

An integrated coastal model for aeolian and hydrodynamic sediment transport

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April 24, 2012

Introduction

Fedor Baart

PhD thesis: Confidence in coastal forecasts

Links

<http://citg.tudelft.nl> <http://www.deltares.nl>

Building with nature, <http://www.ecoshape.nl>

<http://www.openearth.eu>



Integrated Coastal Model

Master's theses

- M.C. Muller, Process-based Modeling of Coastal Dune Development
- T. Pekkeriet, Dynamics of mega-nourishment
- J.P. den Bieman, Integrated coastal modeling

See also:

XL234: A new modelling concept for aeolian sediment transport on beaches (S. de Vries, Today 17:30-19:00)

- 1 Problem
- 2 Modelling approach
- 3 Implementation
- 4 Applications
- 5 Conclusion

Predicting coastal changes

Aeolian transport



Figure : New dune formed after November 2011 storm along the Dutch coast, source PZC

Hydrodynamic transport



Figure : Dune eroded after the 1741 storm, see Baart et al. 2011.

Methodological question

How to predict dune growth and erosion at a time scale of days to years and a spatial scale of 10m to 100km?

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Approach

A combination of **numerical**, statistical and emperical models.

Scales

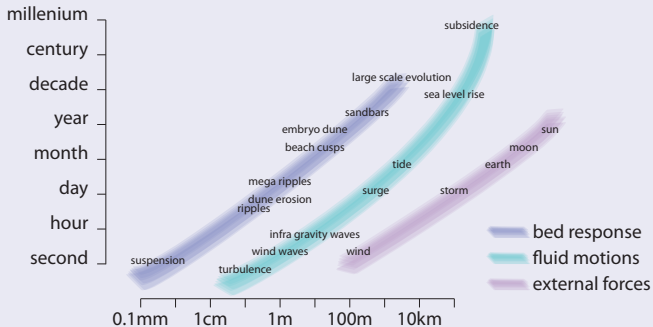


Figure : Time and spatial scales for hydrodynamic processes, based on Stive (1995)

Numerical models

Dune E. J. R. Parteli, O. Durán, H. Tsoar, V. Schwämmle and H. J. Herrmann, PNAS 2009

XBeach D. Roelvink et al, Coast. Eng. 2009

Delft3D Lesser et al, Coast. Eng. 2004

Scales

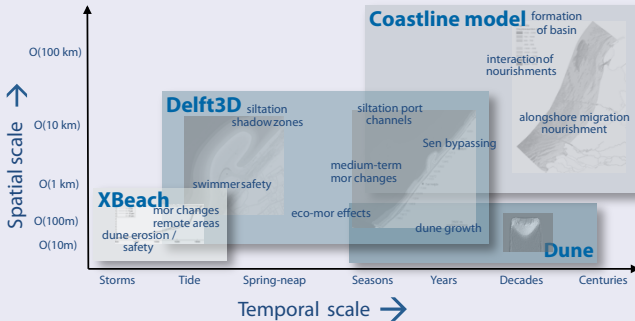


Figure : Time and spatial scales for hydrodynamic processes, picture by Huisman (Deltares)

Numerical models



Figure : Monolithic versus micro models

Coupled model approach

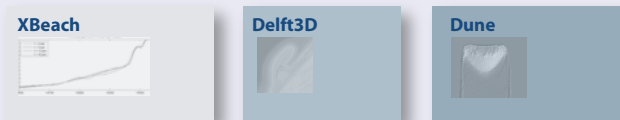


Figure : Coupled model

Coupled model approach



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Coupled model approach

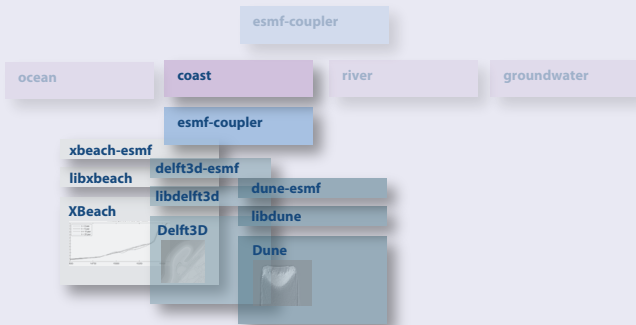


Figure : Coupled model

Typical issues in integrated modelling

Bathymetry changes

$$\frac{\partial z}{\partial t} = \frac{\partial z_{x\text{beach}}}{\partial t} + \frac{\partial z_{\text{delft3d}}}{\partial t} + \frac{\partial z_{\text{dune}}}{\partial t}$$

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Overlapping physics

$$\begin{aligned}\partial z_{x\text{beach}} &= \dots + \partial z_{\text{avalanche}} + \dots \\ \partial z_{\text{dune}} &= \dots + \partial z_{\text{avalanche}} + \dots\end{aligned}$$

Typical issues in integrated modelling

Bathymetry changes

$$\frac{\partial z}{\partial t} = \frac{\partial z_{x\text{beach}}}{\partial t} + \frac{\partial z_{\text{delft3d}}}{\partial t} + \frac{\partial z_{\text{dune}}}{\partial t}$$

Overlapping physics

$$\partial z_{x\text{beach}} = \dots + \partial z_{\text{avalanche}} + \dots$$

$$\partial z_{\text{dune}} = \dots + \partial z_{\text{avalanche}} + \dots$$

$$\partial z_{\text{avalanche}} + \partial z_{\text{avalanche}} = \text{Hole in the beach}$$

Site 1: Assateague Island



Figure : Assateague Island,
Modeling in cooperation with USGS

Results

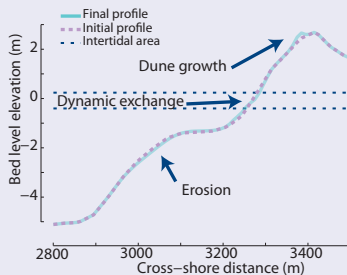


Figure : Model run for Assateague Island (XBeach + Dune) (src: den Bieman)

Site 2: Sand engine



Figure : Sandengine project (picture zandmotor@flickr)

Results

Figure : Sandengine Simulation (src: Pekkeriet), Delft3D

Looking for...

Applications

- Projects for further development
- New field cases for testing

Extensions

- Reuse the components
- Integration into other coupled systems
- Extend and improve current model setup

Get the models

Download Delft3D, XBeach, ESMF couplers from
<http://oss.deltares.nl>