

Coastline management in The Netherlands: human use versus natural dynamics

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Abstract. The boundary between land and sea in The Netherlands changes continuously. Every kilometre of the present position of the Dutch sandy coastline is the result of the interface between natural dynamics initiated by the sea and man-made action on land.

Before 1990, each year ca. 20 ha of dunes disappeared through coastal retreat. In 1990 the Dutch government decided to stop any further long-term coastal recession and chose for 'dynamic preservation', which primarily aims at ensuring safety against flooding and sustainable preservation of the values and interests attached to the dunes and beaches.

Five years later, a first review of the benefits and bottlenecks of the new coastal defence policy could be presented. The overall conclusion is that the 1990-choice for dynamic preservation was right. The considerable losses of dunes and beaches do not occur any longer. Sand nourishment is an effective method of coastline maintenance, which also serves the functions of the beach and dune area for human society.

However, serious erosion of the deeper part of the shore-face threatens the coastline of the 21st century. Nearly a doubling of the nourishment volume is necessary to prevent a renewed landward shift of the coastline. An anticipated accelerated sea level rise (ca. 60 cm/century) will increase the sand losses by another 25 %.

Plans are being finalized for large-scale land reclamation in front of the coastline as an answer to growing spatial problems on land. In other plans polders, now safely protected by sea dikes, will be returned to the sea in order to restore ecologically valuable salt marshes and mud flats.

The position of the coastline will continue to change in the coming decades. Besides natural dynamics, human use of the coastal zone will certainly affect this process: measures to maintain the coastline at its 1990 position need to be seen in perspective: the coastline as a part of the coastal zone.

Keywords: Beach nourishment; Dune; Dynamic preservation; Erosion; Policy; Salt marsh.

Dynamic preservation of the Dutch coastline

The boundary zone between land and sea in The Netherlands is the most dynamic area in the country. Society interacts with the sea in its 'claims' on the coastline, the form of which is shaped by the forces of nature but also by technological developments.

The hinterland of The Netherlands, comprising ca. 55 % of the country's area, is to a large part situated below mean sea level with the deepest points at almost - 7 m. Nevertheless, the country is considered safe from flooding by storm surges. Eight million people (ca. 60 % of the population) are living in this polder land. Ca. 65 % of the National Gross Product is earned here and the estimated value of capital investment here is 2500 billion USD.

The coastline of The Netherlands is ca. 350 km long. Ca. 290 km consists of dunes and beach flats; while the remaining 60 km is protected by dikes, dams and storm surge barriers. The beaches and shore-face, in fact the 'foundation' of the Dutch coastal zone, almost completely consist of sand. More than half of the coastline is subject to coastal erosion. The remaining part is stable or advancing.

The Dutch coast can be divided into three sections, which can be called Delta coast, Holland coast and Wadden coast (de Ruig & Hillen 1997). See Fig. 1:

In the Delta area in the Southwest, the coastal zone is dominated by dams, storm surge barriers and drainage sluices, closing off the tidal inlets (technical constructions resulting from the 'Delta plan').

Behind the central part of the coastline, comprising the uninterrupted coastline of the provinces South Holland and North Holland, about half of the National Gross Product is earned. The sea defence measures guarantee that a storm surge level can be withstood - which has a probability of only 1/10 000 a year.

In the Wadden area in the North, the Wadden islands suffer from a significant loss of sand to the Wadden Sea; beach flats, occurring at the extreme ends of the islands, are very dynamic in character.

Until 1990 coastal defence was directed towards maintaining the defensive structure of the coastline against the sea, and solving only the most acute erosion problems. This should be seen against the background of large losses in the past. In the course of time, entire settlements have disappeared. Particularly in the 17th and 18th centuries, coastal retreat occurred at many places, for instance in North Holland (Fig. 2). In the late 1980s it was generally understood that all functions of the coastal area for human society are affected by long-term (structural) coastal erosion. Therefore a new national coastal

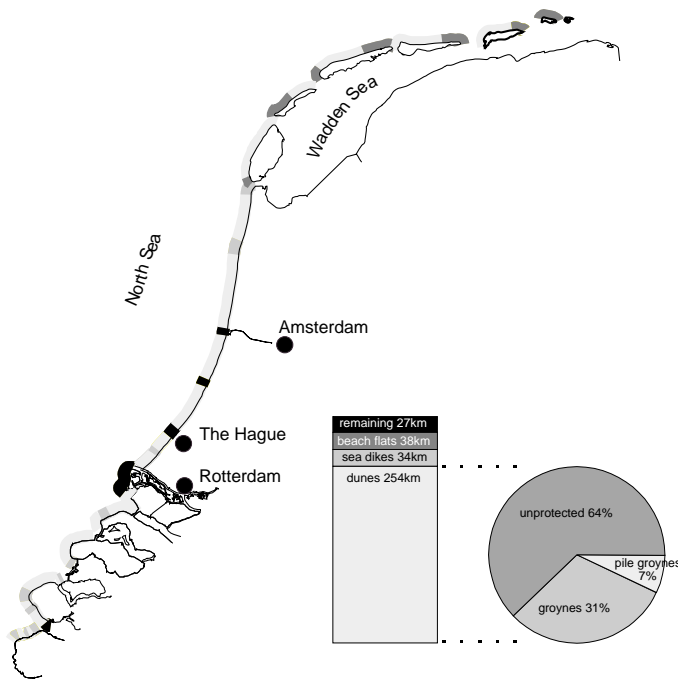


Fig. 1. The coast of The Netherlands, subdivided into the southwestern Delta region, the uninterrupted Holland coast and the Wadden tidal flat coast.

defence policy was developed which involved more than safety alone (Hillen & de Haan 1993). In 1990 the Dutch government decided to stop further coastal retreat. The choice for this ‘preservation’ alternative implied that the coastline will at least be maintained at its 1990 position: all erosion will be counteracted. This policy is primarily aimed at combining safety against floods with sustainable preservation of the values of the dunes and on the beaches. The coastline will be maintained within certain margins, in order to preserve part of the natural dynamics of the coastal zone. The chosen alternative was specified and called ‘dy-

namic preservation’ (Anon. 1990).

The most important aspect of ‘dynamic preservation’ is that the seaward boundary of The Netherlands is maintained at its 1990 position, thereby creating a prerequisite for other forms of human use of the coastal area, such as housing, recreation, drinking water supply and nature conservation. The main method to counteract long-term erosion is beach nourishment, i.e. sand supply to the beach. In this way impoverished coastal sections can be supported in a flexible way, preserving the natural dynamics to a large extent (Hillen & Roelse 1995).

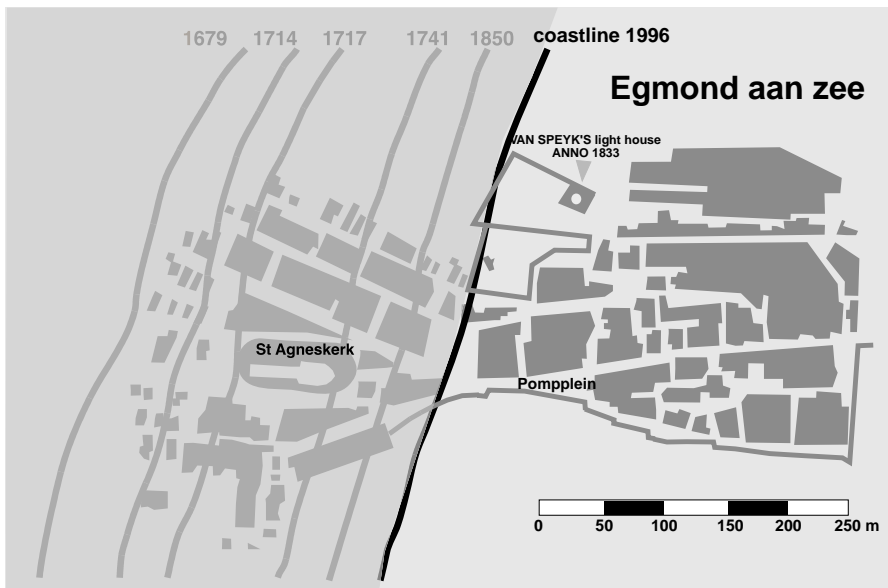


Fig. 2. Reconstruction map showing the impact of coastal erosion on the original village of Egmond aan Zee, province of North Holland. Parcels of land and homes were lost to the sea regularly.

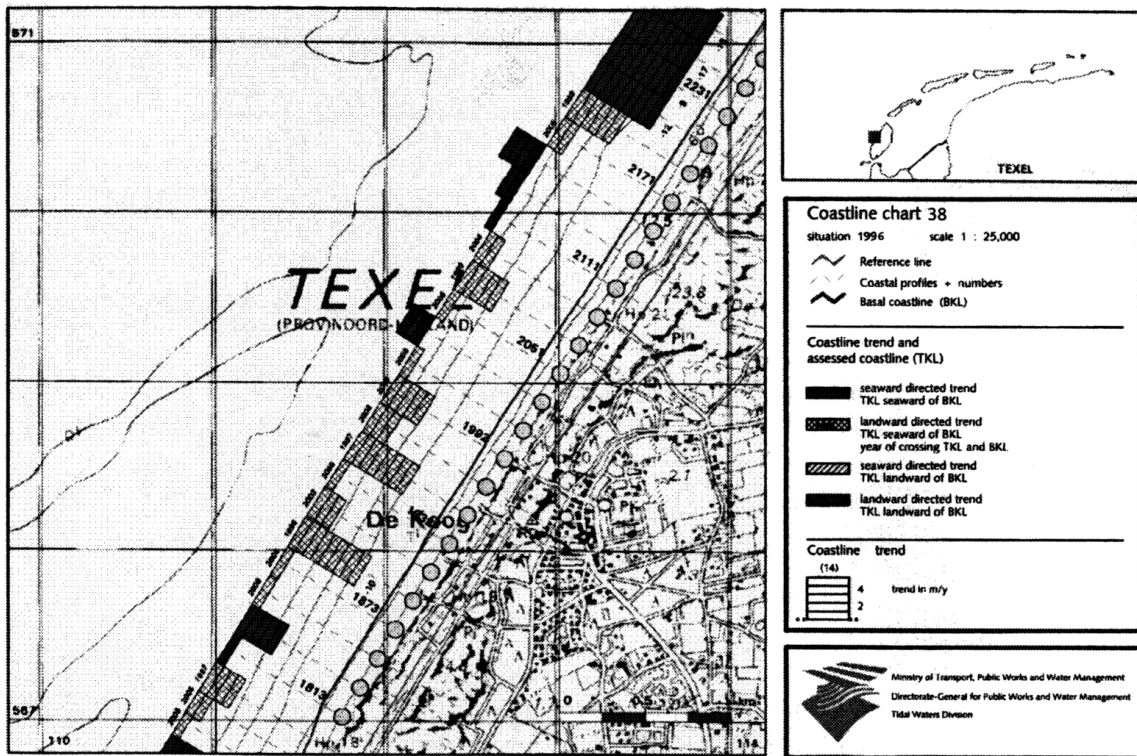


Fig. 3. Example of a coastline map of a part of the Wadden island of Texel. The map presents the results of the assessment on January 1st, 1996 (the original is in colour).

For the implementation of ‘dynamic preservation’ the concept of ‘basic coastline’ has been developed. The basic coastline is in fact the 1990 coastline to be preserved; it has been calculated for the entire Dutch coastline. Each year, the actual location of the coastline is recorded at intervals of 250 m and then compared with the location of the basic coastline. The results of the yearly assessments are presented on the ‘coastline maps’ (Fig. 3). The maps allow a rapid insight into the changes of the coastline position (the trend) for each section of the coast (van Heuvel & Hillen 1994). The comparison is used to determine if and where it is necessary to build up the beach. Sand is deposited in places where it has been washed away. Monitoring, coastal studies and beach nourishment cost roughly 60 million NLG per year.

The second policy memorandum on the coast, entitled ‘Kustbalans 1995’ (‘Coastal balance 1995’; Anon. 1996), was presented in April 1996. This governmental document evaluated the dynamic preservation policy and found it to be successful. In general, sand nourishment is an effective method of coastline preservation, which also serves other uses of the beach and dune area (Fig. 4). Sand nourishment can be planned in a flexible manner on the most urgent places and moments, diminishing the costs of maintenance of groines and sea-defending dunes and dikes (Hillen & Roelse 1995;

de Ruig & Hillen 1997). The sea serves as an ally of man: Its bottom delivers the millions of m³ sand used to compensate for coastal erosion initiated by its waves and currents. The cost per m³ of sand, including dredging and nourishment is about 5 USD.

The ‘perfect’ coastline position

Long term landward shift of the coastline now belongs to the past. However, concern about coastal defence will never end, since large parts of the coast are still liable to erosion and sea level will continue to rise.

On the other hand, schemes have been drawn up for large-scale coastal intervention. For instance, lost ecological values by large infrastructural works might be compensated by returning land to the sea, allowing gradient-rich tidal zones to develop. Attention has also been given to plans to extend the coastline seaward: the coastal zone can act as a source of space for needs such as housing, industry and recreation.

As expected, the coastline position will continue to change in the coming decades. In fact, the equilibrium between the interests of socio-economic development and the maintenance of a natural, dynamic system determines the ‘perfect’ coastline position.

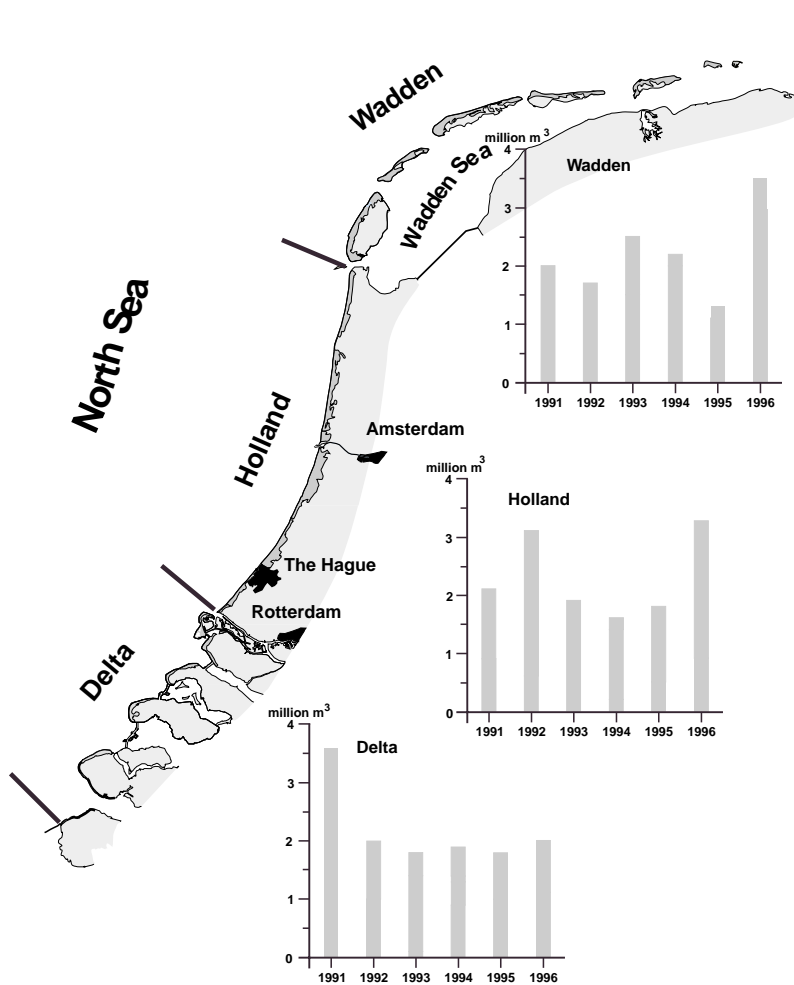


Fig. 4. Sand nourishment volumes along The Netherlands coast between 1991 and 1996.

Sand losses in deeper waters

Analyses of long-term measurements revealed serious erosion of the low-lying parts of the shore-face (more than 6 to 8 m below sea level). The slope of the Holland coast seems to steepen (Fig. 5): sand from the deeper zone is transported to the shallow zone and, above all, to the Wadden Sea. Moreover, the natural supply of sand from the bottom of the North Sea to the coastal zone is limited: less than 3 million m³/year. In the long run this could have serious consequences for the 'foundation' of The Netherlands which is slowly but steadily being undermined.

In the region of the Wadden islands the coast loses sand to the Wadden Sea, ca. 5 to 6 million m³/yr. This refers especially to the ebb tidal deltas. In the Delta area in the southwest part of the country, sand is deposited in front of the closure dams in the former estuaries. As a result of the shifting of tidal channels towards the coast, about 40 km of beaches are subject to erosion (de Ruig 1995).

To compensate for the total sand losses in the coastal zone, including deeper waters (–12 to –6 m MSL) and the ebb tidal deltas, a sand nourishment volume of about 11 million m³/yr is necessary. This is almost twice the present quantity. As a consequence, the government has already decided to raise the 'dynamic preservation' budget by the year 2000.

Land reclamation

An increasing number of plans for land reclamation along the coast have been, and are being developed as an answer to the growing need for space. However, these plans are not always necessary from a coastal defence point-of-view. They rather will provide space for housing, industry, recreation, infrastructure and/or disposal sites for dredged material. In particular in the Rijnmond area, west of Rotterdam, a series of developments (including large land reclamation projects) is being investigated (Fig. 6).

(Natural) coastal accretion has build up wide beaches and vast stretches of sand (beach flats) on the Wadden Islands in the north of The Netherlands. Because these areas have a considerable value concerning nature and landscape, they will be left undisturbed. Here, natural dynamics rule the position of the coastline without interference of civil engineers.

The wide stretch of sand south of the breakwaters of IJmuiden along the Holland coast will meet a different future. This expanse of sand has been assigned a recreational function. A yacht harbour and tourism amenities have already been developed (See Waterman et al. 1998; this issue).

Over the past few years, most attention has been devoted to plans regarding the seaward extension of the coastline by deliberately increasing the land surface. One such proposal is the reclamation of new land seaward of the 15-km long coastal stretch between The Hague and Hook of Holland. The idea of incorporating the seascape into the landscape was first proposed over 20 yr ago. The present plan has become appealing in light of the growing need for space to develop housing in the densely populated 'Randstad Holland' ('Rim-city' including Rotterdam, The Hague, Amsterdam and Utrecht) and the concomitant desire to leave the relatively open area in-between these cities, the 'Green Heart of Holland' open. This area is valuable from a landscape- and environmental point-of-view and deserves to remain more or less intact. An offshore reclamation project might lower the pressure on the Green Heart.

The extension of the already existing Maasvlakte, near Rotterdam harbour is another option. The demand for space, particularly for large industrial plants, is bigger than the Rotterdam harbour area can provide. At present, a feasibility study is under way, accompanied by a discussion on the need for, and use of, a seaward expansion of the Maasvlakte. Some negative effects of the new land reclamation are conceivable: water movement, change in the transport of sand and mud, and a possible degradation of the natural dynamics within the present dune area. These effects have to be weighed against the benefits of having more space. Currently, the government policy for the Rotterdam harbour area pursues two aims. One is to reinforce the economy; the other is to improve the environment (nature and recreation).

Plans for land reclamation could be best considered in an integrated way by the authorities concerned with land use planning. They should always be judged in a broader perspective, i.e. the long-term effects on the total coastal system should be taken into account. The coastal zone is not a dumping place for spatial problems on land; land reclamation plans should lead to an overall increase of the quality of the coastal zone.

The extra costs for maintaining the coastline, both at

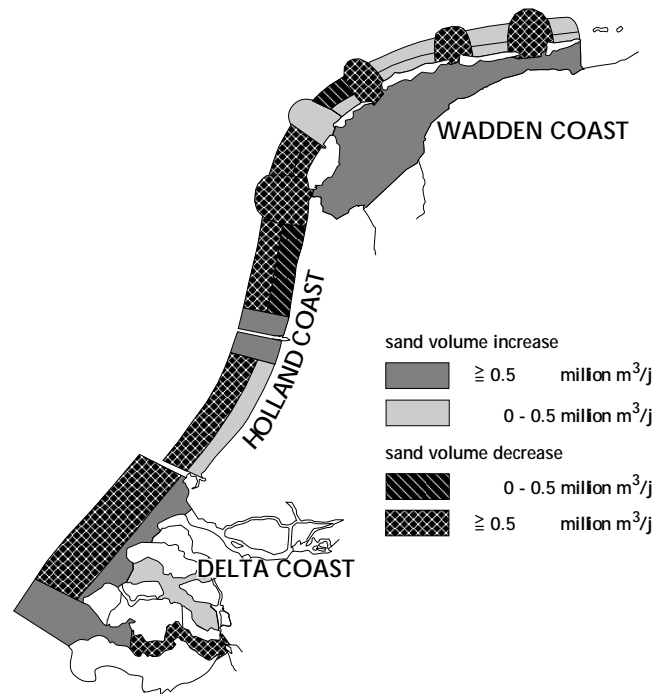


Fig. 5. The sand budget of the Dutch coast (1965-1992); sand nourishment has been excluded (Anon. 1996). Deeper waters: - 12 to - 6 m MSL (mean sea level); shallow coastal zone: - 6 m MSL to top of foredune.

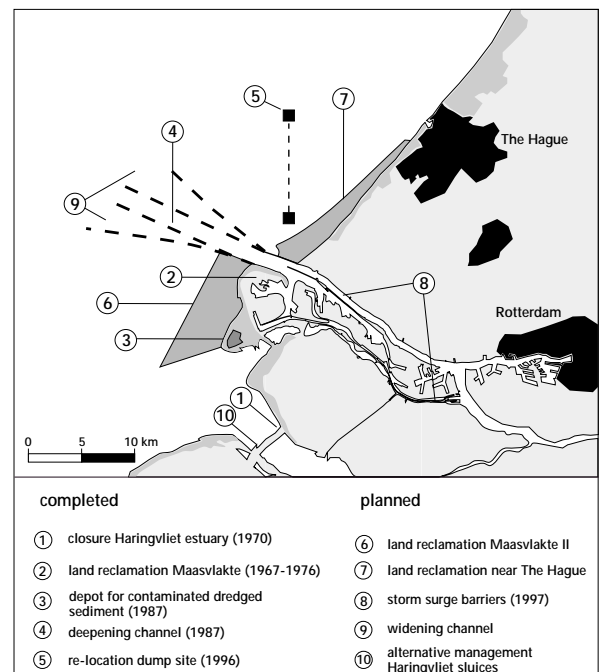


Fig. 6. Actual and potential projects and plans within the Rotterdam harbour region. These projects will have effects on the coastline position and the entire Dutch coastal zone. Middle tone grey indicates dunes.

Nature Development Hedwige polder

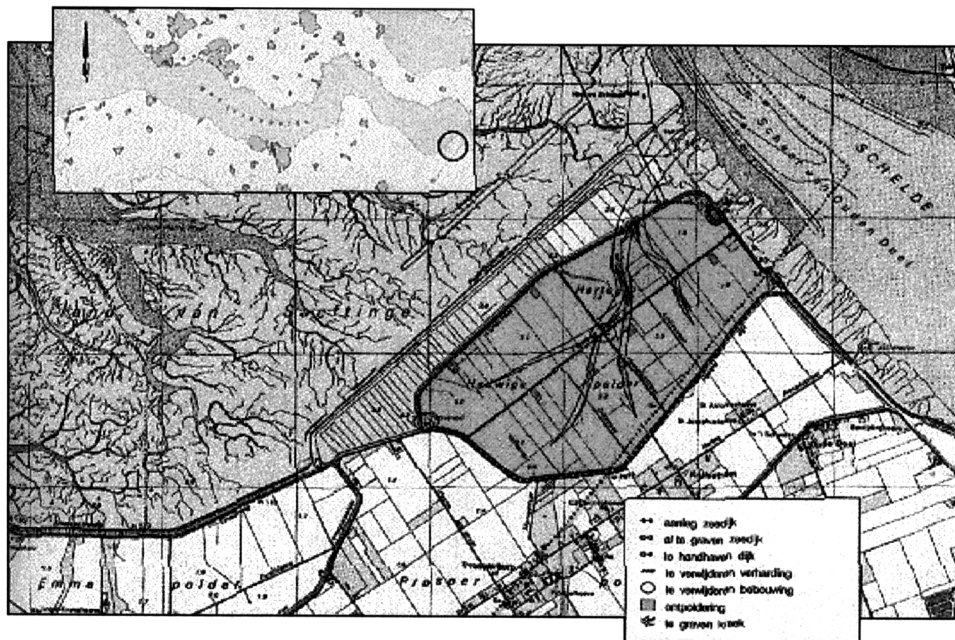


Fig. 7. Nature development plan in order to restore ecological damage by dredging of the shipping channel of the Westerschelde (Western Scheldt) estuary. Example of a selected ‘depoldering’ (= ontpoldering) area: Hedwige polder (320 ha) near the Belgium border (Anon. 1996b).

the reclaimed site and the neighbouring coastal sections, should be part of the land reclamation project. The project plan should also foresee in compensation of natural values and the reduced resilience of the existing coastal system.

‘Sea reclamation’ or ‘depoldering’

The Dutch do not stick to one coastline philosophy. Besides the ‘dynamic preservation’ strategy, there is room for land *and* sea reclamation. In this last option, polders, now protected by dikes, will be opened to the estuaries and Wadden Sea in order to restore ecologically valuable salt marshes and mud flats. An additional effect of this ‘depoldering’ is the increase in the buffering capacity during storm surges; thus this decreases the risk of flooding.

We will now have a closer look at the Westerschelde case. The Netherlands have agreed to cooperate in the effort to deepen the shipping channel of the Westerschelde, which is the seaway to the Belgium port of Antwerp. The dredging work will devastate valuable natural areas along the estuary such as salt marshes and mud flats. Being aware of this effect, the Dutch government has approved the plan to deepen the channel on the condition that compensation will be made for the ecological damage. Such compensation could entail abandoning several polders and returning land to the sea (Fig. 7).

From an environmental perspective, this decision

would be both logical and desirable. However, there are not only ecological motives at stake, but also emotional factors. The struggle against the water is deeply embedded in Dutch history and culture. Land reclamation and accretion are essential to that heritage. Surrendering land to the sea is not part of that legacy. It is not surprising that the idea of relinquishing the polders incites strong opposition from the local people.

The coastline as part of the coastal zone

The combined effort of the overall ‘dynamic preservation’ policy and local land and sea reclamation will determine the future position of the coastline. The question is whether we can anticipate this process by defining a perfect coastline position. Therefore, measures to maintain the coastline need to be seen in perspective: the coastline as a part of the coastal zone.

In The Netherlands, where formal physical planning as such has been in existence for more than a century, coastal zone management has never been defined as a separate issue. It has matured through gradual harmonization and coordination of administrative and legislative frameworks.

Since the beginning of the 19th century, coastal management has been restricted to water management, shipping and protection against flooding. This included

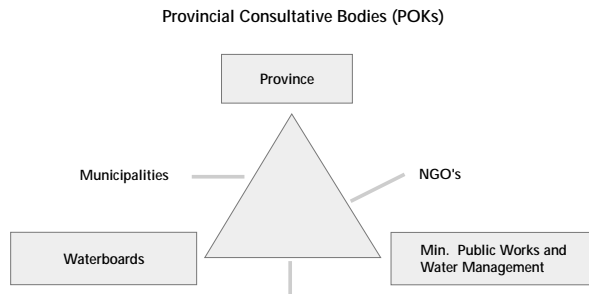


Fig. 8. Cooperation between coastal partners within the Provincial consultative bodies.

the building of sea walls, dikes, sluices, harbour moles, shipping channels, and the execution of coastal protection works such as jetties, breakwaters and artificial dunes.

After World War II new challenges arose, such as finding solutions for increased pollution, the need for deeper channels for seagoing vessels, increasing decline of habitats and resources, and large scale coastal erosion. The answer to these challenges was: step-by-step building up of an 'integrated water management system', including all functions, values and needs. Important elements of this system are flood protection and coastal protection (Misdorp & Terwindt 1994).

The 'dynamic preservation' policy offers opportunities for a more integrated management approach in the coastal zone as implied by Agenda 21 (Anon. 1992; Bijlsma et al. 1993; Misdorp & Terwindt 1997). Essential elements are a multisectoral and multidisciplinary approach and input from national, provincial and local authorities, academic institutes, coastal engineering consultancies and non-governmental stakeholders. Since 1990, in all coastal provinces so-called Provincial Consultative Bodies (in Dutch POKs) deal with all matters relevant to coastal protection and the preservation of the coast (Hillen & de Haan 1993). Members of the POKs are representatives of the central government (Ministry of Transport, Public Works and Water Management), provincial authorities, waterboards, and representatives of coastal municipalities and nature conservation organisations (Fig. 8).

Laws for flood protection and national policy documents on water management and physical planning give guidelines about land- and water use in The Netherlands at different levels of planning: national, subnational-regional and local planning. The tasks of the POKs are set in the Water Defence Act. The central government is responsible for counteracting long-term erosion. The waterboards have the task maintaining the strength of the sea defences (dunes and dikes) and the provinces are in charge of the overall coordination and physical plan-

ning policy. At the local level, the municipalities, although supervised by the provinces and national government, have a substantial influence over area development.

A close cooperation between the POK-members is needed. In fact, all relevant partners in the coastal zone should be involved, to achieve a proper integrated management. For this purpose, other partners and representatives of social interests need to participate in the POKs. This may involve a broadening of the POKs by other governmental and non-governmental organisations. This introduces possibilities for integrated coastal zone management instead of coastline management, and for more ecological, social and economic management issues instead of technical aspects only.

At present, certain zones in the dunes are set aside for coastal defence purposes or reserved for drinking water supply. Other zones have nature conservation or recreation as a main function. For the coming years a more integrated and therefore a more efficient (less scattered) management of the dune area, aimed at larger management units will be stimulated. Regional pilot projects seem to offer the best possibilities to realize integrated management in the coastal zone. The initiatives will be taken by the provinces in close cooperation with the local authorities and regional representatives of the central government. An important step in this process is the coordination of administrative and legal instruments (Fig. 9).

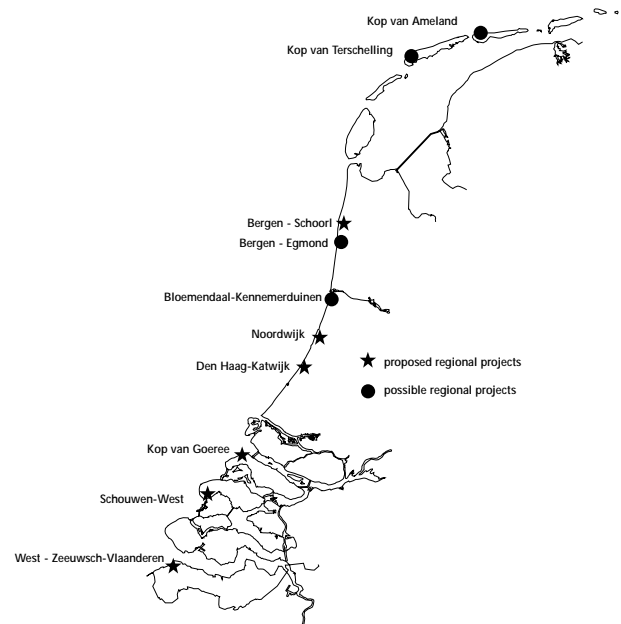


Fig. 9. Regional integrated management pilot projects in the coastal zone as suggested in the second governmental coastal report.

Conclusions

The position of the coastline is in a delicate balance between the pressure of land-based human use and sea-initiated natural dynamics. Both parts tend to extend in the narrow coastal zone, albeit in opposite directions. Even if the Dutch authorities have agreed upon the maintenance of the basic coastline, schemes have been developed for large-scale coastal interventions.

The most important aspect of the 1990 'dynamic preservation' policy is that the seaward boundary of The Netherlands is maintained at a more or less fixed position, thereby creating a prerequisite for other functions of the natural environment of the coastal area, notably urban development, recreation, drinking water supply and nature conservation. This policy has been successful. It also requires a vision on coastal development. The questions "What makes our coastal zone so valuable?" and "What are the weaknesses of the present coastal zone?" are essential in order to give direction to this vision.

The value of the present Dutch coastal zone has four components: space, safety against flooding, nature and economy. They should be harmonized in order to reach sustainable development. This results in the following elements of an integrated vision on coastline management:

- the coastal zone offers opportunities for a further development; however, the coastal zone is not a dumping place for spatial problems on land; land reclamation plans should lead to an overall increase of the quality of the coastal zone;
- the safety against flooding of the mainland must be guaranteed; the extra costs for maintaining the coastline, both at the reclaimed site and the neighbouring coastal sections, should be part of the land reclamation project;
- high-quality ecosystems such as the Wadden Sea will be preserved; losses of natural values will be compensated; on the other hand, 'smart plans' will give opportunities to increase the ecological and morphological resilience of the coastal system;
- plans for land reclamation could best be considered in an integrated way, aiming at an equilibrium between the interests of socio-economic development and the maintenance of a natural, dynamic system with a natural resilience to adjust to future developments such as sea level rise; this requires close cooperation between authorities concerned with water management and land use planning.

Plans for land reclamation could best be considered in an integrated way by the authorities concerned with land use planning. They should always be judged in a broader perspective, i.e. the long-term effects on the total coastal system should be taken into account.

The relationship between the Dutch and the sea is entering a new era. In fact, the Dutch rediscovered the possibilities given by the coastal system in helping them to create new land and to defend their country against flooding. The challenge for the next century is to find the balance between man-made engineering and natural self-organization.

References

- Anon. 1990. *A new coastal defence policy for the Netherlands*. Ministry of Transport and Public Works, The Hague.
- Anon. 1992. *Agenda 21, Chapter 17: Protection of the oceans, seas and coastal areas and the protection, use and development of their living resources*. UNCED, Rio de Janeiro.
- Anon. 1996a. *Balancing the coast 1995*. Ministry of Transport and Public Works, The Hague. (In Dutch.)
- Anon. 1996b. *Compensating Nature Westerschelde*. Report 682/CE96/1036/11953, Bestuurlijk Overleg Westerschelde (BOW). Heidemij advies, Resource Analysis and Rijkswaterstaat, National Institute for Coastal and Marine Management/RIKZ, Middelburg. (In Dutch.)
- Bijlsma, L., Hillen, R. & Misdorp, R. 1993. Changing coastal zones; chances for sustainable development. *Proceedings of the Coastal zone 1993 Conference*. New Orleans, LA.
- de Ruig, J.H.M. 1995. *The coast in perspective*. Report RIKZ/95-005, Rijkswaterstaat, National Institute for Coastal and Marine Management/RIKZ, The Hague. (In Dutch.)
- de Ruig, J.H.M. & Hillen, R. 1997. Developments in Dutch coastline management: Conclusions from the second governmental coastal report. *J. Coastal Conserv.* 3: 203-210.
- Hillen, R. & De Haan, Tj. 1993. Development and implementation of the coastal defence policy for the Netherlands. In: Hillen, R. & Verhagen, H.J. (eds.) *Coastlines of the southern North Sea*, pp. 118-201. American Society of Civil Engineers, New York, NY.
- Hillen, R. & Roelse, P. 1995. Dynamic preservation of the coastline in the Netherlands. *J. Coast. Conserv.* 1: 17-28.
- Misdorp, R. & Terwindt, J. 1997. Coastal zone management: experiences in The Netherlands. In: *Proceedings CZM Conference*. IOC/UNESCO, Karachi.
- van Heuvel, Tj. & Hillen, R. 1994. Coastline management with GIS in the Netherlands. In: *EARSel Workshop on remote sensing and GIS for coastal zone management*, pp. 155-164. Delft.

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