

Mitigation of the ecological effects of nourishment on sandy shores, a case study

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GENERAL INTRODUCTION

Nourishment is the principal option for shore protection in countries like the Netherlands and the United States and is increasingly employed in other countries (Nordstrom 2005). Since only a few years, nourishment projects are not just designed to fill eroded coastal areas, but also to meet wishes from recreation and nature conservation.

In literature more attention is paid on physical aspects of fill material placed on beach and foreshore than on the ecological aspects. However, studies on the ecological effects of borrow and fill activities are increasing in numbers and scope (Nordstrom 2005). Site specific knowledge on the functioning of the sandy shore ecosystem, and on the cumulative and long-term effects of nourishment and other human activities is still very poor. Nevertheless, based on environmental impact assessments recently nourishment practises are mitigated to minimize ecological effects.

The Dutch coastline along the southeast part of the North Sea is about 350 km long. The coast consists of straight sandy beaches and various large-scale tidal inlet coasts. Large stretches of the coast have dunes that prevent the low lying hinterland (which at many places is below sea level) from being regularly flooded. Where dunes are lacking, sea dikes have been constructed as a flood protection measure.

In the Netherlands, as in many other European countries there is an ongoing loss of habitat due to a combination of flood risk management and sea level rise. Coastal erosion is a common feature along the Dutch sandy shorelines. In order to stop any further structural recession of the coastline, in 1990 the Dutch Government adopted the national policy of Dynamic Preservation. The *strategic* objective of this policy is: a sustainable safety level and sustainable preservation of values and functions in the coastal area. This objective was translated into the *tactical* objective to maintain the coast line at its 1990 position.

NATURE CONSERVATION

Large parts of the sea, the beach and the dunes have been designated as protected areas of natural beauty. All areas that are protected under the Birds and Habitats Directives form an ecological network known as Natura 2000. The main purpose of this network is to maintain or restore the habitats and species at a favorable conservation status in their natural range. Several nourishment activities are sometimes performed in so called Special Protection Area's (SPA's) and Special Areas of Conservation (SAC's). SPA's are high level protected sites classified in agreement with the Birds Directive. The species which are involved are listed in Annex I of the Birds Directive and additional regularly occurring migratory species. SAC's are protected sites assigned under the Habitats Directive. The habitat types and species concerned are listed in the Annexes I and II of the Habitats Directive. The list concerns habitat types and species that are considered to be most in need of conservation at the European level.

Birds under special protection are for example breeding birds on the dry beaches, like the Kentish Plover (*Charadrius alexandrinus*) and that need the beach or fore shore for resting and foraging, like the Sanderling (*Calidris alba*) and the Common Scoter (*Melanitta nigra*).

For all the protected birds, habitats and other relevant species favourable reference conditions, actual status and objectives are described. This is done both in quantitative parameters, like number of breeding birds on the beach or the range of mudflats and sand flats in km², and in quality parameters which are characteristic for the abiotic and biotic structure of the habitat type concerned. For instance the quality of the protected habitat 'Sandbanks which are slightly covered by sea water all the time (the fore shore and surf zone)' is characterised by the presence of benthic species like bivalves, and the presence of epibenthic like Common Whelk (*Buccinum undatum*) and fish species like the Thornback Ray (*Raja clavata*) and Small Sandeel

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(*Ammodytes Thobianus*). For the protected habitat 'Mudflats and sandflats not covered by seawater at low tide (the intertidal beach) however, no quality parameters have yet been set.

Although there is a legal basis for the protection of parts of the sandy shore ecosystem, the actual transmutation into conservation measurements for the beach and surf zone ecosystem is still very poor, mainly due to lack of ecological knowledge. Favourable reference conditions, actual status and objectives are still poorly described.

Any flood protecting management plan or other project likely to cause a significant effect on a European site must be considered against requirements of the Bird and Habitat Directive and a appropriate Environmental Impact Assessment must be made.

Where flood management works like nourishments are to be permitted in spite of a negative assessment of the implications for a European site, any compensatory measures necessary to protect the overall coherence of Natura 2000 must be secured before undertaking works.

ECOLOGICAL EFFECTS

First of all, it must be stated that nourishment over the last decades has stopped the coastline from further retreating, erosion and nourishment seems to be in balance. One can expect that some terrestrial coastal habitats, like Embryonic Dunes benefit from this. There is also a positive effect on the habitat Grey Dunes. In the past two decades large amounts of sand were sprayed by the wind from the nourished beaches into the dunes. The amount of this aeolian transport is comparable to 25% of the total amount of sand that was nourished in that period (Arens & Janssen 2009). This freshly transported sand is beneficial to coastal dune succession. On a large temporal and spatial scale nourishments contribute to the conditions of the formation of coastal habitats. It could therefore be seen as mitigation measurement for the loss of terrestrial coastal habitat as a consequence of the policy of fixing the position of the coastline against the background of sea level rise.

Repeated sand nourishment with aberrant sediment composition compared to the originally sand present, may alter environmental condition over time. No information on this phenomenon, however, is available yet for the Dutch coast.

Several authors have described ecological effects of nourishments on a smaller temporal and spatial scale which can be valued as undesirable. These are mainly effects on the scale of individuals (e.g. disturbing breeding birds), of populations and less on communities (e.g. burying benthic communities). A good overview is given by Speybroek *et al* (2006).

MITIGATION / COMPENSATION

The Commission of the European Communities defined 'mitigation' as measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects. The European EIA Directive has mitigation of project impacts as one of its main aims (Wood 2002), and it is required that Environmental Impact Statements (EISs) include details of proposed mitigation measures. There are many different types of mitigation measures, which may be classified in terms of levels of mitigation, the project phase at which mitigation occurs, or as part of a hierarchy (DETR 1997). The concept of 'levels of mitigation' refers to decisions made during project design to mitigate impacts, and includes alternative locations (such as foreshore, beach or dune nourishment) or processes, physical design methods (such as rain bowing or dumping), and management measures.

If a significant adverse effect remains after mitigation, or if no mitigation is possible, one should look for alternatives. When no reasonable alternatives can be found and the project is of great importance (which is almost always the case when coastal erosion is concerned), the project can only take place when the damaged nature is compensated in advance. A new comparable nature area must be developed. Compensation usually takes place at a different location, where as mitigation is usually done at the same time and place.

Until today, no compensation for nourishment projects has been carried out in the Netherlands since no EIA has stated that significant effects will occur from nourishment projects.

Only recently mitigation measures are taken with respect to the effects of nourishments in the Netherlands (ANCLN 2010). The adverse effects are described, followed by the mitigation measure:

Disturbing nesting birds on the beach. Monitoring on nesting sites before the nourishment project starts. If there are sites of coastal breeding birds (e.g. Kentish Plover, Ringed Plover, The Little Tern *Sternula albifrons*) activities concerning nourishment are not allowed within a radius of 250 m. As alternative, nourishment may be started before the breeding season.

Destroying embryonic dunes by covering it with sand. Dragging pipelines and driving with heavy vehicles should be done with care of the embryonic dunes. Embryonic dunes are normally not expected at erosive beach sites where nourishment is carried out. However, a lot of beach activities accompany the nourishment activity in the areas on either side. These embryonic dunes are also very vulnerable to mechanical beach cleaning and other recreation related activities.

Disturbing resting seals. Ships carrying the nourishment sand to the dumping site should stay away at a clear distance from the resting areas (van Duin *et al.* 2007).

Disturbing Red-throated Loon (Gavia stellata) and Common Scoter (Melanitta nigra). Ships are not allowed to disturb large populations of these foraging or resting birds. Shipping and dumping should not be done within a 1500 m. range of large populations of Common Scoter.

Covering benthic populations. Carrying out large nourishment in two time steps and two locations gives the possibility to partial survival of the population and gives opportunity of remigration from the unaffected areas to the nourished sites next year. Covering population of the benthic polychaete *Scolecopsis squamata* on the tidal beach will influence also the foraging potential of the Sanderling (*Calidris alba*). Alternatively, the foraging period of the Sanderling (December – February) and the period in which the main prey species *Scolecopsis squamata* has its larval settlement (September – October) could be avoided.

Covering dense populations of bivalves (e.g. Cut Trough Shell Spisula subtruncata or the Atlantic Jackknife Clam Ensis Americanus), which are important food source for the Common Scoter and Eider Duck (Somateria mollissima). Monitoring the proposed nourishment site on the presence of these shells. If important populations of these bivalves are present, these sites should be avoided.

Covering benthic populations in the trough between the sandbars within the surf zone. Nourishment of the trough is to be avoided. Nourishment in the foreshore should take place at the seaward side of the outer breaker bar. The trough between the two breaker bars is a potential area of high biodiversity. The high abundance of the Sand Mason (*Lanice conchilega*) creates a habitat for other (epi)benthic and demersal organisms and is therefore an important area within the surf zone (Janssen *et al.* 2008).

Deviating sediment composition and beach slope. This aspect of mitigation is still in development. Sediment composition of the nourishment sand should be more or less similar to the composition on the dumping site. Since the composition of the sediment from the extraction site is never completely comparable to the dumping site the question is raised to what extent a

deviation is acceptable. The same holds for the beach slope. Slope of the (inter tidal) beach is changed due to nourishment, with consequences for the surface of the intertidal area. The relation between the beach index BI (McLachlan & Dorvlo 2005) and marine species richness may be used to set the limits of deviation from the before situation in slope and sediment composition. To avoid a significant effect on the species richness, a deviation of less than 5% of the original species richness could be said to be acceptable. The deviation from the original BI and its components can then be calculated. Many problems are still to be solved: the change in sediment composition and slope will be temporally, some or total recovery will take place in time. This should be taken into consideration in setting the standard. This may lead to some standard of deviation over time from the original situation.

References

- ANCLN, 2010. Authorization Nature Conservation Law Natura2000 Ameland. Deen, R.J. Provincie Fryslân 00871365, 1-39.
- Arens B & Janssen G.M., 2009. Kustverdediging, suppleties en natuur. Vakblad Natuur, Bos en Landschap 6(2009)5, 18-19.
- DETR, 1997. *Mitigation measures in environmental statements.* Department of Environment, Transport and the Regions, London, 64 p.
- Duin C.F. van Gotjé W., Jaspers C.J. & Kreft M., 2007. MER Winning suppletiezand Noordzee 2008 t/m 2012. Grontmij 13/99080995/cd, revisie D1.
- Janssen G.M., Kleef H., Mulder S. & Tydeman P., 2008. A Pilot assessment of the depth related distribution of macrofauna in the surf zone along the Dutch coast and its implications for coastal management. *Mar. Ecol.*, 29(suppl. 1), 186-194.
- McLachlan A. & Dorvlo A., 2005. Global patterns in sandy beach macrofauna communities. *J. Coast. Res.*, 21, 674-687.
- Nordstrom, 2005. Beach nourishment and coastal habitats: research needs to improve compatibility. *Restoration Ecology*, 13(1), 215-222.
- Speybroeck J., Bonte D., Courtens W., Gheschiere T., Grootaert P., Maelfait J.P., Mathys M., Provoost S. Sabbe K., Stienen E.W.M., Van Lancker V., Vincx M. & Degraer S., 2006. Beach nourishment: An ecologically sound coastal defence alternative? A review. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 16, 419-435.
- Wood C.M., 2002. *Environmental Impact Assessment: a Comparative Review.* Prentice Hall, Harlow (405 p.) (Second, completely revised, edition).