Universität Rostock
Traditio et Innovatio
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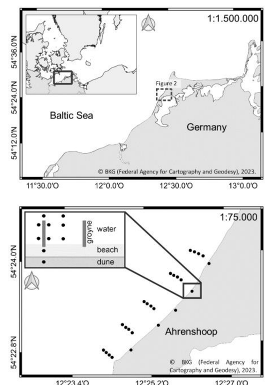
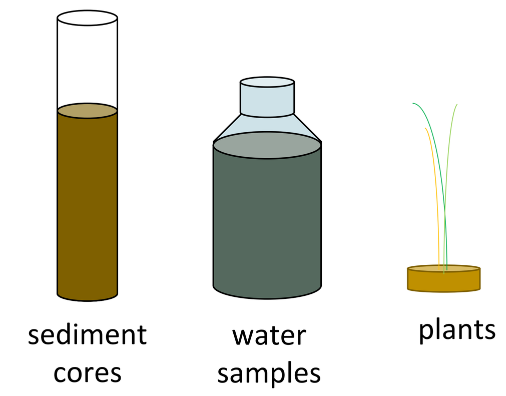
How much nature is in nature-based coastal management?

Can sand nourishments counteract the consequences of climate change while preserving ecosystems: A case study



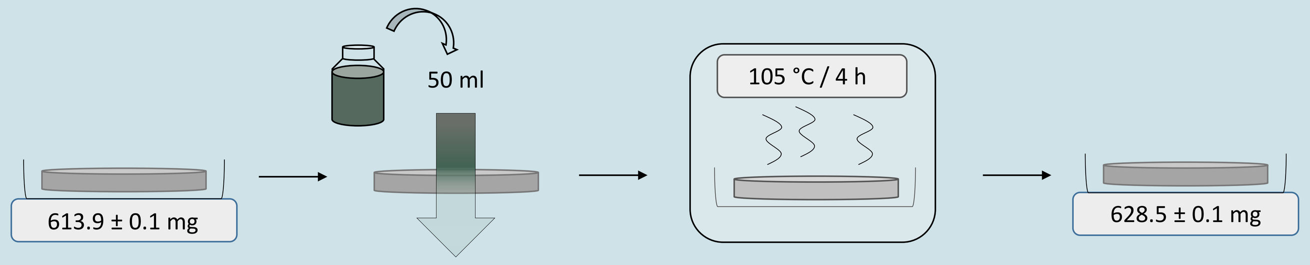
It is generally agreed today that sand nourishments are nature-based solutions for coastal protection measures as they mimic natural processes [3,4]. This term refers to the erosion and sedimentation of cliff sediment providing sandy beaches with sediment. Nevertheless beach nourishments impose risks in disturbing the natural habitats and dune succession since alien sediments are introduced to coastal ecosystems. These sediments are marine sands with characteristics that are typical of a marine seafloor rather than nutrient-poor shallow water, beach and dune ecosystems. This case study focuses on Ahrenshoop (Fig. 1), a small city located at the Darss-Zingster-Boddenchain with access to both the Bodden and the Baltic Sea. Ahrenshoop is endangered during storm floods since the exposed coast of the Baltic Sea has a high lateral sand transport which needs to be compensated by beach nourishments that take place every few years [2]. During the last nourishment in winter 2021/22, around 600 thousand cubic meters of sand were nourished onto the beach and dune at a total length of 4 km. To estimate the effect of such a nourishment, samples were taken during a 12 months campaign. This included sediment cores, water samples and botanical mappings at 20 aquatic stations (3 water depths) and 50 terrestrial stations (on beach, dune and in the shallow water around the groyne-systems installed at the beach). For botanical mappings, two additional sites in the same region were analysed. These are referred here as control site (without any coastal management) and groyne site (with implemented groynes).

Figure 1: Location of Ahrenshoop (top) and sampling positions (bottom).



Material & Methods

Water samples were taken before, during and after the nourishment. The TSS (total suspended solids) concentrations were measured via filtering 50 ml of the sample (number of replicates n = 20) through a glass fibre filter with a pore diameter of 0.4 µm.



We analysed mixed sediment samples (first 20 cm to surface, n = 5) to determine water, organic and carbonate content as well as mean grain size and sorting grade.

We conducted botanical mappings (n = 5) to determine the biodiversity and vegetation coverage using 2 m wide belt transects. The ground coverage of the different species was measured with the Braun-Blanquet-Scale [5] (Table 1). Additional mappings were performed in the same region to compare the nourished site with a site without any costal management and a site with groynes.

description	scale	description	scale
one individual	r	16 – 25 % ground coverage	2b
2 – 5 individuals, < 5 % ground coverage	+	26 – 50 % ground coverage	3
6 – 50 individuals, < 5 % ground coverage	1	51 – 75 % ground coverage	4
> 50 individuals, < 5 % ground coverage	2m	76 – 100 % ground coverage	5
6 – 15 % ground coverage	2a		

Table 1: Braun – Blanquet – Scale [5] which was used for the botanical mapping.

Results

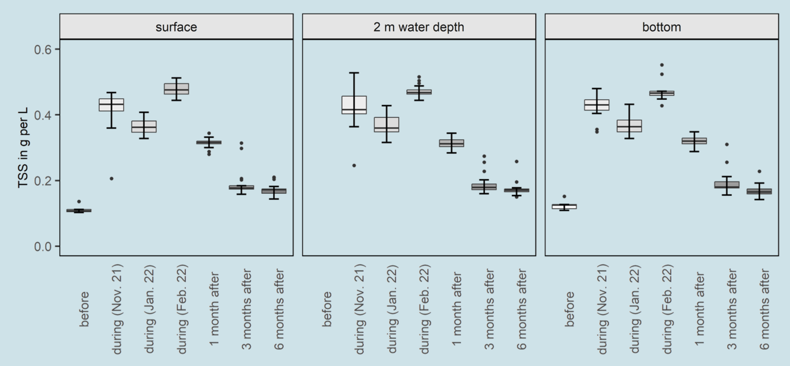


Figure 2: TSS (total suspended solids) concentration in g per liter before, during and after the nourishment at 3 different water depths.

Hypothesis:
Sand nourishments increase the turbidity in the water column during and after the measure.

There was a significant increase of TSS during the nourishment. This was measured at all sampling times and the different water depths (Fig. 2). The TSS concentration decreased after the nourishment. At 3 months after the nourishment, we did not measure additional turbidity anymore.

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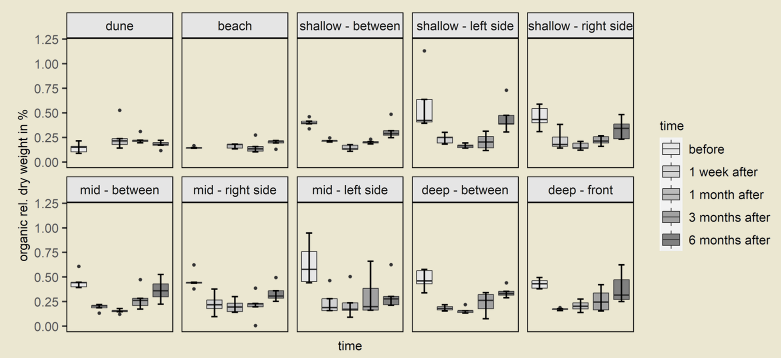

Figure 3: Relative organic content (of dry weight in percent) of the sampling sites before and after the nourishment in Ahrenshoop.

Hypothesis:
Changed sediment parameters can be measured over a long time after a sand nourishment.

There were significant changes in sediment contents after the nourishment, e.g. a decrease in organic content (Fig. 3). But after 6 months, the conditions prior to the nourishment were restored. There were no significant changes in mean sediment grain size and sorting grade at all.

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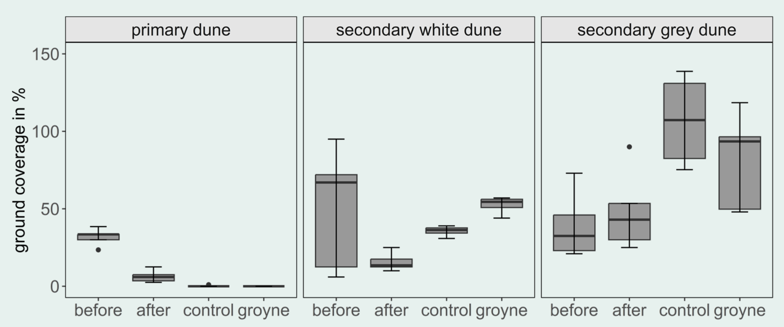

Figure 4: Total vegetation coverage in percent of the three dune habitats (primary, secondary white and secondary grey).

Hypothesis:
Sand nourishments effect the biodiversity and vegetation coverage in nourished areas drastically, but has little to no effect on adjacent areas.

There were no significant differences in ground coverage before and after the sand nourishment but between the nourished site and control sites (Fig. 4). In general, the coverage was lower. This applied also on adjacent areas (e.g. secondary grey dune).

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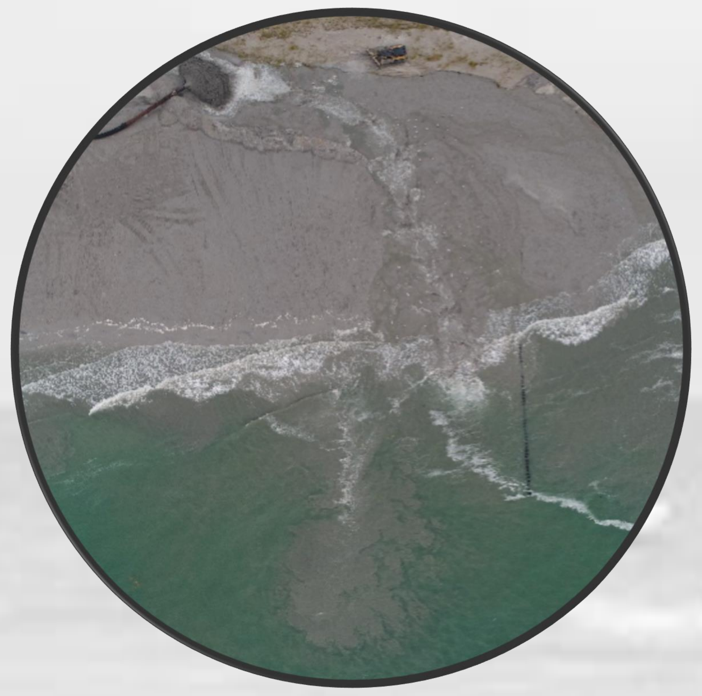

Sand nourishments can mimic natural processes but they do it in a very short time frame. There is no natural event where half a million square meter sand are deposited at a beach and dune, which can lead to intensified sediment transport. Therefore the potential of aeolian sand transport is increased [1] but too much deposition of sand drift can also lead to the suffocation of dune-building plants [6]. The impacts of such a nourishment therefore are not limited to the exact site of the nourishment but can be found in adjacent environments too. The result of this increased sediment transport is most visible while comparing the vegetation composition of the different sampling sites. Short-term influences of the nourishments do not change the composition as much as the repeated implementation of such a measure. Control sites without sand nourishment can be clearly separated from those with nourishments; this applies to both secondary white and grey dune even though the grey dune was not nourished (Fig. 5). Other coastal parameters were not affected long-term. Both turbidity and sediment samples showed that the influence has largely disappeared after 6 months. This suggested that the nourished sediment was very well selected for that coastal section.

Sand nourishments offer a way to stabilize eroding coastal zones but they have a long-term effect on those ecosystems that can change the vegetation compositions drastically. When dune succession is repeatedly interrupted, the natural development of the coastal landscape is inhibited.

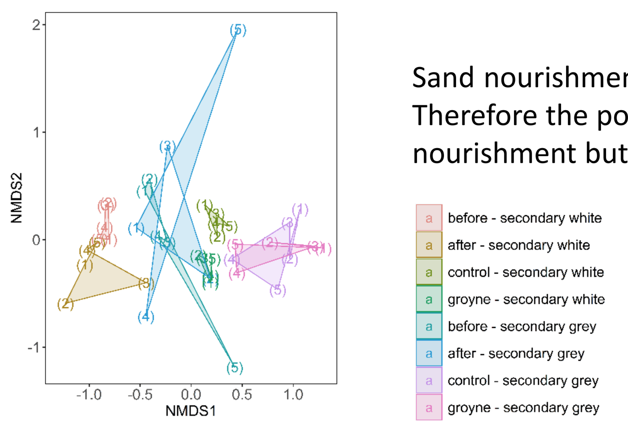

Figure 5: Multi-dimensional-scaling of biodiversity (species) mapped on the secondary white and grey dune in Ahrenshoop and the control sites. Each sampling site is in a different colour. The further the distance between the points, the less similarities the sites have.

This presentation participates in OSPP
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