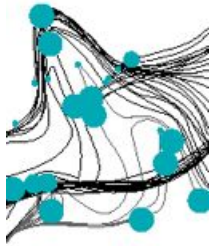


Fast Simulations of Fast Ships in Heavy Seas

JAAP VAN DER VEGT & ONNO BOKHOVE & RENE HUIJSMANS

<http://wwwhome.math.utwente.nl/~bokhove/>





AIMS



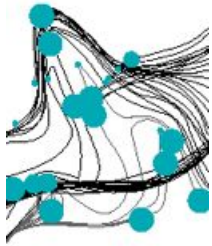
To model and predict:

1. **3D numerical waves** in MARIN's test basins with bottom topography, beaches and the wave-makers
2. **wave resistance** of slow ships (linear & full coupling)
3. **wave resistance** of fast ships in high seas with **wave breaking**



Innovation theme: **clean/smart ships** (fuel reduction & safe seakeeping)

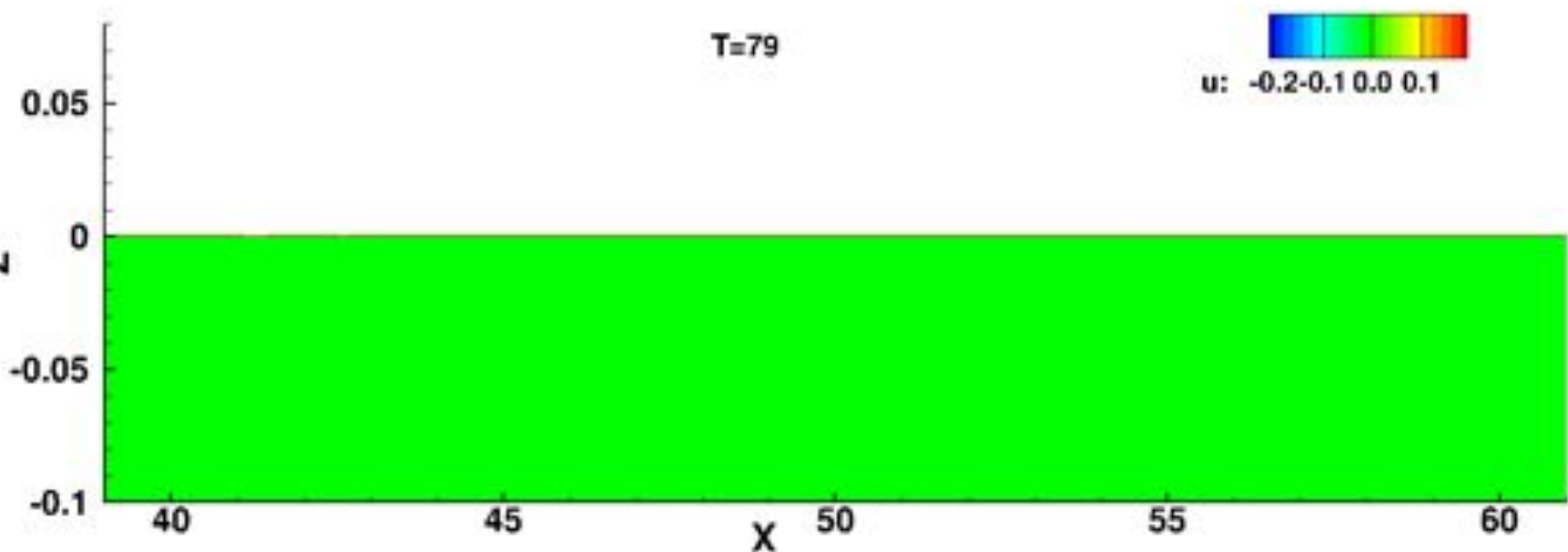
Knowledge area: **hydrodynamics & design**

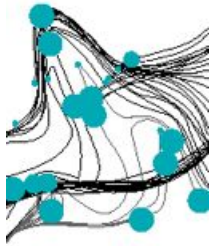


OUR CURRENT TECHNOLOGY

2D & 3D **variational** space-time discontinuous Galerkin finite element models **DGFEM for water waves**:

- Implementation in software environment **hpGEM**
- Cutting-edge **stable time integrators** for fluid-structure interactions
- Use of **variational/Hamiltonian CFD** for water waves essential!





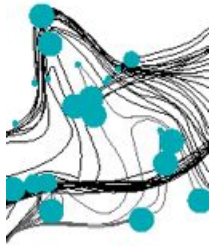
SUGGESTED MILESTONES



- To simulate 3D fully *variational water waves* –DGFEM
- To couple *DGFEM waves & slow moving ship* –linear ship dynamics
- To *validate* against tank data [prof Huijsmans & MARIN]

- To couple DGFEM waves & moving ship –*nonlinear ship dynamics*
- To *validate* against tank data [prof Huijsmans & MARIN]

- To formulate *DGFEM of smoothed wave breaking*, reduction to *variational DGFEM* for smooth waves
- To couple *DGFEM (breaking) waves & fast ships & validate.*



WHY VARIATIONAL FEM?

- Conventional CFD **too dissipative** for water waves:
 - wave amplitudes diminish too quickly & drag calculations inaccurate
- E.g. **SPH** for bore-soliton-splash **can't get wave & jet height right**:



reality: 3.5-4m

SPH: 2.88m



- Variational DGFEM wave modelling offers the right mathematics! But.



TEAM & DELIVERABLES

Team with integrated simulations & experiments:

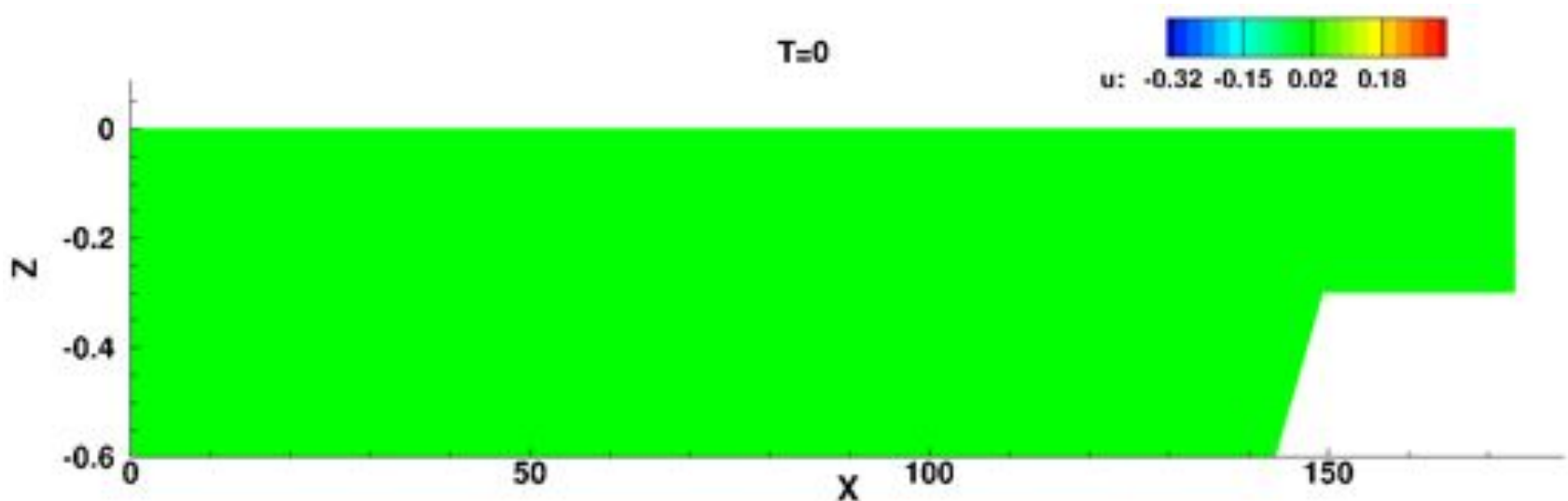
- Profs Jaap van der Vegt & Onno Bokhove & René Huijsmans [TUD]
- *You!*

Current projects:

- **STW** & NWO projects on waves, **EU Industry Doctorates** [MARIN] subm.

Deliverables for fast ships in heavy seas:

- Wave tank tests [TUD] & simulation tools [UT] & **your suggestions?**



Mathematics: University of Twente & University of Leeds

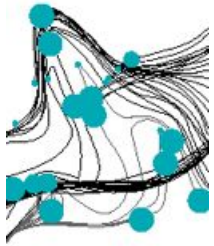
Dredging the Depths of Maths

ONNO BOKHOVE & JAAP VAN DER VEGT

<http://wwwhome.math.utwente.nl/~bokhove/>

UNIVERSITEIT TWENTE.

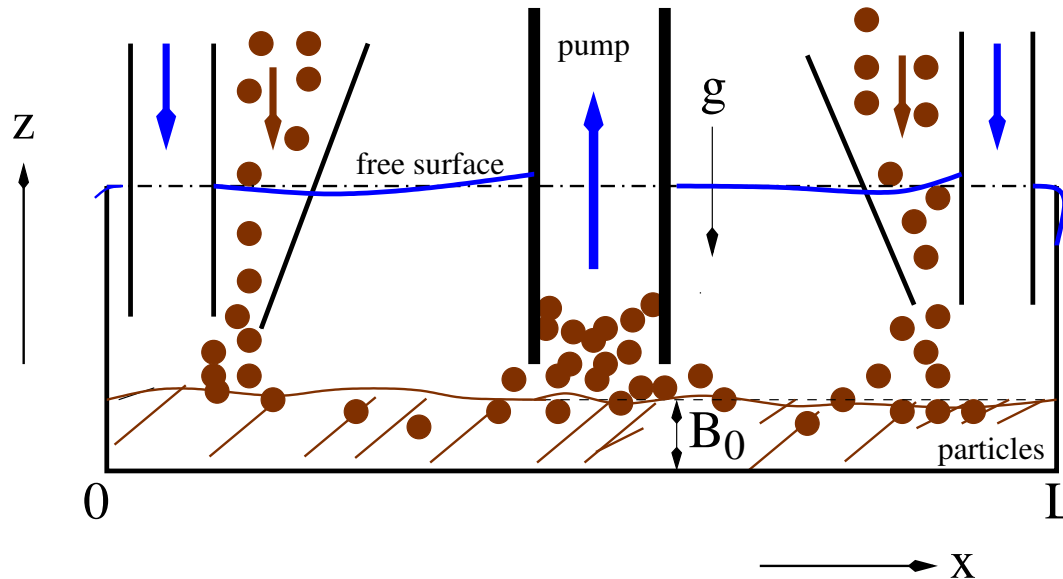




DREDGING: WATER-PARTICLE INTERACTIONS

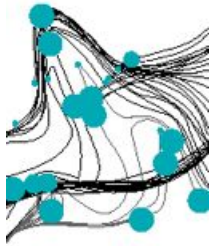
Aims:

- To explore Hele-Shaw dredging laboratory experiments, 2D to 3D:



- To investigate blockage of pumps as function of particle loading:
- prototyping late March
- To perform corresponding mathematical and numerical simulations
- Theme: smart ships & harbors. Knowledge: hydrodynamics & safety

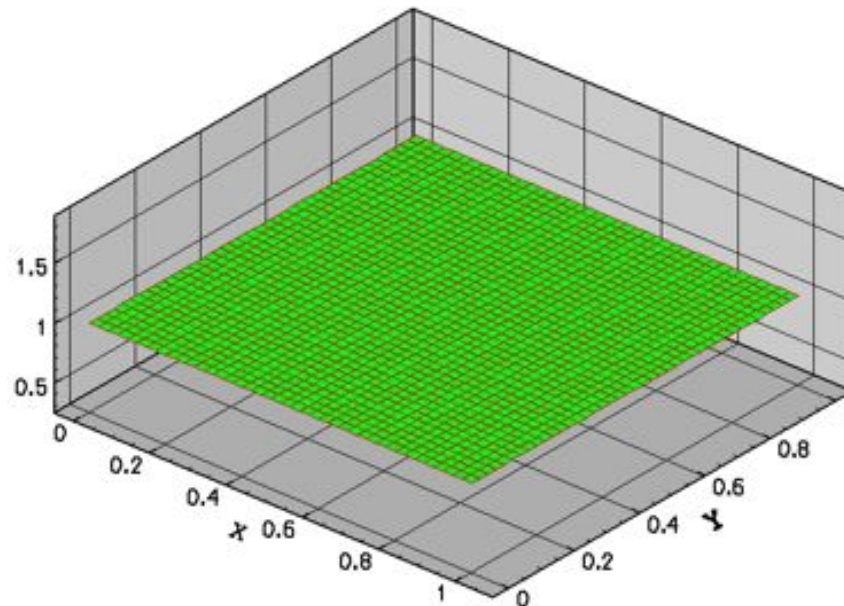




SUBMARINE LANDSLIDES & WAVE GENERATION

To investigate submarine landslides, caused by suction dredging

- To explore resulting wave generation
- To investigate wave impact on dredging ship
- To investigate run-up of tsunami in nearby harbors
- To model & simulate coupled bottom-wave interactions
- Case study: landslide harbor construction Nice, with 3m tsunami.

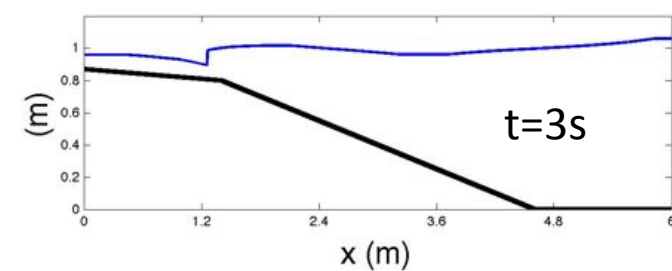
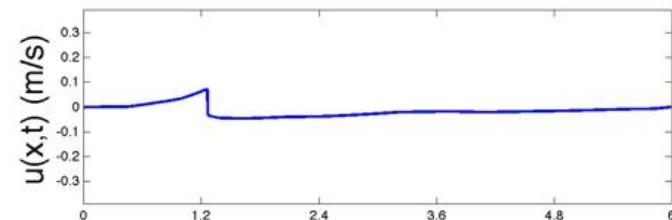
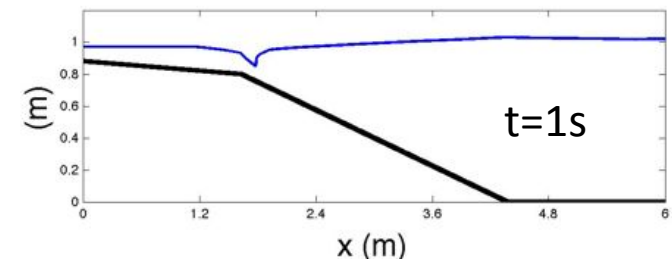
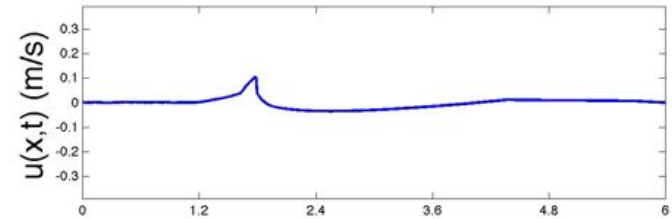
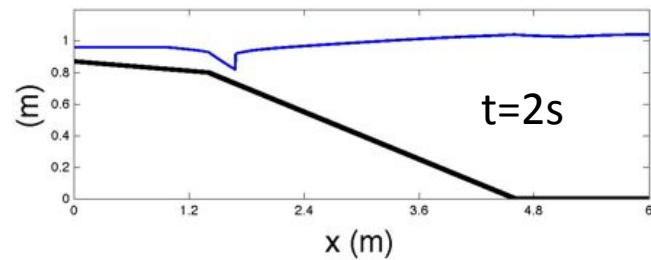
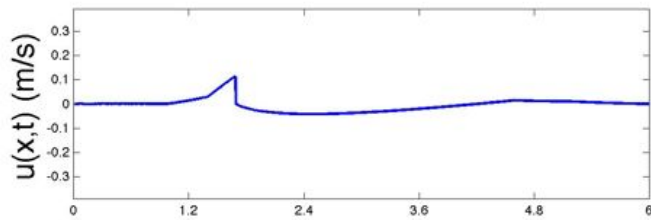
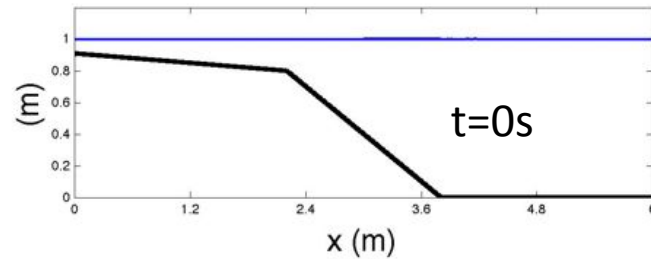
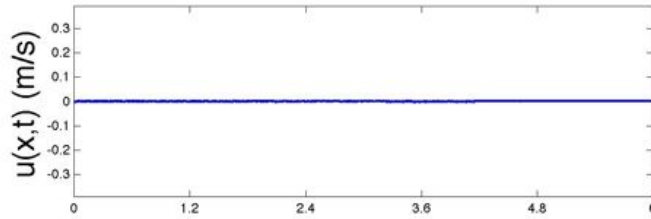


Three dimensional view of the waves generated by the wave maker



SUBMARINE LANDSLIDES: WAVE TANK

- `print -djpeg /Users/bokhoveo/dropbox/STWmatch/stw1.jpg`





TEAM & DELIVERABLES

- Profs Onno Bokhove & Jaap van der Vegt & ... **your team & suggestions!**
- Hele-Shaw beach formation by breaking waves (Leverhulme Fund subm)
- **Wave impact tests** on ships & in harbors (-) + **simulations tools** (UT)

