Analysis of bathymetrical derived features on the Belgian continental shelf as a support for marine habitat mapping

Verfaillie Els[1], Foster-Smith, Bob[2], Van Lancker Vera[1]

[1]Ghent University, Renard Centre of Marine Geology (RCMG), Krijgslaan 281, S8, 9000 Gent, Belgium (Els.Verfaillie@ugent.be, Tel. +32 9 264 45 73, Fax +32 9 264 49 67)

[2] Envision, University of Newcastle, Newcastle upon Tyne, United Kingdom

INTRODUCTION

The study area is a kink area in the middle part of the **Westhinder** offshore tidal sandbank, where a **multibeam** dataset is available with a resolution of 2 m (Figure 1). Deleu *et al.* (2004) studied the morphology of this area thorougly. Both on a large and a medium scale the occurrence of **features** (from sandbank level until medium dune level using the classification of Ashley (1990)) was described and interpreted. Bedforms were **manually drawn** based on the bathymetry of the map, indicating their strike and asymmetry.

The **aim** of this study is to **facilitate** and **automate** the **geomorphological analysis**, comparing different bathymetrical derived features. Furthermore the geomorphology is analysed in the context of marine habitat mapping, as topographic features are assumed to be important possible habitats for marine organisms.

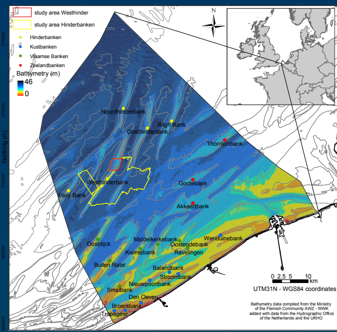
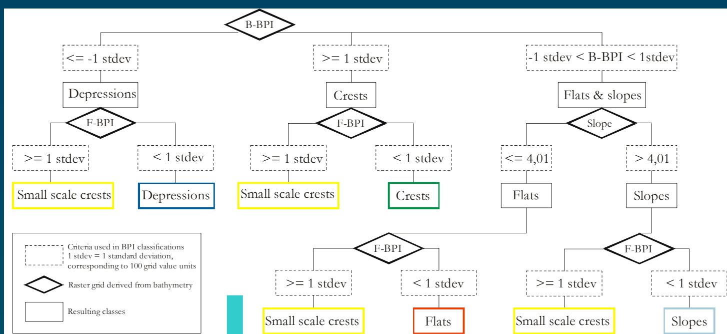


Figure 1: Position of Westhinder study area and larger Hinderbanken study area

MATERIALS AND METHODS

1. **Bathymetric position index** or **BPI**:

- A measure of where a location with a defined elevation is relative to the overall landscape (Weiss (2001), Iampietro & Kvitek (2002) and Lundblad *et al.* (in press));
- Evaluates bathymetry differences between a focal point and the mean elevation of the surrounding cells within a user-defined rectangle, annulus or circle;
- Aims to distinguish slopes, valleys, ridges and flat areas; generally calculated on a broad-scale (B-BPI) and a fine-scale (F-BPI);
- Applies a scalefactor (= resolution of bathymetry multiplied by outer radius of annulus) of 24 and 250 (because the medium and large dunes in this area have an average wavelength of 20 to 25 m, the very-large dunes of 250 m);
- Calculated with ArcGIS Benthic Terrain Modeler or BTM (Wright *et al.*, 2005).



2. **Topographic feature recognition – Isocluster classification**:

- Series of different filters with varying window sizes, reveals different scale features of the bedform morphology;
- Subtraction of filtered images from other images, with smaller cell sizes, creates residual filtered images;
- Filtered images, with varying search radii, reveal bedforms ranging from 10 to 100 m and with heights between 0.4 and 3 m;
- Key scales on different scales (ranging from fine-scale until broad-scale features) are selected from the filtered images to come to a classified image;
- Calculated with Idrisi software Isocluster unsupervised classification (based on maximum likelihood procedure) of the residual images, creating 10 clusters of bedform features.

Figure 2: Classification decision tree developed for Westhinder study area of a B-BPI and a F-BPI classification, resulting in 5 classes: depressions, crests, flats, slopes and small-scale crests

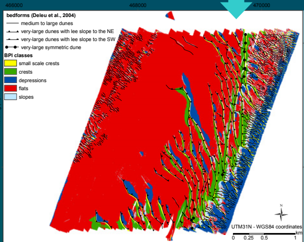


Figure 3: B-BPI and F-BPI classification based on classification decision tree (Figure 2)

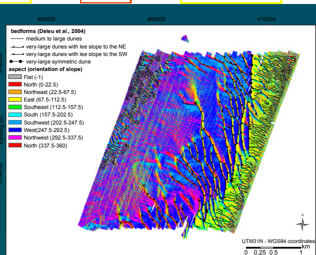


Figure 4: Aspect map of Westhinder area makes it possible to derive asymmetry of bedforms

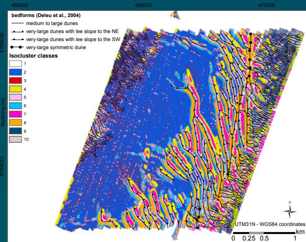


Figure 5: Isocluster classification of 4 key scale filtered images resulting in 10 classes

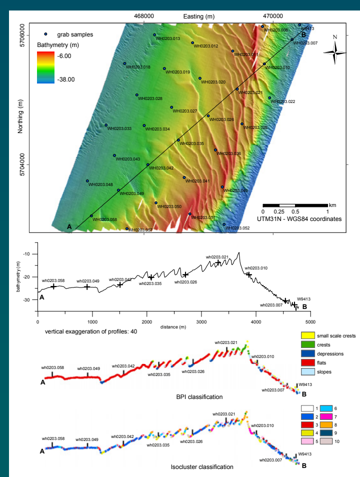


Figure 6: SW-NE profile through the study area; comparison between BPI and Isocluster classification

RESULTS

1. **Bathymetric position index** or **BPI**:

- Classification decision tree (Figure 2), based on B-BPI (4 classes: depressions, crests, flats, slopes) and F-BPI classification (1 class: small-scale crests) results in 5 classes: Figure 3;
- 'Small-scale crests' class corresponds to a large extent to the crestlines of the very-large dunes and, partly, to the crestlines of the medium to large dunes, defined in Deleu *et al.* (2004) (Figure 3);
- Combined with an aspect map (orientation of the slopes: Figure 4) the asymmetry of bedforms can be derived;
- Figure 6: SW-NE profile through a sandbank, very-large dunes, medium to large dunes and 9 sediment samples shows that most of morphological features are extracted using the BPI classification;
- Most of the tops/slopes of the very-large dunes (central part of profile between 1000 and 4000 m on Figure 6) are clearly classified as small-scale crests;
- Depressions/crests are only derived for larger features. For medium to large dunes (at right side of 4000 m on profile) only the largest crestlines, depressions and steepest slopes are derived based on the classification;
- Application on larger area in Hinderbanken (Figure 7): clear distinction between bedforms on sandbanks and swales.

2. **Topographic feature recognition – Isocluster classification**:

- Figure 5: similar features could be extracted, although sometimes difficult interpretation of classes;
- Better extraction of crestlines of medium to large dunes, especially in the NW part of study area;
- Class 1, 3 = noise; class 2 ≅ BPI-flats; class 4, 7, 10 ≅ BPI-depressions; class5, 9 ≅ BPI-small-scale crests; class 6 ≅ BPI-slopes; class 8 ≅ BPI-crests.

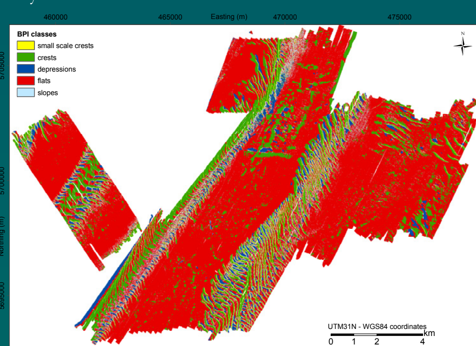


Figure 7: BPI classification applied on multibeam bathymetric dataset (resolution 2 m) of larger area in Hinderbanken: clear distinction between bedforms on sandbanks and swales. Patchy pattern in swales possible indicator of gravel

FURTHER RESEARCH

- Application of bathymetric derived features on other areas
- Correlation of bathymetric features with other physical data layers such as multibeam backscatter and sedimentological samples
- Correlation with marine species/communities to test if they are important possible habitats
- Other bathymetric derived features will be tested as input parameters for models (e.g. rugosity = topographic roughness with a surface area to planar area ratio, as input for sand transport or biological models)

REFERENCES

- Ashley, G.M., 1990. Classification of large-scale subaqueous bedforms: a new look at an old problem. Journal of Sedimentary Petrology, 60 (1), 160-172.
- Deleu, S., V. Van Lancker, D. Van den Eynde, and G. Moerkerke, 2004. Morphodynamic evolution of the kink of an offshore tidal sandbank: the Westhinder Bank (Southern North Sea). Continental Shelf Research, 24 (15), 1587-1610.
- Iampietro, P., and R. Kvitek, 2002. Quantitative seafloor habitat classification using GIS terrain analysis: Effects of data density, resolution, and scale. In Proceedings of the 22nd Annual ESRI User Conference. San Diego, CA, July 8-12. http://gis.esri.com/library/userconf/proc02
- Lundblad, E., D. J. Wright, J. Miller, E. M. Larkin, R. Rinehart, S. M. Anderson, T. Battista, D. F. Naar, and B. T. Donahue, in press, A Benthic Terrain Classification Scheme for American Samoa. Submitted to Marine Geodesy.
- Weiss, A. D. 2001. Topographic Positions and Landforms Analysis (Conference Poster). ESRI International User Conference. San Diego, CA, July 9-13.
- Wright, D.J., Lundblad, E.R., Larkin, E.M., Rinehart, R.W., Oregon State University Davey Jones Locker Seafloor Mapping/Marine GIS Lab (project background at http://dusk.geo.orst.edu/esri04/p1433_ron.html) Joshua Murphy, Lori Cary-Kothera, Kyle Draganov NOAA Coastal Services Center