



Validation Concept for Highly Morphodynamically Influenced Areas Using CPT Testing Results

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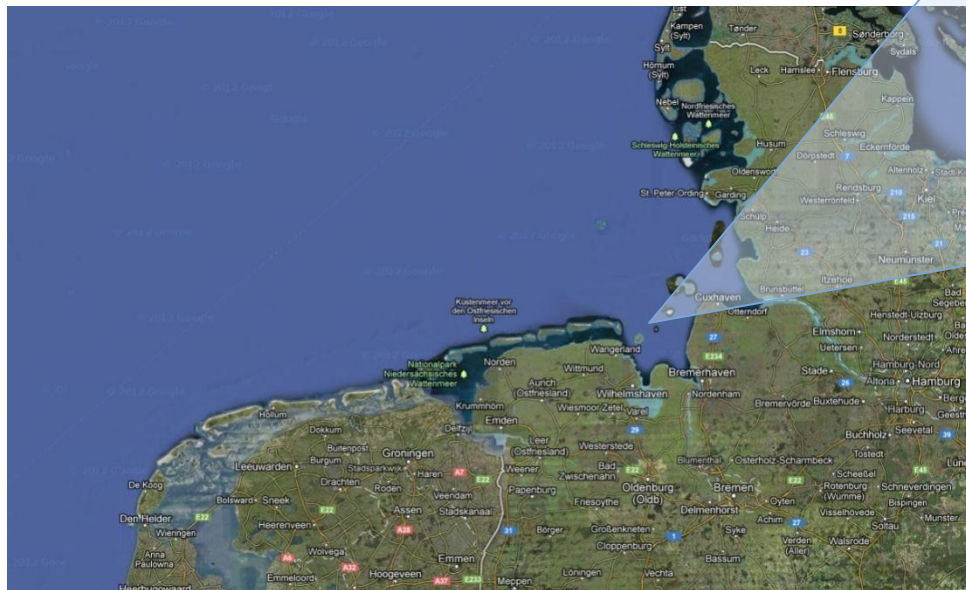
International Conference on Scour and Erosion

Paris, August 2012

Offshore Wind Park Nordergründe

Located in the outer Jade-Weser-Estuary, on the sandbank “Kleine Tegeler Plate”

1. Total wind park area is 3.5 km²
2. Water depths between 4 and 14 m
3. High morphodynamic variability



Google Maps



Energiekontor

Morphodynamics of the Weser Estuary

The morphology in the area is highly dynamic and influenced by several factors such as:

1. Natural seasonal changes
 2. Storm events (exposure!)
 3. Large-scale morphodynamics
 4. Human intervention
 1. River and coastal protection
 2. Dredging and dumping
- Difficult to predict future seabed developments, resulting in a large bandwidth of possible bed levels.

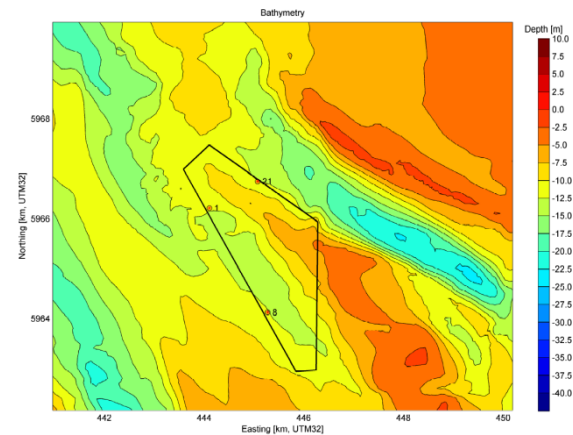
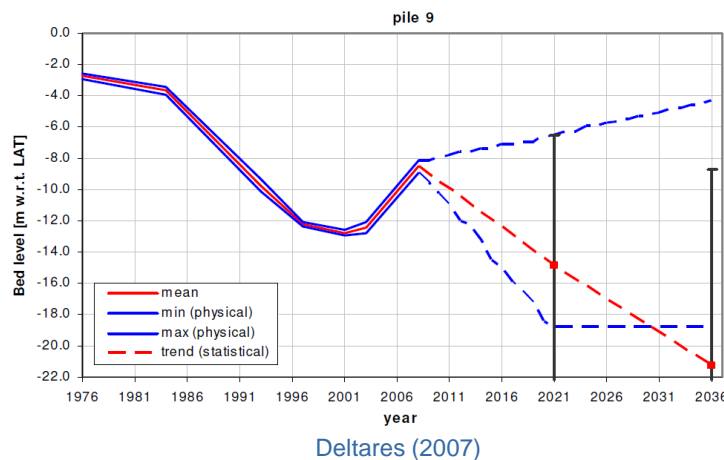
Morphodynamic Study

Estimation of the lowest seabed level for each pile (in 25 years):

- sand wave migration of up to 60 m per year
- physical limit of the lowest seabed level in a radius of 1,500 m

Curves for max./min. seabed levels over a period of 30 years

Approach does not consider the actual migration patterns of the morphodynamically active layers! **Can the outcome of the study be specified or validated?**



Previous Studies

1. Morphodynamics

Bandwidth of estimated seabed developments based on data from 1976 to 2010

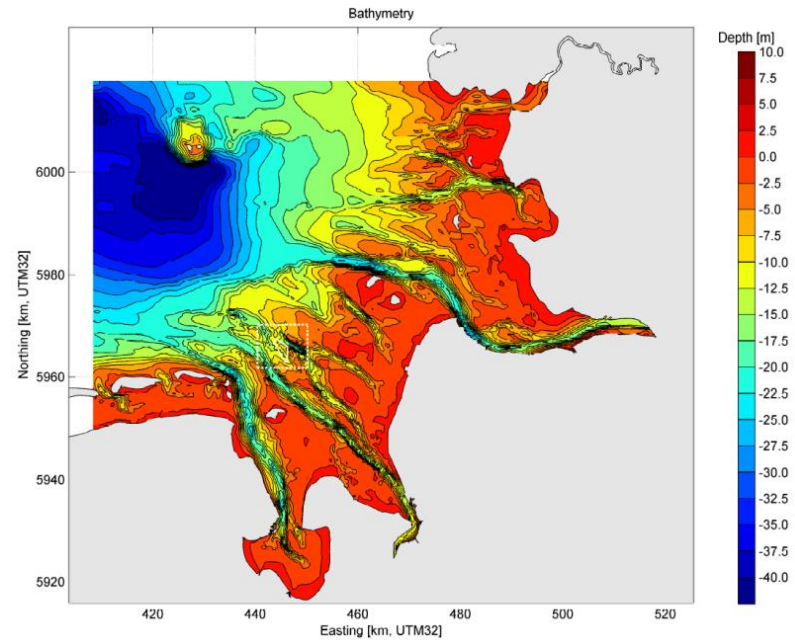
2. MetOcean Data

Waves, currents, water levels

3. Geotechnical Investigations

Cone Penetration Tests

A hybrid approach?



Deltares (2007)

A Quick Journey Through the Geology of the Wadden Sea

Extreme and abrupt climate changes in the past 2.6 m years

Water levels fluctuating between today's level and 130 m below

Stratigraphy of the Wadden Sea is characterized by:

- Active surface layers (loose sediments)
- Transgression horizon (heavily pre-stressed Glacial Sands)

Idea:

→ Find the transgression horizon at each location to separate the stable **base layer** from the morphodynamically **active surface** layers!

Available Geotechnical Data for Validation

1. Preliminary soil exploration campaign (2007)

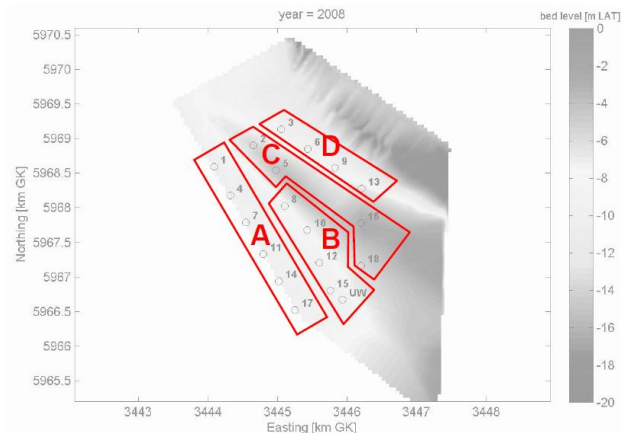
Cone Penetration Tests (CPT) at 3 locations down to -37.7 m below seabed

2. Main soil exploration campaign

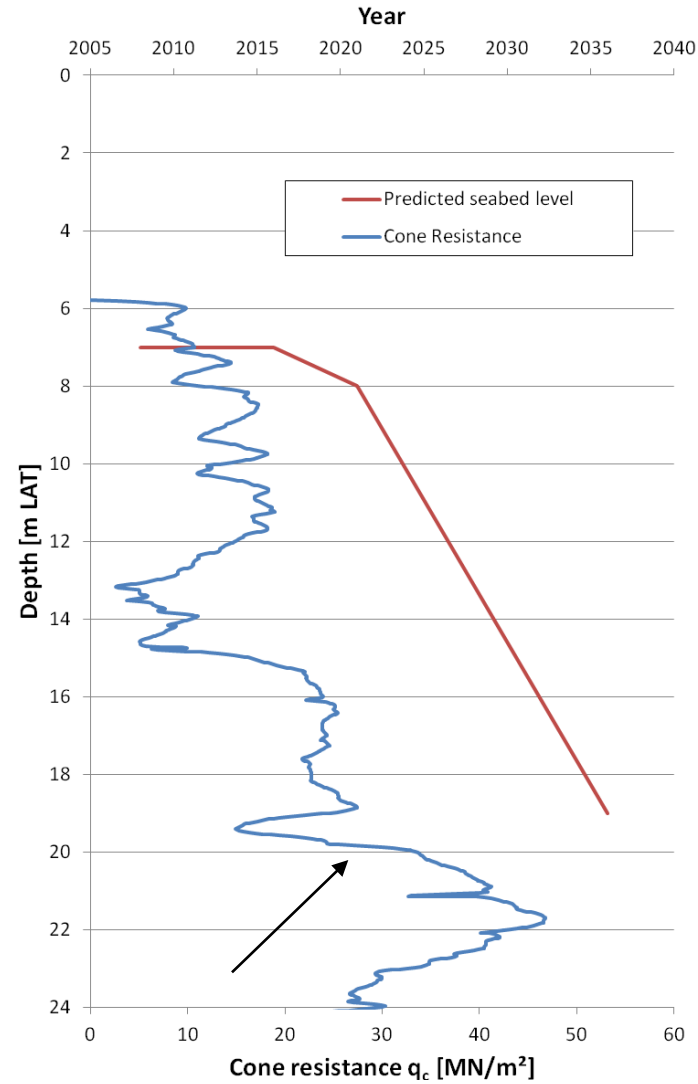
CPTs at all other locations down to -24 m LAT

Exemplary Location 1

Pile Group C

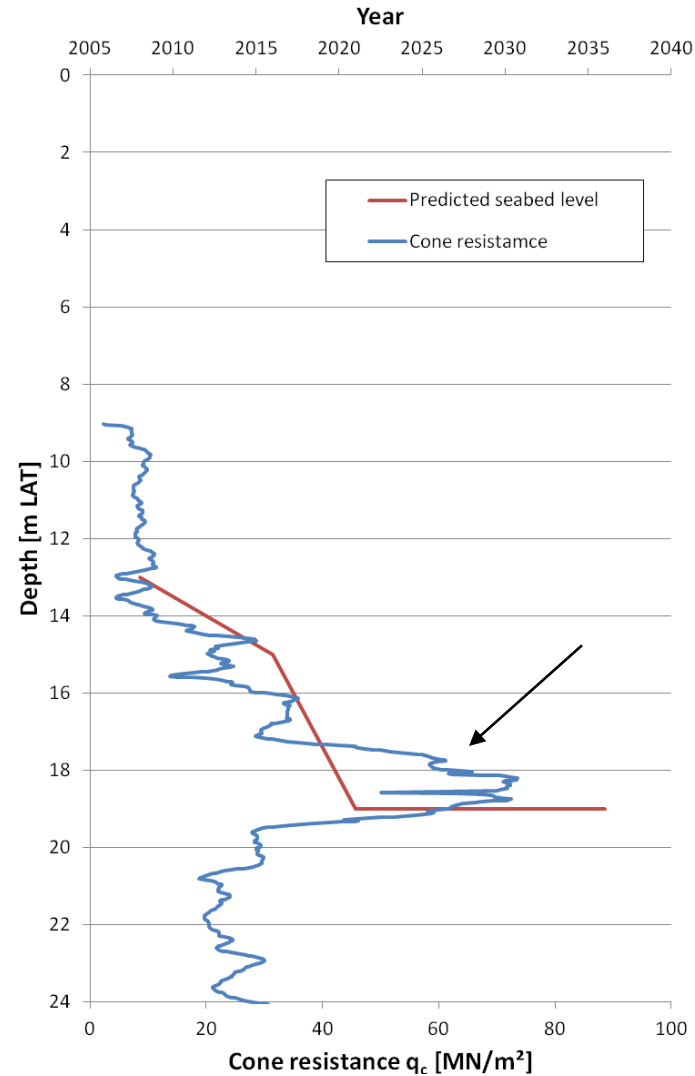
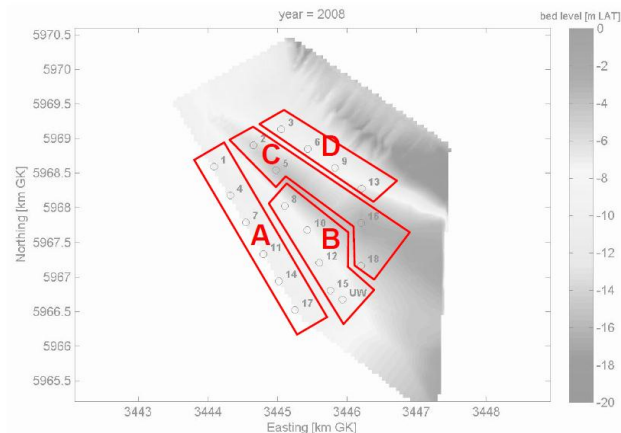


Deltares (2007)



Exemplary Location 2

Pile Group D



Results and Benefits

1. The application of two independent methods led to very comparable results:

Confirmation of previous study

2. Reduce uncertainty by confirming:

No exceedance of previously predicted maximum depths

3. Save costs:

Reduction of previously predicted maximum depths by up to 2 m at a few locations

**Validation of a hydraulic study by looking at geotechnical data
from a geologist's point of view!**

Thank you for your attention!