DI- 4160

Dt: 4160

Marsh Amelioration along the River Schelde (MARS).
Dutch projectplan, Phase I (1995 & 1996)

The restoration of estuarine
Habitats in the Westerschelde

EU-Project,
Life Proposal N°.: LIFE94/B/A/01531/VLA.
Contract N°.: B4-3200/94729.

Ministerie van de Vlaamse Gemeenschap
Departement Leefmilieu en Infrastructuur
A.M.I.N.A.L.
Afdeling Natuur

Ministerie van Verkeer en
Waterstaat,
Directie Zeeland

" Marsh Amelioration along the River Schelde "

Dutch projectplan:

"The restoration of estuarine habitats in the Westerschelde"

Nota AX-95.072

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Middelburg, 4 January 1996.

Preface

The Ministry of Transport, Public works and Water Management, represented by Rijkswaterstaat Division Zeeland and her Flemish partner, the AMINAL-MINA[1] Foundation initiated a project together.
This project, **MARS, M**arsh **A**melioration along the **R**iver **S**chelde, is a cooperation between several public authorities and local nature conservation organizations in both Flanders and the Netherlands.

The aim of the project is to develop and implement different types of management measures for tidal marshes. This, along the entire estuarine gradient of the Schelde estuary in order to both protect and improve the ecological value of these habitats. **The Dutch part of the project is relating to " the restoration of estuarine habitats in the Westerschelde".**

In the framework of the nature conservation field of action within **LIFE '94**, the project is supported financially by the European Community, represented by the Commission of the European Communities.
In order to coordinate activities in the different project sites, to supervise the scientific quality of the project and to inform the Commission, a steering committee has been set up in August 1995 (Appendix III).
This report concerns the activities and planning of the project sites in the Netherlands.

[1] **(Administration Environment-, Nature- Land- and Watermanagement, department of Nature).**

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Appendix :

Summary

The **MARS** project (**M**arsh **A**melioration along the **R**iver **S**chelde) is an initiative of governmental organizations of the Netherlands and Flanders, to preserve and manage an important ecosystem. The Schelde estuary includes internationally valuable habitats and species. An introduction of its specific features is given in chapter 1.

The project consists of the preparation, application and evaluation of several measures to protect or restore marshes along the river Schelde.

Instead of the application of rock filled dams, a more natural way to protect marshes and swallows is being studied (chapter 2).
The results of former experiments (including test-stands) with shore line protection with regard to the ecosystem will be integrated in future management measures (chapter 3).

The management measures applied in this project should have a highly innovative and demonstrative value.
Various measures to protect and restore tidal marshes should become an integral part of plans for waterway management.
The project includes five types of management with different objectives, characteristics and applications to different field sites (chapter 4).

The *objectives* are:

1. ***Reduction of marsh erosion.***
2. ***Restoration of degraded marsh areas.***
3. ***Creating new marshes on inland sites bordering the estuary as a compensation for reclaimed sites.***

In Flanders three field sites are selected, in the Netherlands two. The project is divided in two phases between 1995 and 2000. In this document the project planning of the first phase (1995 & 1996), in the Netherlands is explained.

Rijkswaterstaat Division Zeeland initially planned to start the preparation of a sand suppletion experiment at the field site Bath.
A navigation channel protection construction will be realized in front of the so-called Bath marsh, this will stabilize the navigation channel upto the beginning of the tidal flat. This, in order to prevent navigation channel migration towards the seawall (marsh and mud flat). The idea was to combine the navigation channel protection with a sand suppletion in order to reduce marsh erosion.

Technical engineers, water system managers, morphologists and ecologists of the "National Institute for Coastal and Marine Management (RIKZ)", nature conservation organizations and the executive managers discussed the set up of the experiment.
The conclusion was that the uncertainties of reaching a successful result were too many to start the execution of the project.
A more detailed monitoring programme should precede the implementation of such an experiment (chapter 4.2).

Therefore Rijkswaterstaat Division Zeeland decided to start with a field site experiment at the **'Slufter bij Kaloot'.** Here the preparation activities, which were planned in the second phase of the project, started in September 1995 (chapter 4.1).
Related to the above mentioned topics two other projects will be realized in the first phase.
In order to generate a better knowledge of the **effects of 'navigation channel protection'**, at the marshes and accompanying mud flats a study is being carried out (chapter 4.2).
In order to make a scientific interpretation of test stands to be realized in phase II of the MARS project, **site specific monitoring** is essential (chapter 4.3).

The goal of this projectplan is to describe the activities and products in the first phase of the MARS project.
The Dutch part will be concentrated on three topics:

1. The field site experiment at the 'Slufter bij Kaloot'.

2. The 'navigation channel protection'.

3. 'Site specific monitoring".

1 Introduction

The Schelde estuary, situated between Gent and Vlissingen, including a fresh water tidal area is internationally spoken, of important ecological value. Estuaries represent ecosystems with a high biological productivity due to the continual input, trapping and recycling of sediments coming both from the river and the sea (Meire, 1993).

The tidal areas are of big importance for all kinds of plants and animals. Marshes and associated mud flats provide feeding grounds and nesting sites for a wide range of wading birds and act as important stops over migration sites (Allan and Pye, 1992). The tidal areas are important for fishes as nurseries and feeding grounds for adults. The tidal areas have specific vegetation communities, which can adapt themselves to different conditions (Hoffman, 1993).

The presence of a number of fresh, brackish and saltwater marshes and several bird (and botanical) species is a clear indication of the value of this biotope. Within the estuary, including the freshwater tidal area of the river ecosystem, the marshes form a very important habitat. Along with the presence of rare and endangered species, the gradients present (salt to fresh, high to low and from sand to *mud*) determine the high botanical value of the tidal flats in the Schelde river.

Especially the marshes and mud flats form a part of the most important elements of the estuarine ecosystem, but have been decreasing (in number and surface) during the last decades (Tank, 1994 & Storm, 1994).
This on one hand due to the enclosure of saltmarshes in agricultural use and more recently for a wider variety of industrial and port related, urban, safety and recreational purposes. On the other hand the remaining saltmarshes decrease in area due to erosion processes (Meire, 1993).

The Schelde estuary is located on both Flemish and Dutch territory. The international river basin approach is adapted by the two riparian states as a basic principle. Ideas for a management plan for the whole estuary are being discussed between organizations in both countries.

Restoration of ecological values is also one of the objectives of the International Commission on the Protection of the River Schelde. Flanders and the Netherlands are participating in this project.

The **MARS** project could be functioning as an incentive for further development of integrated management plans for the entire Schelde estuary in the coming decades.
Secondly the MARS project could be good example for restoration measures in other river systems in Western-Europe.

The **"Westerschelde Nature Restoration Programme"** which is prepared and will be carried out related to the deepening of the navigation channel to the port of Antwerpen can benefit from all experience gained through **MARS**.
In this project the holistic water system approach is applied by the public administrations as a basic principle for integral river basin management.

2 Restoration of estuarine habitats: The Dutch policy.

The surface of marshes is decreasing since the end of the seventies this century. In the beginning of this century (1930 - 1950) the area occupied by marshes was growing, due to the introduction of Anglica Spartina (Tank, 1994).
Due to the measures taken by man, like enclosures for agriculture and the construction of dikes for safety, the balance between the morphology and the processes in the river system has been disturbed.

The river too is narrow compared to the deepness, causing an increase in locations with high current velocities.
The amount of locations where the situation is favourable for sedimentation is reducing. As a result erosion velocities on the marshes have increased. The total surface occupied by marshes in South West Holland (including the Westerschelde) has decreased with 60% since 1930 (Storm, 1994)
Until the eighties marshes were most frequently considered as foreshore protection and potential arable land.
Erosion control measures to protect the marshes were applied from a land safety point of view. The marshes situated along the shores of the dikes break the waves and prevent undermining of the dike.
Protection because of the high ecological value of these areas by governmental bodies is becoming more important the last decades. Protection and if possible restoration of marshes and flats, being important natural areas, are nowadays included in policy plans, like the Policy plan for the Westerschelde (Bestuurlijk Klankbordforum Westerschelde, 1991).

In different **policy papers** it is clearly stated that the Dutch Government aims to conserve and restore the remaining marshes. Managers of the marshes should make use of possibilities, for the conservation or extension of the existing area of marshes and mud flats (the third National Policy Document on Water Management, 1989).
Marshes become main points of interest in the policy, which means that natural values should be safeguarded or if possible restored. This, in order to protect and restore the quantity and diversity of these ecosystems.

Classical shoreline protection measures, which were applied in the Netherlands on a large scale, consisted of a shoreline protection of the marshes by means of a rock-filled dam, the so-called **'hard defences'.** This kind of measures, although protecting the marshes against further erosion, diminish the characteristic dynamics and natural processes in the system. It does not protect the mud flats, which form an essential part in this habitat and the relations between the marshes and the mud flats are disturbed.
The present integral water management approach emphasizes the water system as a central element. Management measures are carried out in order to restore natural occurring processes.
Ecological functioning of the watersystem sets limits to the extent of the boundaries, in which human interests can take place.
In this context the natural processes are a central element in water system management. Therefore several experiments have been carried out in recent years protecting the marshes with more natural materials to gain knowledge in this field, the so-called **'soft defences'** (Storm, 1994) (chapter 3).

3 Results of recent projects

Rijkswaterstaat carries out two projects at the moment to invest the dynamics and the processes of the marshes and the possibilities for the conservation and restoration of estuarine values.
These are the *'OostWest'* project and the *'Lamsoor'* project in which marsh protection in a natural way and with respect to the intertidal dynamics is studied.

One of the main purposes in the OostWest project is to study the impact of human interference at the estuarine system. The OostWest project started in October 1989 and will be finished at the beginning of 1996.
The possibilities and effects of depoldering of enclosed areas to the sea and the reduction of dumping dredged materials are studied, in order to restore the natural habitats in the Westerschelde .
Especially the morphological processes and the way in which these can be influenced are studied. Sedimentation, marsh erosion, current velocities and river impoundings are studied.

In 1992 the Lamsoor project, in which different applications towards marsh protection were initiated, started.
One application, made in the Oosterschelde consisted of a slope made of clay at the marsh to the tidal flat transition.
The other construction, in the Westerschelde, was made out of wooden training walls. The training walls were placed perpendicular to the marshcliff, over the mud flat. The objective is to reduce the current velocities, to stimulate the sedimentation between the training walls and reduce erosion at the marshcliff.

The clay construction reduced the erosion significantly, but needs a regular maintenance. This means regular disturbance of the mud flat (including life communities) in front of the marsh and high maintenance costs.
The construction made of wooden training walls was not strong enough for the high current velocities in Westerschelde (Storm, 1994). **Several studies revealed that a general relation between the physical circumstances and the erosion velocity is difficult to find (Tank, 1994; Jonkers, 1991). One of the main conclusions is that local circumstances are varying a lot along the estuary.**
The results of these projects and the gained knowledge will be an essential part in the implementation of the test stands in MARS.

4 Activities and products in phase I

The MARS project consists of two phases (phase I; 1995, 1996, phase II; 1997,1998 & 1999), in which five projects are planned, three in Flanders and two in the Netherlands. In this chapter the activities and products in phase I are described.
In Phase I (1995/1996), in the Netherlands, the following activities will be, or are already being, realized.

- *Restoration works at 'Slufter bij Kaloot'.*
- *Inventory of the effects of 'navigation channel protection'.*
- *Site specific monitoring.*

4.1 Restoration works 'Slufter bij Kaloot'

4.1.1 Present situation

Owner:	**Dutch Government (Financial department 'de Domeinen').**
Surface of the area:	**± 8.5 hectares dunes & marsh and ± 18 hectares swallow (see Appendix I & II).**
Average high tide Average low tide	**2.02 (meters above N.A.P.).** **1.80 (meters below N.A.P.).**
Height of the 'Slufter bij Kaloot'	**2.9 to 8.8 (meters above N.A.P.).**
Related Organizations:	**Waterschap De Zeeuwse Eilanden, LNV[1] directie Zuid-West and Rijkswaterstaat, division Zeeland.**

([1] Ministry of Agriculture, Nature Conservation and Fisheries).

The 'Slufter bij Kaloot' (Gemeente Borselle, Provincie Zeeland, the Netherlands) is an enclosure formed by dunes connected to the estuary through an opening (see Appendix I & II).
The tidal movement of the water level should cause a regular flooding of a part of the area, during the high tide. These flooding processes make that the 'Slufters' have a characteristic kind of flora and fauna.

A 'Slufter' is an coastal area, enclosed by dunes or tidal flats, from which the lower located areas are regularly flooded due to the tidal flow.

The presence of a 'Slufter' is an indication of a dynamic system, which can be formed in different ways.
A 'Slufter' can appear in a situation where sand is accumulating at the coast, the beach can grow until it is part of the dunes. A 'Slufter' is the phase when dunes are present and the tide is entering the enclosed area.
When erosional processes are dominating, the moment the sea creates an opening a 'Slufter' is created.
Slufters are very rare phenomena in the Netherlands and Western Europe and their habitats are seldom.

The aspects which are considered as valuable in a 'Slufter' are (van Gelderen & Löffler, 1994):

- The high variety in (abiotical) environments containing important gradients in soil composition, salt content, exposition/micro climate, flooding frequency and sheltering.

- The presence specific bird- and plant species related to all the different conditions.

The morphology is very diverse in this kind of systems and is strongly related to the ecology (Hoekstra & Pedroli, 1992).
The lowest parts have the highest salt and mud content and are the most regularly flooded. The vegetation is containing species like ***Salicornia sp., Suaeda marítima*** **and** ***Limónium vulgare.***

A little bit higher, pastures are located, which are less rich in salt and mud; vegetation consists of ***Puccinellia marítima, Plantago marítima*** **and** ***Limónium vulgare*****(Appendix V).** The highest salt pastures are characterised by the ***Armeria marítima, Juncus gerardii*** **and** ***Glaux marítima.*** The highest parts have a low salt content, are less frequently flooded and are sandy.

The 'Slufters' are also important places as breeding and foraging areas for birds (stilt-walker, beach-bird, sea-gulls and different kind of birds of prey)(van Gelderen & Löffler, 1994).
A mosaic of habitats, resulting from the different kinds of gradients is characteristic for this kind of ecosystems.

The 'Slufter' near Kaloot is located in the marine (salt) part of the estuary. Marshes are very scarce in the marine part of the Westerschelde.
The dunes in the Slufter are damaged and the aperture is shoaled. The estuarine gradient and the accompanying habitat, with its intrinsic natural value are disturbed.

4.1.2 Objectives

-Restoration of the estuarine gradient

The Slufter can become a part of the natural system where the typical vegetation can develop and birds can find a place to rest or breed.
The dunes will be replanted with *Ammóphila arenária* to protect them and avoid eolic erosion. The replantation will also prevent accretion of the inlet opening.
The aperture of the Slufter will be deepened, to intensify the tidal influence on the area (Appendix V). The creeks will be deepened again and little islands will be restored. In this way the characteristic tidal flooding and draining processes can take place again, so the characteristics of an estuarine environment can develop again.
This is, specially in the marine part where few saltwater marshes are present, a creation of a special estuarine habitat in the Schelde.
Two information plates will be installed on both sides of the dike at the borders of the slufter, to inform people about the goal of the project. And, doing so preventing disturbance of the area.

4.1.3 Activities and products

In order to restore the estuarine gradient in the 'Slufter' the following activities, which will start in **January 1996** are planned:

- The aperture of the "Slufter" will be deepened. The creeks will be deepened and little islands created to encourage vegetation to sprout. **(Jan/Feb 1996)**

- The dunes will be replanted *(Ammóphila arenária)* and if necessary some sandtraps will be installed. **(March/May 1996)**

- The area will be cleaned, unnatural particles floating around be removed. **(Jan/Feb 1996)**

- In coordination with the environmental organizations the different kind of management measures will be planned. The ecological status of the area will also be determined in coordination with these organisations and the local government.

In november/december 1996 a report about the activities and the first results will be published. Further results and an evaluation of the works undertaken will be written and published later.

4.1.4 Finances

The budget for the works at the 'Slufter' is given below, an estimation for the costs of the boatdays including personnel, the material expenses and the plan preparation and results interpretation in general.

Personnel
The restoring of the dunes; the replanting activities and the cleaning (and the installation of the sandtraps). These activities are together (for the executive personnel) estimated at Dfl 5.000.-.
The planning, managing and writing of the results will cost about Dfl 4.000.-. Together costs for personnel are Dfl 9.000.-

Material
For the dredging activities (including the moving of the sand coming from the deepened creeks) 7 days are scheduled, resulting including personnel at about Dfl 15.000.-).

Financial schedule 'Slufter bij Kaloot'.

Costs Dfl x f1000,-	Personnel	Material	total
1995	4	-	4
1996	5	15	20
total phase I	9	15	24

The financial schedule for the deepening and restoration of the 'Slufter bij Kaloot'. Total costs are estimated at ± fl 24.000,-

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4.2 Inventory effects of 'navigation channel protection'

4.2.1 Present situation

At the location near Bath, a test stand was initially planned in the first phase of the project, but this has been the subject of many discussions among the specialists. In the opinion of the technical engineers, ecologists, morphologists and water system managers the combination of a navigation channel protection with a sand suppletion needs a intensive study before a decision can be taken. In order to generate more knowledge about the effects of the navigation channel protection at current velocities, the mud flat and marsh level, surface and erosion processes need to be examinated.

The effects of a navigation channel protection can be favourable for the marsh and the mud flat without a sand suppletion.

Two important questions for this study are:

1. To which extend does the navigation channel protection reduces the erosion of the marsh and the mud flat?.

2. Will a combination of a navigation channel protection and a sand suppletion have a positive effect on the reduction of the marsh and mud flat area?.

A navigation channel protection was completed on several locations in the last eight years. The protection was mainly located close to a mud flat and sometimes accompanied by a rock filled training wall. The training wall should avoid undermining at the backside of the protection by reducing the current velocities. This can reduce erosion at the mud flats and even stimulate sedimentation.
A inventarization of the field sites of the navigation channel protection has been made. Consequently aerial photos and level monitoring data are being studied. The dredging and dumping locations may also influence the processes at the marsh and mud flat.

When the level of the mudflat is rising due to sedimentation processes, changing as a consequence of the navigation channel protection, the effects on the bottom fauna need to be studied. In general the regenerating velocity of the benthos is being studied, because they are an important factor in the ecosystem, specially for birds and fish (monitoring program).
If a suppletion with sand will be realized, the time required by the benthos in the mud flat to recover from a drastic change like this must be studied.

4.2.2 Objectives

The objectives of this study are:

-To generate more knowledge about the effects of a navigation channel protection at the marshes and accompanying mud flats, in order to have a more realistic idea about the consequences of the navigation channel protection projects for tidal flats and marshes.

-To make a better motivated decision about the execution of a future sand suppletion at the Bath location.

This study will be carried out under different circumstances (locations, current velocities, morphology, exposition dumping or dredging of material absent or present) of the seven different marshes and mud flats where a navigation channel protection is located. A broad stocktaking will be made, at each marsh and flat the effects (the current velocities, erosion/sedimentation pattern, changes in surface and bottom fauna, etc) will be studied.

4.2.3 Activities and products

The next activities are planned :

-Data stocktaking ; gauging (level, surface), aerial photos, biological data, digitized maps (satellite images etc.) literature **(Sep/Oct 1995).**

-Data interpretation **(Oct/Dec 1995)**

-Report **(Jan/Feb 1996)**

4.2.4 Finances

Personnel
The gathering and interpretation of data will take about 100 man hours, the writing of the report is estimated at about 140 hours making 240 hours together times Dfl 116.3.- an hour ≈ Dfl 28.000.-.

Material
Copying, printing, publishing and other material costs are estimated at about Dfl 3.000.-.

Financial schedule on 'Navigation Channel Protection' in Dfl.-.

Costs Dfl x f1000,-	Personnel	Material	Total
1995	12	1	13
1996	16	2	18
Total	28	3	31

The financial schedule for the consequences of the 'Navigation Channel Protection'. Total costs are estimated at ± Dfl 31.000.-.

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4.3 Site specific monitoring

4.3.1 Present situation

A. In General

In the second phase of the **MARS** project one or more test stands for the restoration of estuarine habitats will be realized. Because of the differences occurring in processes at the locations where a test stand will possibly be realized, a basic monitoring programme is necessary. The type of test stand (sand suppletion, wooden, clay or stone construction) and the best location for a test stand will be selected, based on this **site specific monitoring.**

-The selection of a certain type of measure (construction, material) requires information about the circumstances at the marsh and mud flat.

-To make a good interpretation of the results of these innovative pilot studies, scientific motivated background information is required. Without a reference situation, it is difficult to interpret the results of a management scheme at a specific location.

It should be emphasized that the scientific motivation of the project could be doubted, if a construction is made, without a proper knowledge of the situation before, during and after construction of the test stand.

In the Schelde estuary, local variations in erosion processes, fetches, current velocities and morfology among tidal marshes and mud flats are large (Bruijne, 1994 & Tank, 1994).

- According to the planned sand suppletion at the Bath location monitoring, related to the effects of a navigation channel protection is necessary.

B. Marsh at Bath

If the study mentioned in paragraph 4.2, results in the decision that a suppletion will be carried out at the Bath location, this 'site specific monitoring' is essential. When the consequences of navigation channel protection on the different processes are known, a suppletion can be carried out and the results can be interpreted.

When the conclusions of the navigation channel protection study will result in the decision that the pilot study at the Bath location will not be realized, one ore more location will be selected in order to protect or restore estuarine habitats.
A motivated selection between the different sites requires more detailed data of the above mentioned processes.

The different locations along the estuary show different erosion and sedimentation patterns. The increase of information and improvement of knowledge of processes towards the implementation of test stands and interpretation of the results is a necessity.

4.3.2 Objectives

The objectives of 'Site specific monitoring' are threefold:

1 **Determination of a reference situation, necessary in order to make a good interpretation of the results of the test stands.**

2 **To motivate a selection of possible locations where restoration measures will be undertaken in phase II.**

3 **The generation of more knowledge on the occurring processes, causing degradation and erosion of marshes and the adjacent mud flats. Generated knowledge which will be published and will be used by Aminal and Rijkswaterstaat for the set up of restoration measures.**

4.3.3 Activities and products

Process orientated measurements towards a test location selection and an improvement in the interpretation. The measurements will be carried out by the Monitoring Division of Rijkswaterstaat and interpreted by the National Institute for Coastal and Marine Management (RIKZ).

The measurements necessary for a better knowledge in the erosion processes are the current velocities at different locations, the directions of the current at different depths, the impact of the waves in different situations and the sediment composition at some locations at the mud flat.

For an interpretation of the results of the dominating processes during the last years, the height of the marsh, the cliff and the flat will be measured and compared with the previous measurements.

For the construction of a test stand, the exact location of the stable sand layer is needed. Some sediment profiles may be required.

The marshes and adjacent flats where the measurements will be carried out are (Appendix I and IV):

-Bath
-Zuidgors
-Waarde
-Paulinapolder

The marsh cliff of first three locations, show the highest erosion rates of the last decades (Tank, 1994). Conservation measures are most urgent at these locations.
The Paulinapolder marsh and the Zuidgors marsh are located in the marine part of the estuary, the total amount of marshes in the marine part is a small percentage of the total marsh area of the estuary.

Bath

This marsh is situated in the brackish part of the estuary. At the location near Bath the navigation channel is migrating towards the mud flat and the marsh.
This is causing high current velocities and this is one of the reasons why this natural area is disappearing rapidly.
A navigation channel protection will be realized here soon (6.2).
The idea was to make a combination of a sand suppletion with the navigation channel protection. But, as mentioned before, a study of the effects of realized navigation channel protection is realized at the moment (4.2).
Monitoring in 1996, to study the behaviour of the mud flat, in order to have a good insight into the present situation is necessary to interpret the results if a (certain kind of) measure will be realized here.
It should also be mentioned that although brackish marshes are vary scarce on a Western European scale, the Bath marsh is only a small part of the total brackish marsh area in the Westerschelde. In this point of view, it could be a good location for a test stand.

Zuidgors

This marsh is situated in the marine part of the estuary, where marshes are scarce (see Appendix IV). The measure here could be a rock filled training wall, transversely placed against the shore line, protecting the marsh and mud flat at the side where highest current velocities are found.
As a consequence, it is expected that current velocities will drop and flow lines will change, stimulating so the sedimentation process and reducing erosion processes.

Another option which is studied at the moment is the addition of a parcel lying behind the dike, which was until the fifties part of the marsh.
This option is a part of an international programme which has to minimize the ecological and morfological effects of the deepening of the river Schelde, which will be carried out next year. All marsh, mud flat and plate areas lost due to the deepening and related increase in erosion will be restored.
All results obtained in the monitoring will directly be used in this programme.

Waarde

The marsh of Waarde is situated in the brackish part of the Westerschelde. Waarde is a recognised and protected national 'nature' area, the vegetation is very diverse, typically coastal species occur together with more inland types (see Appendix IV). The marsh and mud flats are intensively used by different bird species.
The marsh has been showing high erosion rates since 1988. The marsh surface is decreasing with about 0.4 ha. each year. Exact data on the erosion rates are not known. Some general monitoring is being carried out at the moment, the results of which will be used.
On this location, also a project could be realized on behalf of the above mentioned programme. The results of the monitoring in the mars project will possibly have a direct feedback towards erosion reducing measures.

Paulinapolder

The marsh near Paulinapolder is one of the few marshes with a significant area in the marine part of the Westerschelde. The vegetation is very diverse, typical for a salt marsh, communities like *Suaedetum maritimae* and *Halimonetum portulacoidis*. The vegetative cover shows a mosaic formed structure (Schaik et al.,1988)
The erosion processes in this marsh are different compared to the other three, both erosion and accumulation processes occur along the marsh edge on different places (Tank, 1994).

These parameters will be measured:

-Height determination of the marsh, its cliff and the tidal flat. (GPS, Sondings, included in a special habitat mapping project, **1996).**

-Current velocities, a frame will be made and the measurements will be carried out during at least one week. Measurements during a spring tide are necessary **(March/ April 1996).**

-Flow line measurements, using floaters the flow lines at different depths will be determined **(March/ April 1996).**

-Sediment composition on the flats will be determined using samples which will be examined in the laboratory **(March/April 1996).**

-Determination of the sediment profile at several marshes (for location of the sand layer) in order to know at what depth a construction should be build. First the geology at the considered sites will be determined. will be carried out **(March/April 1996).**

-The wave impact on the marsh/swallow will be measured under different circumstances (wind directions and velocities) at the sites **(March/April 1996).**

4.3.4 Finances

The financial schedule of the site specific monitoring is set up in cooperation with the measuring service (Meetdienst AXM).

Personnel
Field measuring service costs about Dfl 150.- an hour, 65 hours times 150 gives Dfl 4950.-.

Material
A boatday including personnel costs ± Dfl 2500.- per day. To complete the different measurements the total amount of 42 boatdays is required. Each boatday is about Dfl 2500.-, so 42 days make Dfl 105.000.-.
Dfl 30.000.- is needed to make the different constructions to measure the current velocities.
Together material costs are Dfl 135.000.-.

Financial schedule 'site specific monitoring'

Costs in Dfl (x 1000)	Personnel	Material/ Boatdays	Total
Marsh & Flat hight	-	15	15
Current velocities	-	65	65
Flow line	-	20	20
Sedim. comp.	5	-	5
Geology	-	15	15
Wave impact	-	20	20
Total	5	135	140

Costs schedule for the 'site specific monitoring' at the four locations. Total costs are estimated at ± Dfl 140.000.-.

5 Planning and finances.

5.1 Overview of activities and products.

Phase I (1995 & 1996):

Realization schedule	Activity	Product
October/ December1995	Navigation Channel Protection.	Data
December/ January 1996	interpret/writing Navigation Channel Protection.	Report
January / May 1996	Restoration 'Slufter bij Kaloot'	Restored natural area
March / May 1996	'Site Specific Monitoring'	Data
May / December 1996	Writing results 'Slufter bij Kaloot'	Report
July / December 1996	Data interpret. + writing 'Site Specific Monitoring'.	Report

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5.2 Overview finances.

In phase I, the total project expenses for MARS are 844.440 ECU, the total financial support is 380.000 ECU, leaving 464.440 ECU as the own expenses for the partners.
The expenses in the Netherlands are 89.522 ECU (± 13 % of total in phase I) and the support is 40.285 ECU.

The figures and calculations in this document, have been done in Dutch guilders due to the standard amounts which are used by the different services.

Phase I, general overview Finances (In Dfl.-).
Including the different categories in what kind of activity what amount of money is spend.

In the first phase, the total amount of expenses for The Netherlands calculated in Dutch florins are estimated at about Dfl 195.000.- .
The financial support by the European Community within the LIFE '94 program is 45 % which is Dfl 87.750.-.

In the contract the Provisional summary breakdown of expenses for the Netherlands the categories from "Detailed resources allocation" are given. (LIFE contract page 10).

Distribution of expenses in Phase I.

Division schedule of total costs in phase I for the Netherlands (for categories see LIFE contract page 10).

Costs in Dfl.- x 1000	'Slufter Kaloot'	Navigation Channel	Site Specific Monitoring'	Total
A1	-	28	-	28
C3	15	-	-	15
F4	-	-	30	30
F5	-	3	-	3
F1	9	-	110	119
Total	**24**	**31**	**140**	**195**

Phase I total:

Restoration 'Slufter bij Kaloot'	Dfl 24.000.-	/ 11.009 ECU
'Navigation Channel Protection'	Dfl 31.000.-	/ 14.222 ECU
'Site Specific Monitoring'	Dfl 140.000.-	/ 64.291 ECU
Finances Total Phase I	Dfl 195.000.-	/ 89.522 ECU

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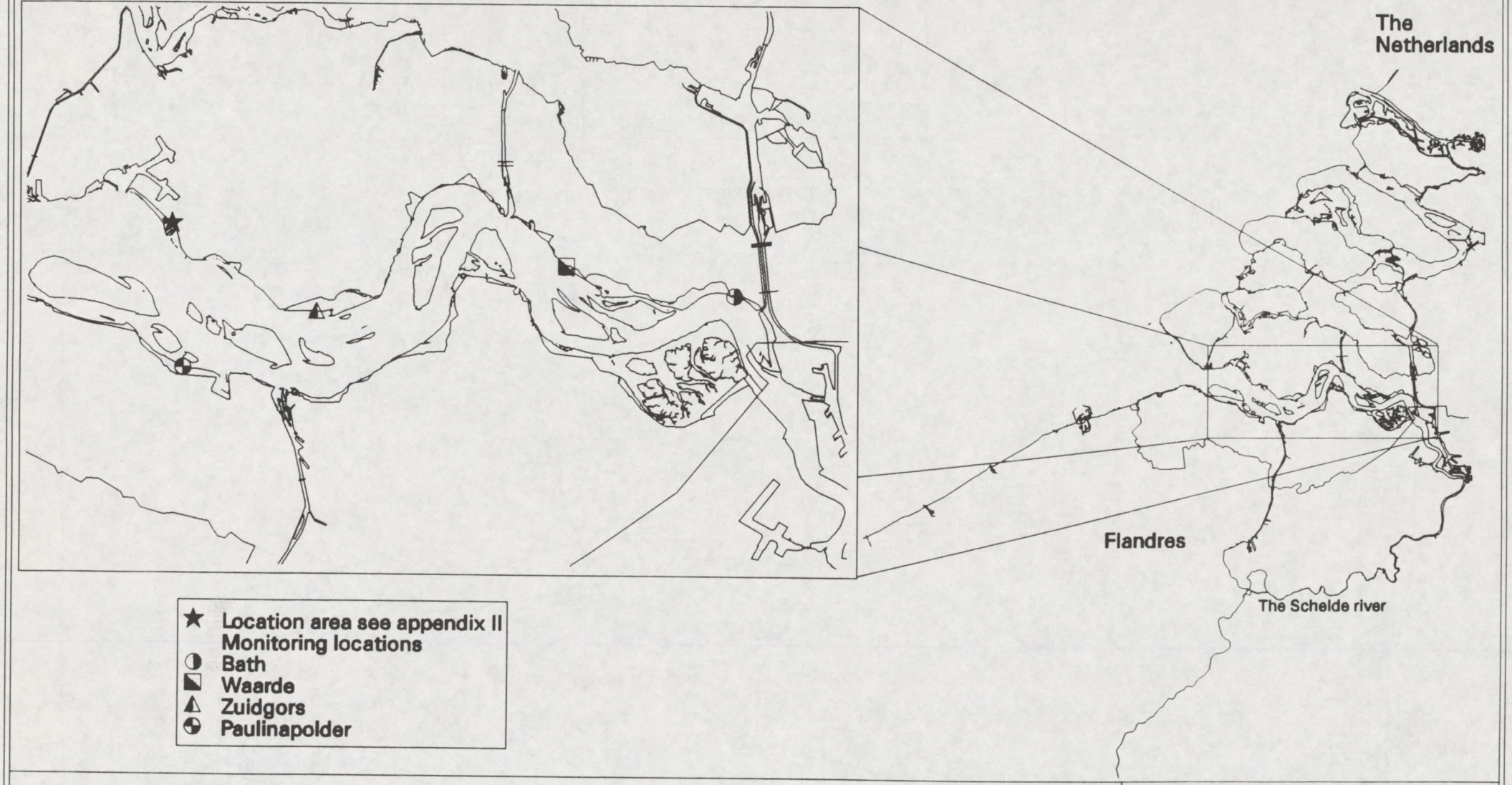


Appendix I

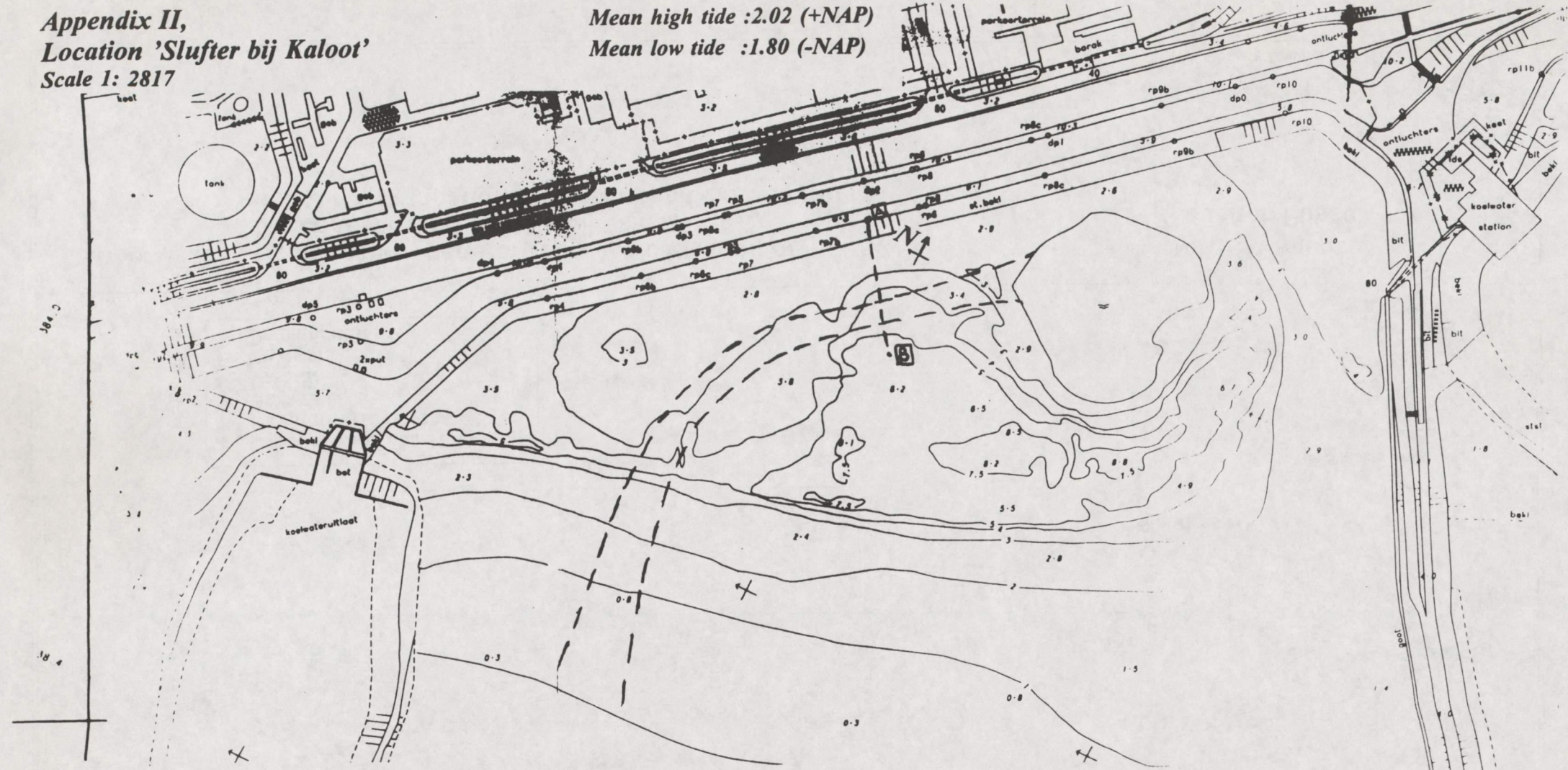
Schelde river, general geographic location of Dutch test-stand "slufter bij Kaloot" and the four locations for site specific monitoring

MARS Project
Location Phase I

RWS Directie Zeeland, afd. NWL

Appendix II,
Location 'Slufter bij Kaloot'
Scale 1: 2817

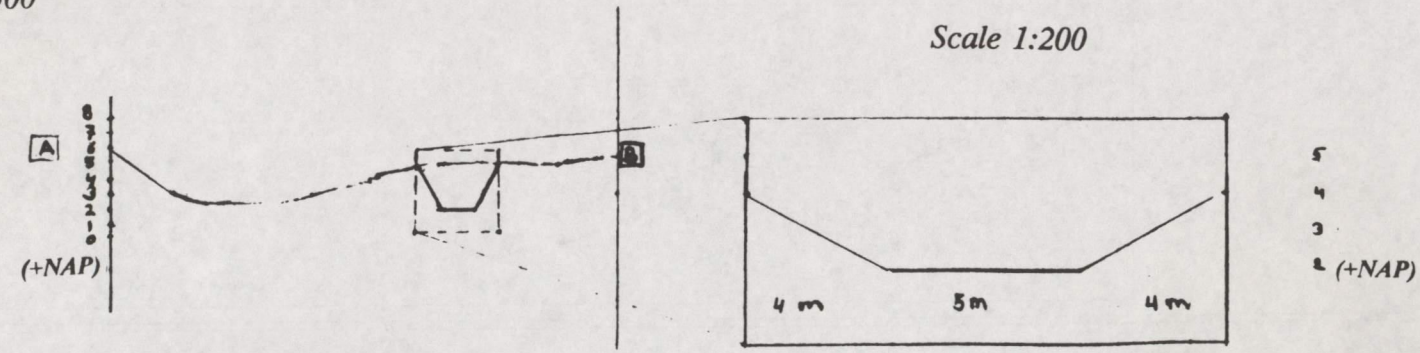
Mean high tide :2.02 (+NAP)
Mean low tide :1.80 (-NAP)



Scale
Hor. 1:1000
Ver. 1:500

Global scedule deepening

Scale 1:200



Appendix III

steering committee

-Dr. P.M. Meire,(chairman and project leader Flemish part)

-Ir. K. de Smet,

-Drs. S.A. de Jong (secretary and project leader Dutch part),

-Ir. L.L.P.A. Santbergen,

-Dhr. L. Hemelaar,

-Ir. W. Graré,

-Ir. W. v/d Hoofd

-Drs. H. Niesing,

-Ir. V. van den Bil.

Project organization (fase I)

The Dutch project group consists of the following persons:

- Drs. S.A. de Jong (RWS-ZLD; chairman)
- Ing. W. Houmes (RWS-ZLD)
- Ir. L.L.P.A. Santbergen (RWS-ZLD)
- Drs. C. Storm (RWS-RIKZ)
- Drs. H. Niesing (RWS-ZLD)
- Drs. H. van de Bosch (RWS-ZLD)
- Drs. D. de Jong (RIKZ)
- Drs. J. Coosen (RIKZ)
- Drs. J. Consemulder (RIKZ)
- Dr. G.J. Buth (Zeeuws Landschap)
- Dhr G. de Groot (Natuurmonumenten)

Agenda Members are:

- Dr. P. Meire (Instituut voor Natuurbehoud; Vlaanderen)
- Ir. K. De Smet (Instituut voor Natuurbehoud; Vlaanderen)
- Ir. S.H. Plantenga (RWS-hoofddirectie)
- Ir. A. Hoekstra (RWS-ZLD; hoofd hoofdafdeling Waterhuishouding en Waterkeringen)
- Drs. G. Raeymaekers (Ecosystems)
- Drs. N. Houtekamer (RWS-ZLD)
- Ir. E. Turkstra (RWS-ZLD)
- Ir. H. Smit (RIKZ)
- Dhr. Gary Post (Ministry LNV)
- P. van Grevenbroek (Staatsbosbeheer)

Appendix IV

marsh and mudflat 'Waarde'(summer situation)

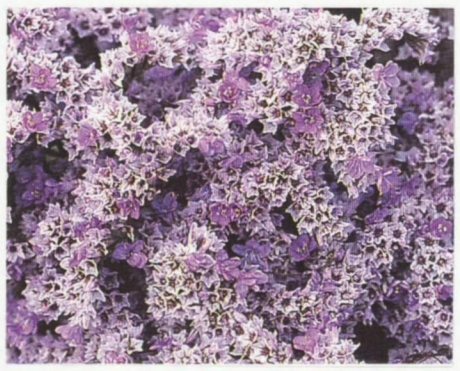
(Photo RWS, Meetkundige Dienst Afdeling Grafische Technieken)

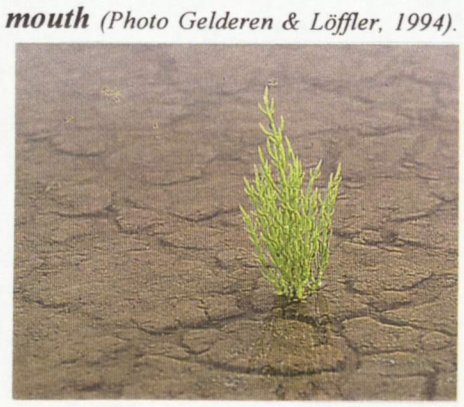
Marsh and mudflat Zuidgors (Winter situation)

(Photo RWS, Meetkundige Dienst Afdeling Grafische Technieken).

Appendix V

A characteristic slufter mouth *(Photo Gelderen & Löffler, 1994).*





Some typical species for a marine Slufter/Marsh (Limonium vulgare, Salicornia europae and Artemisia maritima).(Photo Meire, Hoffmann and Ysebaert).

Location 'Slufter bij Kaloot' *(Photo RWS, Meetkundige Dienst Afdeling Grafische Technieken).*