Recent developments in hydrodynamics and morphology at Deltares

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From Delft Hydraulics to Deltares: why and how

Considering the Netherlands in terms of geophysics, one may simply state that the country consists of water and weak soil. Until recently, several independent research organisations and institutes were responsible to maintain and further develop the overall knowledge base and practical expertise needed to maintain the Netherlands as an environmentally safe and healthy country. Delft Hydraulics (founded in 1927), focusing on water, was one of these.
In the early 2000s the Netherlands government, realising the increasing complexity of environmental tasks and challenges and the need for interdisciplinary approaches, decided to reorganise the institutional infrastructure to create a single institute for water and weak soil.
On 1 January 2008, Deltares was officially launced. It merges three research institutes active in the areas of water and (weak) soil: Delft Hydraulics (water), GeoDelft (soil mechanics), part of TNO (shallow subsoil and ground water), plus the two governmental research departments for marine and inland waters RIKZ and RIZA. Just as GeoDelft and Delft Hydraulics before it, Deltares is an independent foundation for applied research and specialist advice. It has specific “national tasks”, while the larger share of its activities takes place on the European level (EU research funds) and funding from world wide research and advice and assistance studies.

Continuing model developments, cooperation and community models

Hydrodynamic and morphological modelling continues to be a core activity of Deltares. Understanding of processes, development of models for these, verification, validation and application essentially go hand in hand. This has led to continued development and improvement of it modelling codes Delft3D-FLOW and –MOR, which are widely used by many universities, government institutes and industry.

Unlike the founding institutes, Deltares has the task to advise on national research needs, and often has a more explicit responsibility in coordination of national research programmes, in which institutes and market parties of different disciplines cooperate. Both nationally and internationally, cooperation on research, shared model development and joint development of applications is viewed as a good way forward, to the benefit of all parties involved. Community models and open source models are catalysing these developments.

Recent developments in hydrodynamic and morphological modelling

Several recent developments in hydrodynamic and morphological modelling are considered relevant for the KfKI community.

- As of 1 January 2011, the Delft3D-FLOW+MOR+WAVE code is available as open source, and can be downloaded for free. Service packages at several levels can be offered, against a fee. Already after only nine months, the wider user community is regularly sharing new developments and application experiences, which are then integrated in the codes to the benefit of the whole user community. For further information, see e.g. ***http://oss.delft3D.nl***.
- The development of “Xbeach”, a nearshore morphological modelling package for dune erosion and overwash under storm conditions. It is a short waves-averaged but long-waves resolving model of waves, flow and morphological change, formulated in the time domain. It computes the evolution of wave action in x, y, t and over the directional space. Key advantages are that a separate wave model is not needed for the prediction of the mean wave direction, and that it allows different wave groups to travel in different directions. This open source development is led by three Delft based institutes: UNESCO-IHE, TUDelft and Deltares, and is supported by several major governmental organisations abroad, e.g. USGS. This is reflected in the range of test and validation cases that have been modelled so far. For further information, see ***www.xbeach.org*** or ***http://oss.delft3D.nl***.
- The “Sand Engine” project. This is an innovative beach nourishment experiment along the Delfland shoreface at mega scale (21.5 Mm^3 sand), to investigate the Building with nature (BwN) concept, including monitoring of the self distribution over a period of ~ 20 years. One of the considerations for the experiment is sea level rise, which in several scenarios could re-

quire even larger nourishments in the 21st century. The decision to do the experiment was based on extensive analysis and modelling of hydrodynamics, morphology and ecological impacts (EIA study). For further information, see ***www.dezandmotor.nl/en-GB/.***

- Hydrodynamic modelling using unstructured grids, as an alternative to both the orthogonal curvilinear grid approaches presently available in the Delft3D suite and various finite element approaches. The formulation is based on the finite volume approach. Applications have shown that channel-aligned grids in areas with channels and intertidal flats like the Wadden Sea can be made much more intuitively, while reducing computational demands. See e.g. (***Kernkamp et al. Ocean Dynamics, Vol. 63, 2011***).
- In May 2010, Deltares and partners VorTech and TUDelft launched the generic OpenDA data assimilation environment. This is an open source software development for model calibration and forecast improvement (filtering). Presently available and rigorously tested calibration routines include DUD, POWELL, SIMPLEX (Nelder-Mead). Filtering routines include EnKF and several particle filters. OpenDA can be generically coupled to any process modelling system (e.g. Delft3D, SOBEK, MIKE21, ISIS, TRIM3D, TELEMAC, etc.); the only condition is that once the information exchange interface between that model and OpenDA has been defined. Such interfaces or "wrappers" already exist for Delft3D-FLOW, SWAN, WAQUA, SOBEK, FEWS, HBV, WANDA, FEWS and Delft3D-WAQ. For further information, see ***www.openda.org*** and the references and examples therein.

In the seminar on 2 November 2011, the following two topics will be presented in more detail:

- The Sand Engine project
- Hydrodynamic modelling using unstructured grids