Aeolian sediment transport management at the central Danish North Sea Coast

Per Sørensen and H.V. Karlsson

Danish Coastal Authority, Department of Coasts and Climate, Højbovej 1, 7620 Lemvig, Denmark
E-mail: pso@kyst.dk, hevka@kyst.dk

1. MOTIVATION

The central part of the Danish North Sea coast consists of narrow sandy barriers protecting a low lying hinterland from flooding. The narrow barriers are subject to the forces of the North Sea with prevailing strong westerly winds and corresponding high waves. These forces creates a very dynamic coastal system with high wave and wind driven sediment transport rates. The sediment transport cause a negative sediment budget because of erosion, which cause a retreat of the active profile. The retreat however cannot be accepted in many places because of the safety requirements. So sediment management must be undertaken, but how when there are many other objectives than just providing safety?

2. THE BENEFITS OF A NATURAL AEOLIAN TRANSPORT

At Skodbjerge in the southern part of the central Danish North sea coast the dunes are not managed Figure 1. This is possible because houses and major roads are located quite a distance inland due to the Nature protection Act. The annual profile retreat is 1.0 m/year. Until know the amount of sediment that are transported from the beach to the area behind the dune face has not been accounted in the overall sediment budget due to the lack of long term data.

Figure 1: Natural system at Skodbjerge (left), and managed system at Krogen (right).

Since 2005 annual laserscans with red lidar has been carried out which provides adequate data for analyzing the amount of sediment transport into the hinterland, and the yearly variations. The seasonal variations has lately been done by using drone mounted cameras. The analysis was done by dividing the 3.7 km stretch into 10 cells, 5 seaward cells and 5 landwards cells that includes to the landward boundary of significant Aeolia transport. The volumes in each cell were calculated from the lidar data using ArcMap Zonal statistics tollbox.

The volume analysis showed that accumulation was primarily found on the lee side of the dune crest and in the deflation basin of a blow out. Erosion took place in the seaward boxes. The eroded and accumulated volumes pr. m in the study are both 150 m^3/m in the period from 2006-2019. This means that the safety is generally maintained, despite of the retreat of the dune face. At the same time a natural biodiversity was maintained,

It was found that the windspeed and direction is correlated with the variations in accumulations and accretion, but the R2 value is lower than 0.5

3. THE CHALLENGE OF MANAGING AEOLIAN SEDIMENT TRANSPORT

At Krogen Figure 1 the coast is heavily managed because of the narrow dunes and that houses and major roads are located close to the dune face. The natural profile retreat is 0.8 m/year. Frequent shoreface and beach nourishments are carried out. Marron grass planning, brushwood fences are used to retain the sediment in front of the duneface, Figure 1. Similar volumes analysis are done for the Krogen area as for Skodbjerge area. The analysis showed an volume increase in both the seaward and landward boxes. The increase in the seaward box was 75 m^3/m, and 140 m^3/m for the landward cells which is approximately the same for the unmanaged stretch at Skodbjerge. This shows that the measures implemented to reduce aeolian sediment transport were not sufficient to meet the objective.

4. TEST OF A NEW SEDIMENT MANAGEMENT APPROACH

The above analysis shows that it can be difficult to reduce the Aeolian transport to the hinterland in places where it is needed. Such a place is Northern Torsminde tange 30 km north of Krogen where a road was covered by sand by Aeolian sediment transport. Traditionally the sand is tranpoted back to the beach again by dumpers, but based on the presented analysis test were made with different placement patters of the sediment, Figure 2.

Figure 2: Removed sand for the road and back dune and placed in different patterns on the beach.

3 patters are tested, all of the formed 2 m high, and 20 m wide sand volumes, primarily dictated by the size of the dumpers used. Alongshore to patters were tested. A long continuous sand dike and as two groups of 3 70 m long sand dikes. The sand dikes were established which an angle of ±30 to the dune face. The effect of these new measures have been monitored 20 times during a 2-year period. The analysis of the data are not yet finished.

5. ACKNOWLEDGEMENTS

Most of the work was carried out as a part of the Interreg project Building With Nature, BWN. We are grateful for the support. We would also like to thank University of Twente, TU Delft and University of Copenhagen for fruitful discussions.

6. REFERENCES

- Karlsson H V , Larsen B.G.,2021. Aeolian sediment transport and dune development in a natural and managed system, Krogen Denmark, Interreg Building With Nature report, Report
- Karlsson H V , Larsen B.G.,2020. Aeolian sediment transport and natural dune development, Skodbjerge, Denmark, Interreg Building With Nature report, Report
- Hesp, P. 2002. Foredunes and blowouts: initiation, geomorphology and dynamics, Geomorphology 48 (2002) 245-268