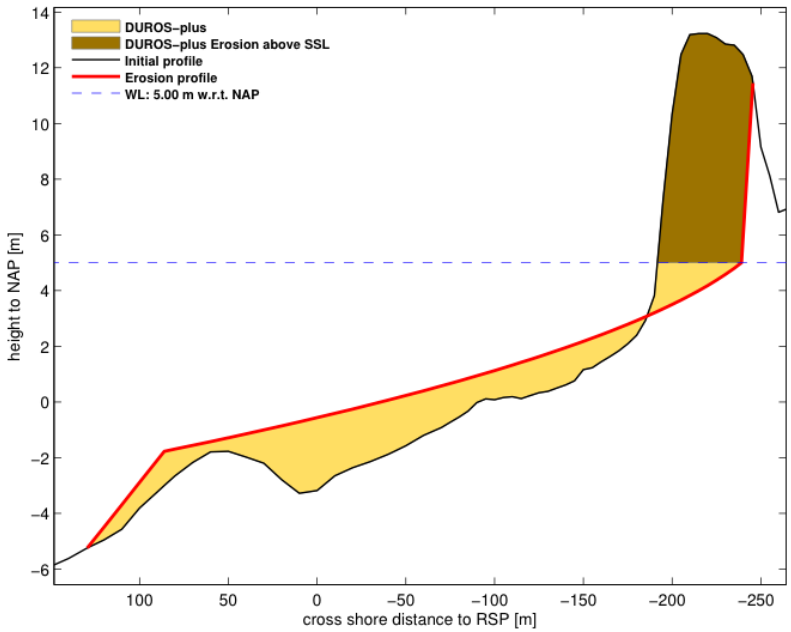


Figure: Improvements to several aspects of the operational coastal morphological model.

Improving the coverage

From local empirical model (applicable to 60%) to a general numerical model (applicable to 90%)



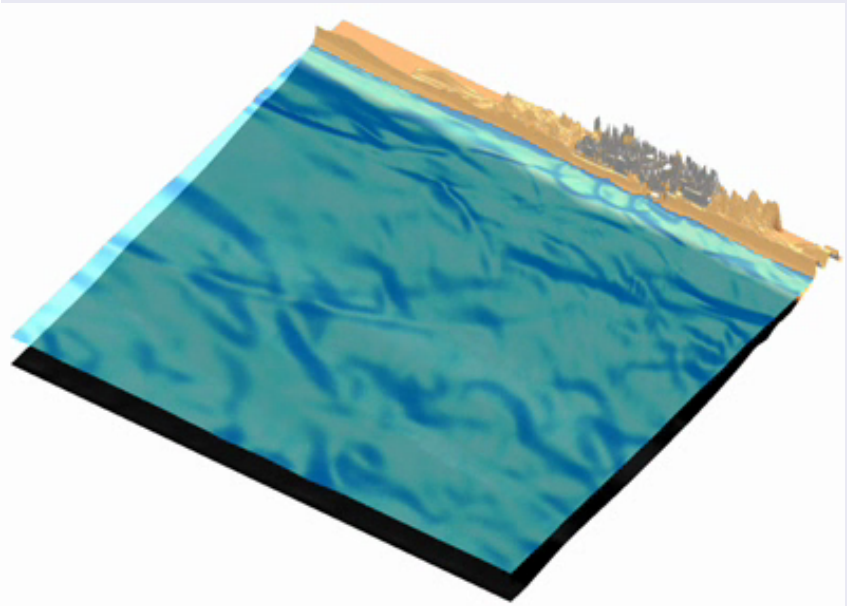


Figure: Duros 1D model versus XBeach 2D model, http://www.xbeach.org

Open Source models

Delft3D

Open source modules: FLOW, MOR, WAVE.

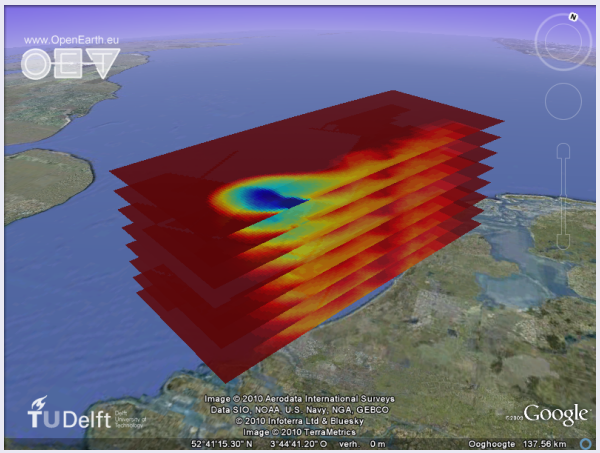


Figure: Delft3D simulation of Rhine rofi, source: De Boer, http://oss.deltares.nl

OpenEarth

Collaboration to share data model and tools.

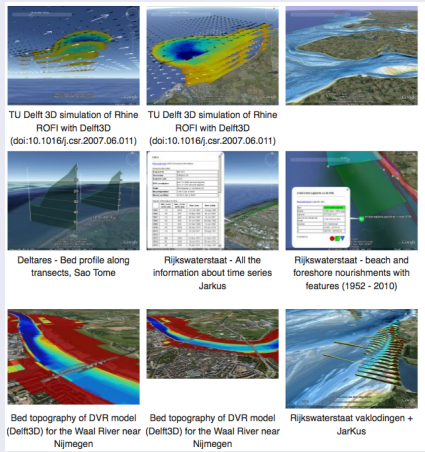


Figure: Visualizations made with OpenEarthTools, http://www.openearth.eu

Operational modelling

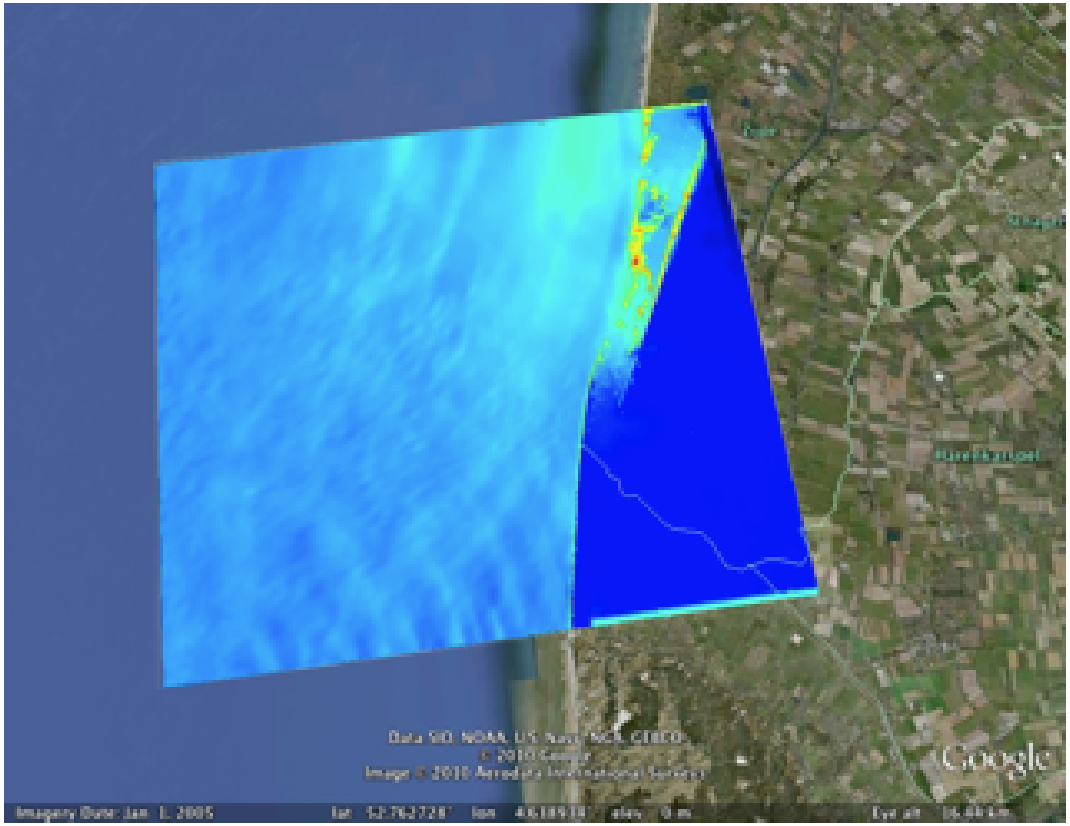


Figure: Forecasting water levels and currents nearshore and erosion

Figure: Swimmer simulator

Response measures

Figure: Twee gebroeders, 1953

Figure: Research: Emergency measures Delfland, Walstra et al

movie

Figure: XBeach model of Petten met hyperstorm ($p < 1/10000$).

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Main question

How confident are we in our forecasts?

3 methods

- *Ensembles propagation*
- Hydrodynamic forecast error
- Morphological forecast error

3 Methods

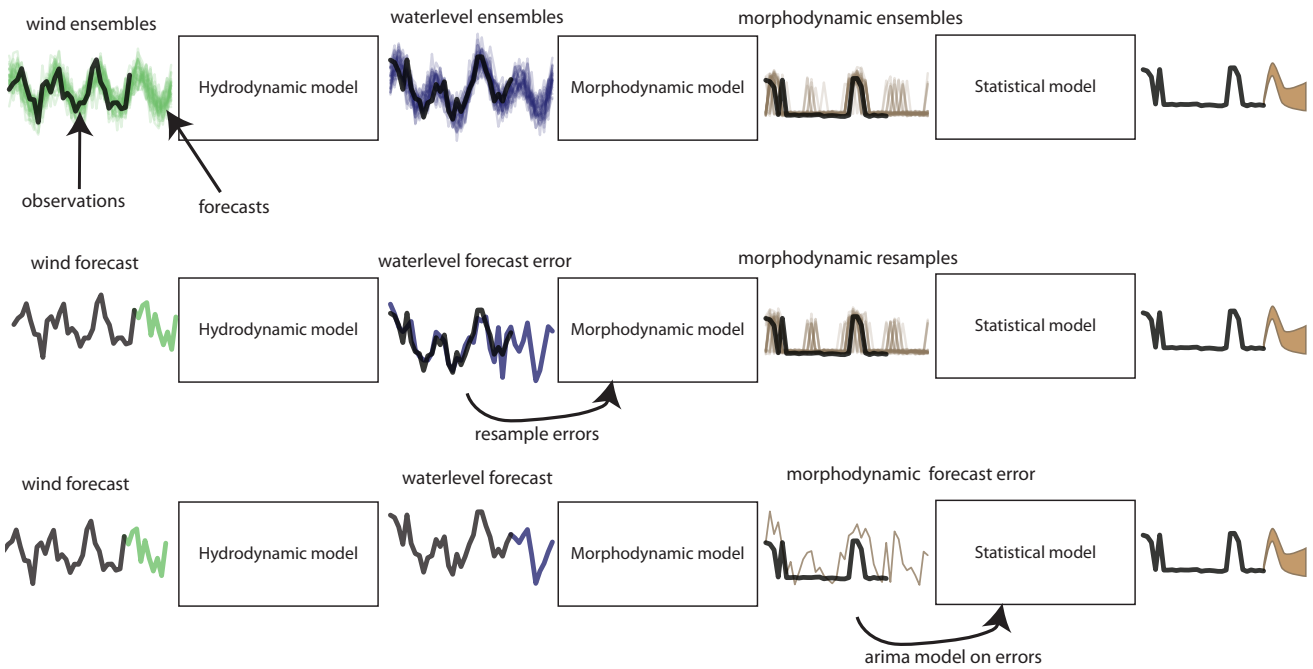


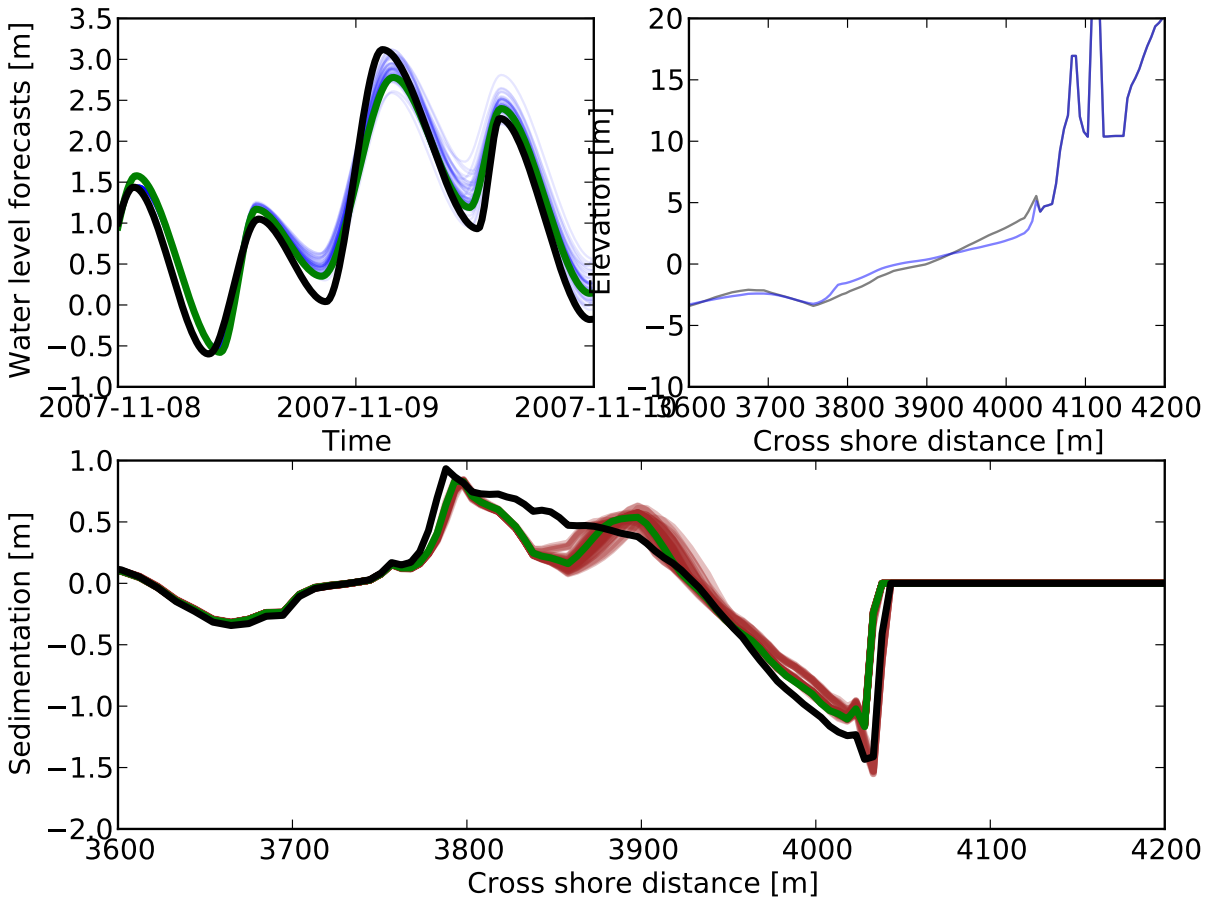
Figure: Methods to estimate confidence interval

Example: Egmond coast

movie

Figure: XBeach model of Egmond 2007 storm.

Ensemble method



Applicability

Method	Error introduction	Data required	Computation time	Assumptions
(a)	Meteorological	Ensemble breeding	6 hours * 50	Ensemble variation propagated through model chain is representative for the error made in morphological forecast.
(b)	Hydrodynamic	History of hydrodynamic observations and forecasts	4 hours + 2 hours * number of resamples (50)	Previous hydrodynamic forecast errors are representative and the main source for errors in the morphological forecast
(c)	Morphodynamic	History of morphodynamic observations and forecasts	6 hours	Previous morphodynamic forecast errors are representative for future forecast errors.

Table: Comparison of the three different methods to compute confidence bounds