How to measure morphologic evolution near a mega-nourishment?

**Introduction**

The Sand Motor, a large-scale nourishment near Ter Heijde, is evolving rapidly on small and large spatial and temporal scales. This complicates monitoring strongly as there is no single monitoring technique that can do it all. Here the aims are to combine smartly three remote sensing techniques with in situ bathymetric measurements and to evaluate their applicability in a rapidly changing environment. We focus on spatially extensive Digital Elevation Models (DEMs) and aggregated morphologic parameters.

**Morphologic evolution from DEMs**

Depth inversion on \( f(x,y,t) \)

ARGUS: cBathy

• Cross correlations between pixel time series: \( C_{ij}(f) = \langle G(x_i,y_i,f) * G(x_j,y_j,f) \rangle \)

• Analysis cube (80x40m x 1024s), Hanning weighted:

  \[ k \rightarrow \text{non-linear fit of observed (EOF on } C_{ij}) \text{ with modelled slope phase ramp} \]

• Running average (Kalman) filter with process error \( Q \sim H_0 \sigma \epsilon \)

X-band: SeaDarQ

\[ k \rightarrow \text{Analysis cube (960x960m x 96s) 3D FFT on } f(x,y,t) \]

**Survey techniques**

The four survey techniques are (1) optical imaging with the Argus video system, (2) microwave imaging by X-band radar, (3) Mobile Terrestrial Laser Scanning (MTLS) and (4) echo-sounding considered as in-situ.

**Morphologic evolution from aggregated parameters**

Cross-shore sandbar position:

• Argus: location white banded outer breaker line from 10min time-averaged images

• *In situ*: location bar crest

Cross-shore shoreline and -1m position:

• Argus: location inner breaker line converted to -1m contour, required shoreline elevation from wave setup and tide.

• *In situ*: location -1m contour

**Conclusions**

- Morphodynamics of spatially extensive study sites, on small to large spatial and temporal scales, can be monitored by combining less accurate frequent remote sensing derived DEMs with a traditional monitoring technique.
- Video derived DEMs improve temporal resolution over *in situ* surveys and morphologic change in the surf zone of O(50m) can be followed on timescales of days to weeks.
- Cross-shore sandbar and shoreline position is an indicator for morphologic evolution on seasonal timescales and can be obtained from Argus imagery.

**Perspective**

- Densely spaced topography:
  - Intertidal-upper shoreface, northward side Sand Motor (cBathy on X-band data)
  - Intertidal-dunes (MTLS)
- Volumetric change as additional aggregated parameter
- Non-linear celerity predictor in cBathy to improve \( h \) estimates in shallow water

**References**