

Environmental Design of Low Crested Coastal Defence Structures

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GENERAL APPROACH

DELOS aims to promote effective and environmentally compatible design of LCS to defend European shores against coastal erosion and, at the same time, to preserve the littoral environment and the coast economic development.

DELOS, which involves 18 partners from 7 European countries, offers the possibility to achieve this aim through integrated collaboration among engineers, who design coastal defence systems, coastal oceanographers, marine ecologists, economists and political institutions, who are operationally responsible for coastal protection works.

OBJECTIVES

- to provide an inventory of existing LCS and a literature based description of their effects;
- to analyse LCS hydrodynamics and stability as well as their effects on beach morphology by observation on sites, by laboratory experiments and numerical modelling;
- to investigate the impacts of LCS on biodiversity and functioning of coastal assemblages by observations and field experiments;
- to develop a general methodology based on CV monetary values obtained in different European countries to quantify benefits for “Integrated Coastal Zone Management”;
- to provide local authorities with validated operational guidelines for the design of LCS based on the achieved knowledge of LCS hydrodynamics and stability, water circulation, beach morphology, impacts on coastal assemblages, human perception and related economic effects.



MOTIVATIONS



Pellestrina before the works

The project origins from two observations:

- Coastal defences were spread over the coast without a scientific analysis of their environmental effects;
- Defence structures are not simply small breakwaters and generate circulation and morphological effects which are not properly described by available models.



EXPECTED IMPACTS

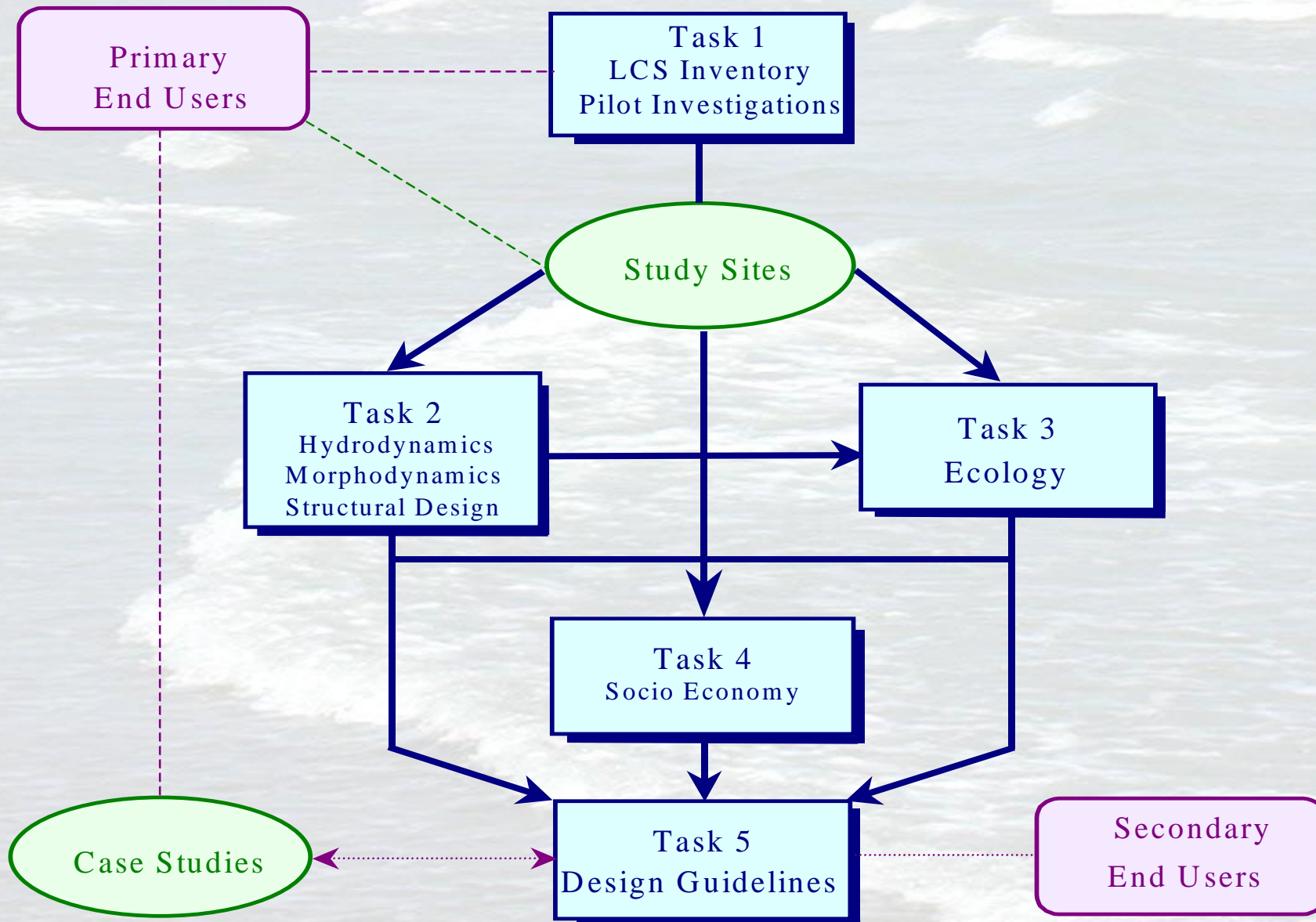


DELOS primary contributions to Community social objectives are:

- Preservation, protection and improvement of coastal environments;
- Improvement of the quality of life, health and safety in coastal areas;
- Improvement of skills and of employment prospects within the Community.



STRUCTURE





TASK 1

Objectives:

- to provide an image of how diffuse the different structure types are, of how effective they are in the different coastal situations, and to identify which parameters may characterise each structure and its effects on the coastal environment
- to develop and test pilot models of the ecological functioning of low-crested breakwaters, in order to optimise the design of field and laboratory studies and to standardise sampling and experimental protocols among partners
- to collect theories and models in the current literature on monetary valuation of environmental changes

✓LCS Questionnaire

LCS Database

- ✓ Pilot ecological models (D2), List of pilot species (D3), (D4)
- ✓ Literature review for statistical analysis (D6)



LCS in Greece

Description: Four successive oblique breakwaters at Alaminos, Larnaka. Alaminos is situated on the South East coast of Cyprus.

Main motive for building the LCS

The coastline in the specific area is steep with a narrow stretch of sandy beach at the toe. During the past 15 years wave action effect has resulted in progressive beach erosion posing a landslide threat. An offshore defense scheme was instigated to cease erosion and build up beach level.

Impacts on bio-environment

Not known

Socio-economic impact

Since construction of the scheme beach level has been stabilized. Moreover, significant sediment accumulation primarily in the lee of the structures has created an improved recreational beach.

System Layout

Angle between breakwaters and shoreline : 13°

Breakwaters length : 140 m

Gap between the breakwaters : 25 -30 m

Offshore distance : 140 m

Crest width : 3.7 m

Typical cross section

Seaward, shoreward slope : 1:1.5

Crest height : 0.5 m above mean sea level

Water depth at the structures' toe : 2 - 4 m.

The breakwaters consist of three layers :

An armour protection layer of natural blocks (3.0-5.0 t)

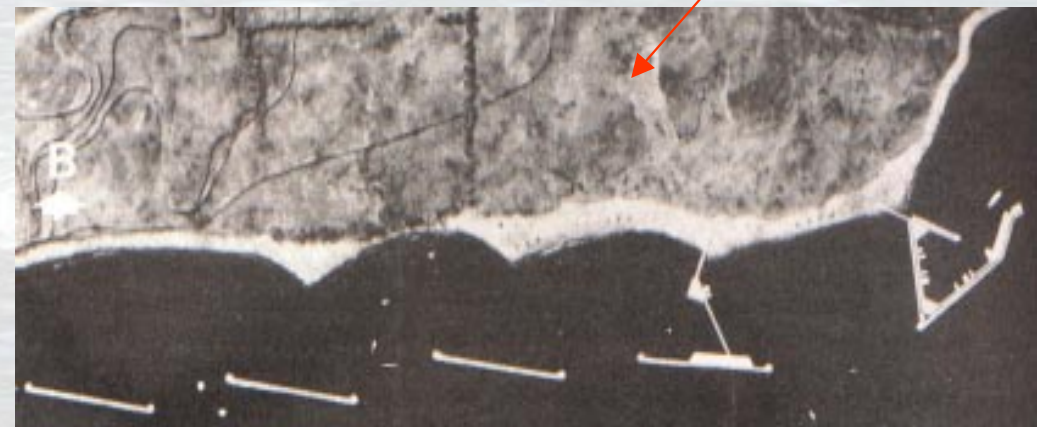
An intermediate layer and a core of rubble stones

Indication of water level variations

Tidal variations are not available at present.

Existence of detailed information

It is questionable whether additional information can be obtained. A response is awaited from the engineering consultants that were engaged in the project.



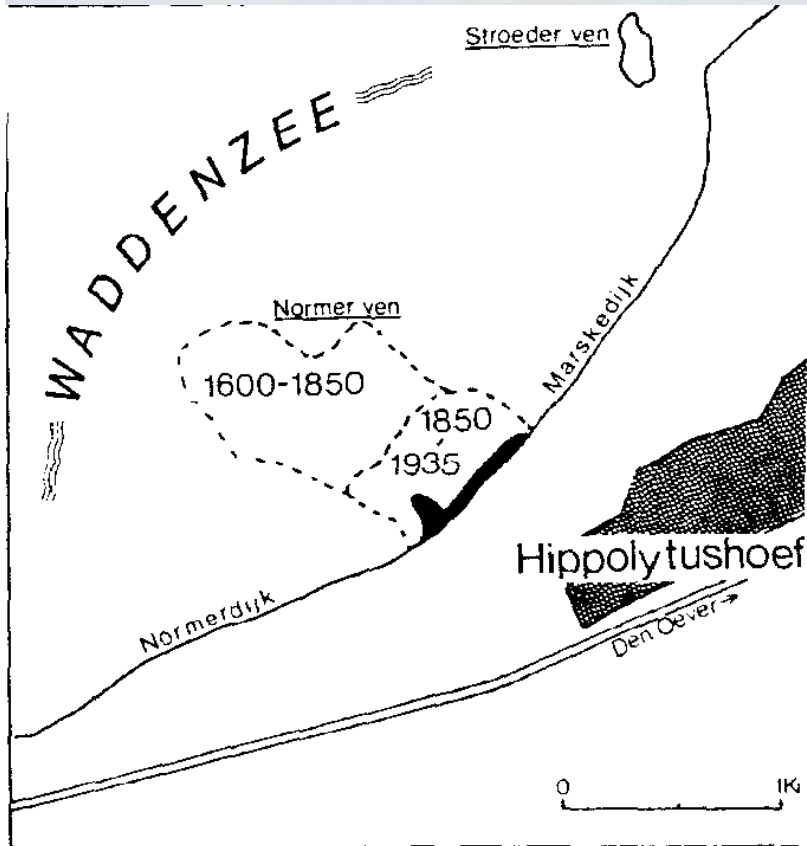


LCS in the Netherlands



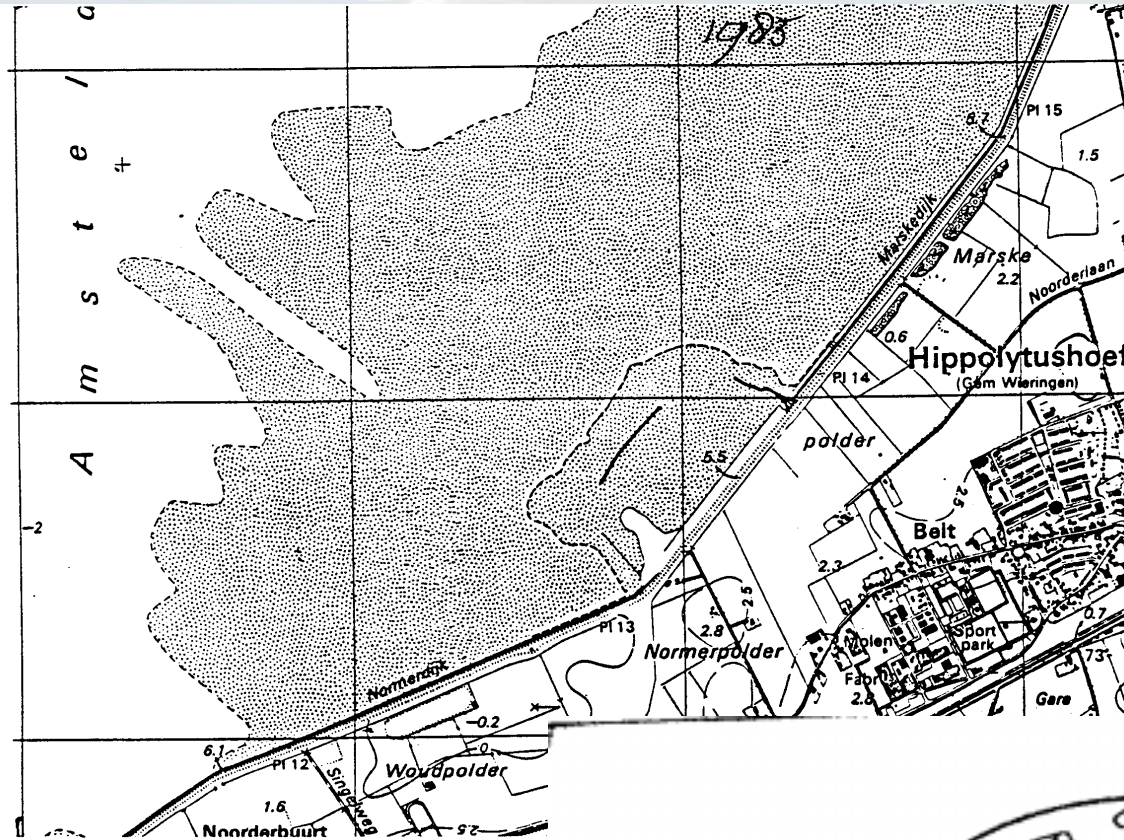


005 Normerven – old and new



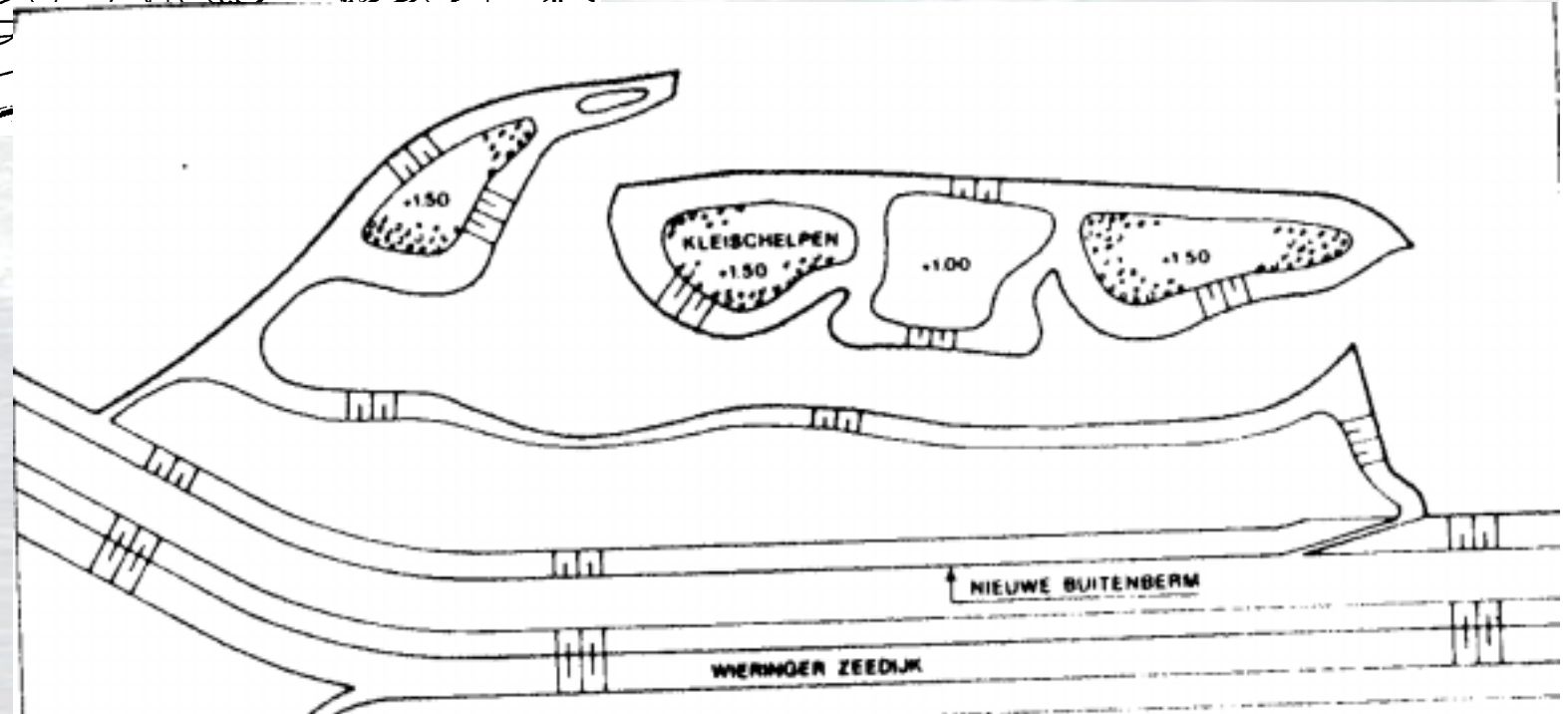
1878





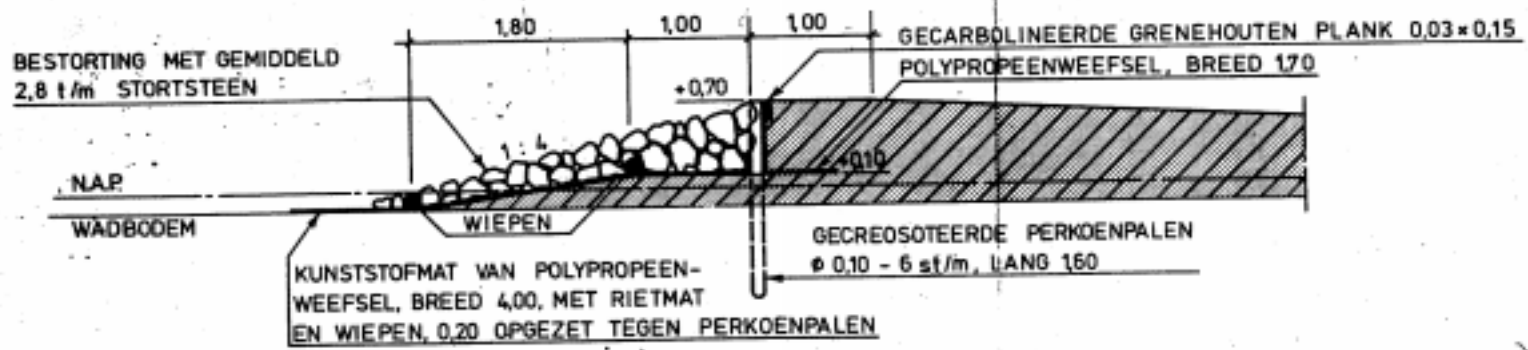
1985 before
restoration

Restoration plan





1986



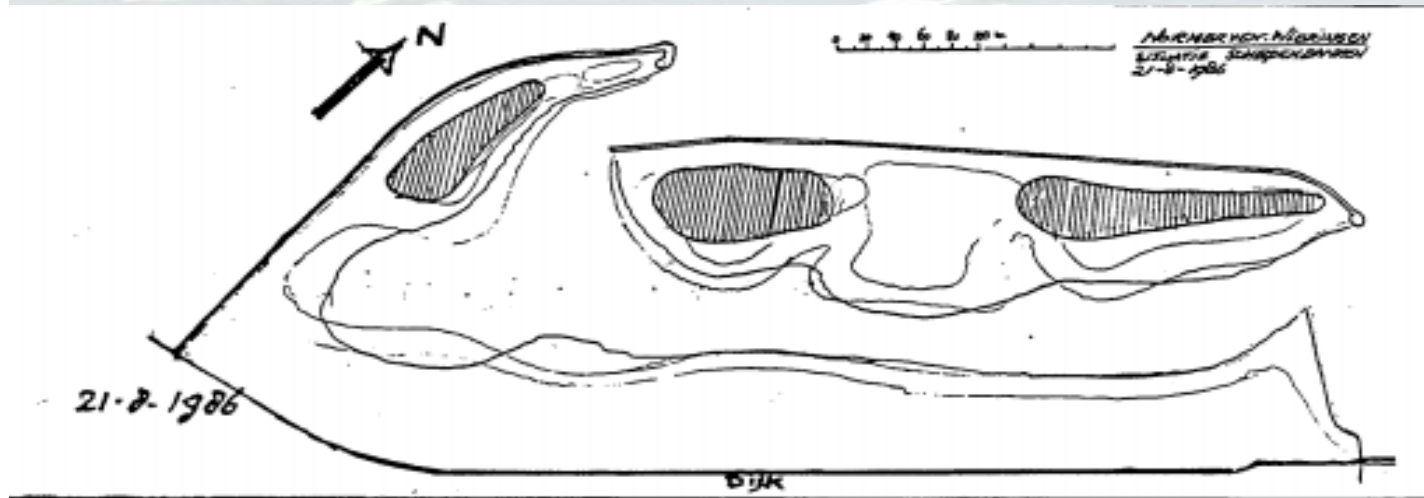
DOORSNEDE C-C

SCHAAL 1:50

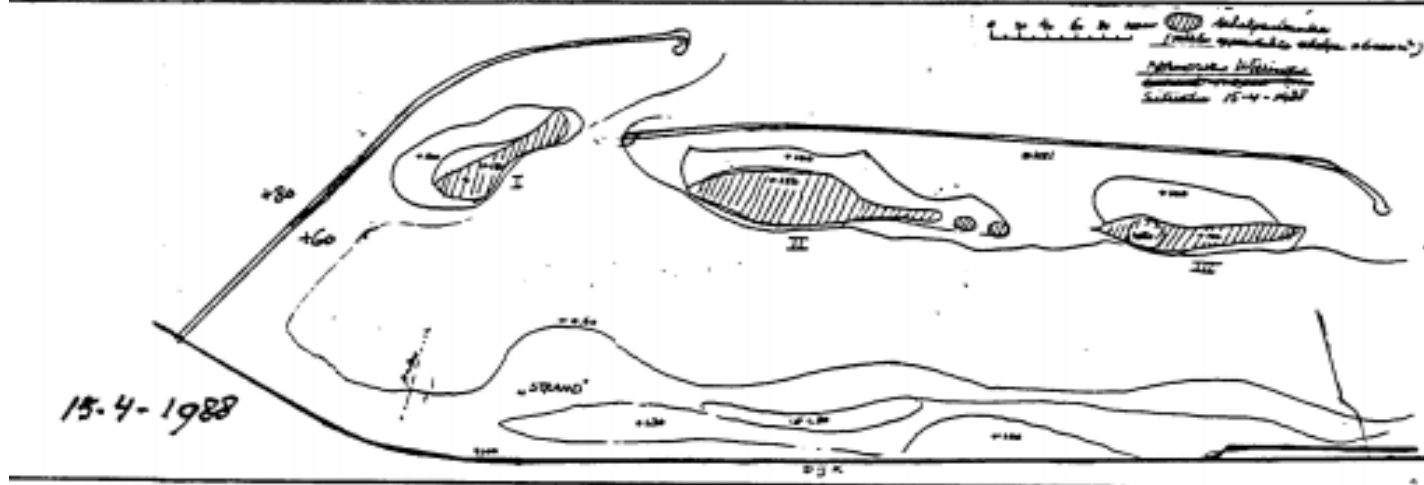


1986

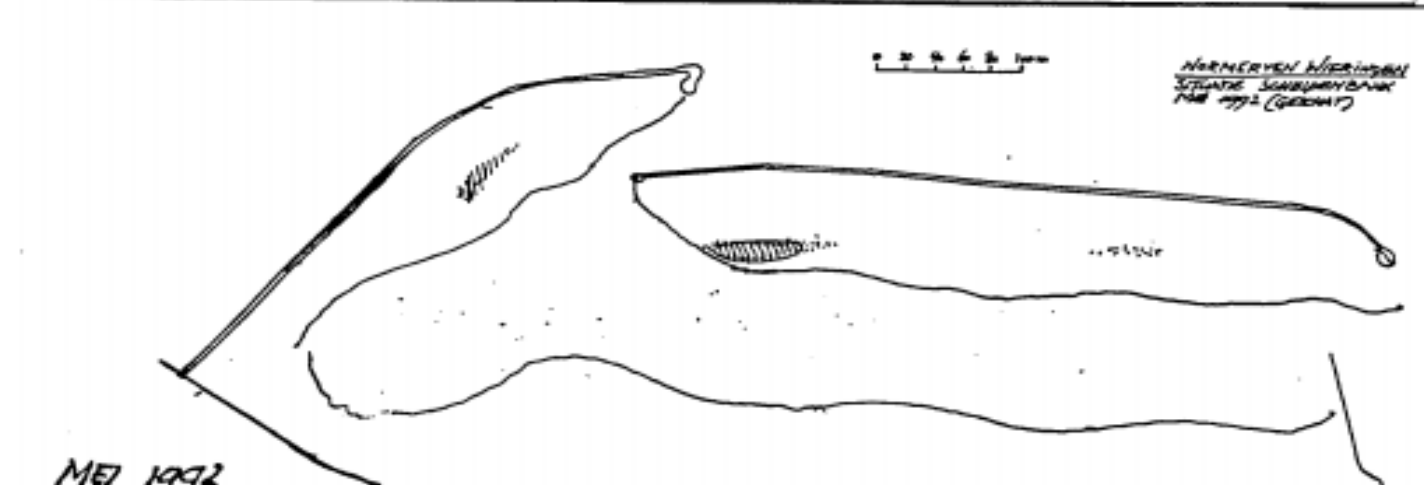




1986



1988

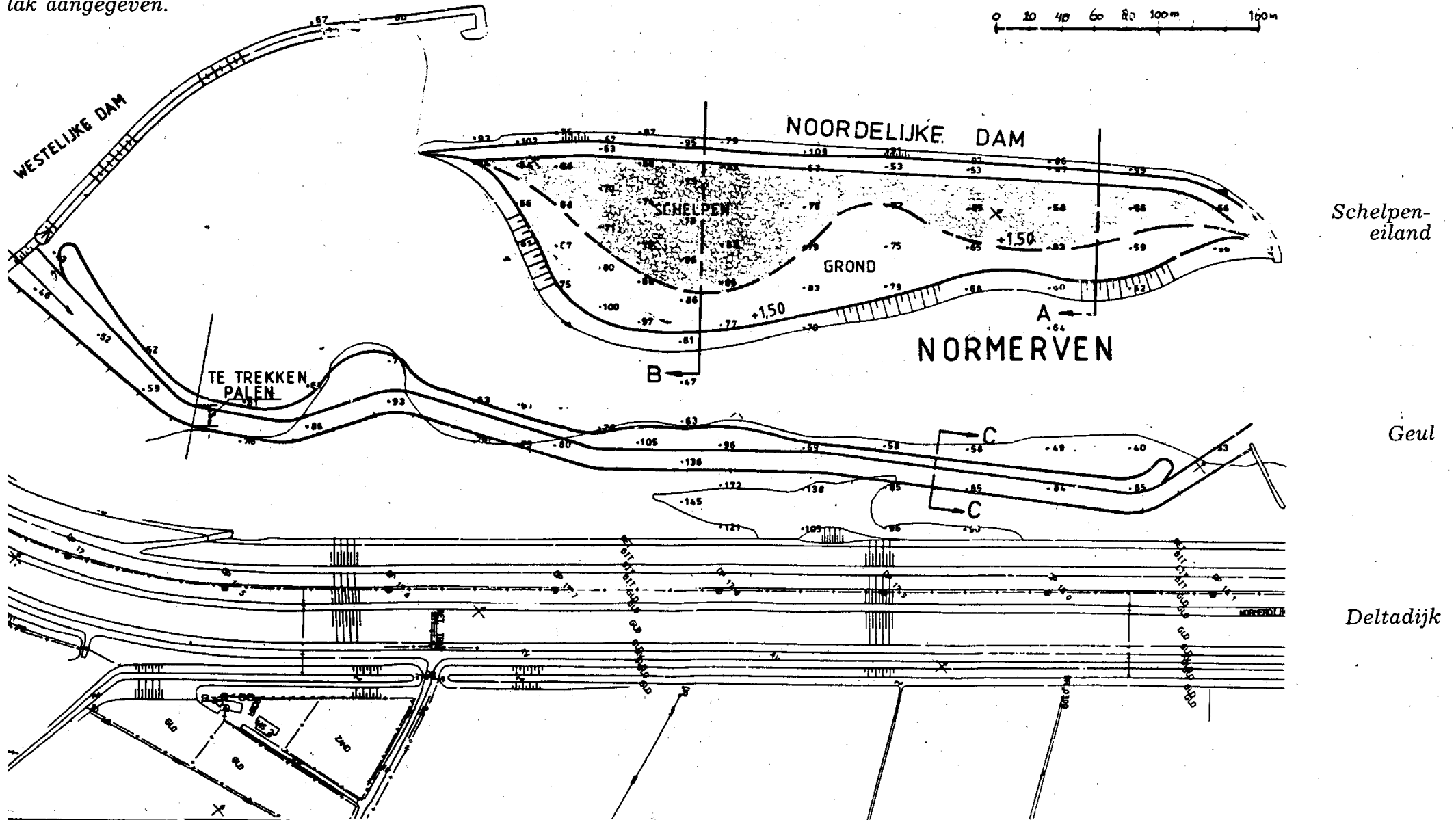


1992



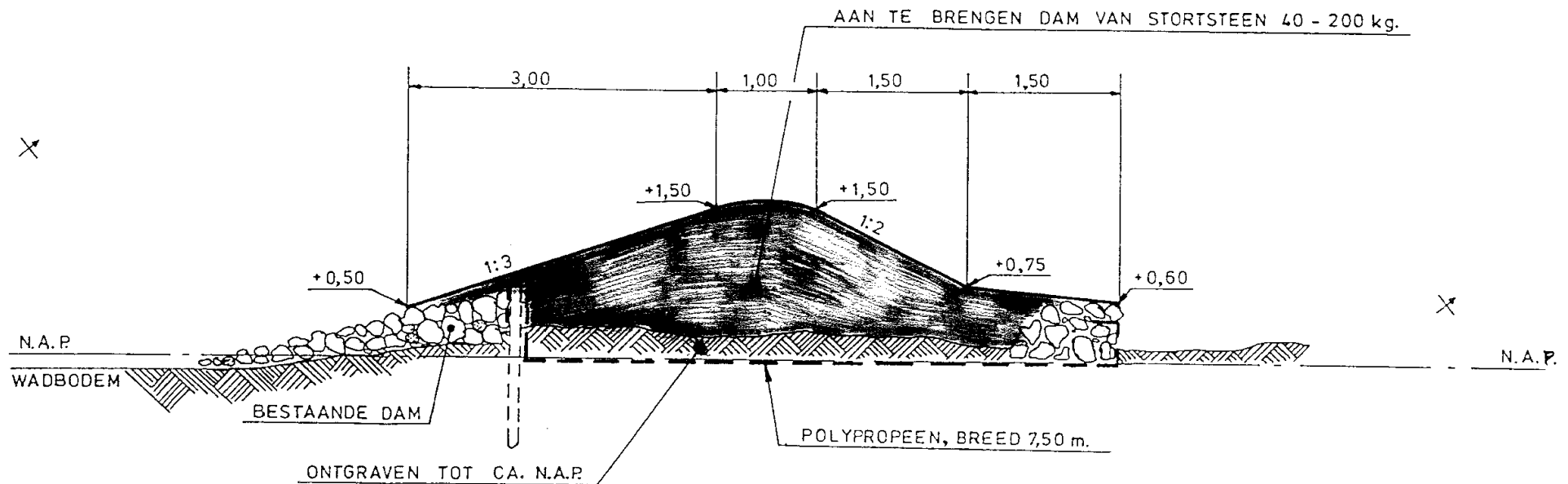
Second restoration plan 1995

lak aangegeven.





DOORSNEDE WESTELIJKE DAM



DOORSNEDE C - C
schaal 1:50



Pairs of birds with nests

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Nile Goose														1
Oyster-catcher	4	9	8	11	7	16	14	13	10	9	8	9	5	4
Avocet	6	140	320	261	69	154	236	151	108	286	110	150	293	240
Ringed plover	3	4	12	16	11	7	9	7	4	6	3	4	1	3
Black-headed gull			10	37	14	32	9	12	34	167	1465	2894	2770	1500
Common tern		46	206	384	150	213	328	193	50	412	455	413	269	520





About 200 avocets on their nests





Nile goose with 4 chickens





STUDY SITES

PELLESTRINA

HIRTSHALS

ELMER



LIDO DI DANTE

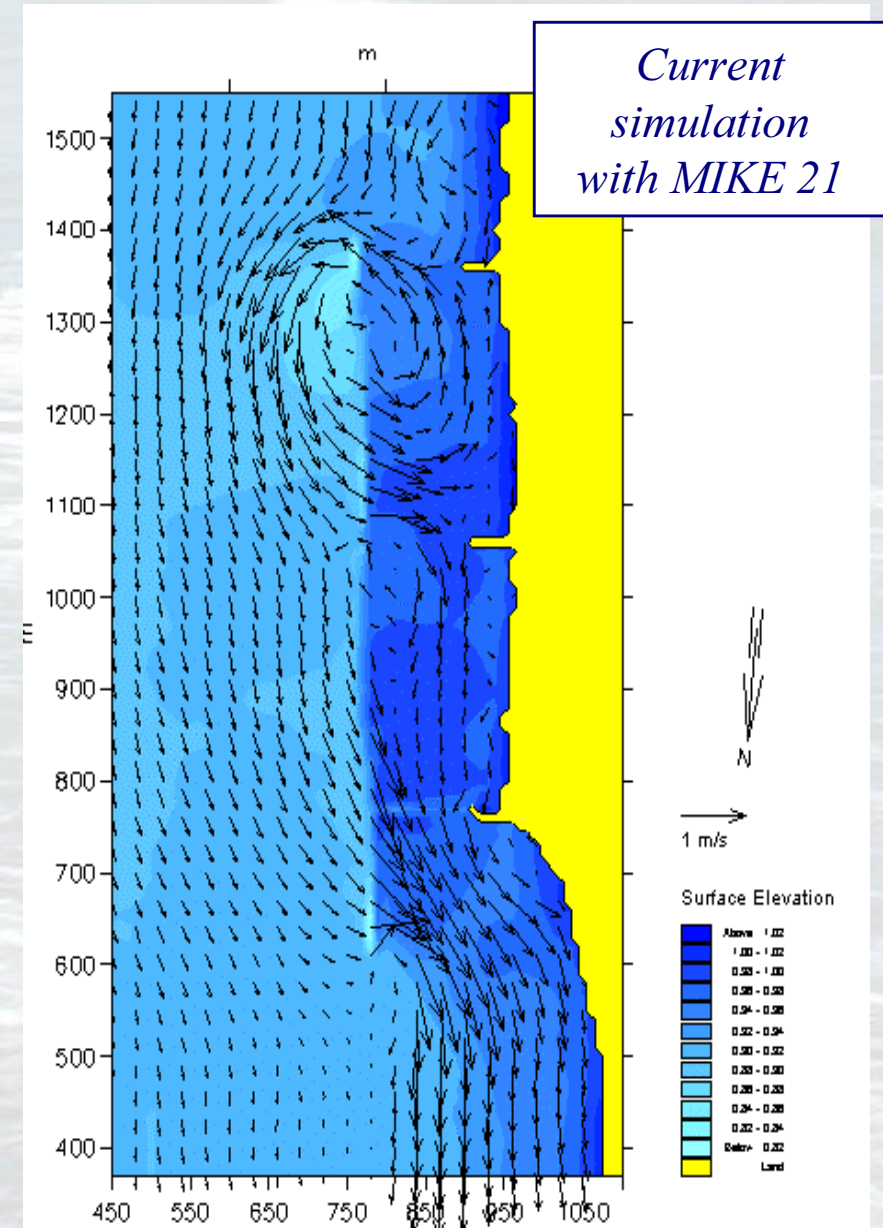
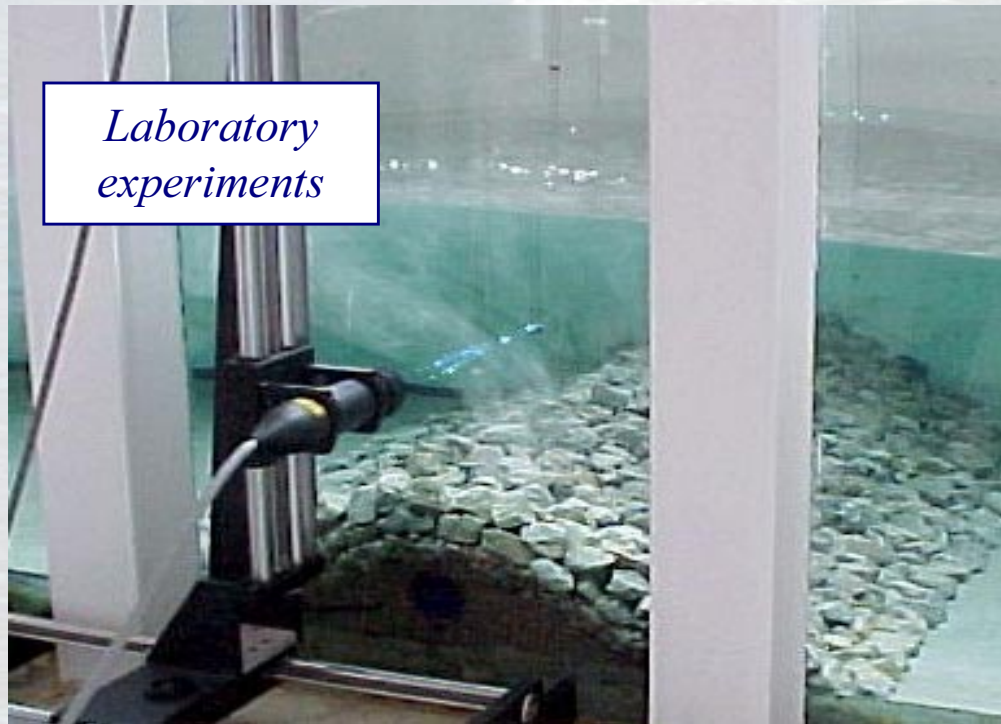




TASK 2

Objectives:

- to analyse structure hydrodynamic and stability
- to provide relationships among water level, discharge and wave characteristics at both sides of the structure
- to analyse currents induced by breaking over the structures and their effects on beach morphology, both near to the structure and over the protected beach, up to the swash limit.





TASK 3

Objectives:

➤to identify, quantify and forecast the impacts of low-crested breakwaters on the biodiversity and functioning of coastal assemblages of animals and plants at a range of spatial (local, regional and European) and temporal (months to years) scales and in relation to different environmental conditions (including meteorological conditions, tidal range, wave action, human usage, surrounding habitats).





TASK 4

Objectives:

- to develop criteria to build in and to transfer Contingent Valuation (CV) monetary values of changes in environmental quality from other case studies in Europe
- to determine the implications for benefit transfer across countries in the European Union (EU) for specific empirical situations

Monetary values are obtained from:

- Literature
- Four CV cases carried out within the Project:

Lido di Dante, Pellestrina, Trieste, Petten



TASK 5

The objective of this Research Task is to develop environmentally sound design guidelines for the design of low crested coastal structures. Production of guidelines is considered an efficient way of presenting the project results in an operational and user-friendly form. Moreover, the design guidelines are an important part of the dissemination of the results.

The design guidelines will be shaped to the needs of potential end-users such as coastal authorities and design offices.

The design guidelines will address design criteria, design procedures and design tools related to:

- Coastal protection performance
- Ecological performance
- Socio-economical performance, including recreational value and environmental quality



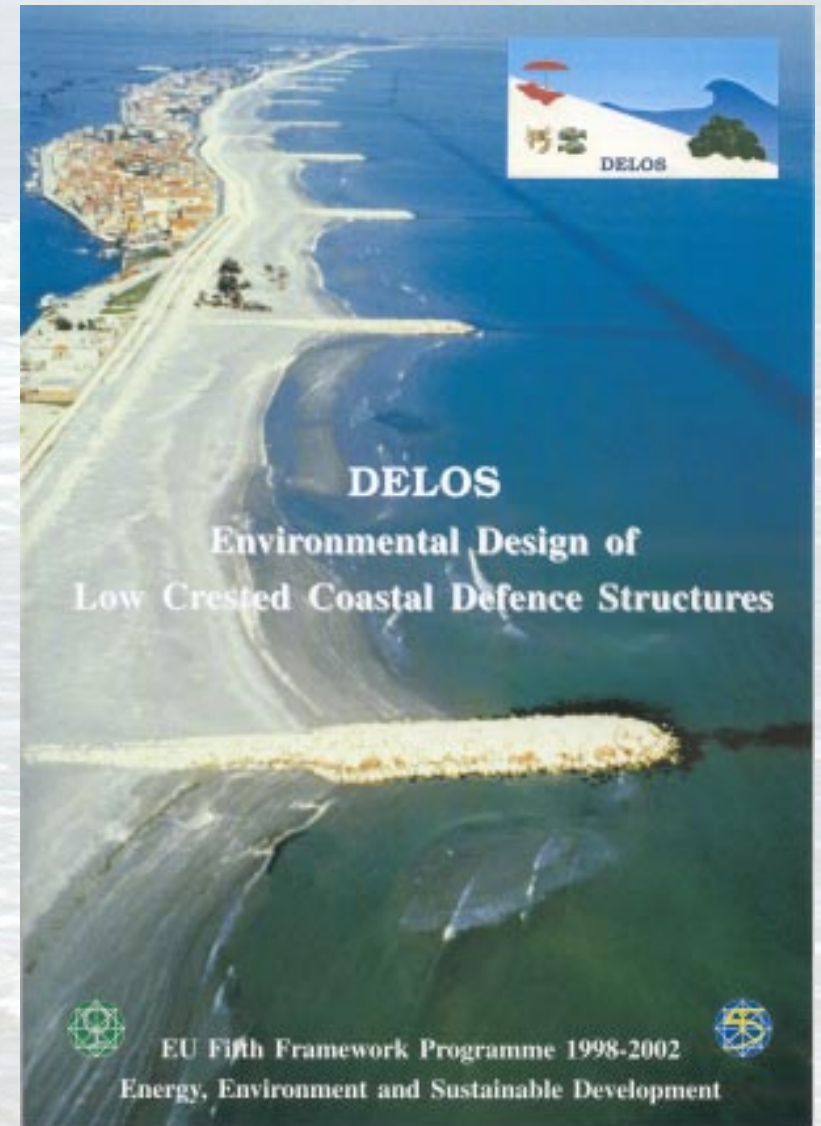
TASK 6

Objective:

➤ to establish communication among partners and with end users.

✓ Project web page: www.delos.unibo.it (D7)

✓ Project leaflet (D8)



Monographic volumes

Design guidelines

Public informative booklets