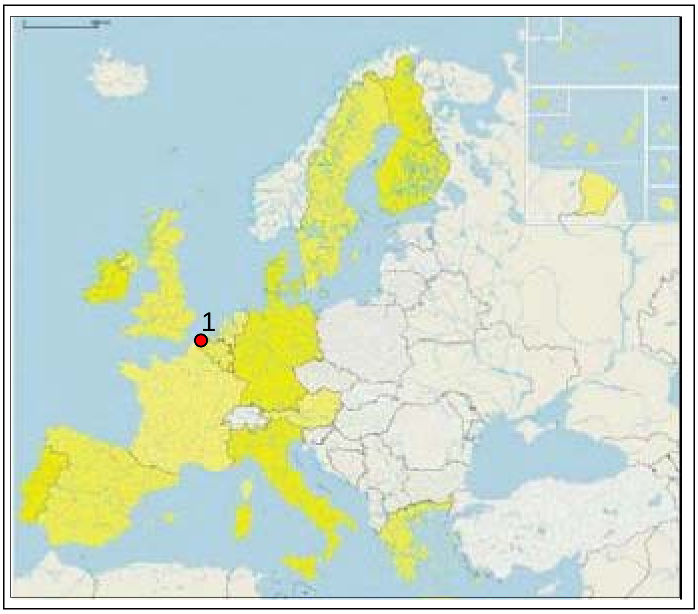
DE HAAN
(BELGIUM)



Contact:

B. MALHERBE

HAECON -Harbour and Engineering Consultants

Belgium

Tel: +32-(0)9 216-6363

1. GENERAL DESCRIPTION OF THE AREA

1.1 Physical process level

1.1.1 Classification

Fig. 1: Location of the case area.

The case area De Haan is located in Belgium (see Figure 1). The coast of Belgium is about 65 km long and forms part of the sandy and rectilinear Southern North Sea coastline that stretches from Cap Blanc Nez (north of France) in the west to the Schelde estuary (the Netherlands) in the east.

The Belgian coast is a macro-tidal coast with sandy beaches and the coastal classification conform the scooping study is:
3a. Tide-dominated sediment. Plains.
Barrier dune coasts

The coastal zone of this type of coast comprises three main units: a very gently sloping and fine sandy beach, a dune ridge and a coastal plain. In Belgium, from west to east the beach slope tends to increase, the grain size distinctly increases and the width of the beach distinctly decreases.

1.1.2 Geology

A few thousand years before Christ the coastal plain of Belgium existed of flats cut of from sea by a very long dune ridge. Transgressions and regressions of the flats have influenced the development of the coast greatly. After the Dunkerquian transgressions, the building of dikes prevented further flooding of the flats. The coastal flats were reclaimed as land and the present coastal zone was developed.

The mean grain size diameter of sand on the Belgian continental shelf ranges from 0,150 mm to 0,300 mm.

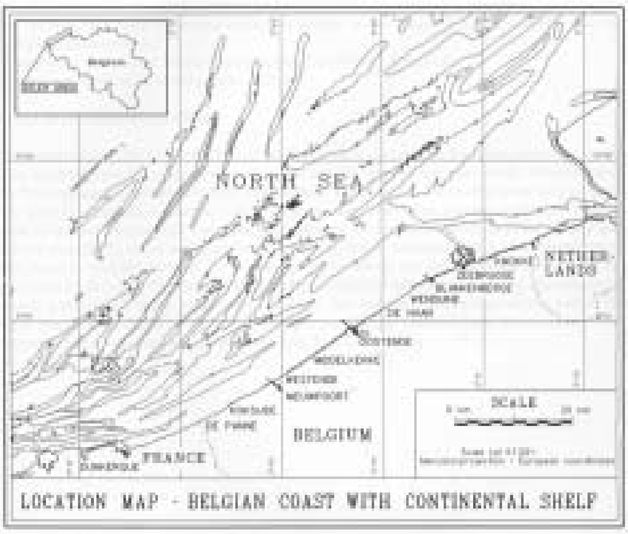


Fig. 2: Overview of Belgian Coast.

1.1.3 Morphology

The morphology of the Belgian North Sea coast is characterized by large sand banks alternating with shoals and tidal flats along the coastline. Parallel to the Belgium coast, the long-stretched Flemish Banks are located in the North Sea. The dunes are 60 to 600 m wide in most parts, only at the Dutch and French border the dunes are 2 - 3 km wide.

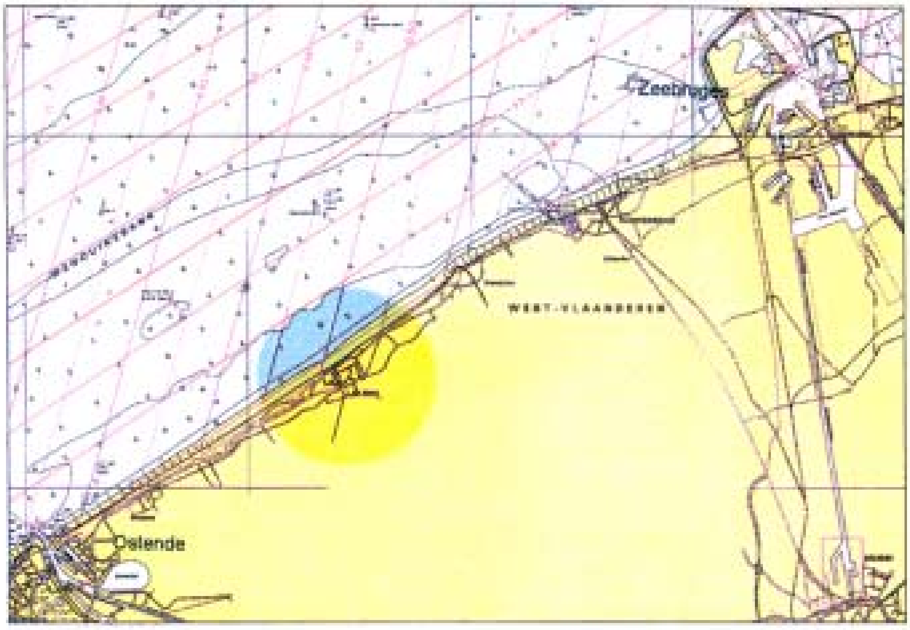


Fig. 3: Case area De Haan.

1.1.4 Physical processes

Tide

The tide is bidiurnal with a small asymmetry. Tidal range is typically between 3,5 m and 5 m. This important tidal range is linked to quite significant tidal currents, which exceeds generally 1,5 knots in the nearshore areas.

Waves

Because of the shallow seas and the short fetch, waves are typically short crested at the Belgian coast.

Current

The gulf stream passes the Belgium coast in a northern direction. This causes a net long shore current in northern direction along the entire Belgium coast.

Storm events

Storm events can cause major erosion of the sandy Belgium coast. On the long run, the beach will recover from this erosion however. This type of erosion is a problem when there are permanent structures in the dynamic cross-shore profile of the beach.

Wind

Wind set-up can generate water elevation at the coast of more than 2 m.

1.1.5 Erosion

Structural erosion

Along the entire Flemish East coast persistent regression of the coastline forms an acute threat. Due to the combination of wave-induced on- and offshore transport with the longshore tidal drift, structural erosion of the Flemish East coast occurs. Net long shore transport is predominantly in northeasterly direction.

Acute erosion

As was described before severe erosion occurs due to storm surges at De Haan. Unlike other parts of the Belgian coast, at De Haan very limited protection from wave attack is provided by shallow coastal sandbanks. A study showed that the major coast erosion mechanism at De Haan is caused by intense cross-shore redistribution of sand in a ridge and runnel beach system. During storms, the sand accumulates in the LW-bar; during calmer weather periods, the sand is remobilised and transported in the onshore direction.

1.2 Socio-economic aspects

1.2.1 Population rate

The population in De Haan counts about 11.500 persons on an area of about 4200 ha (=42 km^2). This results in a population rate of approximately 270 persons/km^2.

1.2.2 Major functions of the coastal zone

- **Tourism and recreation:** De Haan is an important recreational and tourist centre of Belgium, a lot of hotels, restaurants and other recreational facilities are present. De Haan attracts Belgian and foreign visitors.

- **Nature conservation:** There is large nature reserve called “De Kijkuit” at De Haan.

- **Urbanisation (safety of people and investments)**

Fig. 4: Site De Haan during performing of works.

1.2.3 Land use

The coastal area at De Haan is mainly a built up area. The built up area mainly serves a recreational function. Furthermore, the nature area “De Kijkuit”, an untouched dune area, is located at De Haan.

1.2.4 Assessment of capital at risk

Because of the development of tourism, the coastal area has become densely populated and densely built in Belgium. According to Bryant [1995], the entire Belgium coast is at high risk because of the dense population, infrastructure and buildings in the coastal area.

High risk: city or major port or > 150 persons/km2 or >150 m road/km2 or > 10 m pipeline/km2

Moderate risk: 150 < persons/km2 > 75 and 150 < m road/km2 > 100 and 10 < m pipeline/km2 > 0

Low risk: persons/km2 < 75 and m road/km2 < 100 and no pipelines

For De Haan, considering the before mentioned population rate of 270 persons/km2 in the interest area, the risk should definitely be considered as high.

2. PROBLEM DESCRIPTION

2.1 Eroding sites

Surveys of the coastal zone in De Haan indicated a severe regression of the overall beach/dune profile over the last 20 years and particularly after the February 1990 storm a severe regression of the coast was observed. The beach had almost disappeared in the vicinity of De Haan and threats of flood became very real; even the sloped seawall foundation was eroded. Erosion at De Haan occurs mainly after repeated storm surges and is enhanced by high water levels.

2.2 Impacts

De Haan is an important seaside resort in Belgium. The beach is therefore of great importance for the function tourism in this area. Erosion of the beach can threaten the tourist and recreational function.

Furthermore, the function of urbanisation (safety of people and investments) was at risk because of the erosion. The beaches, partly built to stabilise the dune belt, and the sloped seawall are a part of the coastal protection system and were threatened by the occurring erosion.

3. SOLUTIONS/MEASURES

3.1 Policy options

No further retreat of the coastline can be allowed in the coast sections where safety against inundation must be guaranteed by dunes. The policy option is hold the line at these sections (also at De Haan).

3.2 Strategy

Historically and especially in the 20th century, hard constructions were built to hold the coastline at its existing position and to protect the infrastructures and polders against flood. In the early 1930's a sloped seawall was constructed at De Haan in order to stabilise the dune belt and to allow for touristic expansion. The fixed seawall made natural movements of the dune/beach system clearly visible.

After the 1990 storm attack, the foundation of the seawall was put into jeopardy. In order to restore the coastal protection system and thereby the tourist beach, an original concept of works has been engineered and executed in 1991, which combines profile beach nourishment with a subtidal feeder berm. The decision to choose this system was based upon economical, technical and ecological considerations.

In general, the Coastal Defense Strategy in Flanders aims a permanent intervention to repair, each retreat of the coastline in the beach-dune areas. Priorities are given according to urgency plans. This strategy is translated into design criteria for beach nourishment in the following way:

The existing dune-foot must remain stable after two consecutive storms with a return period of 100 years.

If the same sequence of storms hits a section of the coast where a seawall exists, the beach nourishment must prevent the seawall from being exposed to direct wave attack by the first following storm.

3.3 Technical measures

3.3.1 Type

Seawall

The sloped seawall at De Haan was constructed in the early 1930's in order to stabilise the dune belt. The seawall still functions as part of the coastal protection system against flooding, mainly in combination with the coastal dunes.

Combination of feeder berm with beach nourishment

Early in 1991 a feeder berm was put in place for the first time in Europe. Mid 1992 a profile nourishment was carried out to restore the beach profile between the dike and the feeder berm recently built-up.

3.3.2 Technical details

Combination of feeder berm with beach nourishment
The longshore feeder berm has a length of about 2,200 m and is located at 600 m from the shoreline on the seaside of the low water bar. About 600,000 m^3 of sand was dumped at the proper site with a split hopper dredger. For the profile nourishment 800,000 m^3 of sand was pumped onshore through a sunken line of approximately 1500 m long. The works were carried out with self-unloading trailer suction hopper dredgers, discharge pipe + booster station and bulldozers.

- Details feeder berm:

Crest height	H – 1 m
Width	40 m
Fill density	245 m^3/m^1
Grain size	min. 180 µm (good grading)
Length	2150 m

- Details profile nourishment:

Sloped beach replenishment (between H + 7,5 m and H 0 m) with a 40 m bench at H + 7,5 m (beach).
Wind protection screens applied

Fill density	470 m^3/m^1
Grain size	min. 220 µm (good grading)
Length	1,400 m

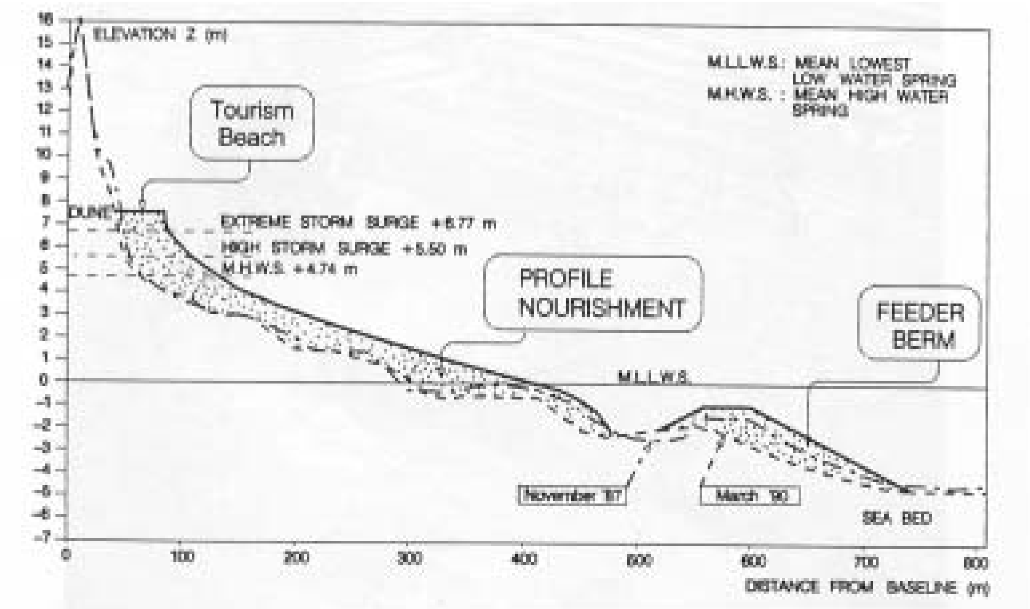


Fig. 5: Typical cross section of feeder berm with profile nourishment at De Haan.

3.3.3 Costs

No information was found on the costs of the feeder berm and nourishment combination.

Fig. 6: Profile nourishment at De Haan.

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

Once the works were finished in 1992, an extended monitoring programme was started to control the effectiveness of the new coastal protection system. During one year, the feeder berm acted on its own as coastal protection. Within this period, no significant losses of sand were registered and a progressive natural nourishment of the intertidal beach up to H + 1,5 m could be observed: accumulation occurred essentially on the seaface of the bars. Some lateral spreading of the feeder berm's sand equally to the West and East was observed. At the site of the sunken pipeline some erosion was observed.

One year after the commissioning of the profile nourishment (June 1993), the situation can be described as follows:

-The losses of sand from the beach at De Haan are at yearly basis about 8 %.
-The feeder berm was lowered to H –1,5 m but the seaside slope was unchanged, the profile nourishment was modified by the appearance of ridges and runnels and by further seaward spreading of the sand.
-The wind screens seemed to be particularly effective for the fixation of Aeolian sands.
-Erosion seems to be concentrated on the two extremities of the working area (edge-effects) and at the location of the sunken pipeline.
-Seasonal effects are clearly identified with net erosion in winter and accretion in spring; erosion seems to be governed essentially by storm surge level (incl. wind set-up) and wave action.

The residual erosion at De Haan site was observed to be approx. 50 m^3/m^1 in the first year. To the west and east and outside the working area, the residual erosion was 110 m^3/m^1 to 140 m^3/m^1 in the first year. Because of the feeder berm, the nourishment has to be repeated at a much lower frequency than with normal nourishment.

4.2 Effects related to socio-economic aspects

The taken measures have created a wide beach at De Haan (function tourism and recreation). Furthermore the wide beaches and thereby the protection of the seawall assure the safety of the people and investments in the hinterland of the coast.

4.3 Effects in neighbouring regions

The combination of feeder berm with beach nourishment does not have great effect in neighbouring regions. Some spreading of the nourishment sand occurs towards the east and the west.

4.4 Relation with ICZM

Only 20% of the dune area is managed as a nature reserve. A major problem for the conservation of natural values in the coastal zone is the fact that most of the remaining dune areas are still private property. In 1995 an "ecosysteemvisie" (dune ecosystem perspective) was needed to "correct" human activities. The perspective will be used for consulation between nature conservation and the different economic and utilitarian sectors that are active : coastal protection, water production, recreation and tourism. The ecosystem perspective presents target landscape types *(nearly natural units, multifunctional units, semi-natural units and controlled natural units)* and target habitat types *(EU Habitats directive)*.

In the past dunes were stabilised by placing fences and planting marram grass. Also marine erosion was prevented by building dykes in front of the dune belt. Fore dunes are now allowed to follow natural dynamics again with maintenance of the present shoreline. The main task is to restore herbaceous habitats. Therefore scrub has been removed followed by grazing with horse and cattle (pattern - oriented management). Also part of restoration is spontaneous woodland development by removal of exotic tree-species and grazing by donkeys (process - oriented management). By diminishing the extraction of groundwater and drainage in the polders, and allowing some sand drift a natural dune fringe landscape with calcareous marshland and wet meadows is expected to develop.

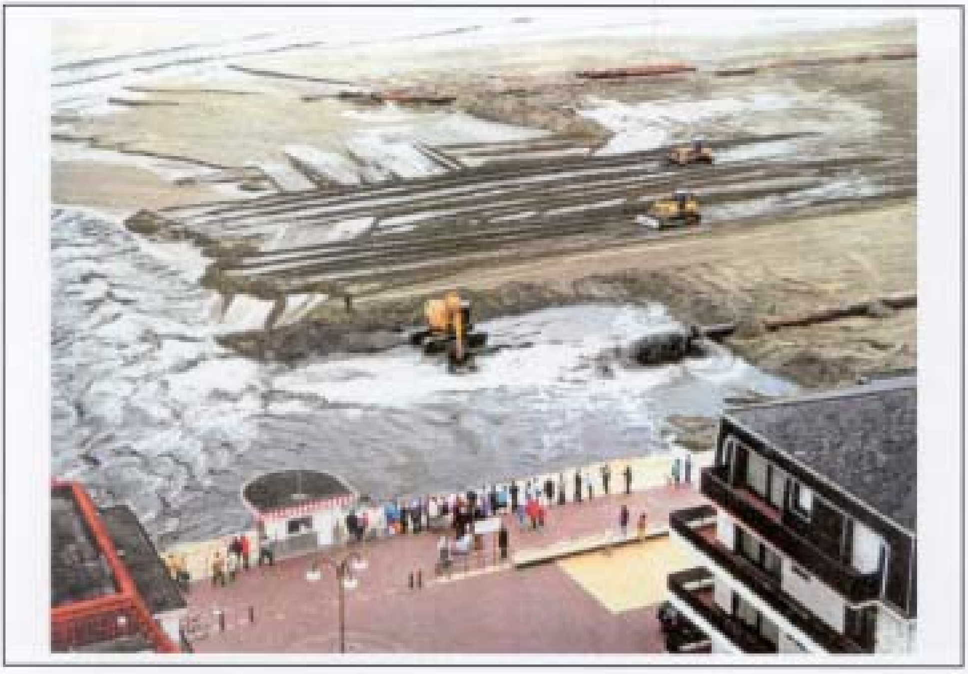


Fig. 7: Beach profiling works at De Haan.

4.5 Conclusions

Effectiveness

Compared to classic beach nourishment, the behaviour of the profile nourishment combined with feeder berm appears to be better. The combined feeder berm/ profile nourishment coastal protection system proves to be an economic and technically feasible alternative to the now already classic beach replenishment procedure. The feeder berm is a quite stable structure, even after a three year period. The profile nourishment however suffers from storm erosion with an annual value during the observation period of approx. 8-10 % of the beach fill density. The sand losses are mainly redistributed to the East and the West of the working area.

Referring to the experiences in other countries and to this successful realisation, the trend to build coastal protection works with sand along the Belgian coast has now become a common work procedure. Instead of trying to maintain existing situations with rigid structures, working in harmony with the natural forces appears to be a more adequate and effective way of achieving coastal protection. This requires however a good knowledge of the coastal processes, a better evaluation of the risks and the adaptation of the design and construction methods.

Flanders is preparing a coastal management plan (Kust 2002 Plan) to fully integrate the coastal protection strategy with other developments in the coastal zone.

Possible undesirable effects

No undesirable effects of the feeder berm combined with nourishment were experienced.

Gaps in information

No information was found on the costs of the measures taken at De Haan.

5. REFERENCES

Bird, E.C.F.; Schwartz, M.L. (1985). *The world's coastline*. Van Nostrand Reinhold Company Inc., ISBN 0-442-21116-3.

De Meyer, C.P.; Charlier, R.H. (HAECON) (1993). *New developments on coastal protection along Belgian Coast*, International Coastal Zone Proc. Hilton Head Island, S.C., USA, June '93.

Helewaut, M.; Malherbe, B. (HAECON) (1993). *Design and execution of beach nourishmnents in Belgium*, 8th Symposium on coastal and ocean management New Orleans, Louisiana, USA, July '93.

Malherbe, B.; Lahousse, B. (HAECON) (1998). *Building coastal protection with sand in Belgium*, International Coastal Symposium ICS '98 Palm Beach Florida, USA, 19-23 May 1998.

Warnier, F.; Raes, E.; Malherbe, B.; Lahousse, B. (HAECON) (1994). *Execution aspects and monitoring of a new beach nourishment concept at De Haan: combined feeder*, ICCE '94, 23-28 October, Kobe, Japan.

Internet:

http://www.coastalguide.org/dune/flemish.html
http://navier.rug.ac.be/public/hydraulica/suppletie00.htm
http://users.pandora.be/dirk.viaene/kust.htm

Figures:

Figure 1: http://www.icm.noaa.gov/country/belgium.html
Figure 2: HAECON, New developments on coastal protection along Belgian Coast
Figure 3: Protection cotiere en region flamande
Figure 4: Project information sheet HEACON, coastal protection works at De Haan
Figure 5: HAECON, Design and execution of beach nourishmnents in Belgium
Figure 6: Protection cotiere en region flamande
Figure 7: Project information sheet HEACON, coastal protection works at De Haan