Journal of Coastal Conservation 3: 203-210, 1997

REPORTS

Developments in Dutch coastline management: Conclusions from the second governmental coastal report

de Ruig, Joost H.M.[1] **& Hillen, Roeland**[2]

[1]*Rijkswaterstaat, National Institute of Coastal and Marine Management, P.O. Box 20907, 2500 EX The Hague, The Netherlands; Tel. +31 70 3114323; Fax +31 70 3114300;* [2]*Rijkswaterstaat, Head Office, P.O. Box 20906, 2500 EX The Hague, The Netherlands; Tel. +31 70 3519010; Fax +31 70 3518760*

Abstract. In 1990 the Dutch government decided to stop any further long-term landward retreat of the coastline. This policy choice for a 'dynamic preservation' is primarily aimed at safety against flooding and at sustainable preservation of the values and interests concerning the dunes and beaches. Five years later, a first overview of the benefits and bottlenecks of the new coastal defence policy could be presented, which was published in the second governmental coastal report 'Kustbalans 1995' (coastal balance 1995). This consists of three elements: (1) evaluation of the implementation of 'dynamic preservation', (2) the consequences of several natural and anthropogenic developments in the coastal zone and (3) integrated coastal zone management. The present report describes experiences of Dutch coastline management and summarizes the main conclusions of the second governmental report.

The overall conclusion of the evaluation study is that the 1990 choice for 'dynamic preservation' was right. Sand supply is an effective method of coastline maintenance, which also serves functional uses in the beach and dune area. However, nearly a doubling of the supply volume is necessary to compensate for sand losses in the coastal zone. A more integrated management of the coastal zone is necessary to find an equilibrium between the interests of socio-economic development and the maintenance of a natural, dynamic system.

Keywords: Beach nourishment; Coastal zone management; Management policy; Sand supply; The Netherlands.

Coastline management in the Netherlands

The coastal zone of The Netherlands, here defined as the area from the coastline to ca. 75 km inland, comprises ca. 55 % of the country's area. The name 'Low countries' really refers to this area which, in part, is as low as 7 m below mean sea-level. At present ca. 65 % of the National Gross Product is earned in this zone and the estimated value of capital investment here is ca. 4200 billion NLG. The coastline of The Netherlands is ca. 350 km long of which ca. 290 km is made up of dunes and beach flats, varying in width from 100 m to more than 10 km (Doing 1995). The remaining 60 km is protected by dikes, dams and storm surge barriers. More than half of the coastline is subject to coastal erosion. The remaining part is stable or advancing.

Five years after the 1953 flood disaster in the southwestern part of the country, the national parliament adopted new safety standards against floods. Three storm surge barriers in estuaries were constructed and the dikes and dunes along the North Sea were heightened to comply with these standards. The Water Defence Act, which passed parliament in December 1995, provides the legal framework for coastal defence in The Netherlands.

Until 1990 coastal defence was aimed at maintaining safe defences against the water and solving only the most acute erosion problems. In the late 1980s it was generally understood that all functional uses are affected by long-term (structural) coastal erosion. Therefore a new national coastal defence policy was developed which involved more than safety alone (Hillen & de Haan 1993). In 1990 the Dutch government decided to stop any further coastal recession. The choice for this 'preservation' alternative implies 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 and interests in the dunes and on the beaches. The coastline will be maintained within a certain margin, to preserve some of the natural dynamics of the coastal zone. The chosen alternative was specified and called 'dynamic preservation' (Anon. 1990).

The most important aspect of 'dynamic preservation' is that the seaward boundary of The Netherlands is maintained in a more or less fixed state, thereby creating a basic provision for other functional uses in the coastal area (e.g. housing, recreation, drinking water supply and nature). The main method to counteract structural erosion is 'beach nourishment', i.e. sand supply to the beach. In this way impoverished coastal sections can be supported in a flexible way (Hillen & Roelse 1995). Another aspect of dynamic preservation is the policy towards a less strict stabilization in the foredunes, thus allowing more natural dynamics (see below). The ‘dynamic preservation’ policy is not generally applicable to other countries. It is the result of specific circumstances, such as the low position relative to sea-level of The Netherlands, a coastal fringe almost completely consisting of sand and the ecological, recreational and cultural-historical importance of the Dutch dunes (e.g. van der Maarel 1979).

Five years after the policy choice a first overview of the benefits and bottlenecks could be presented in the second governmental coastal report ‘Kustbalans 1995’ (‘Balancing the coast’; Anon. 1996). The report includes three elements, which are also discussed in this paper:
(1) the evaluation of the implementation of ‘dynamic preservation’;
(2) an outline of the consequences of developments such as (accelerated) sea-level rise, land reclamation and increasing pressure for additional housing and recreation facilities in the coastal zone;
(3) steps towards implementation of integrated coastal zone management.

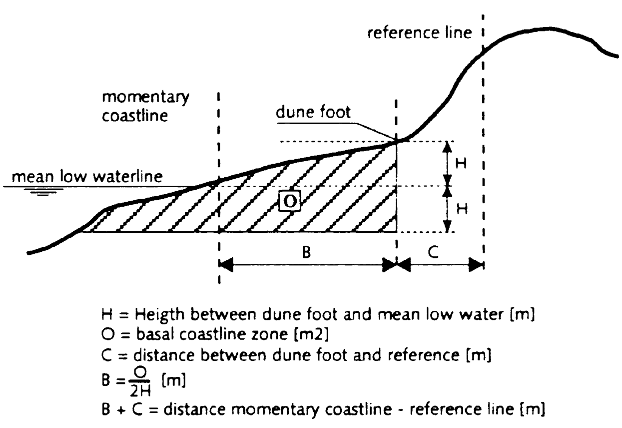
Five years of ‘dynamic preservation’: 1990-1995

Basal coastline

For the implementation of ‘dynamic preservation’ the concept of the ‘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. In fact, the 1990 position of the coastline is the result of a political choice made in that year, and thus it is a flexible coastline. Depending on the morphodynamics and the socio-economic functions of a particular coastal sector, some flexibility is used. As explained earlier (Hillen & Roelse 1995) the concept of basal coastline in practice is interpreted as referring to a specific volume of sand. Every year the actual position of the coastline (calculated from a series of recent coastal monitoring data) is compared with the basal coastline to control whether the basal coastline has not been crossed. The concept primarily aims at identifying sites with structural erosion. The effects of dune erosion from storm surges are ‘filtered out’ by using a volumetric approach for the calculation of the actual position of the coastline and by calculating both the basal and actual coastline over a period of 10 yr (Fig. 1). This implies that preservation of the basal coastline does not mean that all dune damage from storm surges will be prevented in the future (Hillen & de Haan 1993). The basal coastline is not a setback line as used in many other countries. It is rather a standard to check for long-term losses of beach and dune area.

If the actual coastline is located landward of the basal coastline, corrective action is taken. In practice this means that sand supply is provided. Since 1992 an annual assessment is performed and nourishment is planned according to this method. The results of the annual assessments are presented on so-called ‘coastline maps’. 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).

After five years of experience, the ‘basal coastline’ concept has proved its value. The signal function of the method is effective in the detection of long-term erosion. However, sand supplies also determine the main limitation to the calculations, because they make a proper trend calculation impossible in the first two years after the supply. In those cases ‘expert judgement’ is needed.



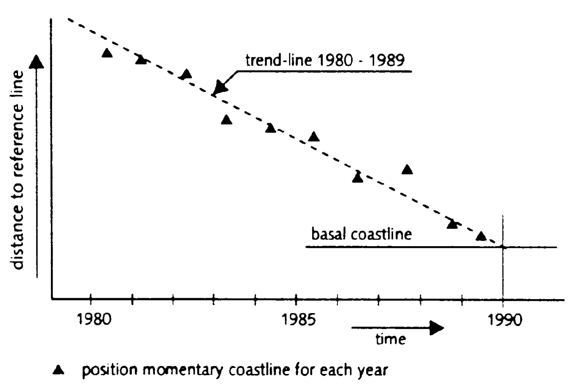


Fig. 1. Calculation of the basal coastline (left) and comparison of the position of the actual coastline with the basal coastline (right).

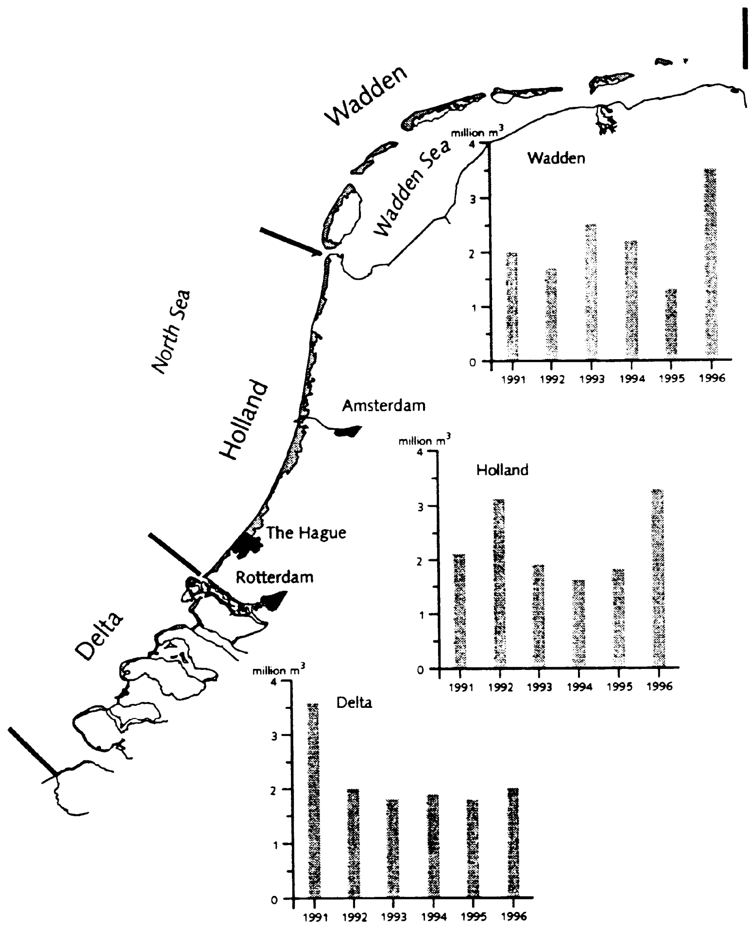


Fig. 2. Sand supply volume along the coast of The Netherlands coast between 1991 and 1995.

Sand supply

Beach and dune nourishment has been chosen in The Netherlands as the principal method to counteract long-term erosion. Since 1991, more than 6 million m^3 of sand have been added to the Dutch coast each year (Fig. 2), at a yearly cost of ca. 60 million NLG. This volume corresponds to the actual total loss of sand within the entire Dutch near-shore zone (with depths < 6 - 8 m below sea-level). An evaluation of both individual and repeated supplies shows that sand supply is an effective method of coastline preservation, which also serves other functional uses in the beach and dune area, such as recreation, nature conservation and flood protection (Fig. 3). Nourishment can be planned in a flexible manner on the most urgent places and moments, diminishing the costs of maintenance of groynes, sea defending dunes and dikes (Hillen & Roelse 1995). Along the entire Dutch coastline the negative trends in sediment losses could be stopped through successive supplies. Only in the Texel section could the autonomous sediment losses not be compensated entirely; the erosive trend of the coastline position, however, came to an end. With the help of supplies the the Walcheren section of the coastline in 1994 even reached its 1940 position.

Coastal erosion patterns on larger temporal (decades) and spatial (10 km) scales are not influenced by successive sand supplies. However, on the scale of an individual supply project, dispersion leads to additional initial sand losses. An average 20 % extra sand volume has to be added to compensate for this loss of sand. To minimize this volume, supplies should be tailored to local hydrodynamic and morphological conditions (Hillen & Roelse 1995). A further optimalization is still possible with respect to size, frequency and location (dune foot, beach or shore-face) of nourishment schemes. The possibilities for longer lasting maintenance contracts for sand supply are being investigated. Nourishment is carried out by placing sand, excavated from the bottom of the North Sea (seaward of the – 20 m depth contour), in the shallow part of the coastal zone (landward of the – 6 to – 8 m depth contour). The abundant supplies of sand on the sea bottom will allow us to continue sand supply for at least the coming centuries

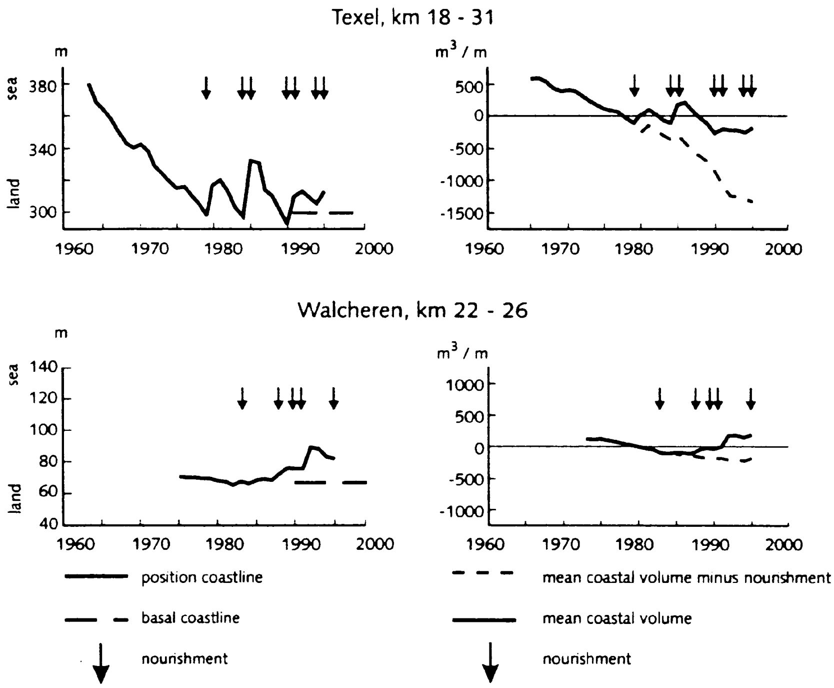


Fig. 3. Changes in sediment volume and coastline position of the coastal sections of Texel and Walcheren over the period 1963-1995. Along the entire Dutch coastline sediment losses could be stopped through successive sand supplies. Only in the Texel section could the autonomous sediment losses not be fully compensated, but the erosion trend was interrupted. By 1994 the coastline of the Walcheren section had even reached a position comparable to 1940.

(Hallie 1995). The ecological effects of individual sand supplies, both at the source area and the supply site, appear to be of minor importance (Anon. 1991; Aerts et al. 1997; van der Wal et al. 1995).

Seaward coastal defence

At first sight, for some parts of the coast, a so-called ‘seaward coastal defence strategy’ might be more profitable than repeated supplies. This applies to coastal sections characterized by a small dune ridge and attacked by severe erosion. According to the seaward coastal defence strategy, in general ’strong’ measures will be taken to influence the morphological system in such a way that erosion is prevented, resulting in a stable or even prograding coastline. Such measures include the construction of dams and groynes. Strong measures deviate from the policy of dynamic preservation. They are only applied in those cases where nourishment is regarded far from sufficient and important functions in the coastal zone are at stake. At the same time, negative effects of the construction on adjacent sectors of the coast should be minimal.

The effectiveness of a seaward coastal defence strategy has to be compared with maintenance by sand supply to the beach. The effects this will have elsewhere on the morphological system, environment and other interests must also be analysed. In order to gain more insight into these matters, feasibility studies have been executed for the most vulnerable locations. At three locations on the Wadden islands of Texel, Vlieland and Ameland strong measures (construction of a beach and perpendicular dams) were necessary, in combination with sand supply.

Seaward coastal defence constructions require considerable investments and are only economical if maintenance of the coastline is possible with limited effort. In most cases, however, repeated supply is at least as economical as a seaward construction (de Ruig 1993). An effective seaward construction assures that structural erosion will be stopped. Because the coastal fringe in The Netherlands largely consists of sand, constructions usually disturb the natural sand transport processes along the coast, which may imply a shortage of sand in neighbouring coastal sections, which in turn will diminish the overall gain. At larger temporal and spatial scales successive sand supplies are the only *structural* measure to compensate for sand deficits along the coast. Only at locations with severe erosion (for example near a coastal inlet) a construction is rewarding (de Ruig 1995).

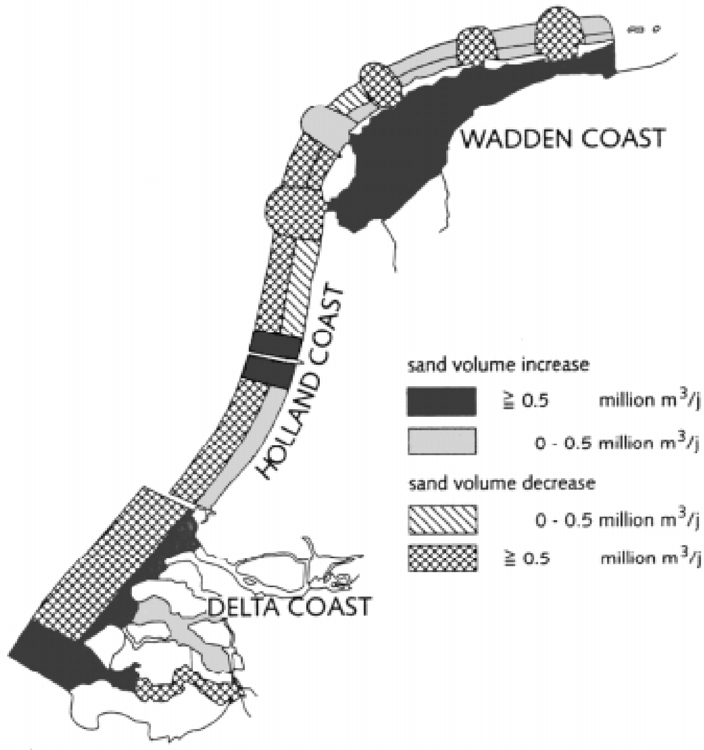


Fig. 4. The sand budget of the Dutch coast (1965-1992); sand supply has been excluded. Deeper waters: – 12 to – 6 m MSL; shallow coastal zone: – 6 m MSL to top of the foredune.

Natural dynamics

The Dutch dune coast has beautiful scenery and represents great international biotic and abiotic values (van der Maarel 1979). While covering only 1 % of the Dutch territory, ca. 2/3 of the Dutch plant communities and 3/4 of the breeding bird species are found in the coastal dunes (Janssen & Salman 1992). The natural values can even be increased through a change in management of the foredunes. Until now management has been conservative: blowouts are covered or stabilized with marram grass to prevent sand drift and small screens are placed to trap sand at the dune-foot. At several places along the coast this has resulted in a straight 'sand-dike', which only vaguely resembles a natural foredune (Hillen & Roelse 1995). In dune areas of several km width there is no need for such a strict foredune management as the position of the (basal) coastline has been guaranteed. A more flexible management will help restore the natural dynamics of the seaward dunes and create more natural gradients. Knowledge of the actual morphological and ecological processes involved is available to estimate the opportunities for nature development. However, since 1990 only a few experiments have been performed to restore natural processes in the foredune area. In the coming years these initiatives will be extended.

Long-term developments in the coastal zone

Steepening of the shore-face

Analysis of long-term annual coastal measurements reveal serious erosion of the low-lying parts of the shore-face (> 6 - 8 m below sea-level). From the sand budget of the Dutch coast (Fig. 4) it can be seen that the slope of the coast in the Holland section is becoming steeper: 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 deeper part of the coastal zone is limited: less than 3 million m^3/yr. Consequently, the coastal profile is 'steepening', i.e. the 'foundation of The Netherlands is slowly but steadily being undermined (van Rijn et al. 1995).

In the region of the Wadden islands the coast looses sand to the Wadden Sea. This refers especially to the ebb tidal deltas: each year about 5 to 6 million m^3. In the Delta area in the southwestern Netherlands, 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, many beaches are subject to erosion (de Ruig 1995). To compensate for the total sand losses in the coastal zone, including the deeper waters of the coastal zone (– 12 to – 6 m MSL) and the ebb tidal deltas, a supply volume of ca. 11 million m^3/yr is necessary. This is almost twice the present quantity. An anticipated sea-level rise of 60 cm/100 yr will increase the sand losses to about 13 million m^3/yr. By 1998, research results may indicate the best method to compensate for the sand losses in deeper water.

Plans for building activities and land reclamation

The pressure on the coastal zone is increasing. Especially the need for additional housing and recreation facilities in the dunes is growing. For decades, building initiatives in the dunes could be stopped as it reduced the safety against flooding of the low-lying polders by the sea. Since the policy choice for ‘dynamic preservation’ has been made, this is no longer a valid reason, at least not in wide dune areas.

The Dutch coast is an important recreational resource: 30 % of all holidays in The Netherlands are spent here. The beach and foredune are excellent locations for recreational activities. However, buildings in this area are at risk of damage or flooding during storm surges. With increasing housing development individual risks may turn into an unwanted public risk.

Finding an equilibrium between the interests of socio-economic development of the coastal area and the maintenance of a natural, dynamic system is perhaps one of the largest present-day challenges society has to face.

The dynamic characteristics are the strength of the coastal system, determining its resilience in adjusting to future changes as sea-level rises. Undisturbed water and sediment dynamics, combined with sand supply to compensate for sand losses, offers outstanding conditions for a development along with a rising sea-level. If the coastal system is fixed by housing and other urban developments the resilience of the coast will diminish. Human adjustments are not possible or are difficult to realize, and consequently expensive. The current awareness concerning global climate change and sea-level rise should be turned into sound investments and no-regret measures. This could be achieved through comprehensive coastal zone management and formalized within the land use planning system.

Several plans for land reclamation have been developed as an answer to the growing need for space on land. These plans are not always necessary from a coastal defence point of view. They 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 possible developments (including large land-reclamation projects) is being investigated (Fig. 5). 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 use and need for such developments need to be discussed seriously. 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. The project plan should also foresee in the compensation of lost natural values and a reduced flexibility of the existing coastal system.

Integrated coastal zone management

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 had been restricted to water management, harbour facilities and protection against flooding. This included 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 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 of UNCED, the United Nations (Anon. 1992; Bijlsma et al. 1993; Misdorp & Terwindt 1994). Essential elements are a multisectoral and multidisciplinary approach and input from national, provincial and local authorities, academic institutes, coastal engineering consultancies and stakeholders.

Since 1990 in all coastal provinces, so-called POKs, Provinciale Overlegorganen voor de Kust (provincial consultative bodies deal with all matters relevant to coastal protection and the preservation of the coast (Hillen & de Haan 1993). Members of POKss are representatives of the central government (Ministry of Transport, Public Works and Water Management), provincial authorities, water boards and representatives of coastal municipalities and nature conservation organisations. The tasks of the POKs are set in the Water Defence Act. The central government is responsible for counteracting structural erosion. The water boards have the task to of

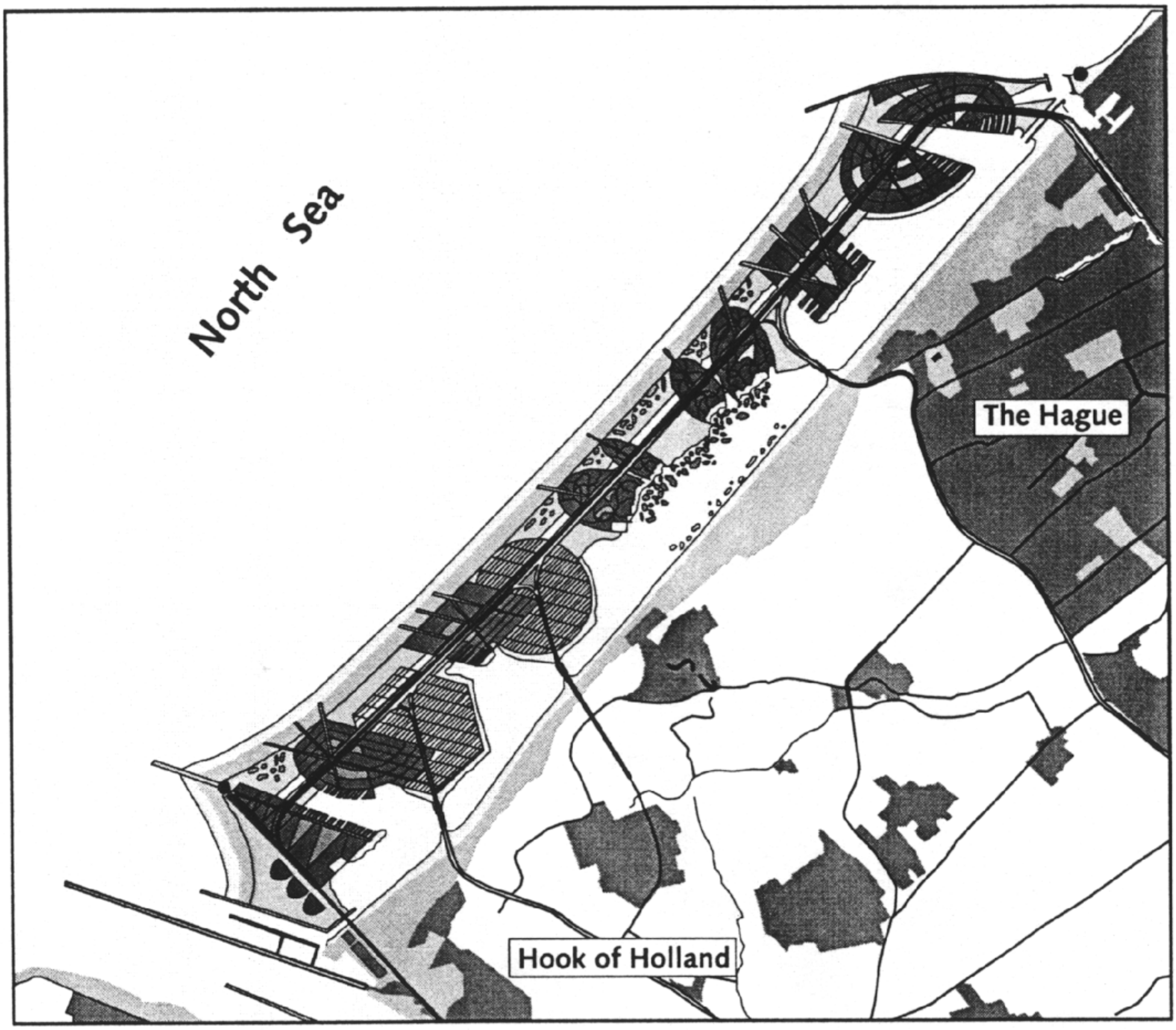


Fig. 5. Potential land reclamation along the Dutch coast between The Hague and Hoek van Holland with development of urban, recreational and natural areas.

maintaining the strength of the sea defence works (dunes and dikes) and the provinces are in charge of the overall coordination and physical planning policy. A close co-operation between POK-members is needed. In fact, for a proper integrated management, all relevant partners in the coastal zone should be involved. 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 natural, social and economic management issues instead of only technical aspects. At present, specific zones of the dunes are designated primarily for coastal defence purposes or for drinking water supply. Other zones have nature conservation or recreation as a main function. During the coming years a more integrated and therefore a more efficient (less scattered) management of the dune area, aiming 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.

Conclusions

The overall conclusion of the evaluation study is that the choice, in 1990, for dynamic preservation was right. The 'basal coastline' concept is working well. Structural (long-term) losses of beach and dune area, in 1990 the main reason for the choice of dynamic preservation measures, has come to a standstill. On larger temporal and spatial scales, (repeated) sand supply is the only long-term solution to replenish the loss of sand through structural erosion in the coastal zone. Evaluation studies of individual supplies show that this is an effective method of coastline preservation, which also serves other uses in the beach and dune area, such as nature conservation and recreation. For some specific sections with severe coastal erosion a seaward defence construction might be profitable if lee-side erosion can be prevented. Analyses of long-term annual coastal measurements show a serious erosion of the deeper lying part of the shore-face. To compensate for the total sand losses in the coastal zone, almost a doubling of the present supply volume is necessary to prevent an increase in coastal erosion in the coming decades. An anticipated accelerated sea-level rise will further increase sand losses. Land-use types such as housing, industry and recreation increase pressures on the coastal zone. The growing need for space could best be considered in an integrated way by the authorities concerned with land use planning. In any case, a fixed, non-dynamic coastal system, without natural flexibility to adjust to future developments as sea-level rise, should be prevented. To reach sustainable development, measures to maintain the coastline at its 1990 position need to be seen in perspective: the coast*line* as a part of the coastal *zone*. Therefore a more integrated management of the coastal zone is necessary, preferably performed by all parties involved in coastal zone policy and management.

References

Anon. 1990. [*A new coastal defence policy for The Netherlands.*] Ministry of Transport & Public Works The Hague. (In Dutch.)

Anon. 1991. [Regional extraction plan for the dutch part of the North Sea/Environmental Impact Statement.] Ministry of Transport and Public Works, North Sea Directorate, Rijswijk. (In Dutch.)

Anon. 1992. *Protection of the oceans, seas and coastal areas and the protection, use and development of their living resources*. UNCED, United Nations Conference on Environment and Development, Agenda 21, Chapter 17, Rio de Janeiro.

Anon. 1996. [*Balancing the coast 1995.*] Ministry of Transport & Public Works, The Hague. (In Dutch.)

Aerts, J.C.J.H., de Boer, M.E. & Heil, G.W. 1997.[*Impact of beach nourishment on sand drift in the foredune area.*] Report RA/97-255, Resource Analysis, University of Utrecht and Rijkswaterstaat, Delft. (In Dutch.)

Bijlsma, L., Hillen, R. & Misdorp, R. 1993. *Changing coastal zones; chances for sustainable development*. Proceedings Coastal Zone 1993, New Orleans, LA.

de Ruig, J.H.M. 1993. *Seaward coastal defence: limitations and possibilities*. In: Proceedings 4th EUCC Congress, Marathon.

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.)

Doing, H. 1995. Landscape ecology of the Dutch coast. *J. Coastal Conserv*. 1: 145-172.

Hallie, F.P. 1995. [*Sand mining for the benefit of coastal nourishment*. Report Rijkswaterstaat, North Sea Directorate, The Hague.] (In Dutch.)

Hillen, R. & de Haan, T. 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. Am. Soc. of Civil Engineers, New York, NY.

Hillen, R. & Roelse, P. 1995. Dynamic preservation of the coastline in the Netherlands. *J. Coastal Conserv*. 1: 17-28.

Janssen, M.P.J.M. & Salman, A.H.P.M. 1992. [*Dunes in the wind.*] Stichting Duinbehoud, Leiden. (In Dutch.)

Misdorp, R. & Terwindt, J. 1994. *Coastal zone management: experiences in The Netherlands*. In: Proceedings CZM Conference. IOC/UNESCO, Karachi.

van der Maarel, E. 1979. Environmental management of the coastal dunes in The Netherlands. In: Jefferies, R.L. & Davy, A.J. (eds.) *Ecological processes in coastal environments*, pp. 543-570. Blackwell, Oxford.

van der Wal, D., Peters, B.A.M., van der Putten, W.H. & van Tongeren, O.F.R. 1995. [*Research on ecological effects of beach nourishment.*] University of Amsterdam and Dutch Institute for Ecological Research, Heteren. (In Dutch.)

van Heuvel, T. & 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.

van Rijn, L.G., Reniers, A., Roelvink, J.A. & Ribberink, J.S. 1995. [Sand budget and coastline changes of the central coast of Holland between Den Helder and Hoek van Holland. period 1964-2040.] Delft Hydraulics, Report H2129.