The optimal Use of Numerical modelling Tools in connection with Coastal Protection and Developments

By

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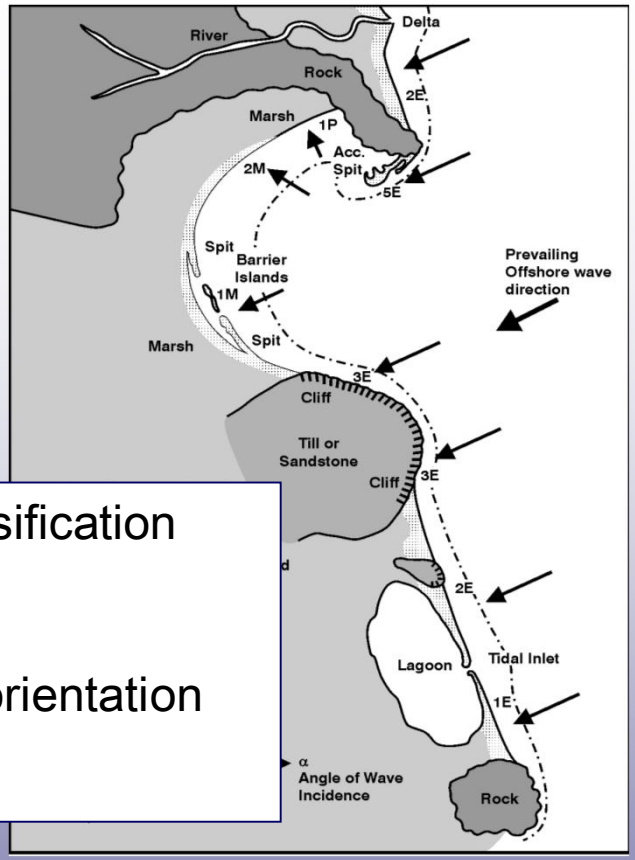
The phases towards a succesful coastal project

With focus on sandy beaches

Base line studies

- Coastal classification
- Littoral drift
- Equilibrium orientation
- Variability



Development of conceptual schemes including environmental screening

Environmental optimisation and detailed design

Detailed plan form and profile shape

Sediment properties

Final shape of structures

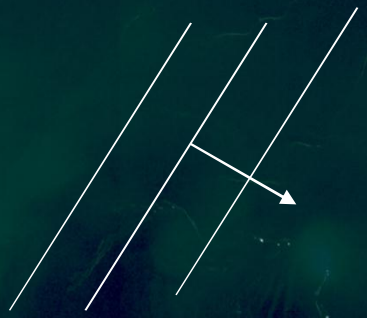
Waves Currents Water Levels Sediment transport

Astronomical tide

Air pressure

Wind

Waves



Deep water

Wind generation

White caps

Bottom friction

Interaction between waves and currents

Shallow water

Wave fronts

Refraction

Shoaling

Reflection

diffraction

Complex sediment transport

Littoral drift

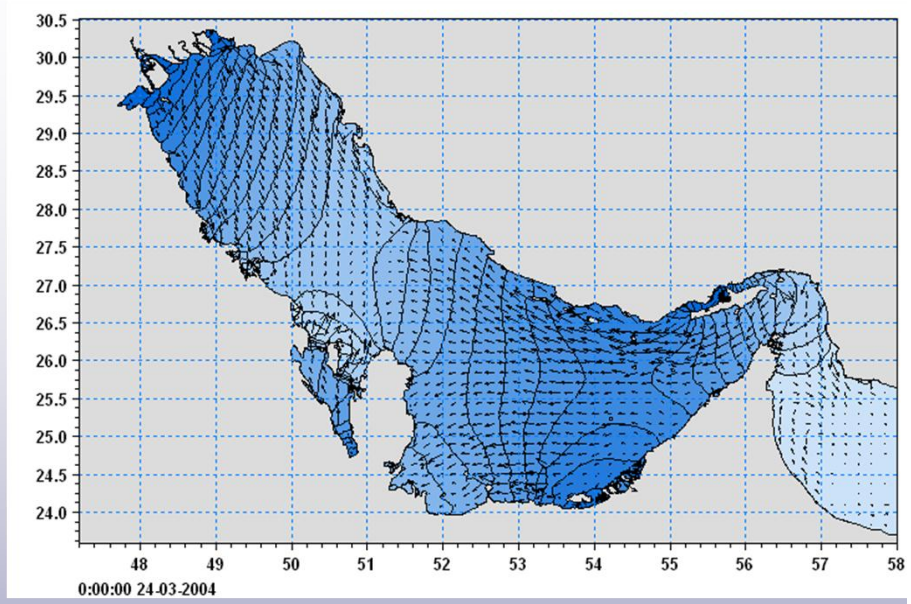
Metocean Data

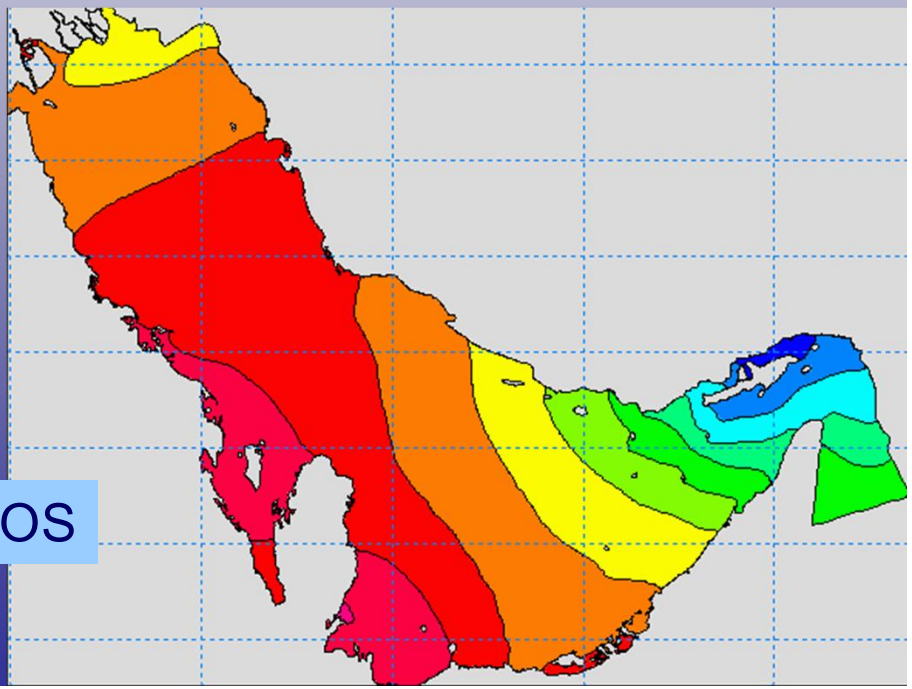
- Hindcast/Forecast Numerical models:

Spectral Wave model SW
- wave heights
- wave periods
- wave directions

2D and 3D Hydrodynamic Flow Simulations (HD)
- water levels
- currents

Statistical Analysis
- short-term statistics
- long-term statistics





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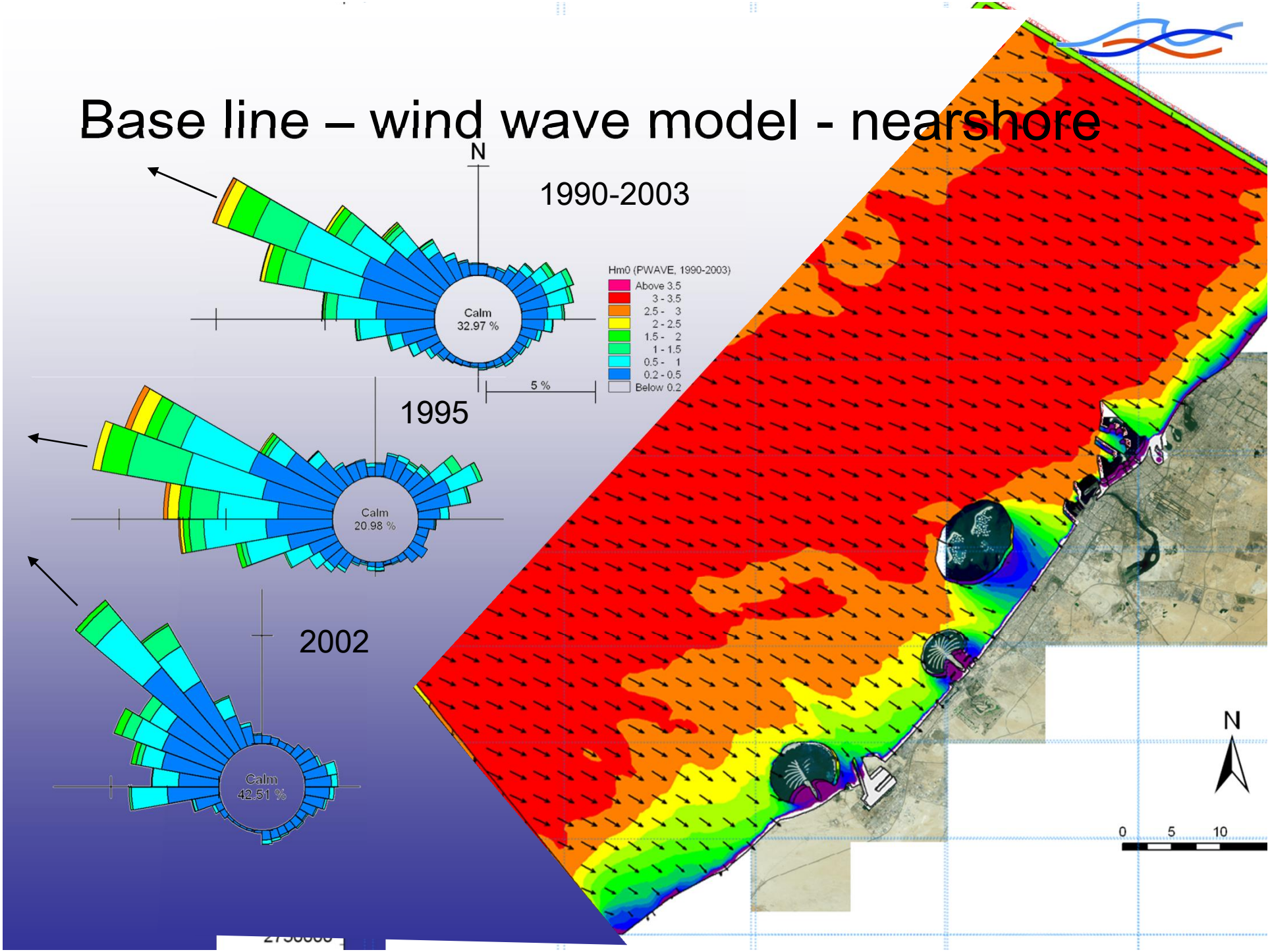
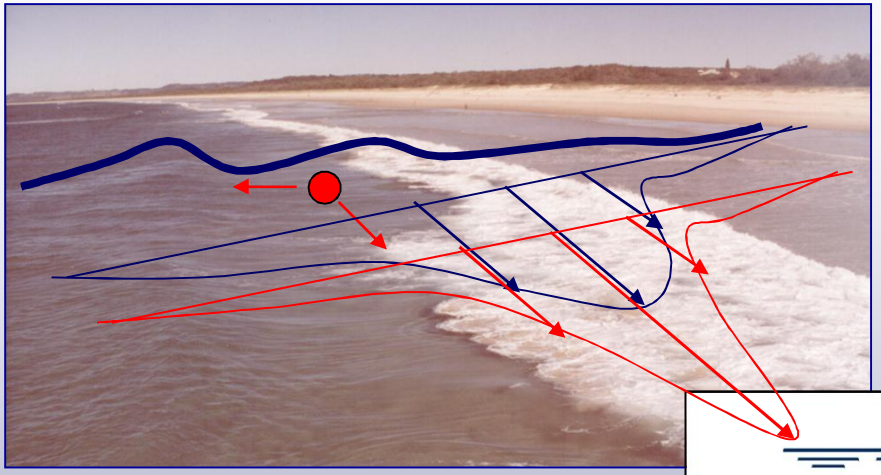
Forecast Models

Base line – wind wave model - nearshore

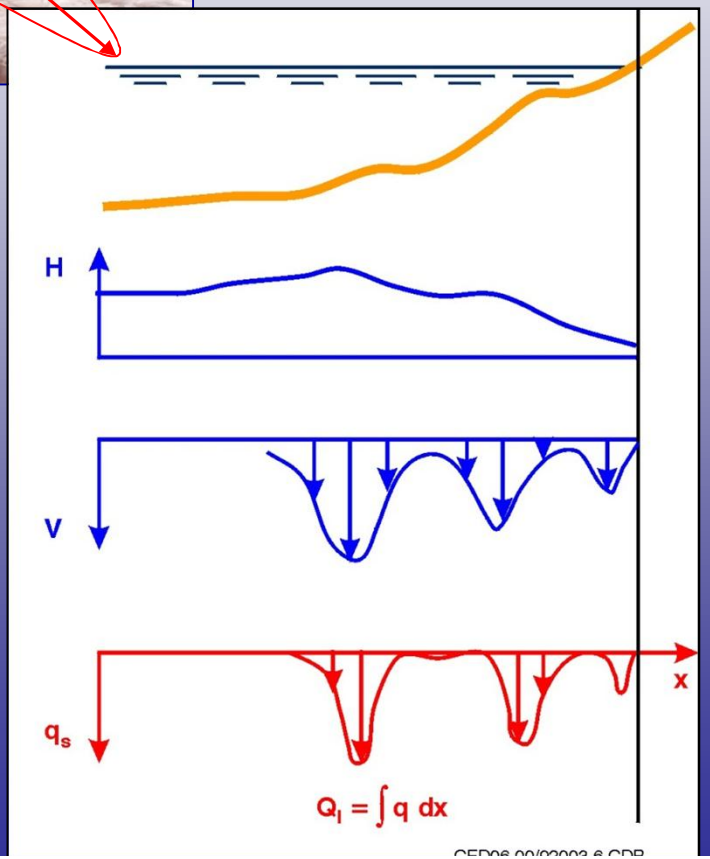


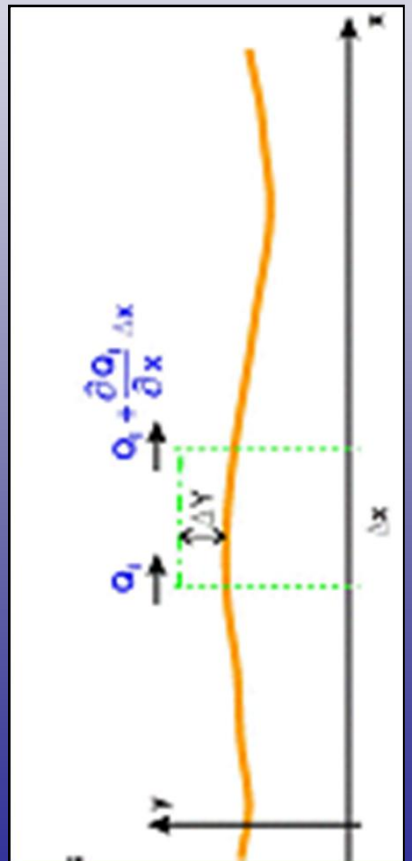
Base line – Littoral drift – open uniform coast



Littoral drift

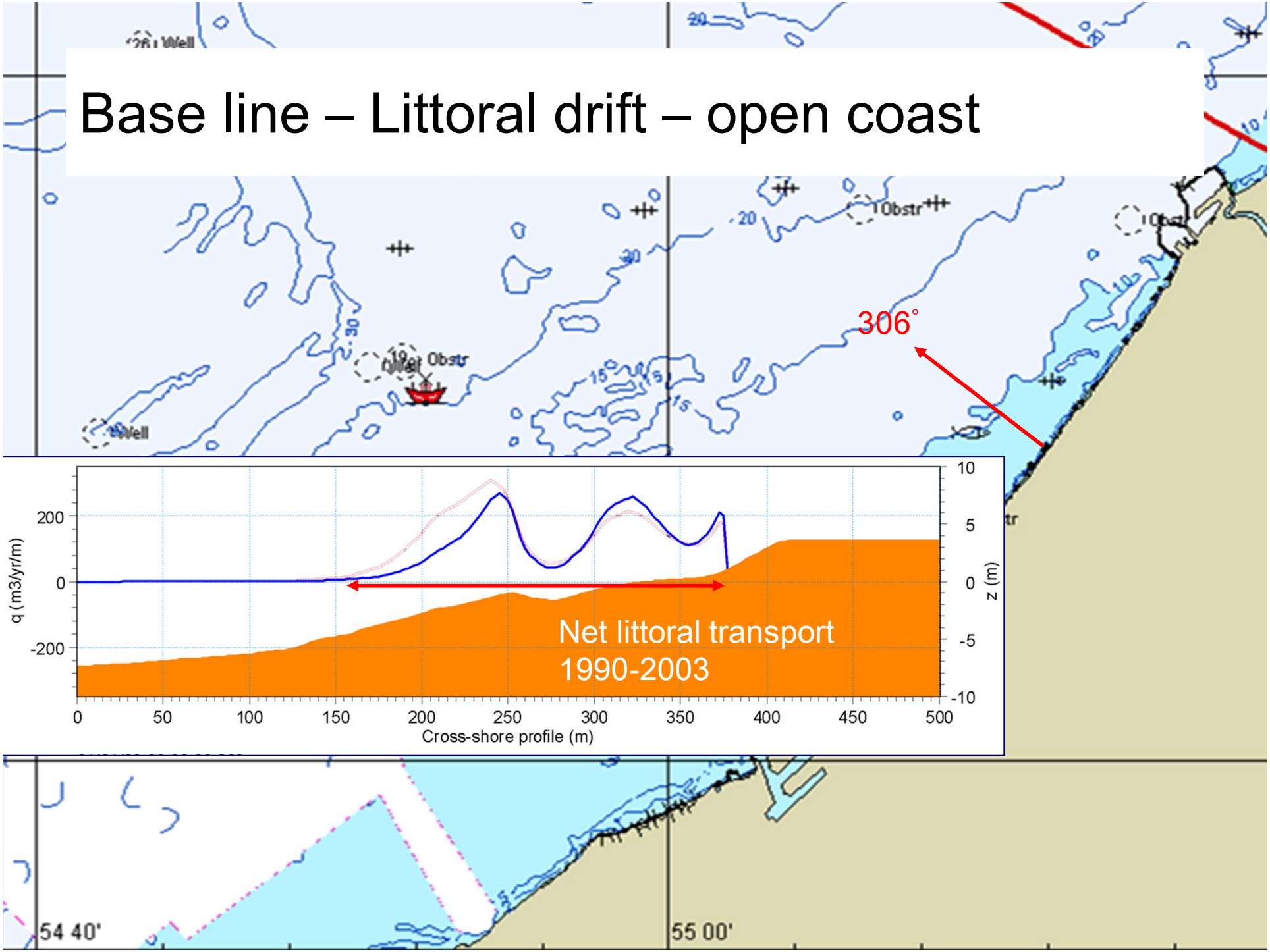
Shoreline evolution



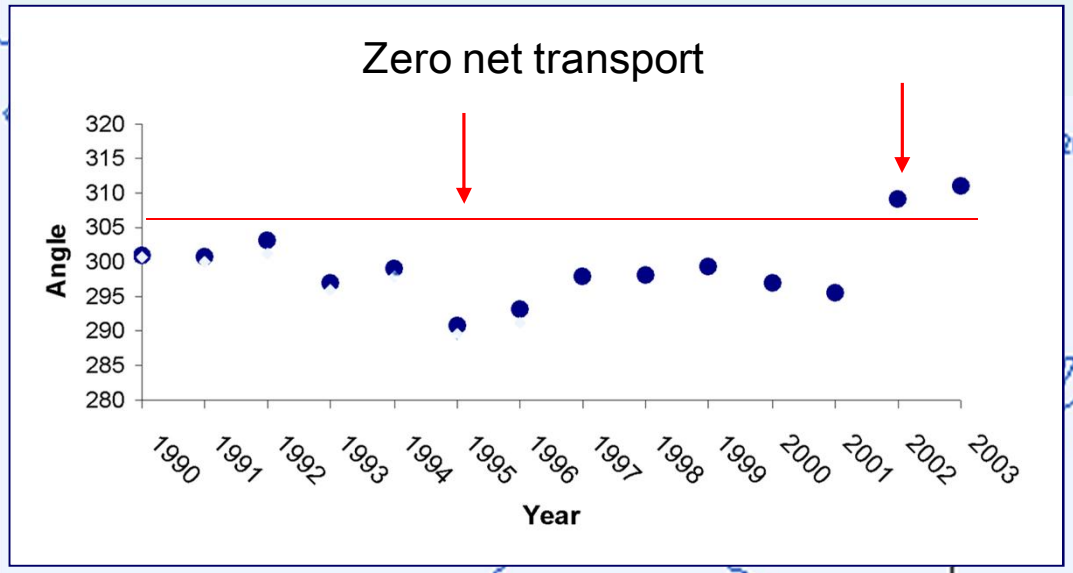


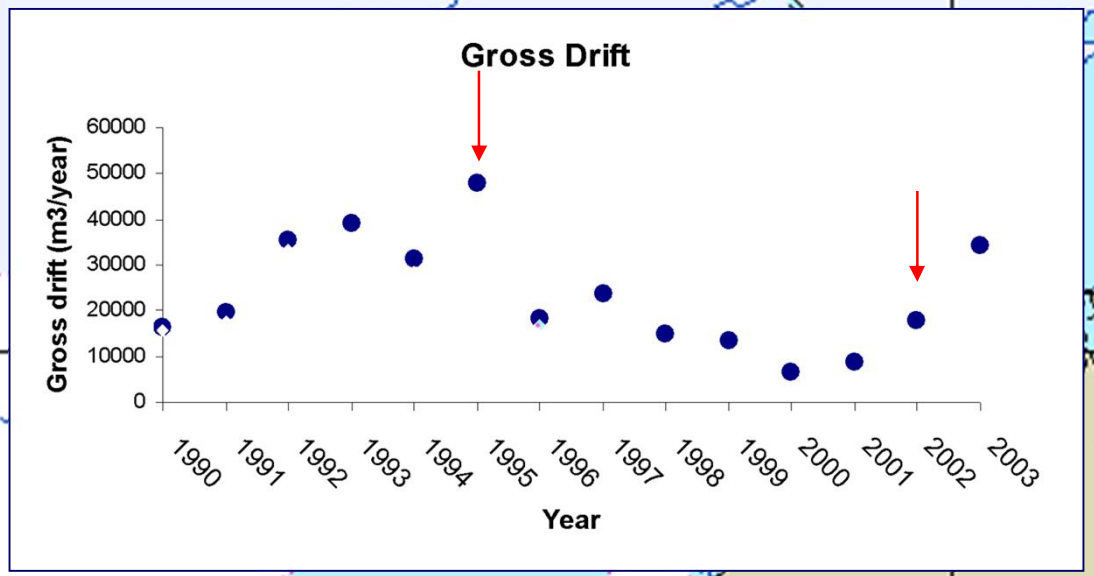
Sand Transport:
- Water depth
- Waves
- Currents
- Sediment properties

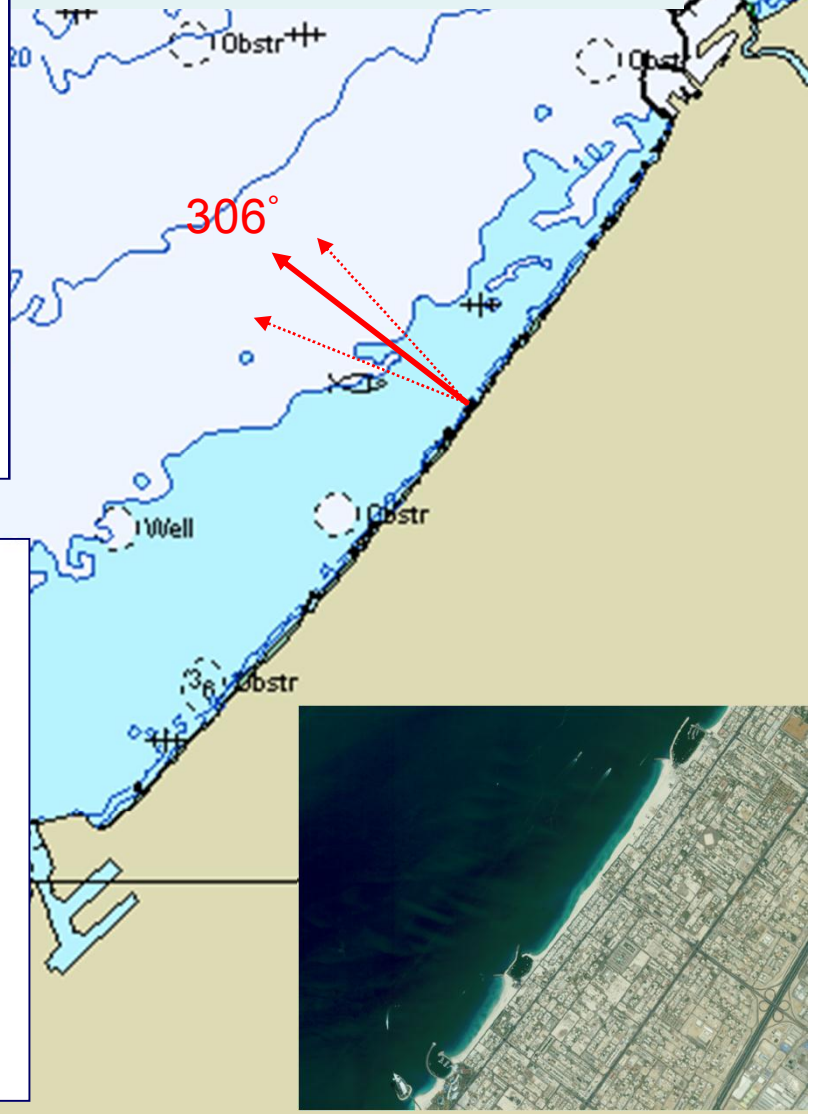
Base line – Littoral drift – open coast



Base line – Littoral drift – open uniform coast







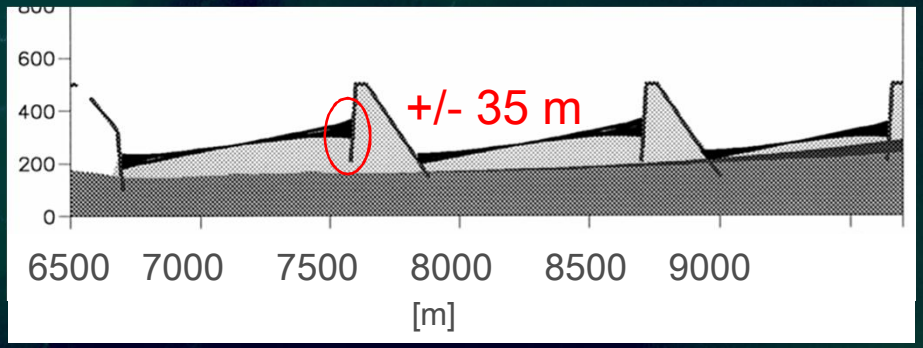
Conceptual schemes ”open coast”

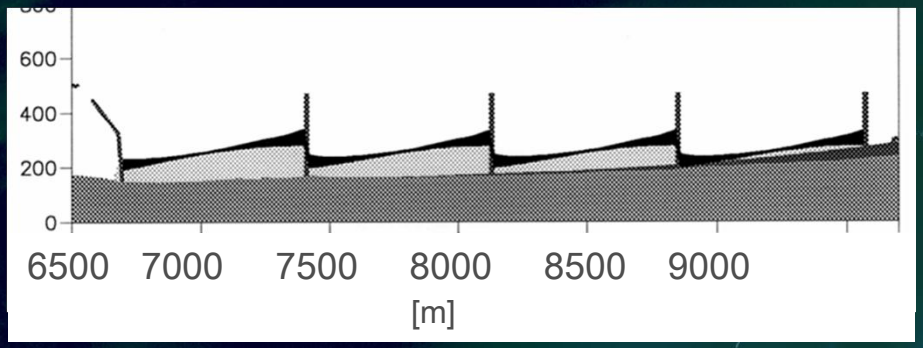
Wave modelling, littoral drift and shoreline evolution modelling

Shoreline orientation and variability due to year to year variations determine

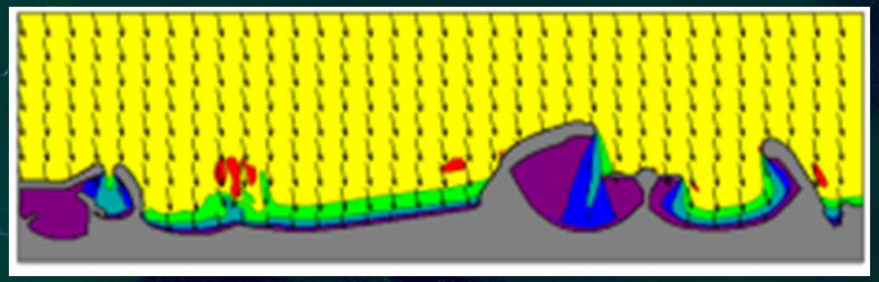
- length of structures
- Lenght of cells

} Detailed design

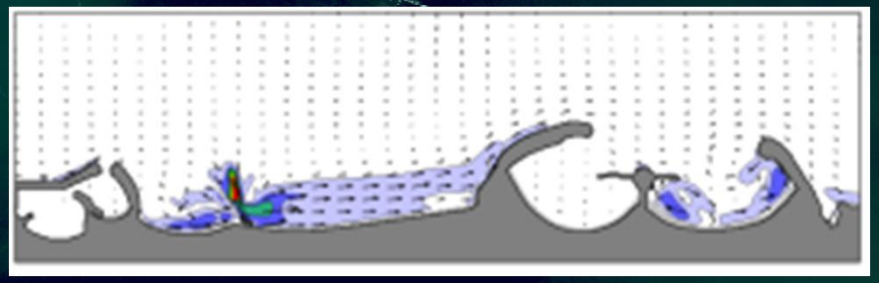




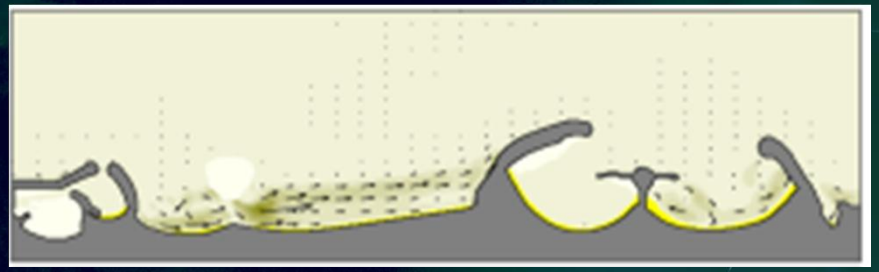
Conceptual schemes ” embayments”



Waves

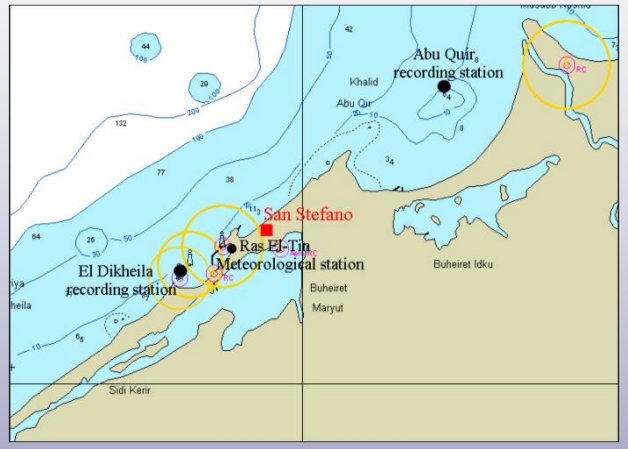


Currents



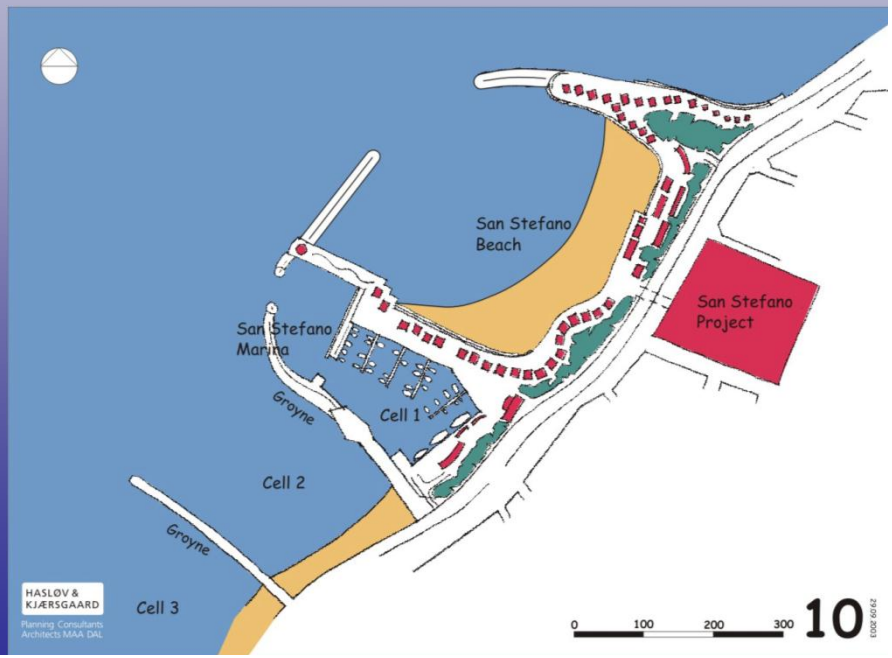
Sediment transport

Detailed design, combination of marina and beach, San Stefano, Egypt - “embayment”



Existing conditions: no beach, very exposed coast

Concept:
New artificial beach:
Equilibrium bay shape protected by big structures
Separate entrances to harbour and beach

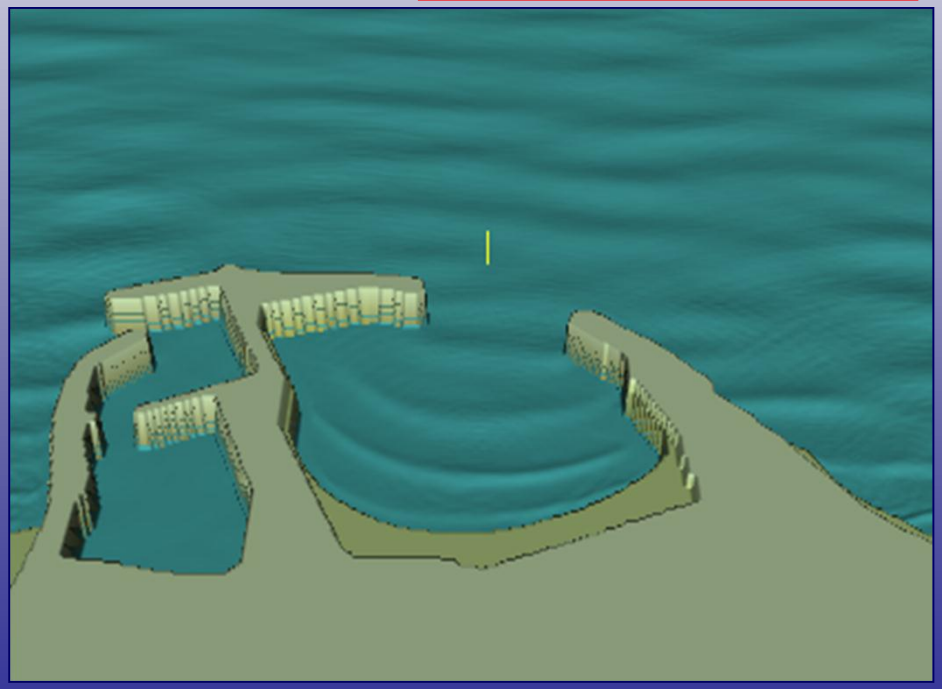


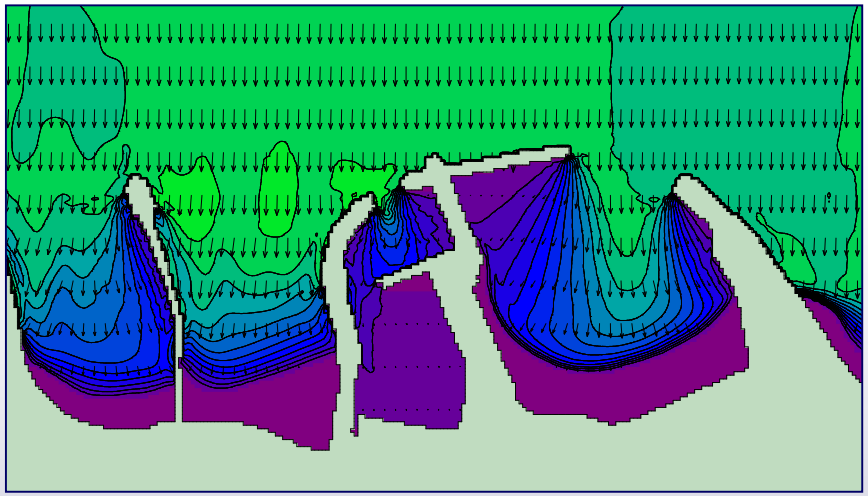
Detailed design modelling:

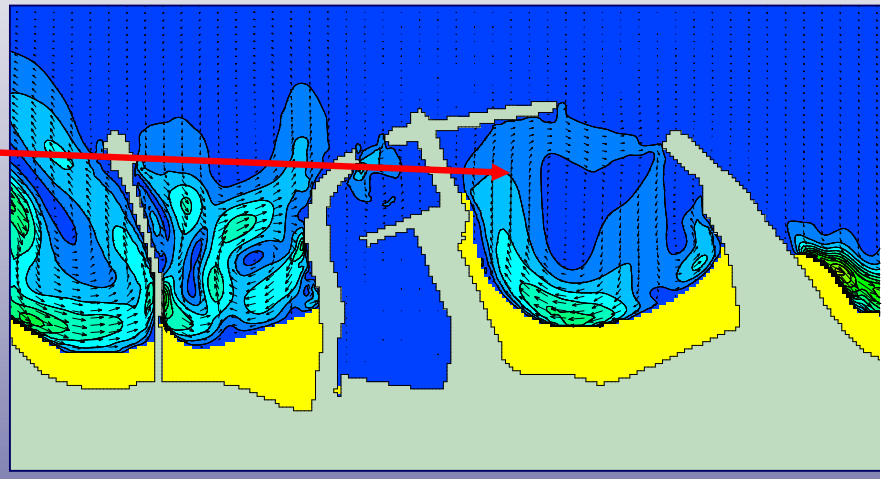
Optimisation of structures and first estimate of bay shape by detailed modelling of diffraciton pattern

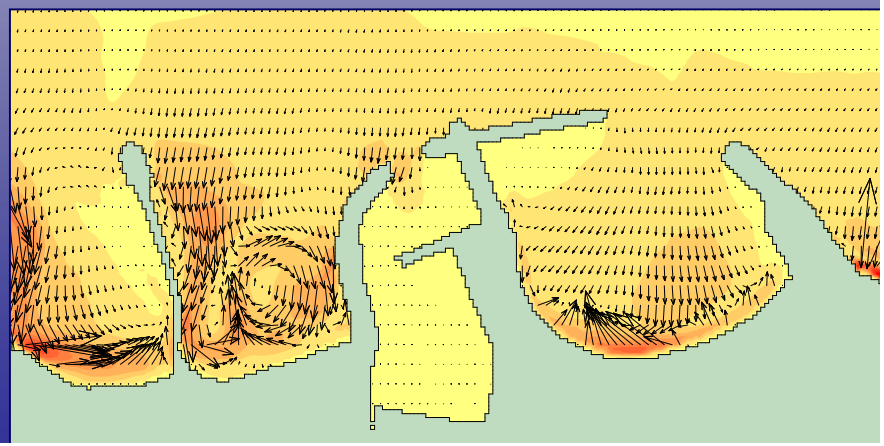
Final testing by calculation of sediment transport

Safe Swimming

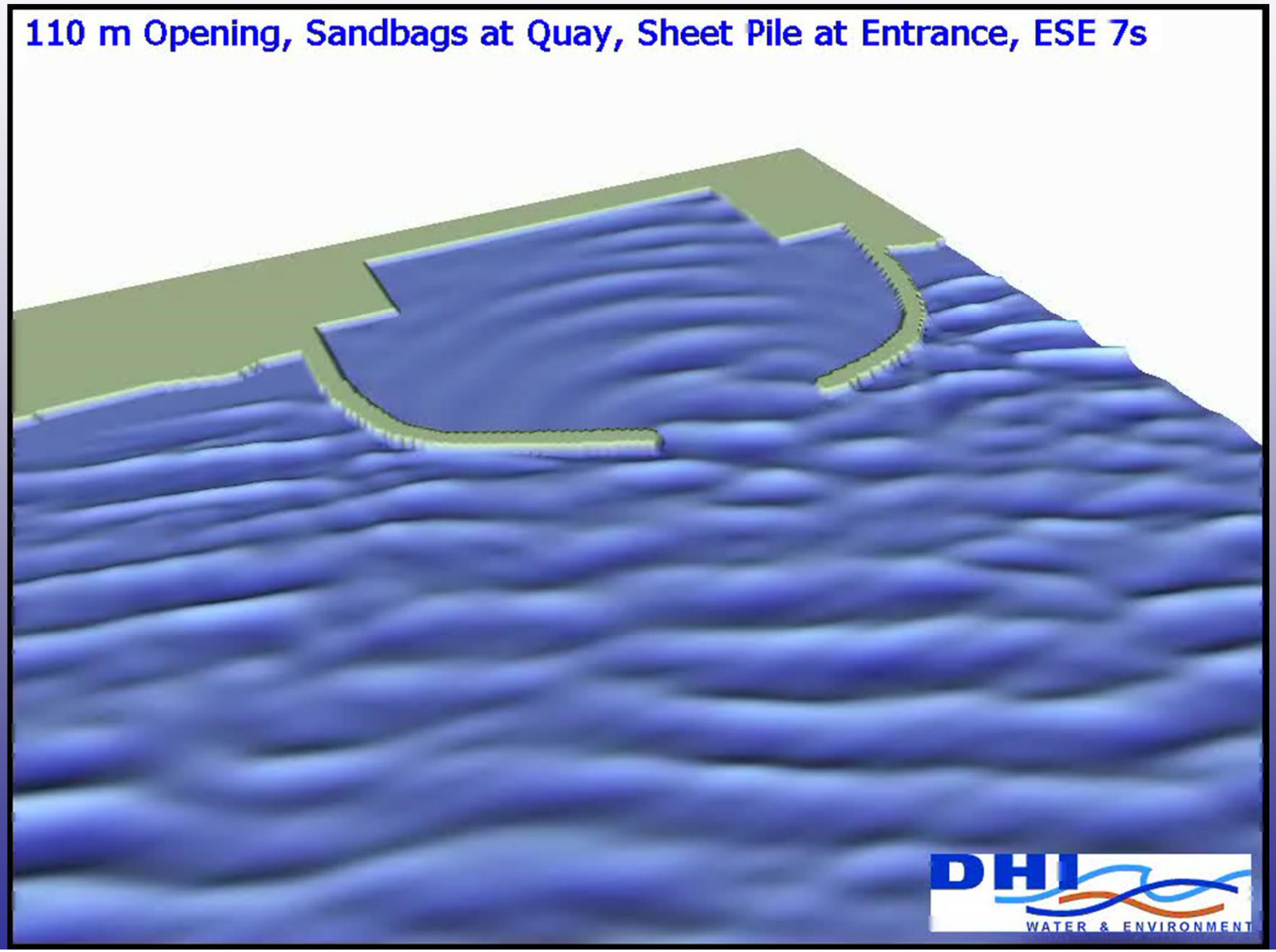








Detailed design - wave patterns



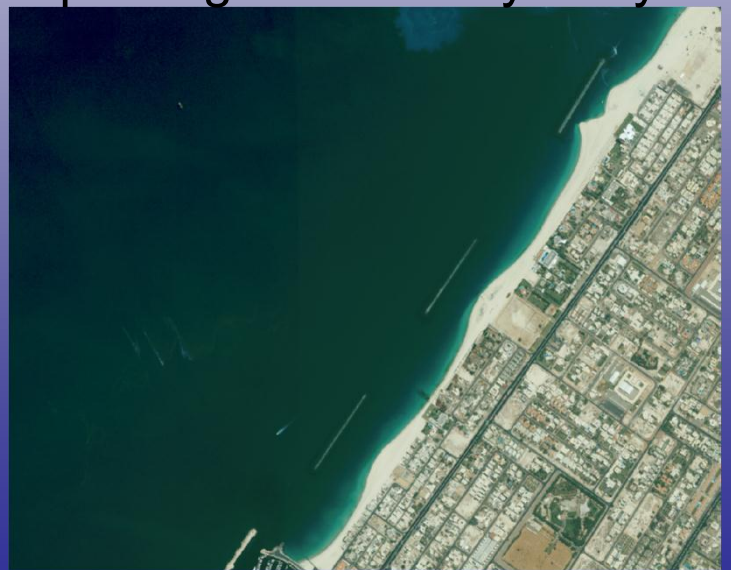
Detailed design – embayment

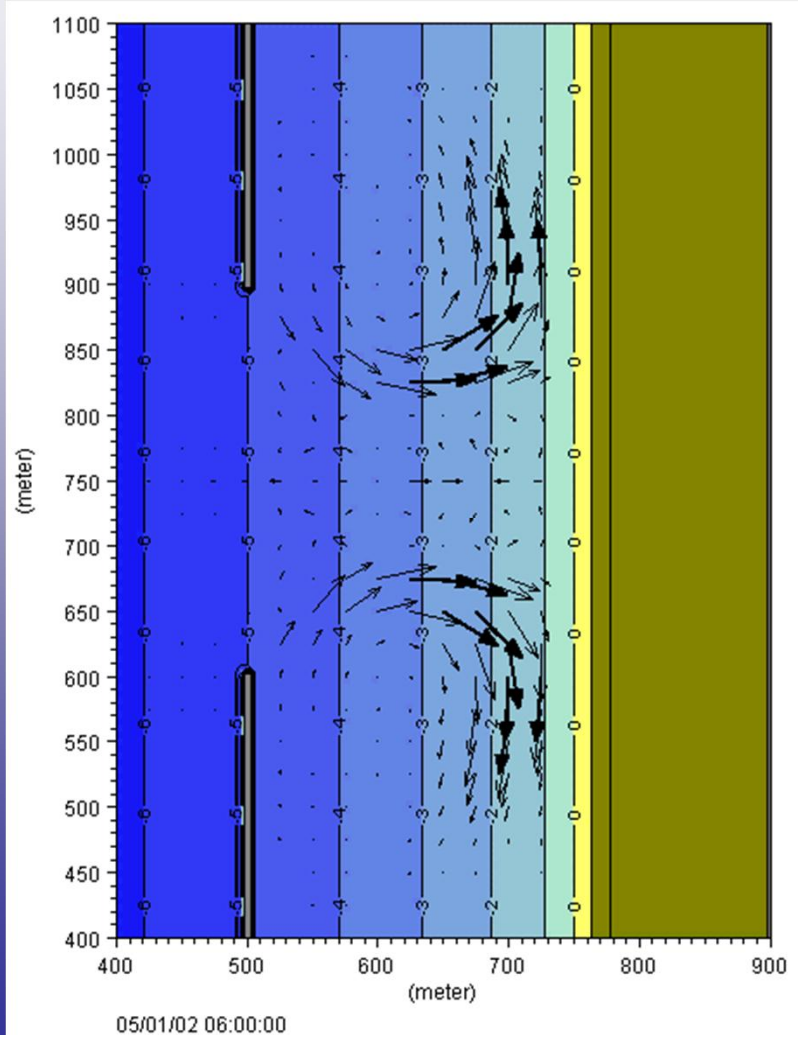
“morphological modelling”

Sequence of modelling

- waves
- Currents
- sediment transport

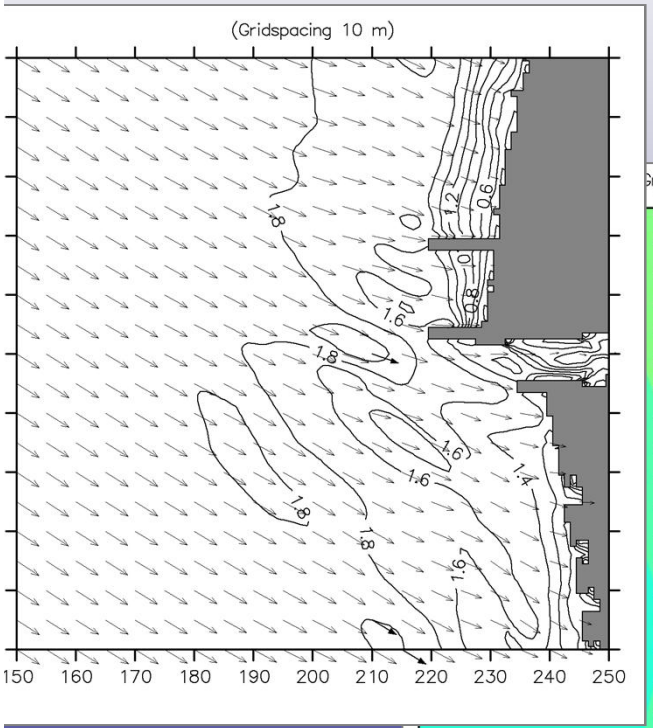
Including simutaneous updating of the bathymetry

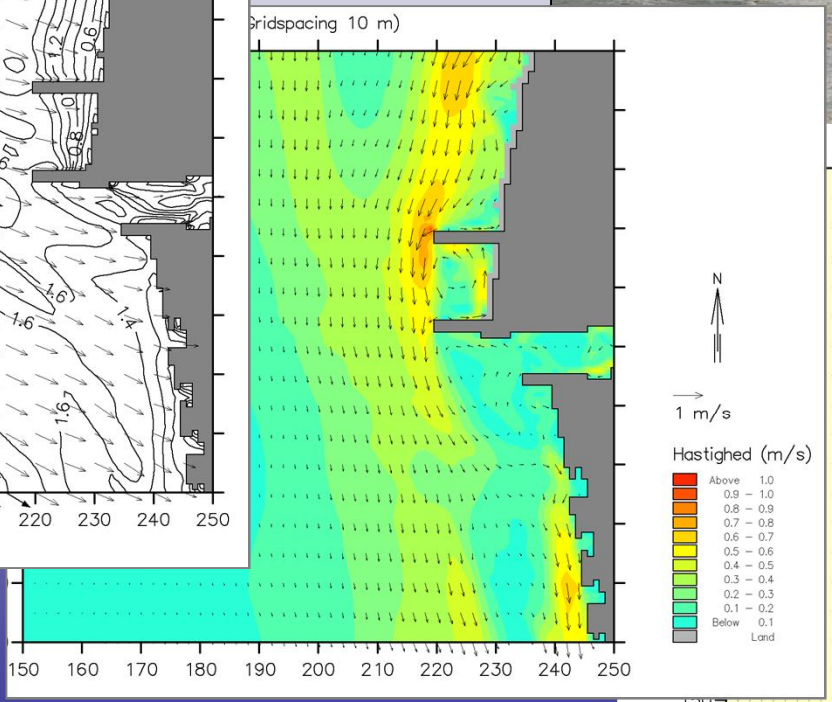


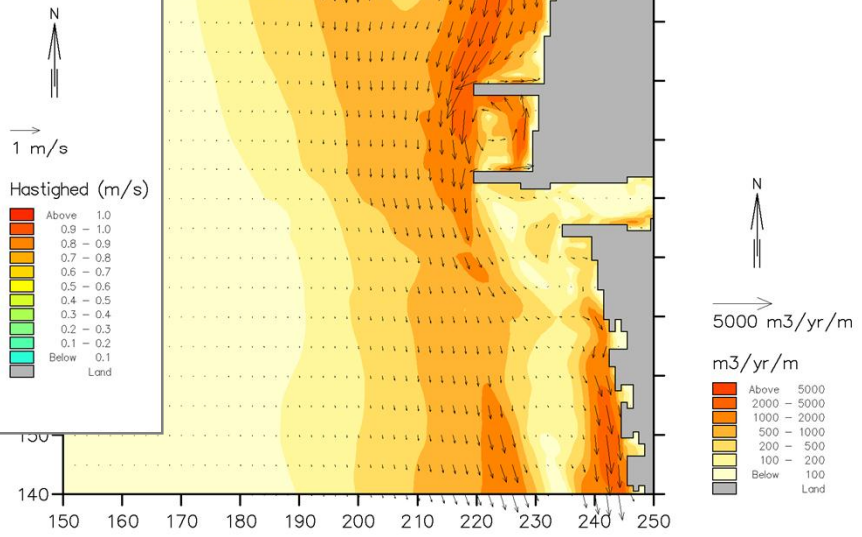


Thorsminde

Small fishery port with big sedimentation problems - and down drift erosion



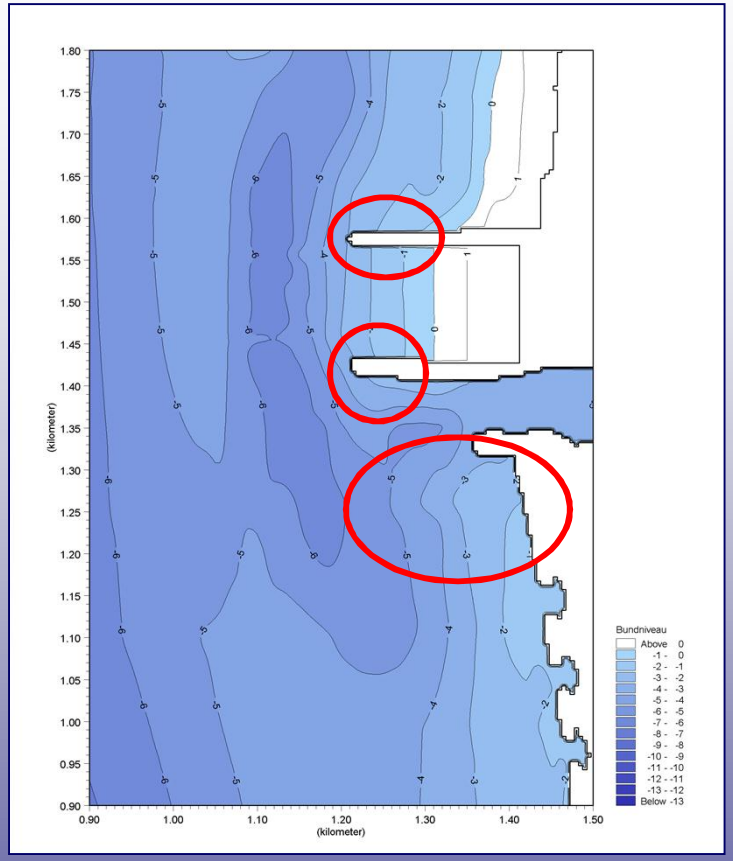




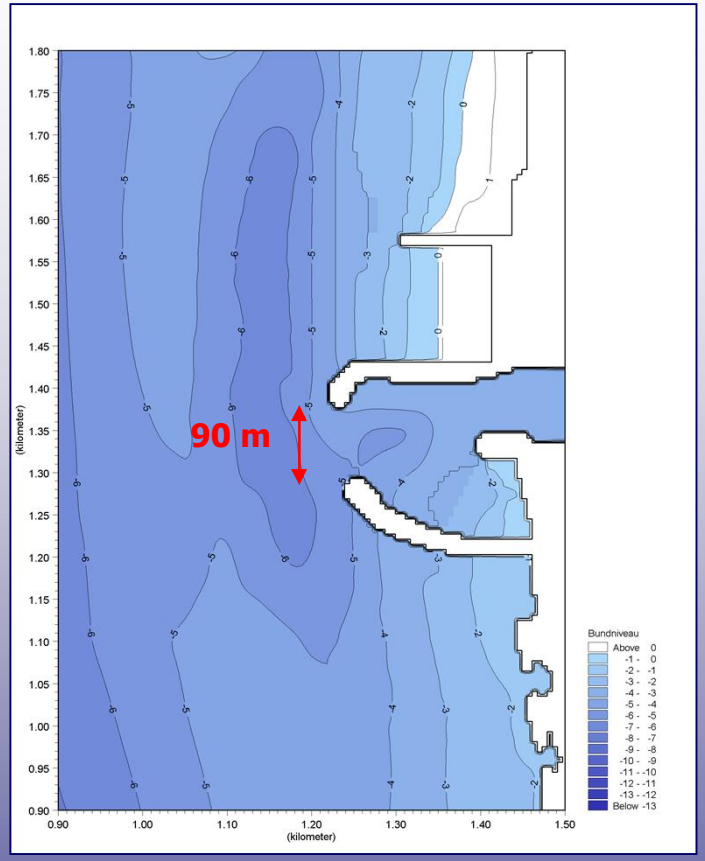
Hs= 2.0 m

dir. = 310 deg

Existing layout

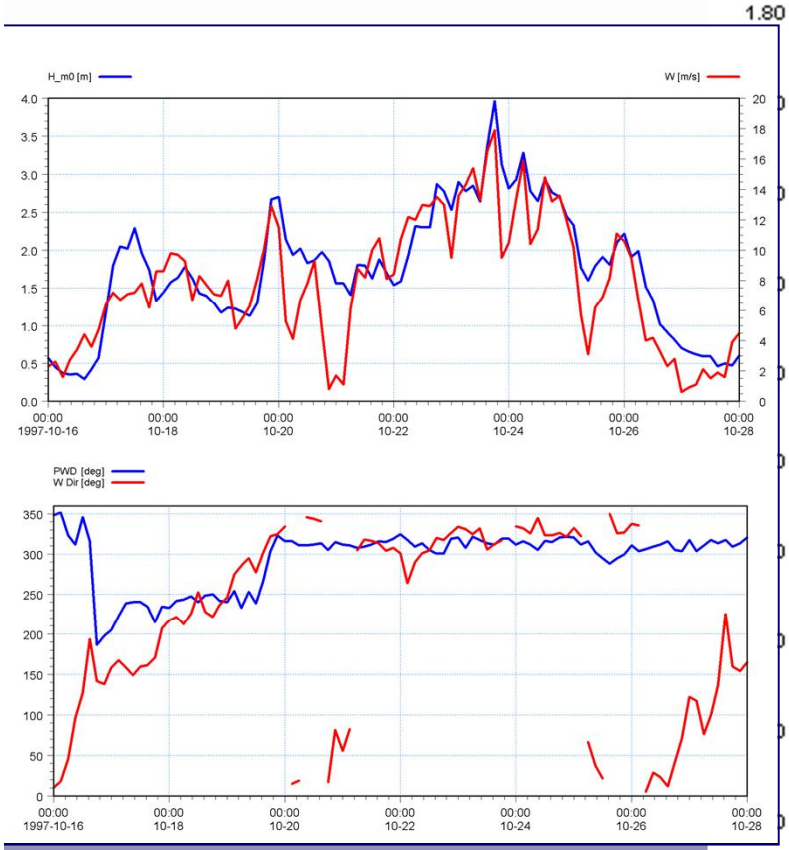


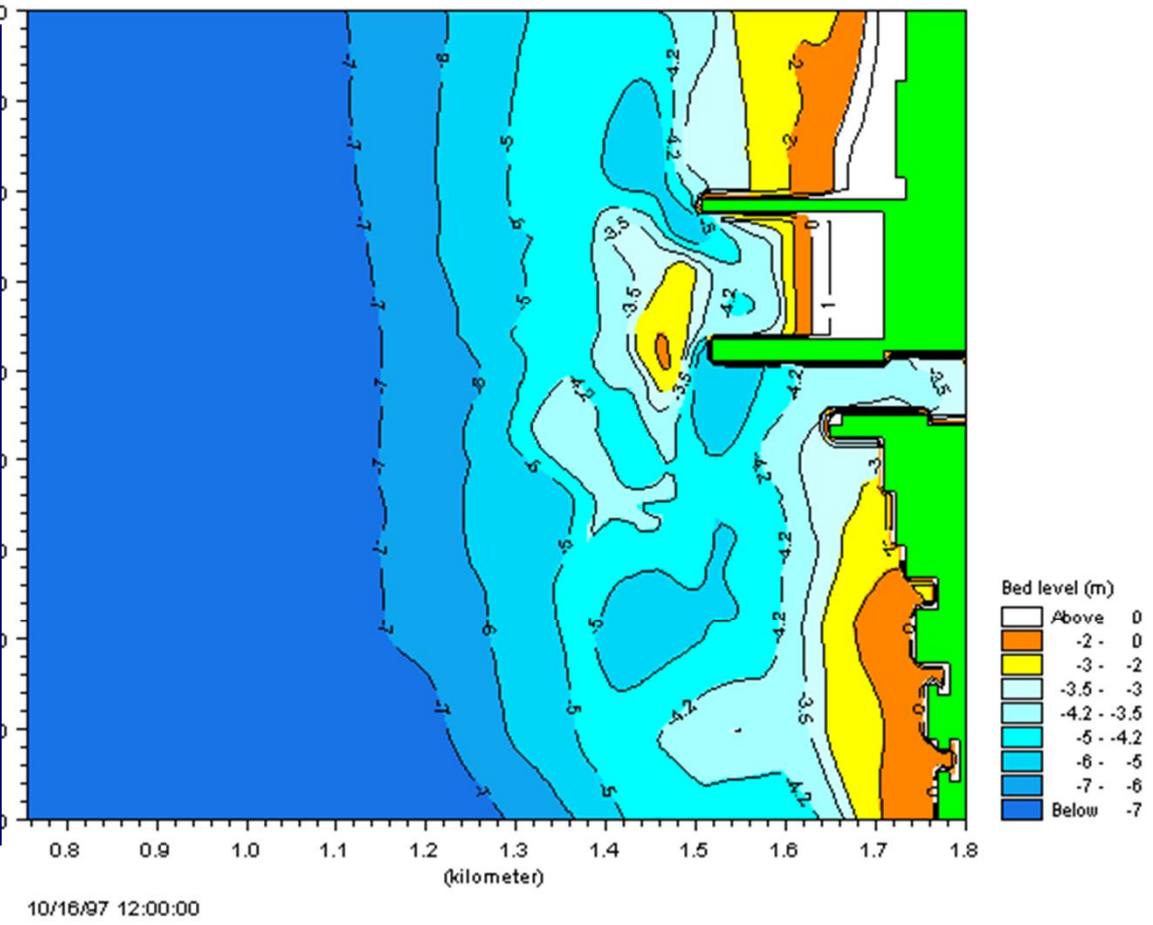
Optimised layout



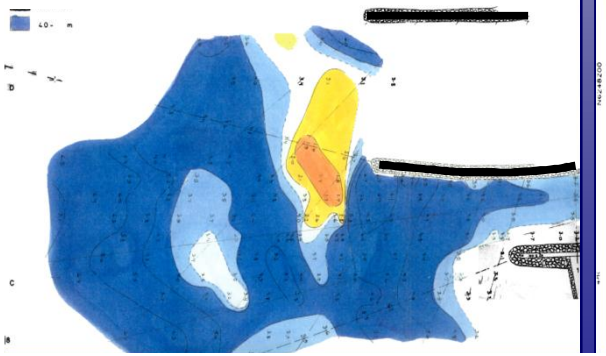
- Maintain sufficient water depth in front of the harbour
- Minimise sedimentation
- Increase natural by-pass

NV storm, existing layout

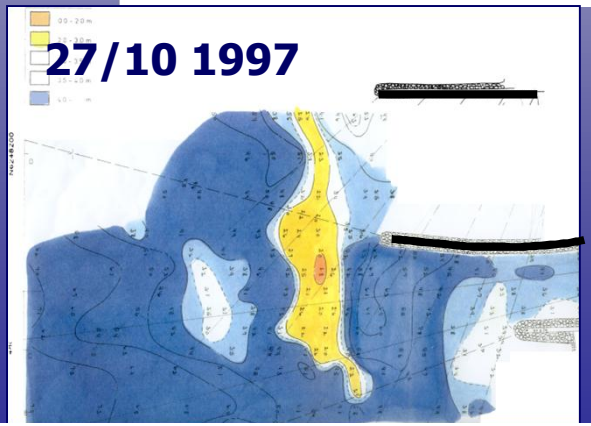




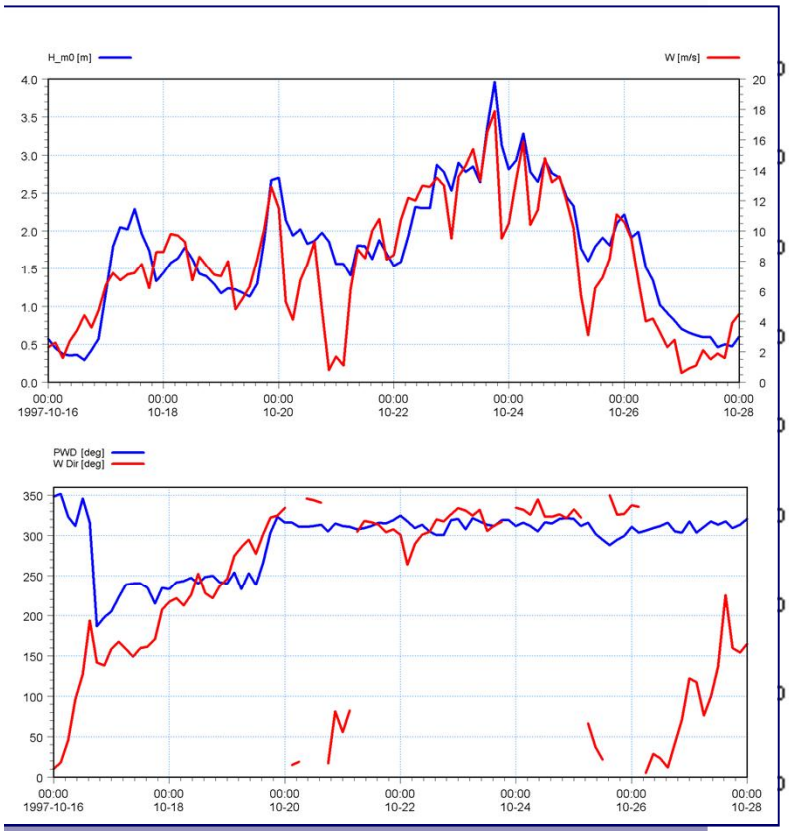
16/10 1997

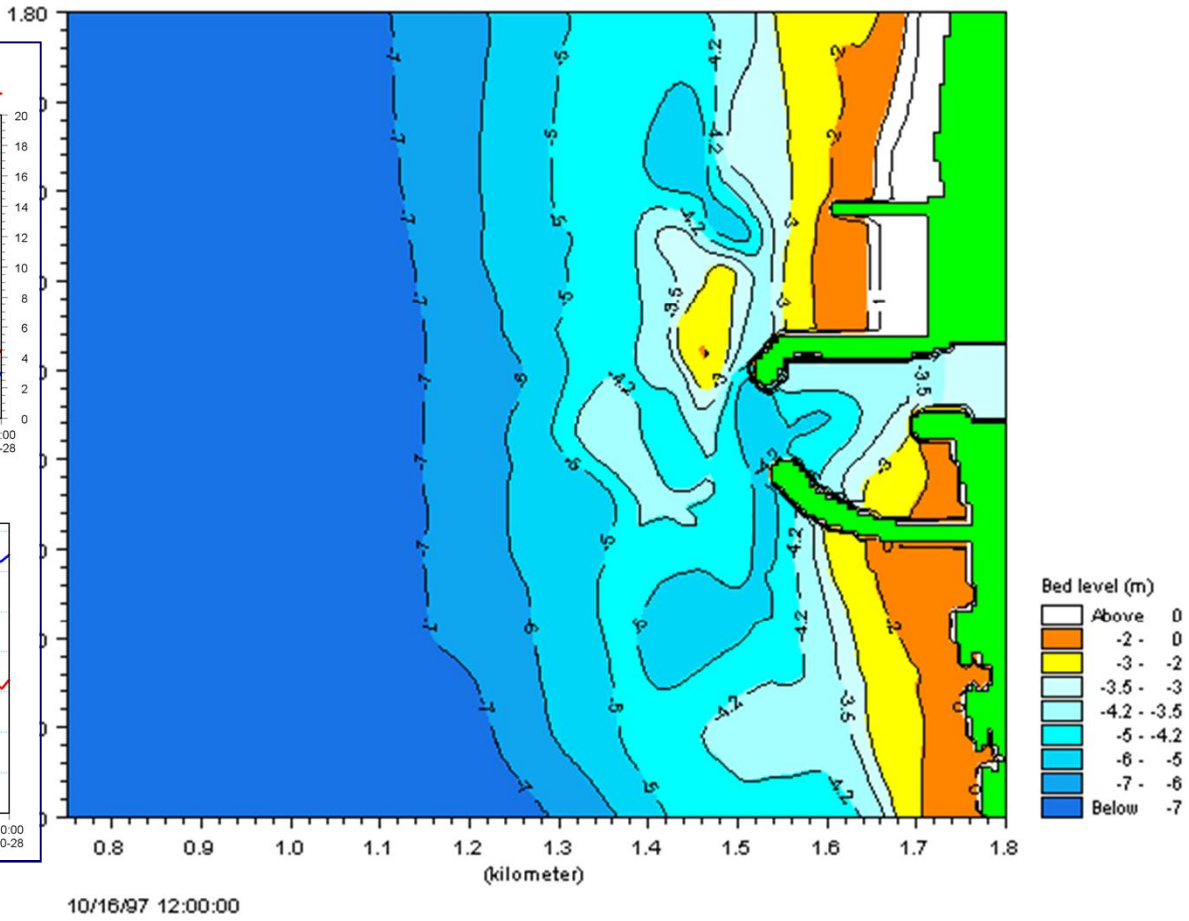


27/10 1997



NV storm, optimised layout





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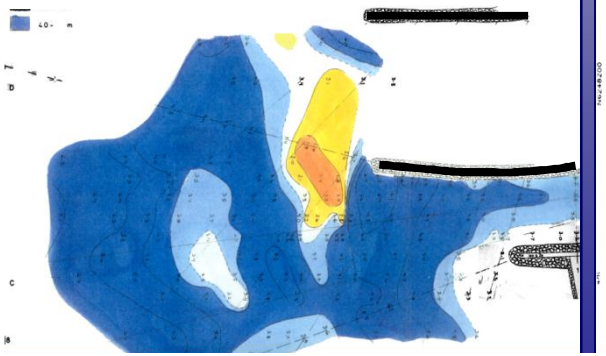

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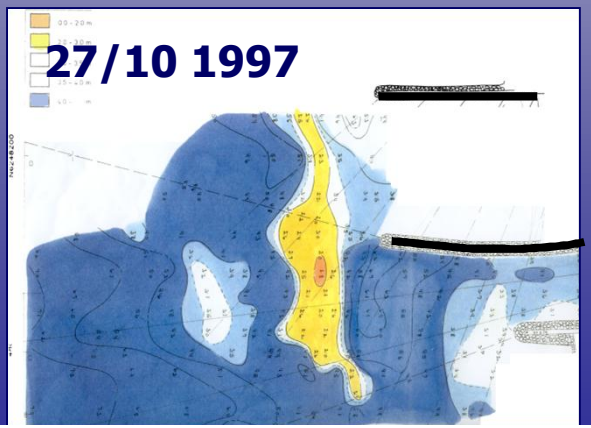
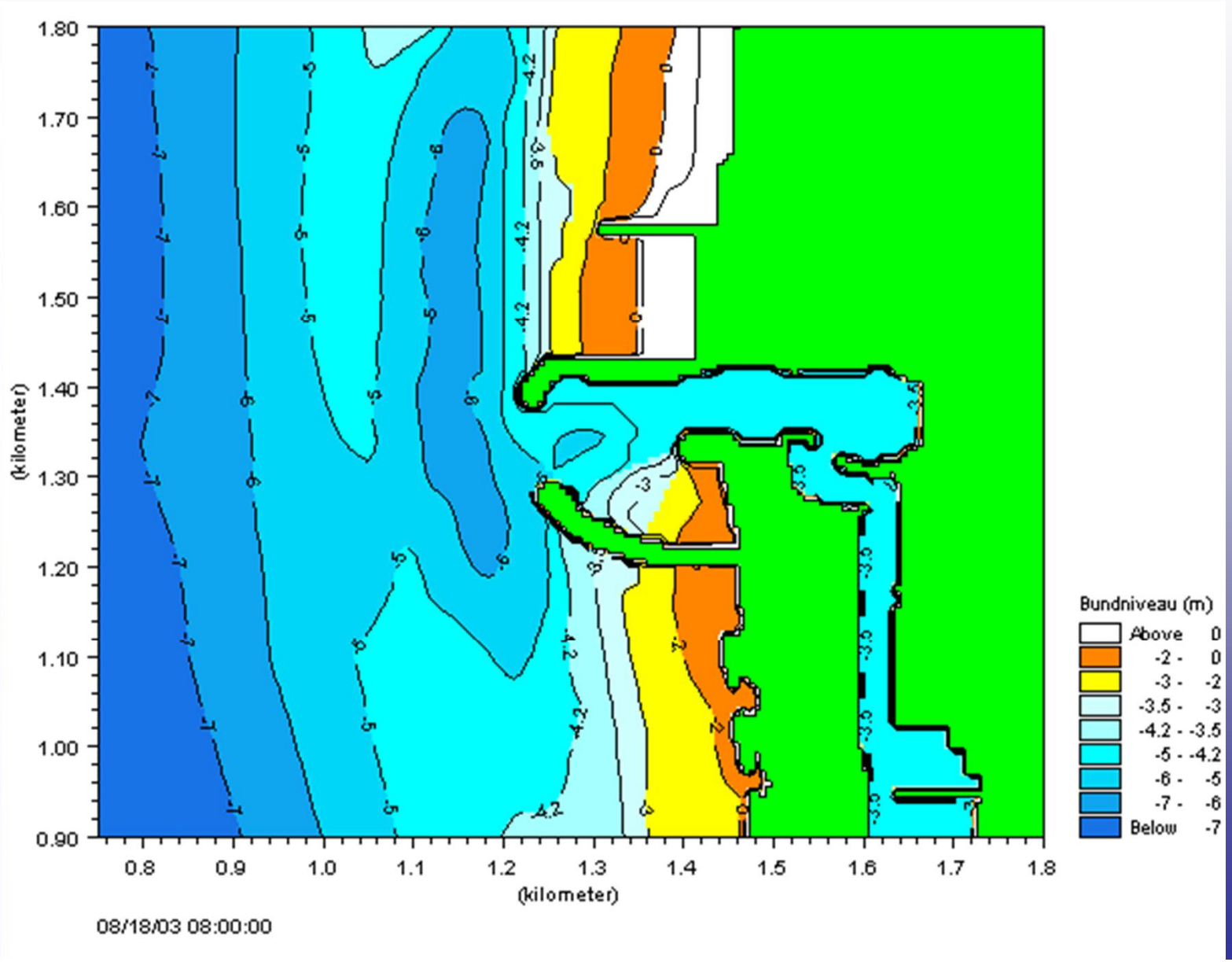
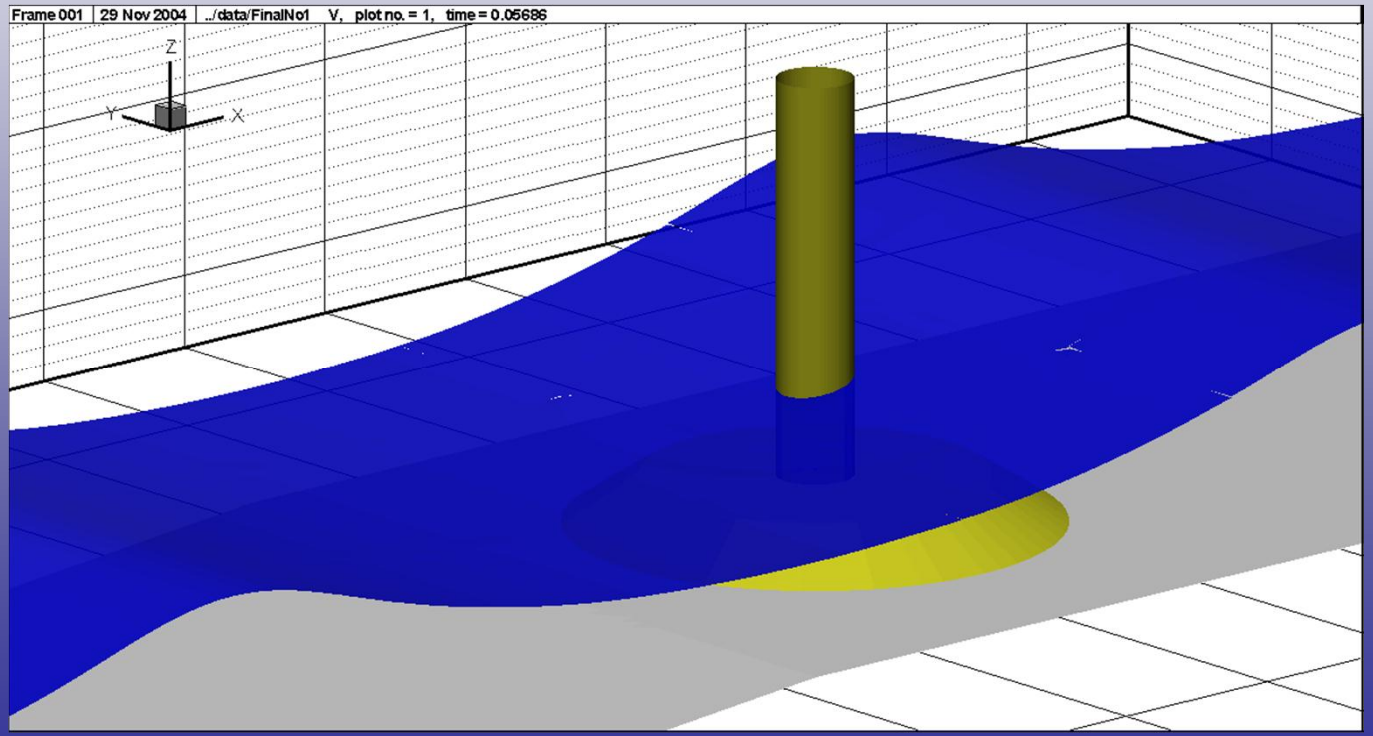


NW Stationary conditions 30 days Hs 3.5 m



Detailed design – forces on structures – run up

Detailed 3D modelling of flow around structures and forces on structures



Conclusions

Modelling tools exist which can be used to

-provide design basis

-test and optimize various layouts incl. morphological development

-quantify impact on the adjacent coast lines

-quantify sediment loss

--- but they cannot invent the conceptual scheme !