Lessons learned in the Building with Nature project

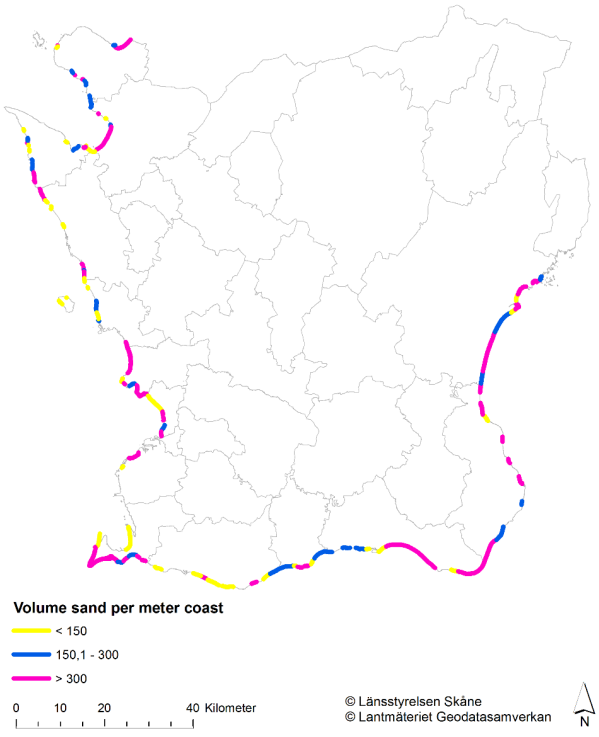
The Interreg VB North Sea Region Building with Nature project (2015-2021) has the overall aim, to make coasts, estuaries and catchments of the North Sea Regio (NSR) more resilent to climate change by both applying and learning from the implementation of Building with Nature (BwN) measures. The project is taking place in the North Sea Region, involving 15 partner organisations from Norway, Sweden, Denmark, Schleswig-Holstein (DE), Niedersachsen (DE), the Netherlands, Belgium and Scotland (UK). The objective of this leaflet is to share key successes from the coastal laboratories of the partners in the NSR.

Introduction

The identification of societal challenges in the North Sea region coastal areas is the base for a successful risk assessment, which was performed for all coastal labs. Also expected future developments are being quantified both with and without acceleration due to climate change effects like Sea Level Rise. One example from our laboratories is the coasts of Skåne, by determining the sand volumeand the distance between the coastline and the nearest buildings and infrastructure, insight is gained in the vulnerability to sea level rise (Reference of Swedish report: Johanna Birgander, Thorbjörn Nilsson, Pär Persson; "Inventory of coastal sandy areas – protection of infrastructure and planned retreat", 28.02.2018)

Depending on the societal challenges, the results of the risk assessment and the expected future developments there might be a need to implement measures. In some coastal laboratories Nature Based Solutions (NBS) or Building with Nature (BwN) solutions might be an option (Reference for BC-Guidance Report: BwN-WP5; Building with Nature Business Guidance Report, 2020)

When nourishments have been selected as the preferred approach in a specific location, nourishments designs have to be made. The evidence base generated in the Interreg Building with Nature project highlights observed effects of nourishments. It is encouraged to take these effects into account when planning or designing nourishments. The observed effects can not be considered generally applicable to all coastal areas in the NSR since conditions vary locally and only a subset of typical sandy coastlines are included in the project. However these lessons provide valuable insights that can inform the planning and design of nourishments (Reference for Co-Analysis (unpublished): Rinse Wilmink; Vermaas, Tommer; Lodder, Quirijn; Hillmann, Simon; Blum, Holger; Hinrichsen, Arfst; Peters, Christian; Hansen, Jens; Karlsson, Henrik; Sørensen, Per; Co-analysis of nourishments, 2021).



Sand volume assesment Skåne, Sweden

International collaborations pays off

The partners in the project shared experiences and insights during the project. This exchange of ideas has led to a common shared understanding of the role and function of coastal Building with Nature solutions, nourishments especially. A shared knowledge base is created.

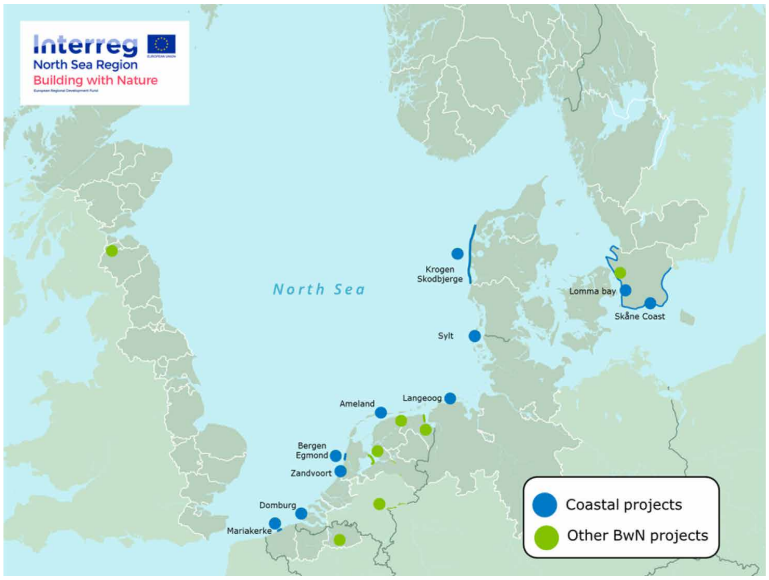
Photo cover co-analysis: Towards a transnational understanding of nourishment behaviour

Joint data sharing and analysis is crucial

This project has made us even more aware of the crucial role data and data analysis plays in cross country learning and sharing insights. To really understand each others policy and practice it is not enough to share presentations and reports. Real learning starts when you start doing the data analysis together and also using each other's data. Together we created one database that contains 5840 transect locations in 4 countries with measurement time up to 150 years.

International field visits: a very efficient way to learn

During the project field visits took place to nearly all coastal and fluvial laboratories. These visits have proven to be a excellent way to deepen transnational understanding, cooperation and mutual trust. All of which are essential for lasting collaboration to make european coasts and rivers resilient to the effects of climate change as a task without borders.



https://building-with-nature.eu/case-studies/interactive-project-map/

Lessons learned

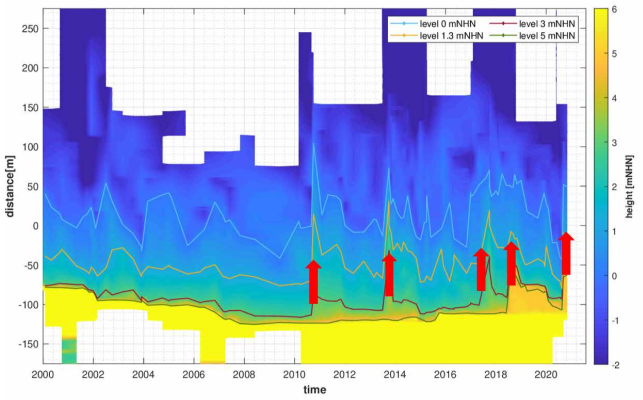
During this project the Co-analysis was developed by the project partners. This led to national analysis with a shared international methodology. Comparable analyses based on hypothesis testing and shared understanding led to various insights. These are stated as lessons learned and are presented in the following pages.

More information to the shown figures can be found in the national reports (Hansen et al. 2019; Hillmann et al. 2021; Rivero et al. 2018; Vermaas et al. 2019) or the Co-Analysis Report (Wilmink et al. 2021).

Observed effects of nourishments:
Beach and shoreface nourishments can stabilize beaches

Explanation

At each coastal laboratory nourishments have been placed in the last decades. Through an assessment with a shared methodology (averaging volumes for set slices of the profile) it is possible to show that nourishments compensate chronical erosion and thus stabilize the coastline. The erosional natural coastal processes are not stopped, the effect of these processes – coastal retreat – is stopped because the sediment losses in the area are compensated by new sediments. This allows the coast to remain a sandy system including the associated habitat, while preventing coastal retreat and providing flood risk management benefits just like recreation or fresh water supply.

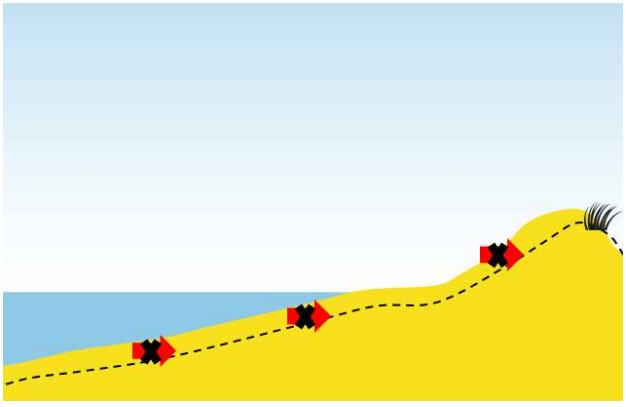


Germany (Lower Saxony), *Beach development in one transect over time at Langeoog. Arrows indicate nourishments. The red line indicates the position of the dune foot. While the beach is nourished for several times, the dune foot is shifted seawards.*

Additionally, from our labs we have indications that the stabilizing effect of beach nourishments is enhanced when combined with a shoreface nourishment. One of the reasons is most likely a relocation of the erosion hotspot from the beach towards the shoreface area after a shoreface nourishment. It however might also be possible that the shoreface nourishment feeds the beach and hence reduces erosion rates. When combining beach and shoreface nourishments, the volume of the shoreface nourishment should preferably be significantly larger than the beach nourishment. Otherwise no extra stabilizing effect of the beach is expected.

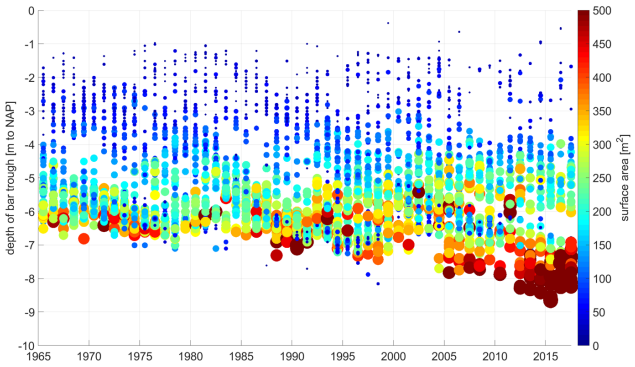
Schematic design of beach and shoreface nourishment, cross-shore

Schematic, design of shoreface nourishment plan view



Observed effect, coastal retreat due to chronical erosion is stopped or mitigated

Observed effects of nourishments:
Shoreface nourishments can influence the morphology. At coasts where breaker bars are present, placement of a shoreface nourishment can increase the depth of the trough

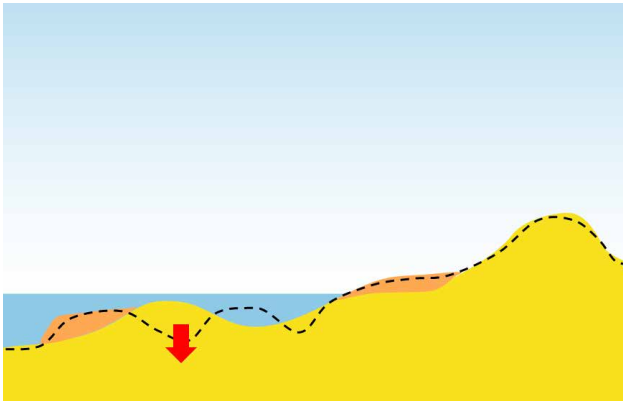


Trough depth in time and bar area (colour and size of circles) for all transects at the Bergen-Egmond lab, dashed lines indicate shoreface nourishments. Each point represents one bar in a profile. It can be clearly seen that deepest throughs are present after nourishments.

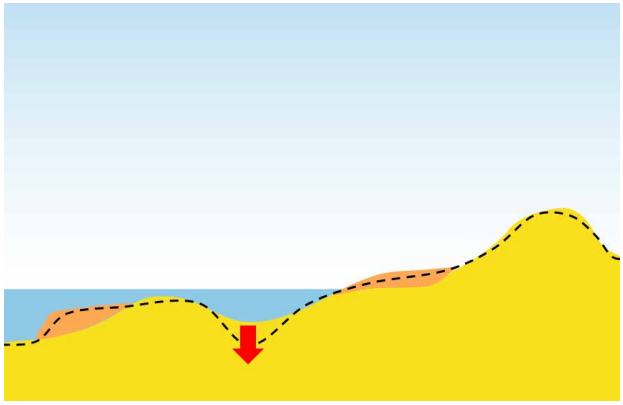
Explanation

Shoreface nourishments can influence the morphology, mainly by their effect on breaker bars. Several factors seem to influence the depth of the trough, including the total volume of the nourishment and the volume per stretch of coast.

Schematic effect



Observed effect, deeper troughs develop than in the pre Nourishment situation.
When the trough is further offshore because there are multiple breaker bars no additional sediment loss from the beach is expected.



When the trough is close to the beach additional sediment loss from the beach might occur.

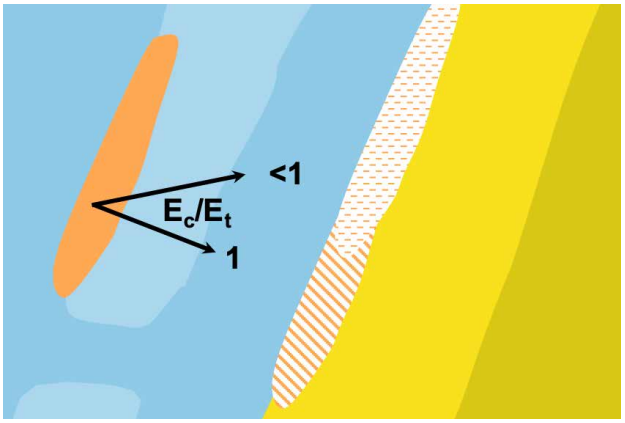
Observed factors that influence the effect of a nourishment: The location of beach stabilization due to nourishments depends on the local morpho- and hydrodynamics

Explanation

The location where shoreface nourishments have influence on morphology, sediment volume, etc. depends on the local processes, like wind, waves and tides. When cross-shore processes are dominant, effects can be expected directly behind the nourishment.

If the alongshore component becomes more important, effects will occur more oblique or parallel to the coast. (Hansen et al. 2019; Hillmann et al. 2019; Rivero et al. 2018; Vermaas et al. 2019) or the Co-Analysis Report (Wilmink et al. 2020).

Schematic effect



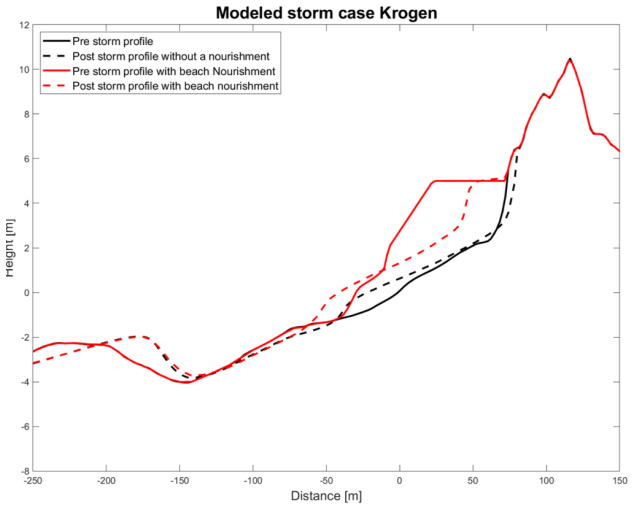
Schematic location of beach stabilization. Directly behind the nourishment when cross-shore processes are dominant. More oblique when alongshore when shore parallel processes are more important. Ec = Cross-shore energy, Et = Total energy

Waves breaking with specific angle on the beach in Denmark

Modeled effects of nourishments: Strategic placement of nourishments can cause short term reduction of duneerosion due to “design” storm surges

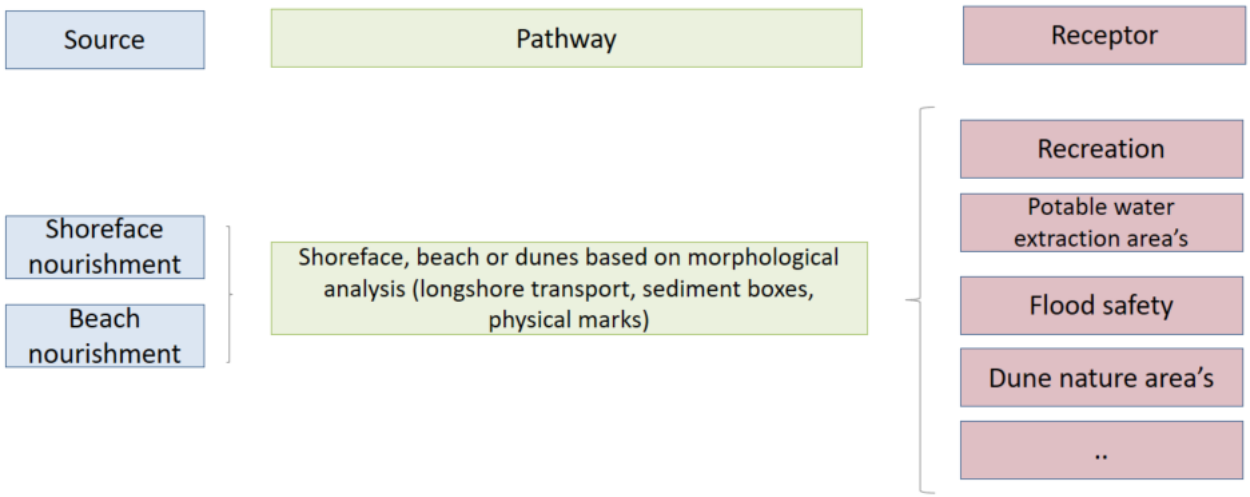
Explanation

During storm surges, severe acute erosion of dunes can happen. XBeach is a numerical model for wave propagation, long waves and mean flow, sediment transport and morphological changes of the nearshore area, beaches, dunes and back-barrier during storms, especially focusing on dune erosion during storm conditions. Using this model several scenarios were made to assess how (for each selected lab) the Source Pathway and Receptor for water and sediment can be influenced in such a way that benefits for society or the ecosystem (receptors) can be achieved (Hillmann et. al. 2021).

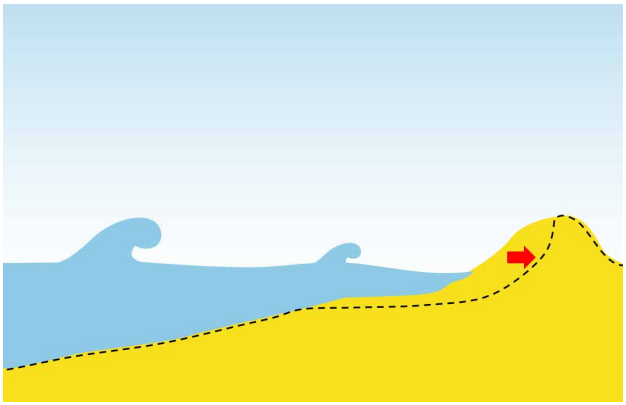


Modeled storm erosion on Krogen. The scenario “without a nourishment” and “with beach nourishment” show the influence of the nourishment in dune erosion.

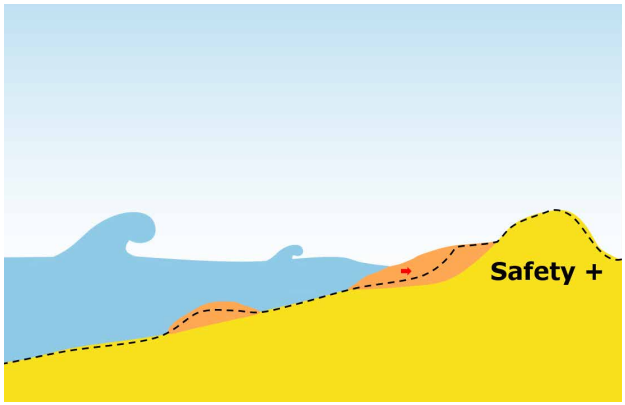
SPR flowchart Sediment



Schematic effect



Effect of beach/dune erosion during storm conditions



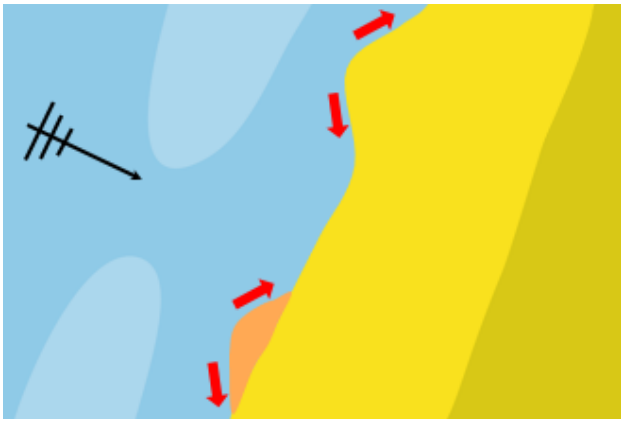
Effect of a shoreface/beach nourishment during storm conditions

Observed factors that influence the effect of a nourishment: Higher exposure of a stretch of coast can lead to larger erosion rates at that location. This also applies for (beach) nourishments

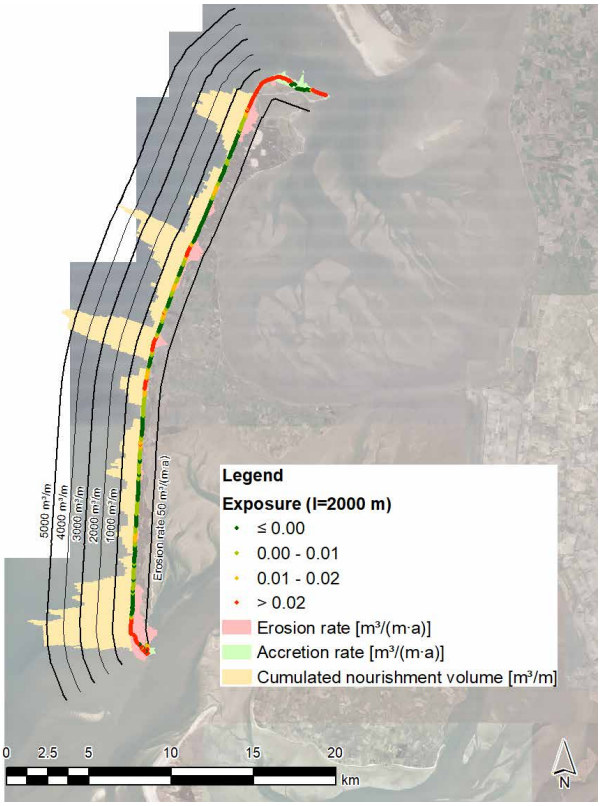
Explanation

Where other influencing factors are similar, there is a clear correlation between exposure and erosion. I.e. the sea would like to flatten the coastline. To maintain exposed sites (if that is the policy) an increased effort needs to be made compared to adjacent less exposed sites, e.g. a higher amount (higher number and larger volume) of nourishments, needs to be placed. The adjacent less exposed sites benefit directly from the nourishments in the exposed sites.

Schematic effect



Erosion tends to flatten the coastline by increased erosion of exposed areas



Exposure (l = 2000 m, mid dune level) for Sylt in comparison with the cumulated nourishment volumes (1971 - 2019) and mean erosion rates (1984 - 2019)

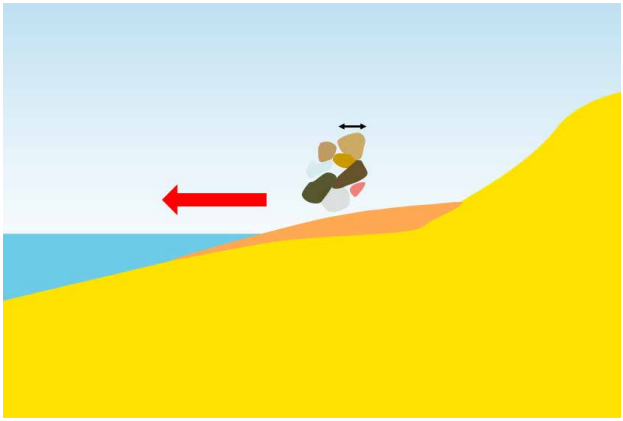
Observed factors that influence the effect of a nourishment: The grainsize of the nourished sediment influences its stability

Pictures of sand sampling on Langeoog 2017

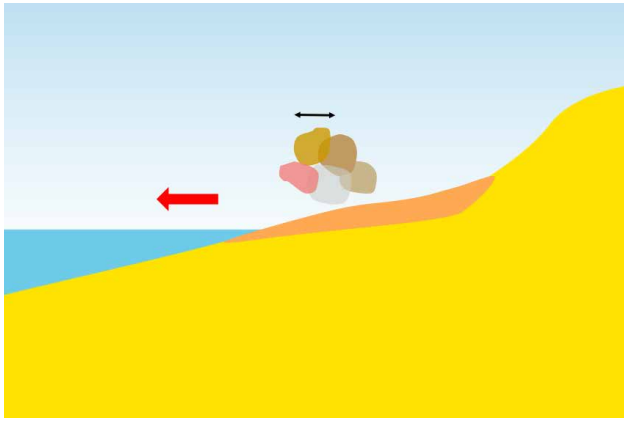
Explanation

The (median) grain size can influence the lifetime of a nourishment: a larger grain size may result in a longer lifetime. Grain size is known from literature to have other effects as well, including affecting the steepness of the coastal profile. However, structural changes in grainsize might have effects on beach habitats.

Schematic effect



Smaller sediment grainsize tends to erode quickly



Larger sediment grainsize can result in a steeper slope