NCK theme day OASE

Offshore Activities and seabed evolution
Opportunities & Challenges

Luitze Perk
Trends

Offshore developments:

- Ongoing construction of Offshore Windfarms
- Related need for burial of Export- and infield cables
- Growing demand of sand for nourishments (from sand mining areas)
Questions from our Clients

**Offshore Windfarms**
Optimal locations of individual wind turbines?
Scour extend /magnitude at wind turbines & offshore constructions?
Seabed level > 40 years?

**Cables**
Minimum required burial depth cables > 40 years?
Maximum possible burial depth cables > 40 years?
Optimal cable routing with lowest CAPEX-OPEX?
Best landfall locations?
Maintenance dredging requirements of trenches/ dredged channels
Effect of sweeping (cut-off crests) sand waves
Most plausible location & depth of Uxo's 1940 => 2018?

**Sand mining areas**
Where to find optimal type of sand from borrow areas?
Infill rate of present sand mining areas
Location/ depth of hard geological layers (clay)
Questions from our Clients

**Offshore Windfarms**
Optimal locations of individual wind turbines? Seabed lowering / raise?
Scour extend /magnitude at wind turbines & offshore constructions?
Seabed level > 40 years?

Deltares, 2016
Questions from our Clients

**Offshore Windfarms**
Optimal locations of individual wind turbines?
Scour extend /magnitude at wind turbines & offshore constructions?
Seabed level > 40 years?

**Cables**
Minimum required burial depth cables > 40 years? => exposure
Maximum possible burial depth cables > 40 years? => thermal radiation
Optimal cable routing with lowest CAPEX-OPEX?
Best landfall locations?
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Offshore Windfarms

- Optimal locations of individual wind turbines?
- Scour extend/magnitude at wind turbines & offshore constructions?
- Seabed level > 40 years?
- Cables: Minimum required burial depth cables > 40 years? Maximum possible burial depth cables > 40 years?
- Optimal cable routing with lowest CAPEX - OPEX?
- Best landfall locations?
- Maintenance dredging requirements of trenches/dredged channels?
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Legend:
- Bathymetry
- Meters
- 0-1
- 1-3
- 3-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-30
- 30-35
- 35-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100-150
- 150-200
- 200-250
- 250-300
- 300-350
- 350-400
- 400-450
- 450-500

- Stations
- Expert cables
- Gateway connection
- Pipelines
- Pipelines natural turn over zones (5000m)
- Kilometres/5 km
- Kilometres/10 km
- Alpha 1 Long
- Alpha 2 Long
- Beta 1 Long
- Beta 2 Long
- Alpha 1 Short
- Alpha 2 Short
- Beta 1 Short
- Beta 2 Short
- Line zab
- Subsea terminal
- Disposal areas (level N63-R67)
- Disposal areas (Wedgepipe tunnels)
- Disposal areas (level N67-R68)
- Traffic separation boundary
- Wastewater Maasgouw

- HKZ parois
- Wind farm sites

Crossing sandwave field perpendicular
Crossing sandwave field parallel
Crossing sand mining pit
Crossing dumping ground
Crossing Maasgeul
Landfall

Kilometers
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Development of knowledge

**Scour** (Existing research programme and JIP's ongoing):
- Effect of type of structure
- Effect of sediment characteristics/ depth / environmental conditions

**Long-term seabed dynamics:**
- Decrease uncertainties sebed dynamics by:
  - High frequent bathymetrical surveys
  - 3D modelling of sand waves to better understand effects of parameters as: depth, tidal flow, waves, grain size, etc. on dynamics
  - Pilot projects (or monitor existing works) of sand wave dredging

**Sediment transport & mega ripple dynamics** and its effects on:
- sand wave migration
- sedimentation of trenches
- Long-term dynamics of present sand mining areas

**Long-term foreshore dynamics:**
- How will foreshore evolve in time:
  - given our management strategy not allowing regression of our coastline (steepening of coastline), and;
  - related nourishment strategy

**Thermal resistivity of the subsoil:**
- Improve the geological & thermal resistivity models
- In-situ measurements of heat dissipation from cables
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*Case I*, *Case II*, *Case III*
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  - Storms irt Climate change

Deltares, 2016
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To fully understand the seabed dynamics and decrease the uncertainties in our designs, a combination of frequent measurements and 3D modelling is key.