

DELOS

Environmental Design of Low Crested Coastal Defence Structures



EU Fifth Framework Programme 1998-2002
Energy, Environment and Sustainable Development



APPROACH

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

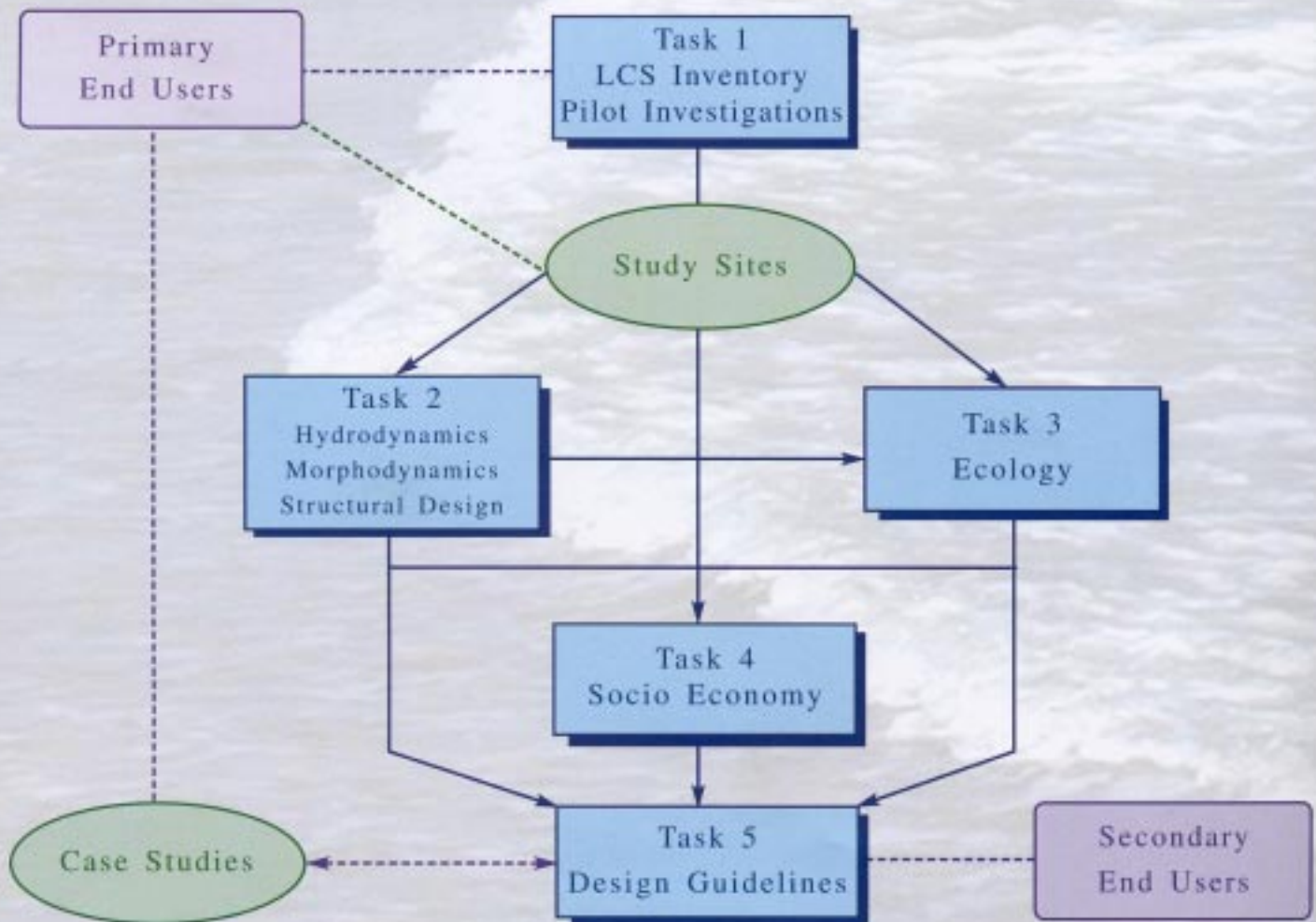
DELOS, which involves 18 partners from 7 European countries, offers the possibility to achieve this aim through integrated collaboration among engineers, who design coastal defence systems, coastal oceanographers, marine ecologists, economists and political institutions, who are operationally responsible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

OBJECTIVES

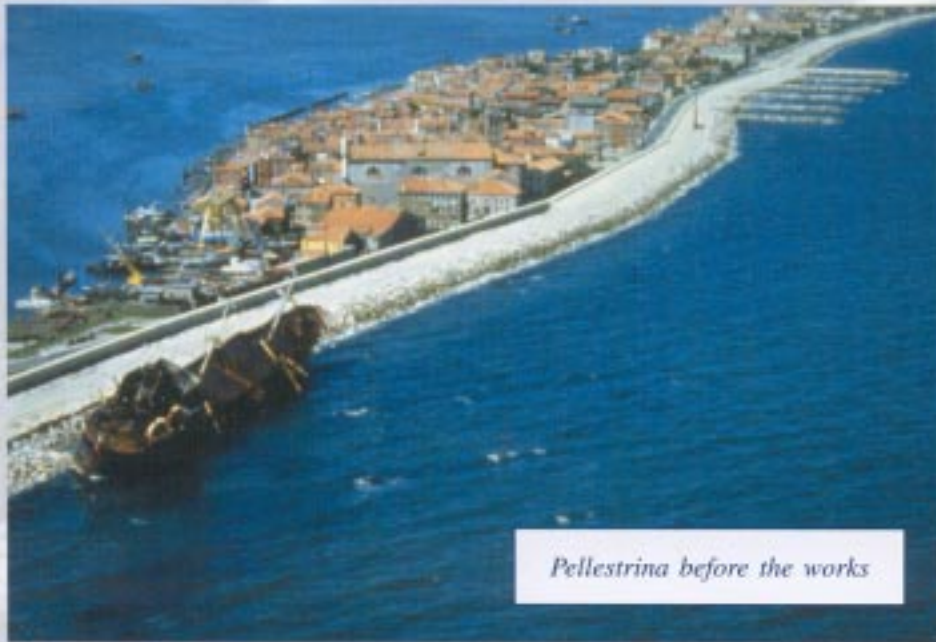
Specific objectives and methods of DELOS are:

- 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 to quantify benefits for "Integrated Coastal Zone Management" based on Contingent Valuation monetary values obtained in different European countries;
- 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.

STRUCTURE



MOTIVATIONS



Pellestrina before the works

Long stretches of the European coastline are threatened by erosion and flooding and, at the same time, their economic importance grows due to concentration of population in coastal areas. Coastal defence structures are designed by transposing at a lower scale techniques and results mainly derived for breakwaters, with little attention paid to the fact that wave load parameters and tidal range do not scale down. In particular, these structures are low and result severely overtopped at high tide and frequently submerged, causing currents and relevant beach modifications.

The project origins from two observations:

- defending the coast from erosion becomes more and more widespread, often in seas presenting problems as far as water quality is concerned, whereas the environmental effects of the defence system are only supposed, in absence of a positive scientific demonstration. For instance, the proliferation of hard defence coastal structures, by enhancing as stepping hard substrate communities, which may act as stepping stones for the dispersal of invading species, could result in relevant environmental implications.
- coastal defence structures are often constructed as low rubble mound structures, showing two peculiar characteristics: in the sandy coast, they form structures similar to rocky reefs; as low and heavily overtopped structures they generate water circulation and effects on the beach that are not quantitatively described by available wave theories essentially based on mild slope approximation.

As long as hydrodynamic, morphodynamic and ecological problems posed by low crested structures are not clarified, unsuccessful design will be frequent (insufficient retention of sand, erosion in gaps or at the roundheads, etc.) and unexpected ecological effects, not properly accounted for - either negative (invading species) or positive (rocky reefs breeding environment for fishes, water oxygenation) - could take place.

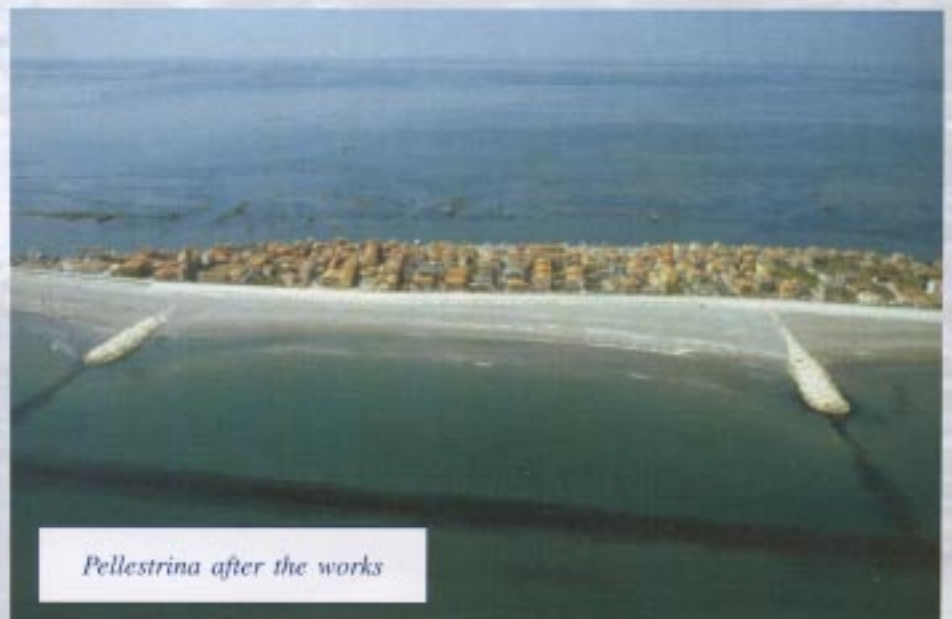
EXPECTED IMPACTS

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.

Short to medium term employment benefits are also expected as a consequence of economic benefits, strictly related to the quality and integrity of the beaches themselves that DELOS aims to guarantee through the identification of secure and environmentally friendly design guidelines for coastal defence systems.

The methodologies and tools developed will contribute to improve the design of coastal defence structures and will help the authorities to implement national and EU environmental regulations.

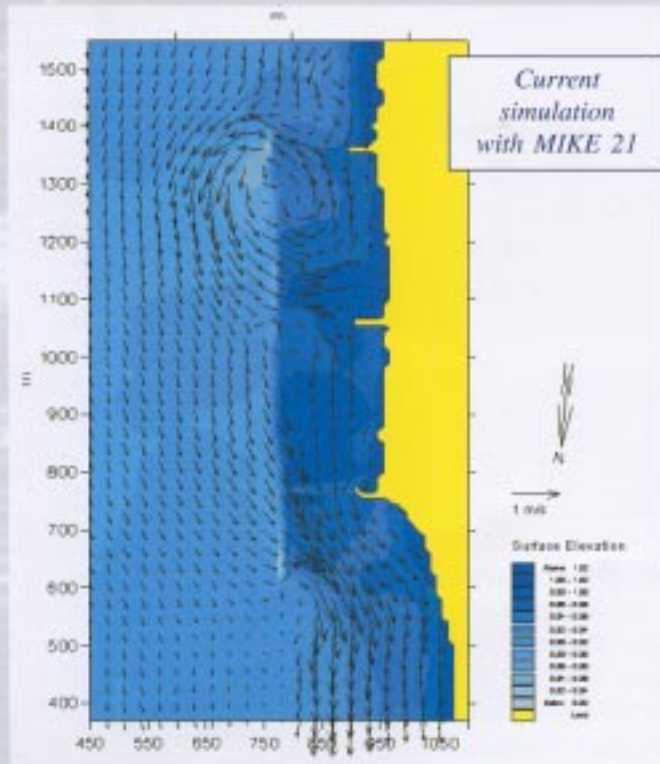


Pellestrina after the works

TASK OVERVIEW

The work is grouped in six integrated Research Tasks, which aim to achieve specific objectives:

➤ **Task 1:** 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.



➤ **Task 2:** 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. This shall be done by observation on sites, by laboratory experiments in wave channel and wave basin and by numerical modelling.

➤ **Task 3:** 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:** to develop a general methodology for Integrated Coastal Zone Management linking economic and environmental components, based on Contingent Valuation monetary values obtained in different countries in Europe and on criteria for transferring them from one country to the other, accounting for the effects of situations specific to each country.

➤ **Task 5:** to provide guidelines for an environmental design of such structures, based on practical experience, on the most recent scientific results regarding the structure hydrodynamics and stability, water circulation and beach morphology, impacts on coastal assemblages, and accounting for human perception and related economic effects; guidelines will be verified by application to the study sites and selected case studies.

➤ **Task 6:** to establish communication among partners and with end users.

STUDY SITES

The North-western Jutland coast of Denmark is a medium sand sedimentary coast including boulder reefs of morainic origin, open to strong sea waves and subject to low tide excursions. The harbour of **HIRTSHALS** was built in one strong point, near to a natural boulder reef that can be seen in the upper left corner of the image marked by breakers. The site offers a good occasion to compare biota developed in a natural reef and a mound breakwater, that are near one to the other and equally exposed to the sea.



The Southern coast of England is characterised by rock outcrops and relevant tide excursion. **ELMER** presents a beach renourishment with shore parallel breakwaters to reduce wave energy and modify the nearshore wave climate.

Images present the site at high tide (on the left) and at low tide (on the right); both images are Published with permission of Arun District Council, UK.

On the same coast, Portland and other structures between Plymouth and Southampton will be studied.

Broadscale surveys will be undertaken on the fish tailed groynes that protect the Wirral, Merseyside.



Northern Adriatic Italian coast is a low fine sandy beach exposed to a moderate Mediterranean wave climate and low tide excursion. In **LIDO DI DANTE** (Ravenna, image on the right) and **PELESTRINA** (Venice, image on the front page) nourishments protected by submerged barriers were completed in the recent past and monitoring projects are carried out on national funds.

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PARTICIPATION

Institution & Location	Contact Person	Acronym, Nation Role
University of Bologna, DISTART Viale Risorgimento 2, 40136 Bologna, Italy http://www.idraulica.ing.unibo.it	Alberto Lamberti Tel: +390512093749; Fax: +390516448346 Mail: alberto.lamberti@mail.ing.unibo.it	UB, I Coordinator Task 6 Leader
Fondazione Flaminia, LES Via Tombei dall'Ova 55, 48100 Ravenna, Italy http://www.ambra.unibo.it/asili/ecolab/page/ecologia.htm	Marco Abbiati Tel: +390544218616; Fax: +39054431204 Mail: abbiati@delfino.ambra.unibo.it	FF, I
University of Roma 3, DSIC Via V. Volterra 62, 00146 Roma, Italy http://www.uniroma3.it/inge.htm	Leopoldo Franco Tel: +390655175024; Fax: +390655175034 Mail: leofranc@fenice.dsic.uniroma3.it	UR3, I
Modimar srl. Via Monte Zebio 40, 00195 Roma, Italy http://www.modimar.it	Alberto Noli Tel: +39063269461; Fax: +390636000789 Mail: modimar_srl@iol.it	MOD, I
Aalborg University, Dept. of Civil Engineering Sohngaardsholmsvej 57, 9000 Aalborg, Denmark http://www.civil.auc.dk	Hans Burcharth Tel: +4521420522; Fax: +4598142555 Mail: burcharth@civil.auc.dk	AAU, DK Task 1 and 5 Leader
Technical University Denmark, ISVA Bygningstorvet Building 115, Kongens Lyngby DK 2800 Denmark http://www.isva.dtu.dk	Jorgen Fredsøe Tel: +4545251407; Fax: +4545936328 Mail: jf@isva.dtu.dk	ISVA, DK
DHI Water & Environment Ager Allé 11, Hørsholm DK-2970, Denmark http://www.dhi.dk	Julio A. Zyserman Tel: +4545169176; Fax: +4545169292 Mail: jaz@dhi.dk	DHI, DK
University of Cantabria, E.T.S.I de Caminos, Canales y Puertos Avda. de los Castros s/n, 39005 Santander, Spain http://www.gioc.unican.es	Cesar Vidal Tel: +34942 201810; Fax: +34942 201860 Mail: vidal@puer.unican.es	UCA, E Task 2 Leader
Consejo Superior de Investigaciones, Dept. of Aquatic Ecology Cami de Santa Barbara S/N, 17300 Blanes, Spain http://www.ceab.csic.es	Daniel Martín Tel: +34972336101; Fax: +34972337806 Mail: dani@ceab.csic.es	CSIC, E
Technical University of Catalonia, LIM/UPC Jordi Girona 1-3, Barcelona 08034, Spain http://lim-ciire.upc.es	Agustin S. Arcilla Tel: +34934016468; Fax: +34934011861 Mail: agustin.arcilla@upc.es	UPC, E
Göteborg University, Marine Botany PO Box 461, SE 405 30 Göteborg, Sweden http://www.botinst.gu.se	Per Åberg Tel: +46317732707; Fax: +46317732727 Mail: per.berg@marbot.gu.se	UGOT, SE Task 3 Leader
University of Twente, MICS Po Box 217, 7500 AE Enschede, The Netherlands http://www.sms.utwente.nl	Anne van der Veen Tel: +31534893213; Fax: +31534894040 Mail: A.vanderVeen@bsk.utwente.nl	UTW, NL Task 4 Leader
Delft Hydraulics, WL PO Box 177 Rotterdamseweg 185, Delft 2600 MH, The Netherlands http://www.wldelft.nl	Mindert De Vries Tel: +31152858801; Fax: +31152858582 Mail: Mindert.deVries@Wldelft.nl	WL-DH, NL
Infram ltd, Geomatics Business Park PO Box 16 Voesterweg 28, 8326 PT Marknesse, The Netherlands http://www.infram.nl	Jentsje W. van der Meer Tel: +31527 242341; Fax: +31527241119 Mail: jentsje.vandermeer@infram.nl	INF, NL
University of Southampton, SOES Oceanography Centre SO14 3ZH Southampton, United Kingdom http://www.soc.soton.ac.uk	Michael Collins Tel: +442380592786; Fax: +442380593052 Mail: mbc@soc.soton.ac.uk	US, UK
Marine Biological Association (with University of Plymouth) The Laboratory Citadel Hill, Plymouth PL1 2PB, United Kingdom http://www.mba.ac.uk	Stephen Hawkins Tel: +441752633331; Fax: +441752669762 Mail: sjha@mba.ac.uk	MBA, UK
Aristotle University Thessaloniki, Dept. of Civil Engineering University Campus, Egnatia Str., 54006 Thessaloniki, Greece http://www.civil.auth.gr	Christofer Koutitas Tel: +3031995701; Fax: +3031995658 Mail: koutitas@civil.auth.gr	AUTH, EL
University of Aarhus, Dept. of Marine Ecology Finlandsgade 14, Aarhus N DK-8200, Denmark http://www.biology.au.dk	Grete E. Dinesen Tel: +4589424394; Fax: +4589424387 Mail: grete.dinesen@biology.au.dk	BIAU, DK