SAND WAVES CHARACTERISTICS: THEORETICAL PREDICTIONS VERSUS FIELD DATA

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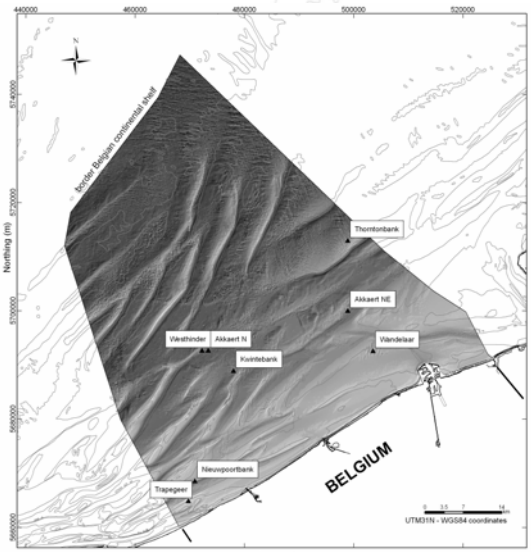
In the coastal region, the interaction of the flow generated by waves and tides with the sea bottom gives rise to a variety of bottom forms characterized by different length scales. The largest bed forms are the sand banks and the sand waves. Sand waves have wavelengths of the order of hundreds of meters and heights of the order of few meters. Their crests are almost orthogonal to the direction of the tidal current.

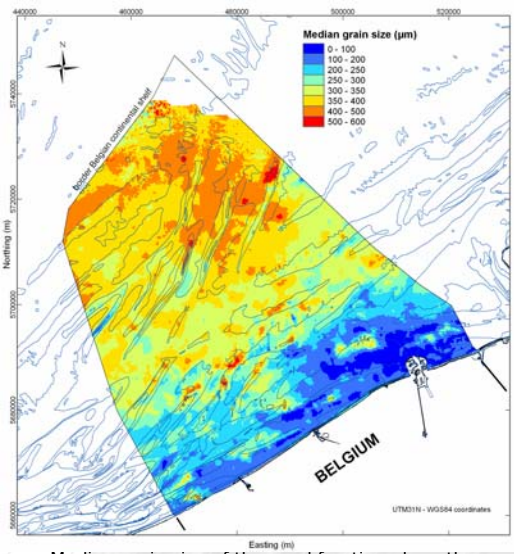
The theoretical investigation of sand wave appearance forced by tide propagation has been mainly carried out by means of linear stability analyses which study the time development of arbitrary bottom perturbations of small amplitude superimposed to the flat bottom configuration.

The capability of the model of Besio et al. (2006) to predict the main geometrical characteristics of tidal sand waves is tested by comparing theoretical predictions with field data. In particular, field observations carried out by Van Lancker et al. (2005) on the continental shelf of Belgium are used.

The Belgian territorial waters occupy about 3600 km^2 in the southern part of the North Sea and they are typically shallow with water depths ranging from 5 to 55m. In the present study, to estimate the tidal currents, we use the measurements carried out at 8 locations (Mouchet 1990): i) Kwintebank, ii) Nieuwpoortbank, iii) Trapegeer, iv) Thorntonbank, v) Wandelaar, vi) Westhinder, vii) Akkaert NE, viii) Akkaert Noord. Harmonic analysis shows that the semidiurnal component is the dominant one with maximum velocities ranging from 54 to 70 cm/s. Sediment characteristics are obtained from a digital terrain model (250x250 m) of the median grain size of the sand fraction (Verfaille et al. 2006). Superficial sediment coarsens in the offshore direction. Very-fine to fine sands dominate the near coastal area.



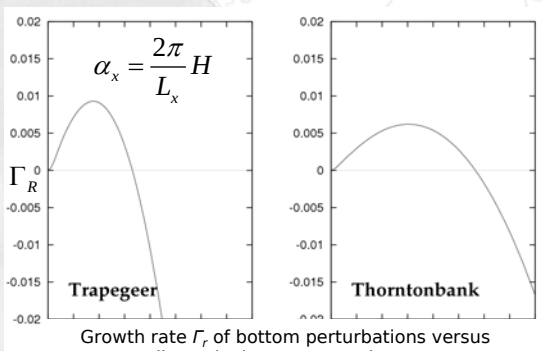
Bathymetry digital terrain model (DTM) of the Belgian Continental Shelf (Van Lancker et al. 2005)



Median grain size of the sand fraction along the Belgian Continental Shelf (Verfaillie et al., 2006)

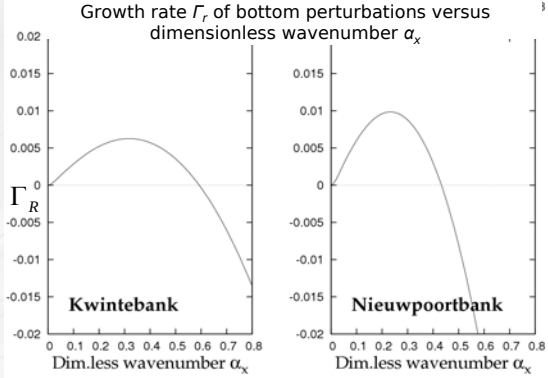
Occurrence and dimensions of sandwaves are derived from a morphological map compiled at Ghent University (Van Lancker et al. 2005).

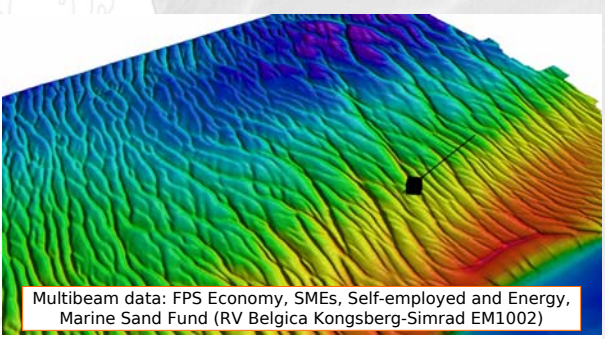
Sandwaves, 2 to 4 m in height, are generally present where sandbanks occur. For each location, the geometrical characteristics of sand waves are determined analyzing different profiles of the sea bottom in order to identify the mean value of the sand wave wavelength and the minimum and maximum wavelengths observed in the field. Comparing different profiles obtained in proximity of the Thornton Bank, it is possible to notice that local geometrical characteristics (amplitude and wavelength of bottom forms) can vary even in the neighbourhood of a limited region. Therefore to compare theoretical predictions and field observations only the mean value of the sand wave wavelength is considered.



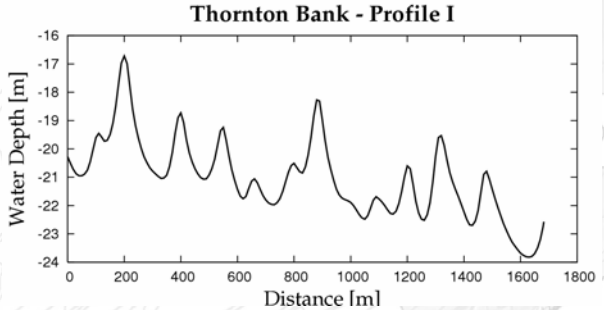
Growth rate Γ_r of bottom perturbations versus dimensionless wavenumber α_x

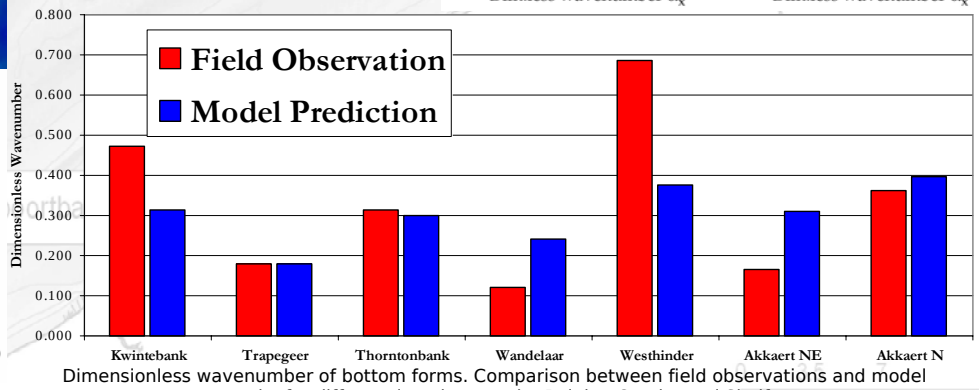
Agreement between the observed and the predicted wavenumbers/wavelengths is good for all the locations considered. Field surveys show a few locations, close to sand banks, where the seabed is devoid of sand waves. Even though no accurate measurements of tidal currents were available to us at these locations, an attempt to apply the model was made using values of the current interpolated on the basis of the data of the nearest current-meters. The model predictions indicate the presence of sand waves. It is suggested that local large scale morphological patterns (sand banks) can be responsible for altering the intensity and direction of the tidal current, enhancing the growth of the sand waves or inhibiting their appearance. Therefore, only the availability of accurate data can allow the prediction of the local morphology in a peculiar site where the local characteristics differ from those of the surrounding area.





Multibeam data: FPS Economy, SMEs, Self-employed and Energy, Marine Sand Fund (RV Belgica Kongsberg-Simrad EM1002)





Dimensionless wavenumber of bottom forms. Comparison between field observations and model results for different locations on the Belgian Continental Shelf