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Systematic errors estimation in repeat MBES surveys

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Abstract— Repeated multibeam echosounder (MBES) surveys are carried out over dredging areas to control the sand extraction. This work aims at detecting and estimating systematic errors present in a bathymetric time series by performing a robust and global registration of their osculatory surfaces.

Keywords—MBES; Bathymetry; Bedforms; Trend surfaces; Registration; Systematic errors; Osculatory surfaces;

I. INTRODUCTION

The volume of sand extracted in the Belgian part of the North Sea is derived from Electronic Monitoring System (EMS) data. EMS are black-boxes installed aboard dredger ships recording both their position and pump activity. The environmental impact of sand extraction on the bathymetry is controlled by repeated MBES surveys of monitoring areas. Analysis of discrepancies between volumes estimated using EMS and MBES surveys highlights the presence of systematic errors in MBES datasets. In order to detect and quantify these systematic errors, a new robust and global approach was developed and successfully applied to a monitoring area.

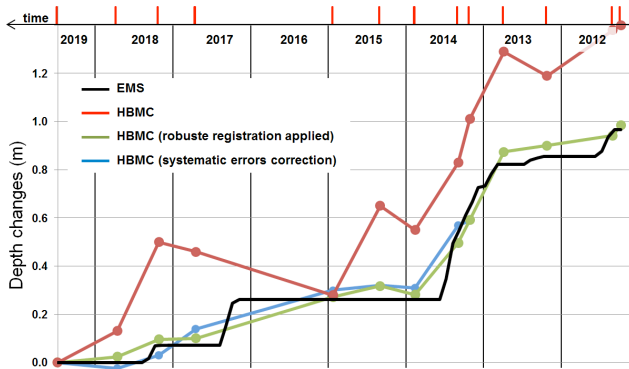


Fig. 1. Variations in sediment volumes estimated from MBES and EMS data as a function of time. The time origin is the last survey.

II. DATASET DESCRIPTION AND METHODOLOGY

Our studied area (HBMC) is located in the S4c extraction sector of the Belgium continental shelf. This monitoring zone is a narrow strip of land that partially covers the Oosthinder bank, a tidal sandbank assumed to be stable. This reference area is surveyed since April 2012 up to July 2019 using the RV *Belgica* SIMRAD EM3002D. Bathymetric data acquired

during these surveys were corrected using the same processing steps. The thirteen DBMs (Digital Bathymetric Model) available on HBMC show that a large part of the zone undergoes noticeable sand extraction or large dune migration. While the temporal evolution of the sand volume estimated from MBES data is mainly explained by the extraction, differences between EMS and MBES data exist and were investigated using osculatory surfaces [1]. Osculatory surfaces are trend surfaces extracted from DBM that split the sandbank into a stable part and dynamic part for a given time period. The detection and estimation of systematic errors rely on the robust and global registration of stable bedform features while taking into account the dredging impacts on the seabed morphology [2].

III. RESULTS AND CONCLUSIONS

Our approach was applied to the global registration of the thirteen osculatory surfaces on HBMC using the last survey as a reference. Indeed, this survey was reduced using GNSS derived tidal data and is therefore considered as more reliable. The temporal volume variations deduced from MBES bathymetric data after removal of these residual bias significantly improves the correlation with EMS data. Thanks to the GNSS tidal reduction applied to data of the last survey, we now have an estimation of systematic errors associated with each DBM. For each survey, a statistical analysis of heave, dynamic draft and tide gauge data was conducted that confirms the estimation deduced from the robust registration of osculatory surfaces time series.

These results show that, despite the difficulties inherent to HBMC dataset (sparse and irregular MBES surveys, dredging periods and hydrodynamic complexity) our approach is a promising tool that will help hydrographers to detect and estimate systematic errors present in bathymetric time series.

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