Impact of marine sand extraction on benthic communities west off Sylt (SE North Sea)

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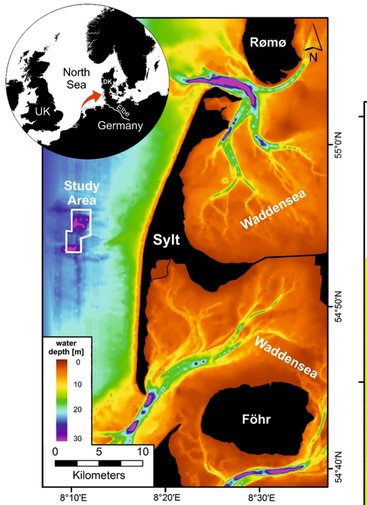
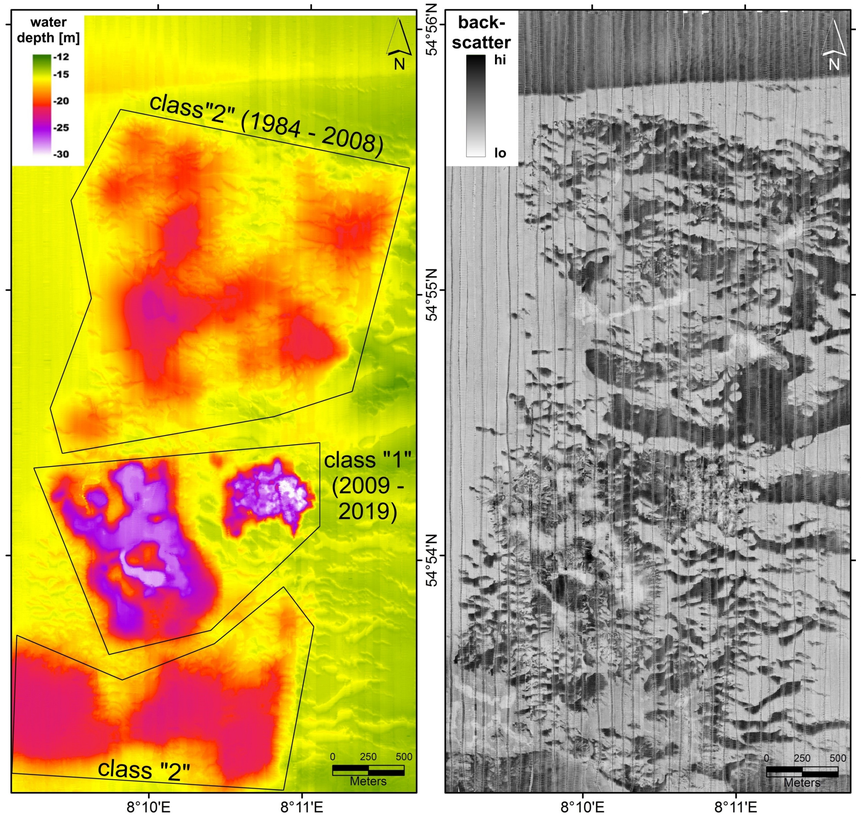


Fig.1: The study site „Westerland Dredging Area" is located 7 km offshore Sylt. Since 1984, unconsolidated proglacial sand deposits were extracted here for the purpose of beach nourishment of the islands exposed western shoreline.

Ongoing erosion at coasts, beaches and dunes accompanied by a climate change-induced sea-level rise requires extensive protection measures. At the Island of Sylt (SE North Sea) beach nourishments were conducted for almost 50 years to protect the exposed western coast against erosion. Since 1984, the materials for the sand replenishments were dredged from an offshore excavation site approx. 7 km west off Sylt in the German Bight (Fig. 1). In this study, we investigate the long-term effects of sand extraction on the local geomorphology and the associated benthic habitats and fauna. Hydroacoustic surveys and grab sampling revealed that after more than 35 years changes in bathymetry (with dredging pits of down to ~15 m below sea floor) and also changes in habitat characteristics are still present (Fig. 2, Fig. 3). Additionally, the sediment compositions have changed (Fig. 4).



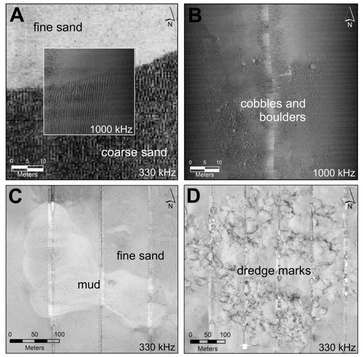
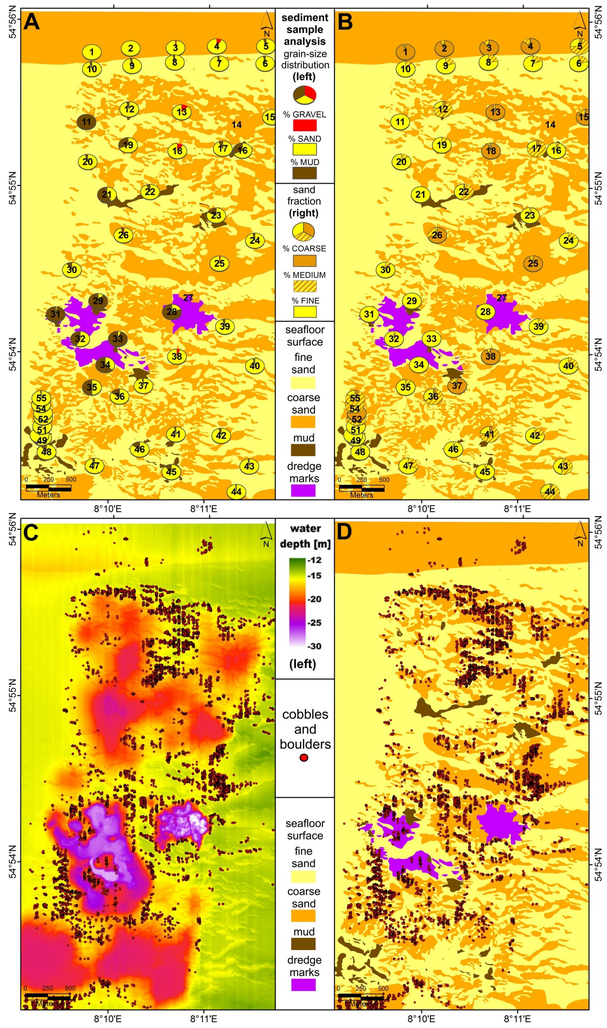


Fig.3: Seafloor features detected within the sidescan sonar mosaic.

Fig.2: Results of the hydroacoustic survey from January 2019.Left: post-processed bathymetric map of the study site measured with multibeam echosounder; class "1":sites where sediment was extracted during the past 10 year (1984 –2008); class "2": sites where sediment extraction terminated at least 10 years prior tot he sampling (2009 –2019); class "0": sites which were never dredged (area outside the boxes).Right: Backscatter response of the seafloor recorded with sidescan sonar.

Fig.4: Habitat maps created with a combination of hydroacoustic data and ground-truth information. (a), (b): Position and sediment composition of the grab samples. (c), (d): appearance of stones.



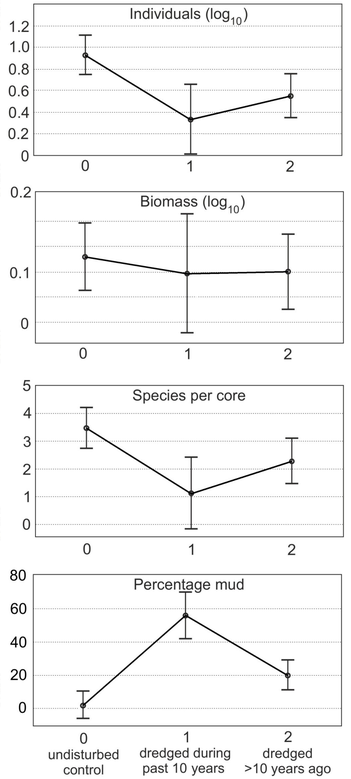


Fig.5: Macrozoobenthos abundance, biomass, species density and the mud content of sampling stations across the sediment extraction area. Site class 0 = control sites unaffected by sediment dredging; class 1 = sites dredged within the last 10 years; class 2 = sites >10 years after dredging.

A comparison between dredged areas and undisturbed seafloor revealed significant differences in mud content , the number of individuals and species of macrozoobenthic organisms (Fig. 5). This indicates that the benthic communities in the dredging areas are in a persistent successional stage. Mud-loving species (e. g. *Notomastus latericeus* and *Kurtiella bidentate*) profit from the changed habitats, however sand-preferring organisms (e.g. *Pisione remota* and *Aonides paucibranchiata)* largely disappeared. Because of the slow backfill rates, we conclude that a complete backfill of the deep dredging pits is likely to take centuries. The same is expected to apply for the regeneration of the benthic communities. However, since rather coarse-to-medium sand was removed from this area and re-accumulation of this Pleistocene material is not possible because of weak transport rates, a re-establishment of benthic communities that prefer coarser sand seems to be unlikely. Virtually no stones could be detected in the older dredging pits (Fig. 2, class 2; Fig. 4c ,d), as they were most likely buried by slope failures shortly after the dredging activity . Since benthic communities are strongly linked to the habitat characteristics, habitat mapping using hydroacoustic techniques is an efficient and cost-effective measure to monitor the state of regeneration in this study site.

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