Sand dynamics on beaches and shorefaces

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Point of view of coastal protection

1) Protection against superstorms

**PRINCIPLE**

- Wave length: ~100m
- Surge height: ~3m
- Maximum wave height: ~10m
- Water depth: ~13m

**PRACTICE**

Masterplan Kustveiligheid: ±1 million m³ / year (2010...2015...)

Point of view of coastal protection

2) Protection against structural erosion

PRINCIPLE
• Hold the line
• Seaward development
• Managed retreat

PRACTICE
• NL, DK, Sylt (D), ...: hold the line
• UK (local cliff erosion): managed retreat (locally)
• B: hold the line => seaward development ? => Vlaamse Baaien study
Complexity

Natural sand dynamics and coastal morphology

• Drivers: waves, tides, grain size distribution, human activities (infrastructure works, dredging, nourishments)
• Spatial scale: kilometers, dunes-beaches-shorefaces-gullies-sandbanks
• Time scales: years, decades, storm effects

⇒ present insight in coastal sand balans is limited
⇒ current models have limited predictive capacities
⇒ large needs for integrated research combining modeling with most importantly in-situ measurements / monitoring

Example of longshore sand transport in breaker zone (littoral drift)
topography/bathymetrie
beach - shoreface
Blankenberge - Zeebrugge

Legend (depths are positive and in meter)

-8 -7.5  -7.5 -7  -7 -6.5  -6.5 -6  -6 -5.5  -5.5 -5  -5 -4.5  -4.5 -4  -4 -3.5  -3.5 -3  -3 -2.5  -2.5 -2  -2 -1.5  -1.5 -1  -1 -0.5  0 -0.5  0.5 -1  1 -1.5  1.5 -2  2 -2.5  2.5 -3  3 -3.5  3.5 -4  4 -4.5  4.5 -5  5 -5.5  5.5 -6  6

flanders
HYDRAULICS RESEARCH
The problem

Wave climate

Tidal range ~4 m

direction net longshore transport =
dominant residual tidal current
dominant wind/waves obliqueness
The problem

How to make a first estimation of the net longshore sand transport if....

- No direct measurements available.
- Poor performance of available models.
Methodology and tools

Complex problem start with simple tools:

- GIS based morphological trend analysis.
- 1D Numerical modelling.
Morphological trends analysis

**Tool:** ArcGIS

± 15 year topo-bathymetric data (1995-2010)

- Datasets completed by inventory of dredging, disposal and nourishment activities in the study area.

**Goals:**
- Identification of clear erosion and accretion zones.
- First estimation of net rates in the area.
Results of the trends analysis

Net longshore transport estimation: $400000 \pm 35000 \text{ m}^3/\text{y}$
Numerical modelling

**Tool:** LITPACK – LITDRIFT

**Goals:**

- Identification of most active area for longshore transport for figures obtained in the trend analysis.

- Calibrate roughness to reproduce empirical value of littoral drift and separate net rate into two bruto rates NE 3,5 ÷ SW 1
Lessons learned

• The “taking a very simple first approach to a complex problem” principle helps to learn about how the problem should be tackled.

• It is possible to have an acceptable first estimation of net (longshore) transport based on morphological trends analysis. The method will be useful to compare with results from numerical models.

• It is necessary to further develop combination of different tools and methodologies.

• Estimate of littoral drift for B-coast:
  – NET  +- 400,000 m3/year to NE
    • Bruto to NE +- 550,000 m3/year
    • Bruto to SW +- 150,000 m3/year
Current and further work

- Improving of numerical modeling tools for beaches and shorefaces:
  - sand dynamics / morphology / hydraulics:
    - Use of 2D models accounting for cross-shore as well as long-shore effects.
    - Investigating model abilities to account for the presence of structures (e.g. groins).
    - Calibration/validation with high quality data.

- Improving the trends analysis method:
  - Assess uncertainty on trend results from measurement inaccuracies (topo/bathy).
  - Using more datasets and including more accurate figures about dredging, nourishment etc.

- Intensive in situ measuring and monitoring on beaches and shorefaces:
  - smaller scale to better understand processes
  - larger scale to better understand the system