Sediment volume trend analysis by combining JARKUS and multibeam data

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Introduction

The Dutch coast is maintained by sand nourishments with the objective to keep the shoreline at its 1990 position. The assessment of the shoreline position was implemented successfully using the yearly measured JARKUS-transects (Van Koningsveld and Mulder, 2004). Since 2001 a second objective was added: to maintain the sediment volume in a larger coastal area, the 'coastal fundament' (Min. V&W, 2000).

To assess the change in volume of this coastal area several studies use JARKUS-transects (e.g. Stam, 1999; Van Rijn, 1997). These transects consist of point data and are measured since 1965, that have poor coverage of the deeper coastal area. Since 1990 multibeam bathymetric grid-data is measured every three years in addition to the transects. The two datasets will extend each other in time and space, but are never used together to calculate changes in sediment volume.

The main objective of this study was to combine the two datasets for the North-Holland coast and use the new dataset to calculate changes in sediment volume. These results are compared to previous studies.

Methods

1: Combining the datasets

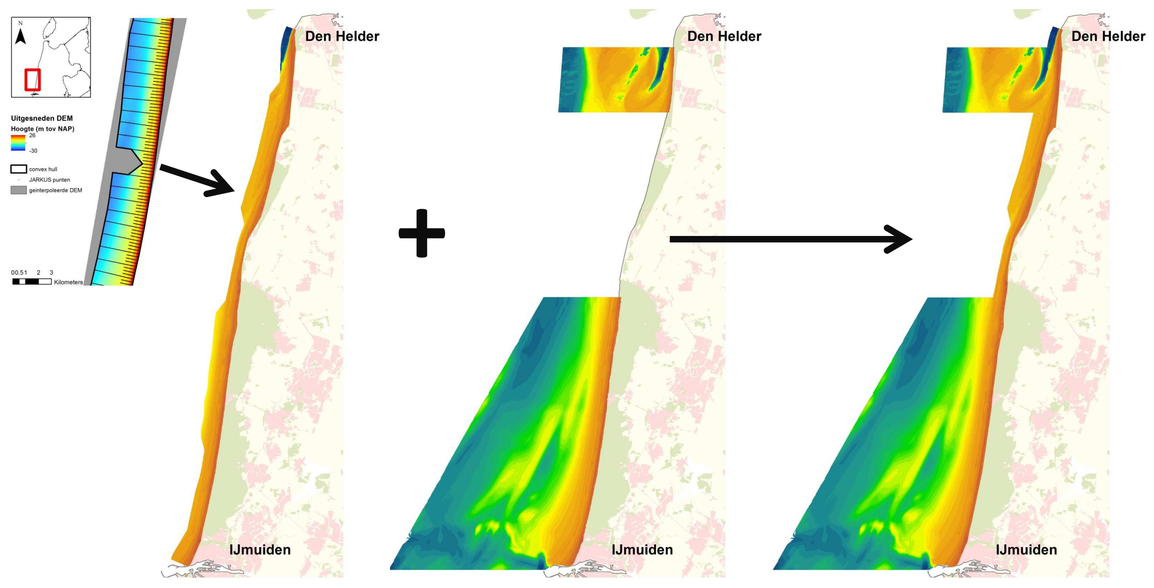

Figure 1. Datasets are combined by interpolating JARKUS point-data and merging the resulting DEM with vaklodingen DEM, for each year. For years without vaklodingen only the JARKUS data was interpolated (example is for the year 2005).

2: Trends in sediment volume

The change in sediment volume is calculated for seven areas with uniform morphological behaviour (after Van Rijn, 1997). In cross-shore direction two zones are determined: a shallow zone between NAP (Dutch ordnance level) -1 and -8 m and a deeper zone between NAP -8 and -12 m (cross-shore boundaries are determined using data from 1990).

For each year the DEM was subtracted from the DEM from 1990 to create erosion-sedimentation maps. For each area the average change in height of the seafloor within that area is calculated from the erosion-sedimentation maps. Multiplying these values with the surface of the area yields volumetric changes.

For three different periods a linear trend has been calculated on these relative volumes. The periods in time are based on changes in coastal maintenance policy: before 1990 almost no sand was nourished, but between 1990 and 2001 approximately 6 million m^3/year for the whole Dutch coast, and since 2001 approximately 12 million m^3/year for the whole Dutch coast.

Results

The resulting trends in volume change show a change from negative values before 1990 to positive thereafter, due to the nourishments. Comparison with other studies for the period where no multibeam data was available shows very similar trends (Figure 2). The more recent period, with additional data based on the combined data set, shows in a lower positive trends for several areas than the trends based on JARKUS-data only.

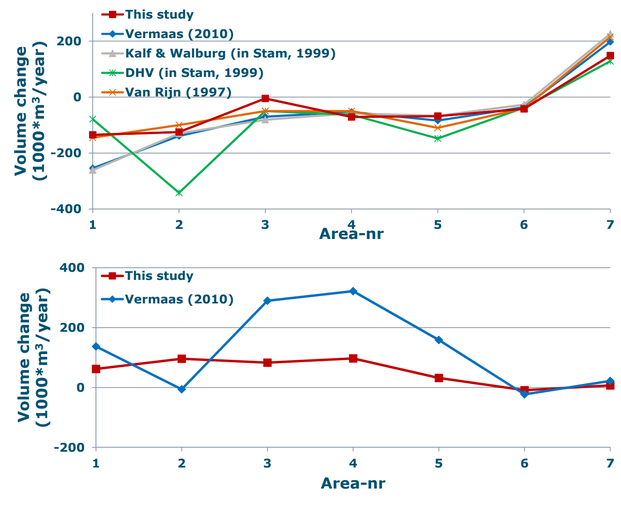

Figure 2. Comparison of olume trends per area (between -8 and -12 m depth) for periods 1965-1990 (upper) and 2001-2008 (lower).

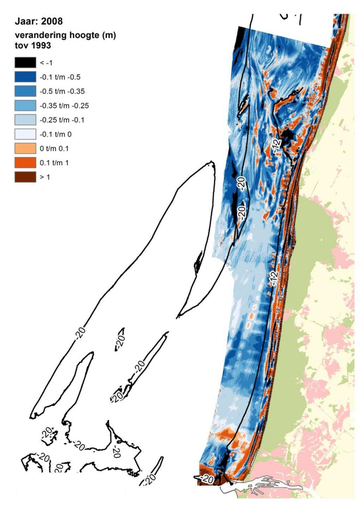

Figure 3. Difference map for larger area of the Holland coast (2008 relative to 1993).

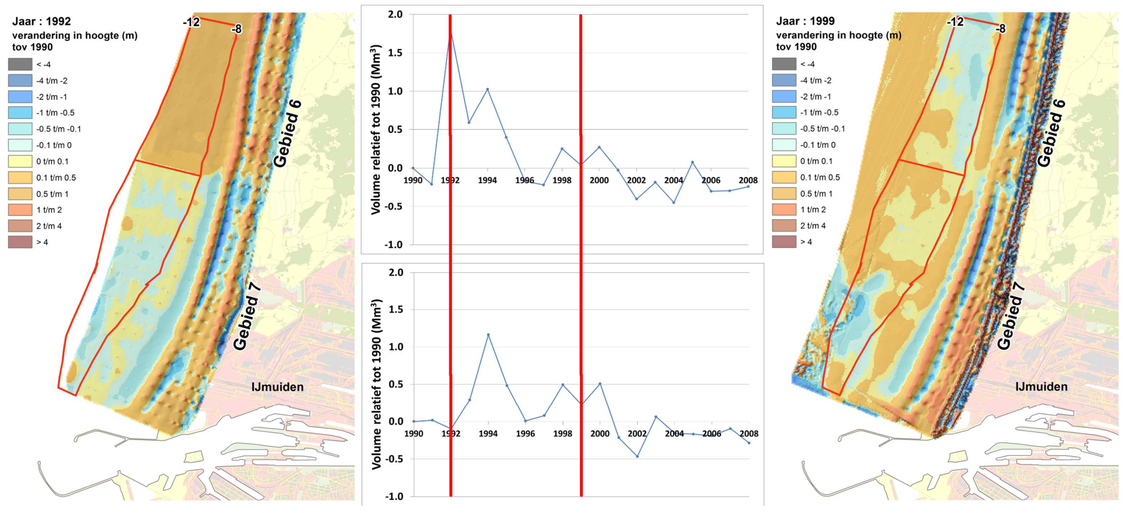

Figure 4. Difference maps and development of relative volumes in 1992 (left) and 1999 (right) relative to 1990, for areas 6 and 7 between -8 and -12 m depth.

Conclusions

Sediment volume trends can be analyzed by using the combined JARKUS-bathymetric dataset. The results are in line with previous studies. However lower sedimentation rates for the recent period are due to addition of multibeam data of the deeper area within the studied areas. This deeper area is nourished less than the shallow and is still eroding. Volume trends based on JARKUS data only therefore overestimate the volume trend for these areas.

References

- Min. V&W (2000). Tradition, Trends and Tomorrow. 3rd Coastal Policy Document, Ministry of Transport, Public Works and Watermanagement, The Hague NL.
- Stam, J.M.T. (1999). Zandverlies op diep water aan de Hollandse kust. Rapport RIKZ/99.006, Rijksinstituut voor Kust en Zee/RIKZ.
- Van Koningsveld, M. and Mulder, J.P.M. (2004). Sustainable coastal policy developments in the Netherlands. A systematic approach revealed. Journal of Coastal Research, 20(2): 375-385.
- Van Rijn, L.C. (1997). Sediment transport and budget of the central coastal zone of Holland. Coastal Engineering, 32(1): 61-90.
- Vermaas, T. (2010). Morphological behavior of the deeper part of the Holland coast. Report. Deltares, Delft, The Netherlands.

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