Journal of Coastal Research	11	4	1221–1228	Fort Lauderdale, Florida	Fall 1995

Combat Erosion By Law
Coastal Defence Policy for the Netherlands

M.J. Koster†, R. Hillen‡

ABSTRACT

KOSTER, M.J. and HILLEN, R., 1995. Combat erosion by law coastal defense policy for the Netherlands. *Journal of Coastal Research*, 11(4), 1221–1228. Fort Lauderdale (Florida), ISSN 0749-0208.

In 1953 a flooding disaster occurred in the Netherlands with more than 1800 death casualties. It was decided that such a disaster may "never" happen again. A special committee was installed and advised upon a safety standard: water retaining structures (like dunes) must be able to withstand storms having a frequency of exceedance of only once in the ten-thousand years. This safety standard is, amongst others, based on economic optimization criteria.

The Dutch decided to formalize this safety standard by incorporating it into a law. Now, after forty years, this safety standard is finally met along the whole coast. The question arising now is, how can this safety standard be preserved? For the dutch, coastal defence is a matter of survival, and therefore it was decided again to let Government and Parliament make a choice. The decision made was to preserve the 1990 coastline. This decision, as well as specific tasks of Provincial authorities and waterboards is outlined in the oncoming Water Defence Bill.

In this paper some backgrounds are given on the coastal defence policy for the Netherlands. Coastal defence in the Netherlands is not only a State affair, and therefore the dutch combat erosion by law.

ADDITIONAL INDEX WORDS: *Control flooding, hazard, disaster, shore protection, water defence.*

INTRODUCTION

The Netherlands is protected from the sea by natural sand-dunes and high dikes. Large rivers-Rhine, Meuse and Scheldt-are flowing through this low lying area into the North Sea. In fact, the Netherlands is part of a large delta system which have been occupied by man ever since about 5000 years ago. At first, people lived on the higher elevated grounds. Later they colonised the marshes behind the dunes. The new inhabitants drained the marshes and started a process of subsidence which is still going on. For that reason, they had to build mounds and (since 1000 years) dikes to protect themselves against flooding by the sea and the rivers. At present, 8 million people (more than 60% of the Dutch) are living in their polders up to 6 meters below mean sea level. Nevertheless, the country is considered safe from flooding by storm surges.

The Dutch have always been fighting the sea, often winning this struggle, sometimes losing. The last flooding disaster occurred in 1953, with more than 1800 death casualties and a damage of approximately 14% of the GNP. After this event, the national parliament adopted new safety standards against flooding. These standards are defined in the Water Defence Bill which provides a basic legal framework for all coastal defence measures in the Netherlands. For the coast of central Holland, for example, the sea defences (dunes and dikes) are able to withstand a storm surge level which is exceeded only once in ten thousand years on average (*i.e.*, the probability of exceeding this level is one ten-thousandth per year). For other parts of the coast, other safety standards apply, basically depending on the economic value (real estate, infrastructure, *etc.*) of the polderland.

The coastline of the Netherlands is about 350 km long; 254 km consist of dunes, 34 km of sea dikes, 38 km of beach flats and 27 km of boulevards, beach walls and the like. The width of the coastal dunes varies between less than 200 metres and more than 6 km. The dune coast and the beach flats (occurring at the extremes of the northern Islands) are dynamic in character. At some locations there is sand accretion; at other locations erosion prevails. Erosion and accretion patterns also vary in time. Since the middle of the 19th century, the position of the dune-foot and the high- and low-water lines are measured every year. For this purpose, fixed reference poles (beach posts) have been set up on the beach at intervals of 200 to 250 metres. Since the middle of the 1960's, the annual coastline measurements have been performed through a combination of remote sensing (onland) and sounding techniques (offshore). At every beach post a coastal profile is measured, extending from approximately 200 metres landward of the beach post to approximately

94060 received 11 August 1994; accepted in revision 15 September 1994.

† Ministry of Transport, Public Works and Water Management, Road and Engineering Division, P.O. Box 5044, 2600 GA Delft, The Netherlands.

‡ Ministry of Transport, Public Works and Water Management, Tidal Division, P.O. Box 20907, 2500 EX Den Haag, The Netherlands.

800 metres seaward. The result of this annual coastal monitoring is a unique data-set available for all types of coastal research and evaluation. Sand balance studies and shoreline predictions are made using this data set, indicating locations where accretion and erosion can be expected in the coming decades.

COASTAL DEFENCE POLICY

Until 1991, an ad-hoc policy was followed; measures were only taken when the safety of the polderland was at stake or when special values in the dune area (*e.g.*, drinking water supply areas, nature reserves) were threatened. After the 1953 floods, the dikes and dunes along the North Sea were strengthened to meet the required safety level, thereby ensuring the safety of the polders. However, if no measures are taken against ongoing coastal erosion, tens of kilometres of coast will become unsafe and hundreds of hectares of valuable dune area will be lost every decade. An accelerated rise in sea level will enhance this problem even further.

In 1989, the so-called Discussion Document was presented including four policy alternatives (MINING TRANSPORTATION AND PUBLIC WORKS, 1990):

(1) *Retreat*: coastal recession will only be counteracted at those locations where erosion threatens the safety of the polders;
(2) *Selective Preservation*: intervention would not only be pertinent to those locations where the safety of the polders is threatened, but also where major interests in the dunes or on the beach may be lost;
(3) *Preservation*: the entire coastline would be maintained at its 1990-location;
(4) *Expansion Seaward*: at locations of concentrated erosion, artificial defences extending into the sea would be built, bringing coastal recession to a standstill. Elsewhere along the coast, the 1990-coastline would be preserved.

Benefits and costs for all policy alternatives were calculated for the period 1990–2090. In 1989 and early 1990, an extensive public discussion was initiated among national, provincial and local authorities, scientists, environmentalists and other people concerned with the dune and beach areas. Out of the four policy alternatives the preservation alternative was almost unanimously preferred by all parties. In November 1990, the national Parliament decided for the Preservation alternative. This policy choice is primarily aimed at enduring safety against flooding and sustainable preservation of the values and interests in the dunes and on the beaches. To emphasize the wish for the preservation of the natural dynamics and character of the dune coast, the chosen alternative was specified and called "Dynamic Preservation".

The policy choice in 1990 marks a new era in coastal defence policy in the Netherlands. The most important aspect of this choice is that for the first time in history the coastline is to be maintained at a fixed position. Until 1991, large sections of the Dutch coast were eroding, at some locations resulting in a retreat of 5 km in 4 centuries. From 1990 onward, all structural erosion is to be counteracted. For this purpose the concept of the "basal coastline" has been developed. Other important aspects of the policy choice include a yearly budget for coastline maintenance, administrative measures such as the definition of tasks assigned to different authorities, and the choice for sand nourishment as the main method to combat erosion.

The policy choice for "dynamic preservation" in 1990 was in a way facilitated by the severe storm surges of that year. During those storm surges, extreme water levels and severe dune erosion occurred and the Dutch once again realised the thread and power of the sea. Directly after those events public awareness and support for coastal defence were at its maximum. But to safeguard the yearly budget for coastline maintenance after several relatively calm winters is obviously more difficult.

Public opinion, *c.q.*, public support plays a key role in the successfulness of a new policy. Therefore, much attention is paid to inform the public through brochures, video's and the press. Some examples of public discussions on "hot issues" during the last two years are:

(1) The technique of beach nourishment has been questioned by many. During the last 40 years the Dutch are used to "hard" Deltaworks to be constructed for centuries. What people see now is that money is spent on sand which is for a part out of sight after the first storm surge. It is apparently not fully understood that sand which has been replaced from the beach to the fore-shore, is not lost for coastal defence. In 1991 a brochure and video on sand nourishment have been produced which are distributed and shown at the nourishment sites. Moreover, a project to evaluate nour-

ishment projects is presently carried out. Today we see the first results: ecologists and local administrators are explaining the benefits of beach nourishment to the press.

(2) The public does not understand the difference between structural erosion and incidental storm damage. The new coastal defence policy involves the counteraction of structural erosion, but it is still impossible to avoid all damage from individual storm surges on the dunes. On this subject a press information bulletin has recently been prepared.

(3) In the new coastal defence policy beach flats are permitted to develop more or less without restriction. These beach flats are almost exclusively found on the northern Islands, more particularly at their extremes. Stopping all coastal defence measures at these locations implies more dynamics and optimal chances for nature development. For the island of Rottumeroog (the easternmost northern Island) the long-term consequence would be that the island would disappear into a large tidal gully. Although nobody actually lives on the island and in this area and history has proven that new islands develop in the course of time, a spontaneous public discussion arose and showed that a large majority of the Dutch did not agree to stop all defence measures. A pressure-group "Friends of Rottummeroog" was born and a bank donated money for the maintenance of the island. Eventually the Minister agreed to continue a limited maintenance on the island to lengthen its life. Now the "friends" do help Rijkswaterstaat with their own hands to maintain the island.

PRESERVATION OF THE COASTLINE

Over the last 2½ years, several important steps forward have been made to imple-ment the new coastal defence policy: the basal coastline has been calculated for the entire Dutch coastline; for each coastal province a so-called Provincial Con-sultative Body has been formed, every year a number of sand nourishments (totalling 5 to 7 million m^3 sand per year) is carried out.

But other problems arise, such as the increasing pressure on the dunes (*e.g.*, housing, recreation, land reclamation) in spite of the decision of the central government that the majority of the dunes will be nature reserve areas. Moreover, adverse effects of an increased rise in sea level are expected.

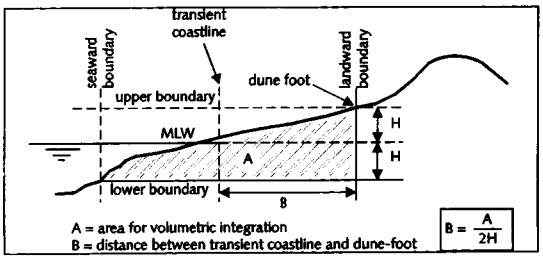

Figure 1. Method to calculate the transient coastline.

The Basal Coastline Concept

The new coastal defence policy implies "preservation of the 1990-coastline" and "counteracting structural erosion". For hard coastal structures, such as dikes, there is no discussion on the position of the coastline. *Where* is the 1990-coastline for a dune coast and what is *structural* erosion? For these questions the concept of the "basal coastline" has been developed. The "basal coastline" is in fact the coastline-to-be-preserved. Every year, the position of the coastline will be compared with the basal coastline to control, if the basal coastline has not been crossed.

The position of the basal coastline for a dune coast is measured for each fixed reference point along the Dutch coast. First the so-called transient coastline is determined from the results of the yearly coastal measurements. The transient coastline for a certain location and for a certain point in time is the result of a volumetric integration of the most dynamic part of the coastal profile (Figure 1). The amount of sand on the beach and on the shallow shoreface in fact determine the position of the transient coastline.

To calculate the position of the basal coastline for a certain reference point, the position of the transient coastlines over the period 1980–1989 are plotted against time (Figure 2). The position of the trend-line on the 1st of January 1990 is the position of the basal coastline for that particular reference point.

Thus the basal coastline for the entire coastline of the Netherlands has been calculated. The results of these calculations have been discussed among coastal morphologists and within the Provincial Consultative Bodies for the coast. In 1993, the Minister will officially establish the position of the basal coastline for the entire country. Then the standard for the preservation of the coastline is fixed.

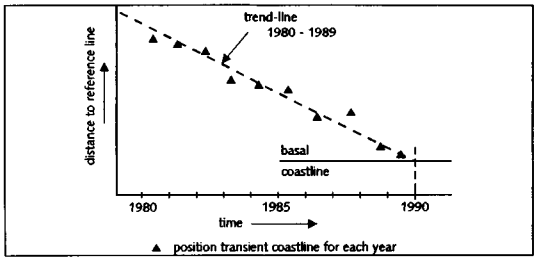

Figure 2. Method to calculate the basal coastline.

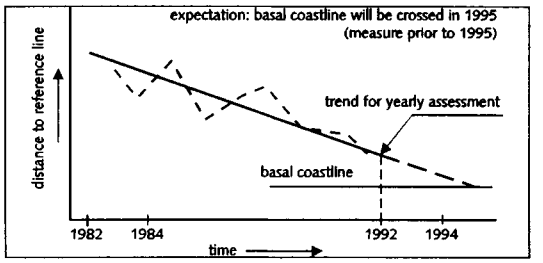

Figure 3. Method to compare the position of the coastline with the basal coastline.

Every year, the trend in coastline development is calculated from the transient coastlines of the past 10 years. If this trendline will cross the basal coastline in the next few years, preventive action will be taken (Figure 3). In practice this means that a timely sand nourishment is carried out. Since 1992, yearly calculations are performed and nourishment works are planned according to this method.

It is interesting to note that the results of individual storm surges do not really affect the position of the basal coastline. The concept is aimed to identify locations with structural erosion in the first place. The effects of dune erosion as a result of storm surges are "filtered out" by using a volumetric approach for the calculation of the transient coastline, by calculating the basal coastline over a period of 10 years and by comparing a 10 years trend line of transient coastlines with the basal coastline. This implies that preservation of the basal coastline does not mean that all dune damage from storm surges will be prevented in the future.

Sand Nourishment

Sand nourishment is a common measure to combat coastal erosion in the Netherlands since the end of the 1970's. Over the years, sand nourishment has proven to be an effective, flexible and financially sound method. Prior to the policy choice of 1990, sand nourishments were mainly carried out to repair the damaged coastline at selected locations. Since 1990 the nourishments are no more repair works, but they are meant as a buffer, preventing crossing of the "basal coastline". The sand is placed on the beach; thus creating an transient coastline in a more seaward position. The nourished sand forms a buffer against the ongoing erosion and will be placed on the eroding beach *before* the basal coastline is exceeded.

Every year some 5 to 7 million m^3 of sand is added to the Dutch beaches (Figure 4). For this purpose a yearly budget of appr. 35 M US$ is available. In fact these costs can be considered the maintenance costs for the coastline. Just for comparison, the average costs for the maintenance of one km of sandy coastline is less than the average maintenance costs of a km motorway.

Preservation of the Dynamics of the Dutch Coast

Nature conservation organisations and ecologists fully support the policy choice of preservation of the coastline and the choice for "soft" coastal defence methods. At their request also the term "dynamic" was added to ensure the dynamic character of the Dutch coastline. Several nature conservation organisations now plead for a less strict policy with regard to the maintenance of the foredunes.

From the viewpoint of coastal defence, there are possibilities for natural development of coastal areas, but not everywhere and unconditioned. On the beach plains at the extremes of the northern islands no active coastal defences measures are carried out. Basal coastlines will not be established for these areas. On the other hand, several dune areas (especially in the Delta area) are too narrow to allow nature development experiments.

For the remaining dune areas a less strict stabilization policy could be considered as long as the safety of the polderland is not endangered. This might imply a different management of the dune area. Presently, certain zones of the dunes are set aside to realize the coastal defence requirements, other zones are nature conservation

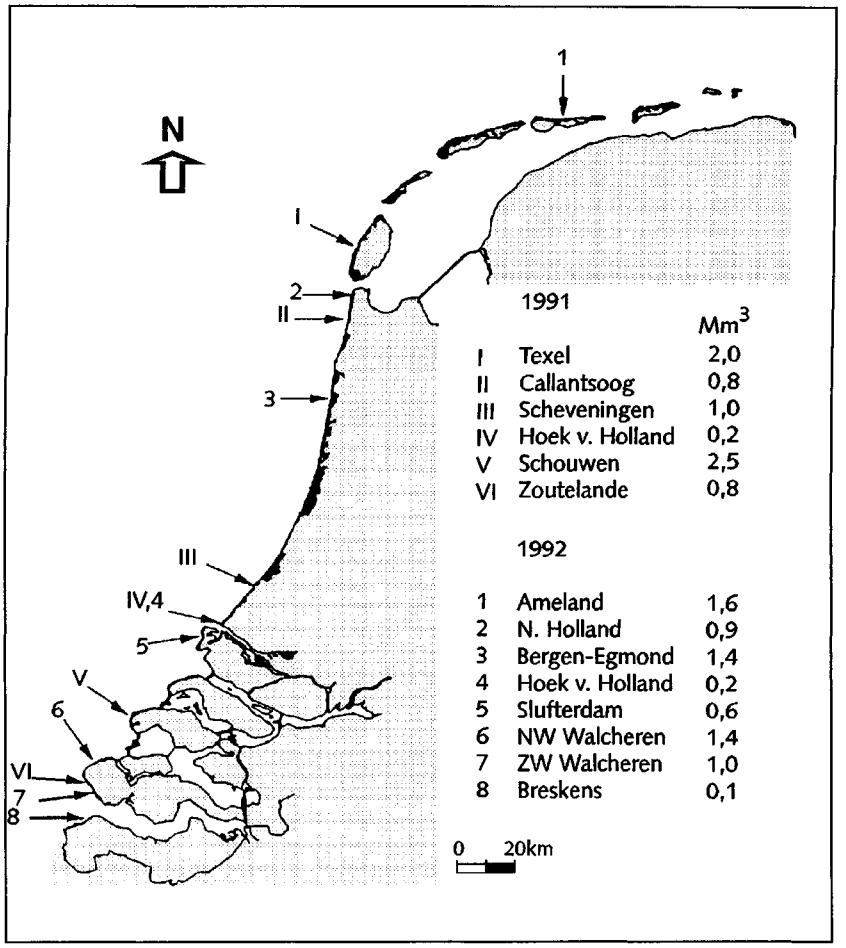

Figure 4. Beach nourishments along the Dutch coast (1991–1993).

areas or drinking water supply areas. In the future, a more integrated management of the dune areas could be considered.

INSTITUTIONAL AND LEGAL FRAMEWORK

One of the lessons from Dutch history is that landowners could only get good protection against the water when they cooperated. They joined forces and founded waterboards. The costs of the tasks of the waterboards-except some grants of the central government-are met by the landowners inside the territory of the waterboard. They pay their waterboard taxes proportional to the area they own. Nowadays buildings are taxed too, and there are so many buildings that the owners of buildings pay together more than the landowners in some waterboards but all proportional to the value of their properties.

The law provides the power for the waterboards to execute their tasks. This way the waterboards are governing bodies operating on the same level as the municipalities but with a specialised task.

Soon there was a need to supervise the waterboards in the tasks they execute, for instance because a lot of the waterboards were small bodies. In the 17th and 18th centuries and the landlord was the supervisor. Later the provinces, then the almost independent federal states of the Republic of the United Netherlands, took over the supervision. Around 1800, the centralistic French occupiers gave the central government the a task of supervision. This lead to the following system:

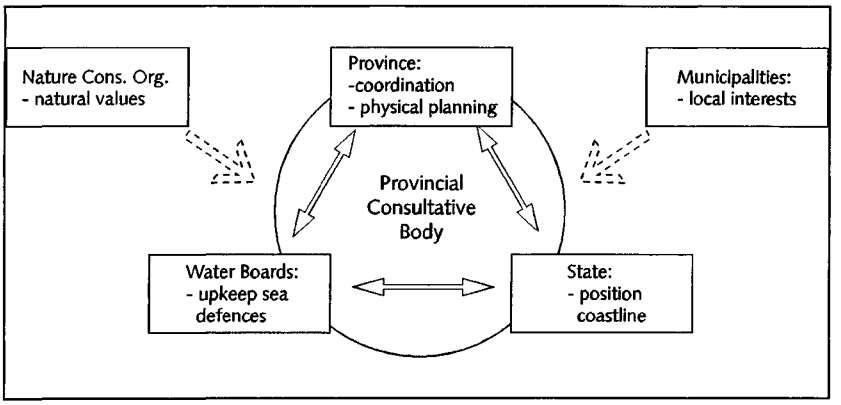

Figure 5. Collaboration within the provincial consultative bodies.

Waterboards manage dikes and dunes. To manage means:

(1) To maintain in the technical sense and to strengthen the dikes and dunes if necessary;
(2) To protect the dikes and dunes from damage by acts of men. Nobody is allowed to do anything in, on or near a dike or dune without a licence from the waterboard;
(3) The provincial governments supervise the waterboards in the execution of their technical duties, but also in their administrative and financial powers. The provincial governments have the power to give the waterboards instructions;
(4) The central government-in particular the Minister of Transport, Public Works and Water Management-supervises the provincial governments in the way they supervise the waterboards. In particular this is important when the territory of a waterboard is within the territories of two provinces. The minister has the power to give the provincial government instructions. If the province and the waterboard do not execute these instructions, the minister can execute measures at the expenses of the waterboard.

This system also applies for the water defences along the North Sea coast.

From 1991 the central government protects the coast against structural erosion by maintaining the basal coastline. The waterboards still have the task to maintain the strength of the sea defences (dikes and dunes) to meet the safety standard. They have to repair the damage of stormsurges on the dunes and to prevent narrow dunes from damage by aeolian transport of sand.

These tasks will be founded in the Water Defence Bill. This Bills orders the Minister of Transport, Public Works and Water Management to undertake the works to counteract structural erosion. Before the works are carried out, the minister has to consult the Provincial Consultative Bodies. In these bodies, at least the provincial government, the waterboards and Rijkswaterstaat (Department of Public Works and Water Management) are participating. In some provinces, also municipalities and/or nature conservation organisations are represented in the Provincial Consultative Bodies (Figure 5). However, the Water Defence Bill does not specify any specific task for these authorities and organisations. The provincial governments (chairing the bodies) have the freedom to invite municipalities and organisations. Although the Water Defence Bill is still in discussion in Parliament now, the authorities cooperate as it is ordered in the Bill, because there is consensus among all parties and the Parliament.

The presence of the members of the bodies reflect the wish of all parties to approach coastal defence matters in an integrated way. In practice, the Provincial Consultative Bodies deal with all matters relevant to the preservation of the coast, including the struggle against erosion. Concepts on integrated coastal zone management could well be realized through the Provincial Consultative Bodies.

LOOKING INTO THE FUTURE

The new coastal defence policy of "dynamic preservation" is in fact only at its infancy. A thorough evaluation cannot be given at this stage, but developments since 1990 are encouraging. A set of instruments has been developed (institutional framework, yearly budget, *etc.*) and new developments are investigated (both fundamental coastal research and innovative coastal defence measures). At the request of the national Parliament, a thorough evaluation of the policy will be presented in 1995.

Coastal Research and Monitoring

Out of the yearly budget for coastline preservation, about 1.8 million US$ are spent on coastal research and monitoring. The coastal monitoring system, as briefly described, has proven to be necessary for both research and evaluation purposes. Without these data no accretion/erosion patterns can be made and no yearly calculation of the transient coastline can be carried out.

The coastal research in the Netherlands is mainly concentrated in the Coastal Genesis project, a multidisciplinary project aimed to understand coastal processes and to predict future coastal developments. The information and knowledge gained through this project has been of great value to evaluate the various policy alternatives.

Together with the Discussion Document, 20 Technical Reports were published in 1989. These reports can be considered as the state-of-the-art in the field of coastal defence of that moment. Based on these technical reports also the "white spots" in knowledge could be identified; for example, the response of the coastal system to a rise in sea level, the limited knowledge of cross shore transport processes, the "sand wave" features along the coastline that are not yet completely understood, and the processes governing transport of water and sediment in tidal inlets. Present Coastal Genesis studies are primarily directed towards these "white spots".

Innovative Coastal Defence Techniques

With the choice for "dynamic preservation", the government and Parliament have chosen sand nourishment as the main approach towards protection of the dune coast. This does not mean, however, that other forms of coastal protection are excluded. Sand nourishment may not offer the best or cheapest solution at every point along the Dutch coast. At some locations, the added sand is rapidly carried away via deep tidal gullies; this occurs for example, near large tidal inlets in between the barrier islands in the north of the country. To carry out sand nourishments more frequently and in larger volumes could become a very expensive solution here. In such situations, alternative, more suitable measures are also considered, such as the construction of dams perpendicular to the coast, or the protection of the shoreface with stones (both examples of "hard" coastal protection measures), possibly in combination with sand nourishment. For two locations along the Dutch coast feasibility studies are worked out for alternative defence measures.

Innovative sand nourishment techniques are also considered. In 1993, a shoreface nourishment project will be carried out on the island of Terschelling at a waterdepth of 5 to 7 meters. A desk study has indicated that foreshore nourishment, under certain conditions, will be less expensive than beach nourishment. Moreover, during the execution of a foreshore nourishment project, recreational activities on the beach are not interrupted. For the extensive modeling and monitoring aspects of such an innovative nourishment project, co-operation with Danish and German coastal research institutes has been established and financial support from the MAST-programme of the European Community, through its programme on Marine Science and Technology MAST, will be given.

Characteristic of all studies into alternative coastal defence methods is that it aims to preserve the coastline with a minimum of means and effort. Management of the coastline means nothing more nor less than regular maintenance of the coastline. This is done with the most efficient and effective means available, taking into account the other interests in the coastal zone (for example: nature and recreation) as much as possible.

INCREASED RISE IN SEA LEVEL

An increase in sea level rise is widely considered one of the most serious threats for low-lying countries such as the Netherlands. Studies show that if the most likely sea level rise scenario of approximately 60 cm in the next 100 years is adopted, the total costs for the Netherlands would amount about 7,500 million US$. For the preservation of the coastline, the additional costs would be 6 million US$ per year, *i.e.*, an increase of the present nourishment budget by 15% (RIJKSWA-

TERSTAAT, 1991). Both in terms of finances and know-how, the Netherlands will be able to cope with an increased sea level. As compared to many of the low-lying developing countries and several small island states, the Netherlands are in fact not very vulnerable to an increase in sea level rise.

DEVELOPMENTS IN THE COASTAL ZONE

Through the preservation of the coastline on its position of 1990 at the minimum, the State Government in fact realizes a basic condition for other functional uses in the dunes and on the beach. The new policy also offers opportunities for new developments in the coastal zone, *e.g.*, opportunities for the restoration and development of nature, for the application of new coastal defence techniques, and for a more integrated management approach in the coastal zone. Such opportunities can probably best be realized through initiatives on a regional or local level.

The stress on the coastal zone is increasing rapidly. Especially the pressure for additional housing and recreation facilities in the dunes is growing step by step. Over the past few years also, plans for land reclamation along some coastal stretches have been developed. Such plans could best be considered in an integrated way by the authorities concerned with physical planning on a regional level. The discussion on consequences of such plans for coastal protection could very well be channeled via the Provincial Consultative Bodies for the coast.

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