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European Regional Development Fund

EUROPEAN UNION

Triton

L'EROSIONE DELLE SPIAGGE E LE OPERE PER LA DIFESA

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Alcune spiagge sono caratterizzate da avanzamento della linea di riva, altre da erosione.

Perchè ?

Da dove proviene il sedimento di spiaggia ?

Da dove proviene il sedimento di spiaggia ?

Da depositi di sedimenti di erosione continentale per processi glaciali, fluviale, eolici, di versante e gravitativi

formazione della *spiaggia*

la morfologia della costa è sempre il risultato di due azioni concomitanti: l'apporto di sedimenti dall'entroterra e la loro ridistribuzione ad opera del moto ondoso.

Sedimenti dai corsi d'acqua

Materiale eroso da un corso d'acqua

Delta del Mississippi

Quando il corso d'acqua sversa in un grande ricettore si verifica la riduzione dell'intensità delle caratteristiche cinematiche e i sedimenti depositano.

Sedimenti trasportati dall’azione del moto ondoso

Le onde rimaneggiano il sedimento resosi disponibile alla foce e lo trasportano lungo il litorale

Sedimenti ottenuti dall'erosione della costa

I tratti di costa rocciosa esposti ad attacchi ondosi di forte intensità forniscono sedimenti alle spiagge limitrofe.

Black sand beach, Big Island, Hawaii

Dinamica dei litorali

Uno schema semplice

Il clima ondoso medio per il paraggio è una costante

Dunque, l'erosione è dovuta al deficit di apporti

Cause d'erosione dei litorali

- Bonifica delle aree palustri
- Estrazione di inerti da alvei fluviali
- Invasi artificiali
- Opere marittime
- Riforestazioni
- etc…

Un caso comune: le opere di sistemazione

Cambiamenti climatici - SLR

Come si muove il sedimento

- *Beach drift*
- *Longshore drift*
- *Cross-shore*

I fronti d'onda giungono con una certa obliquità in corrispondenza della riva.

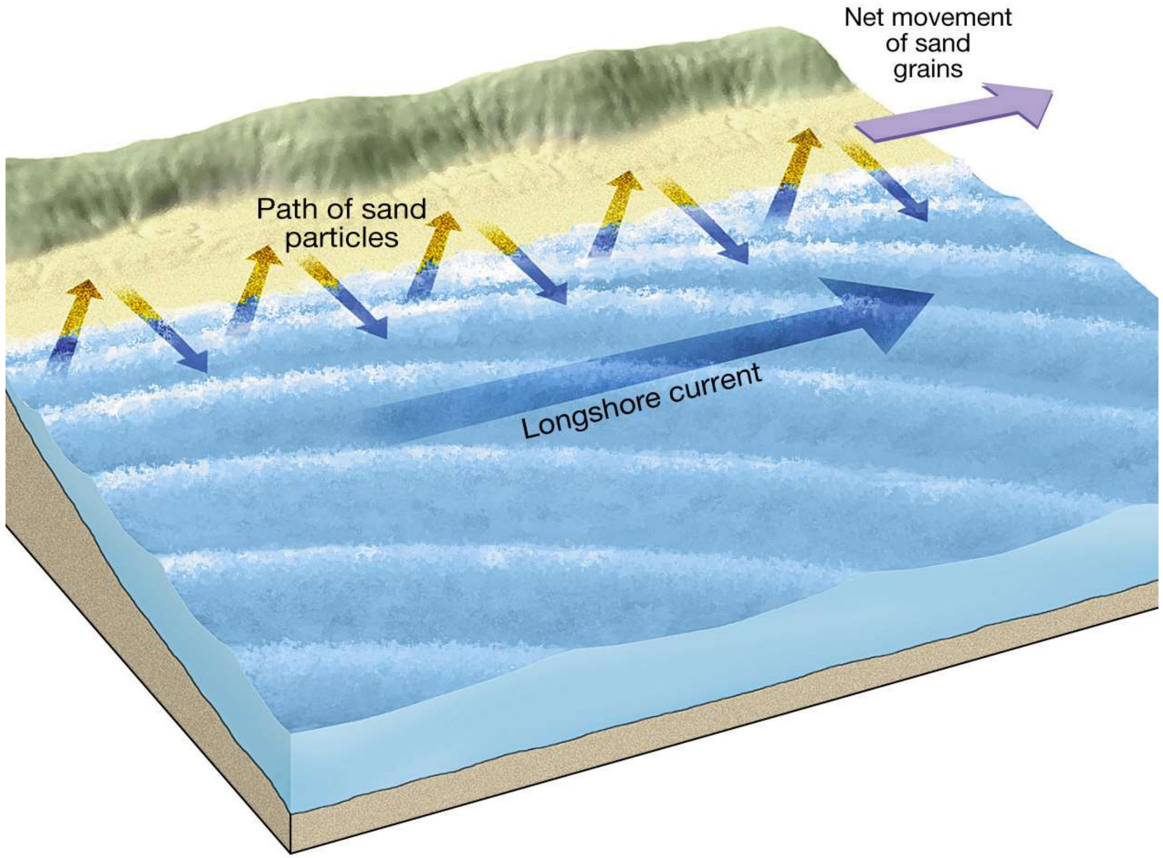
Beach drift

La risalita dell’onda sulla battigia (swash) è obliqua.

Il percorso del riflusso dell’onda è normale alla linea di riva.

Le particelle di sedimento compiono un percorso a zig-zag.

Il *beach drift* trasporta sabbia e ciottoli per centinaia o migliaia di metri al giorno.

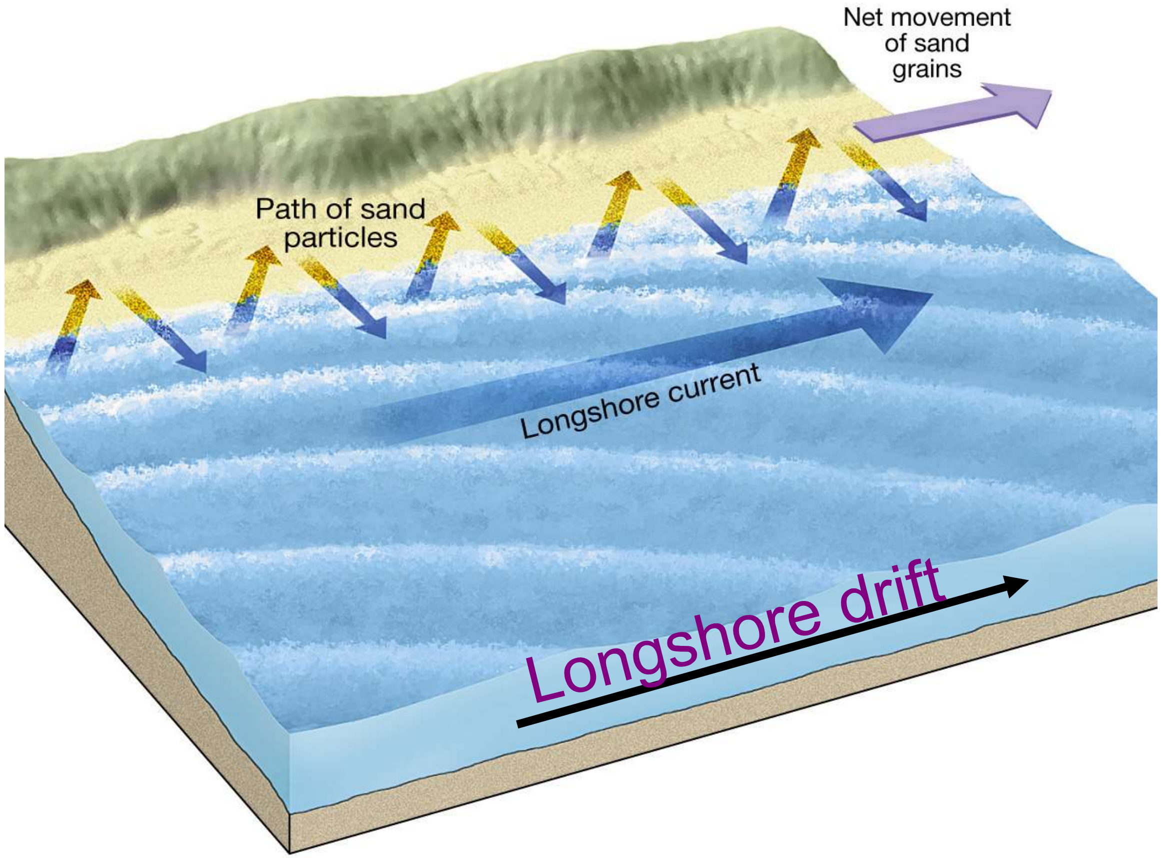


Longshore drift

In modo analogo, la corrente indotta dal moto ondoso agisce pressocché parallela alla riva. La corrente litoranea.

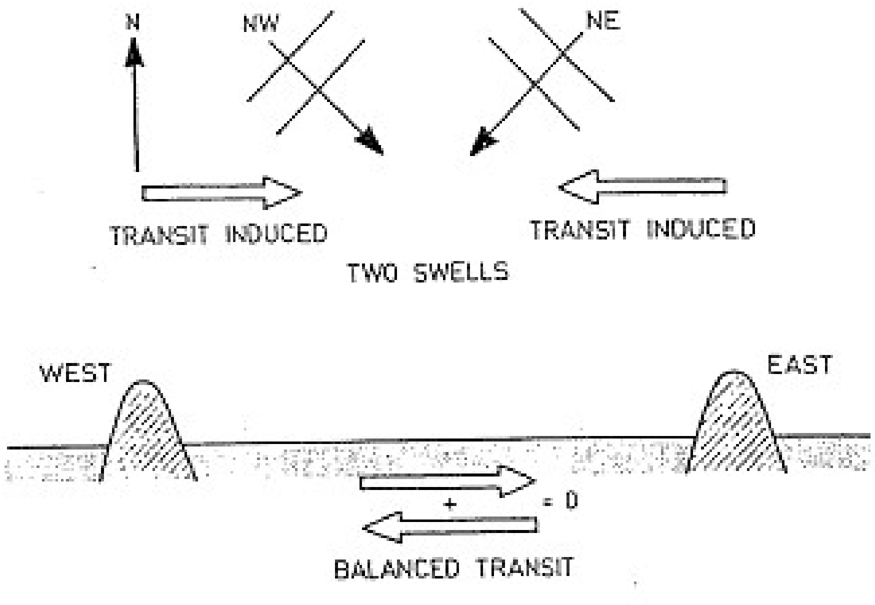
Essa induce il movimento dei sedimenti della spiaggia sommersa.

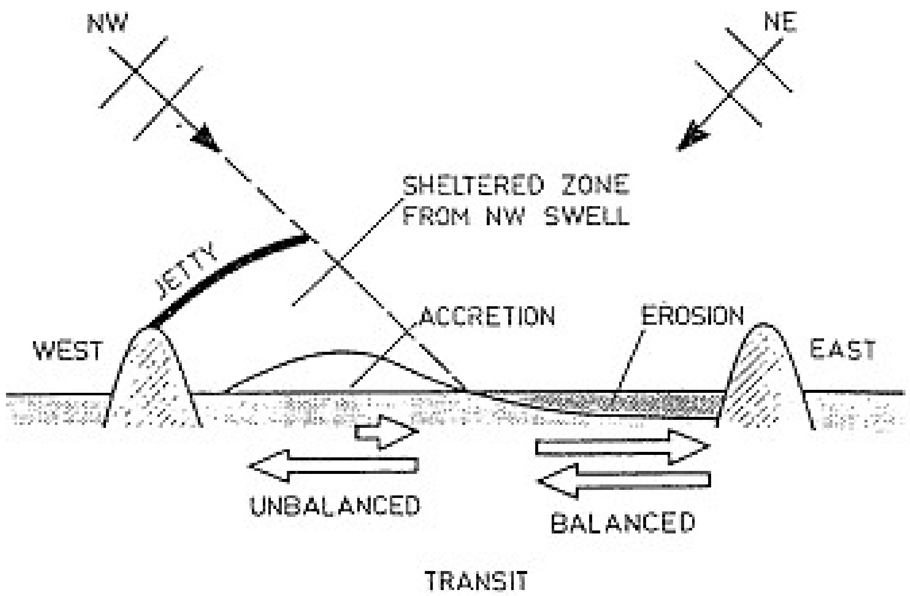
Si ha il trasporto litoraneo o *longshore drift*.

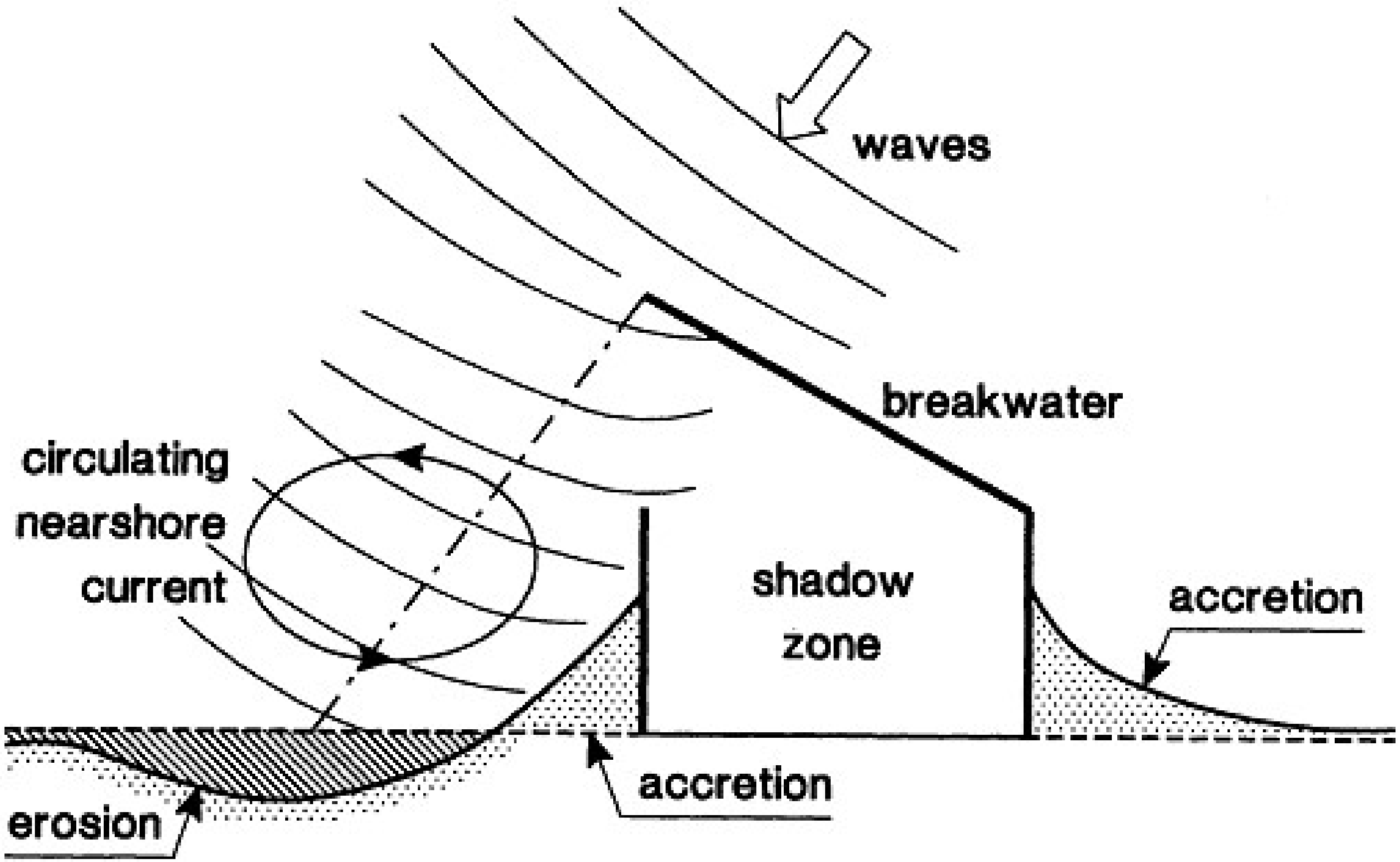


The Littoral Cell

Defined as a reach of shoreline in which all sediment transport processes are related. In theory, it has zero alongshore sediment flow past its updrift and downdrift boundaries.

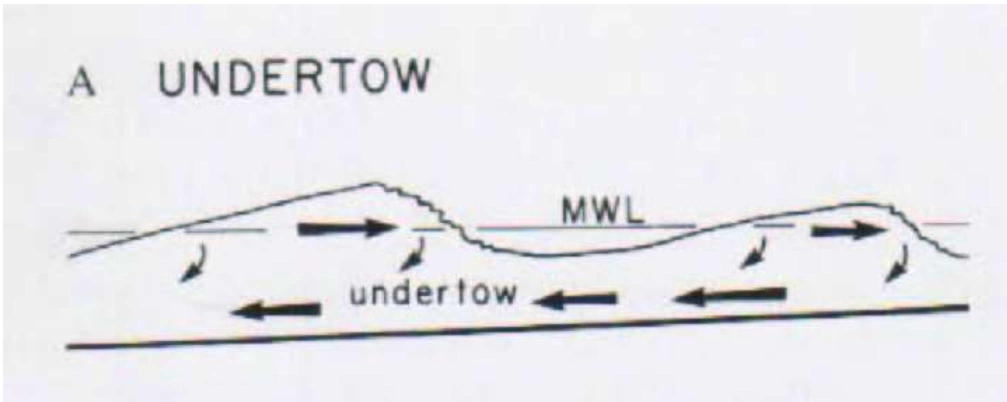


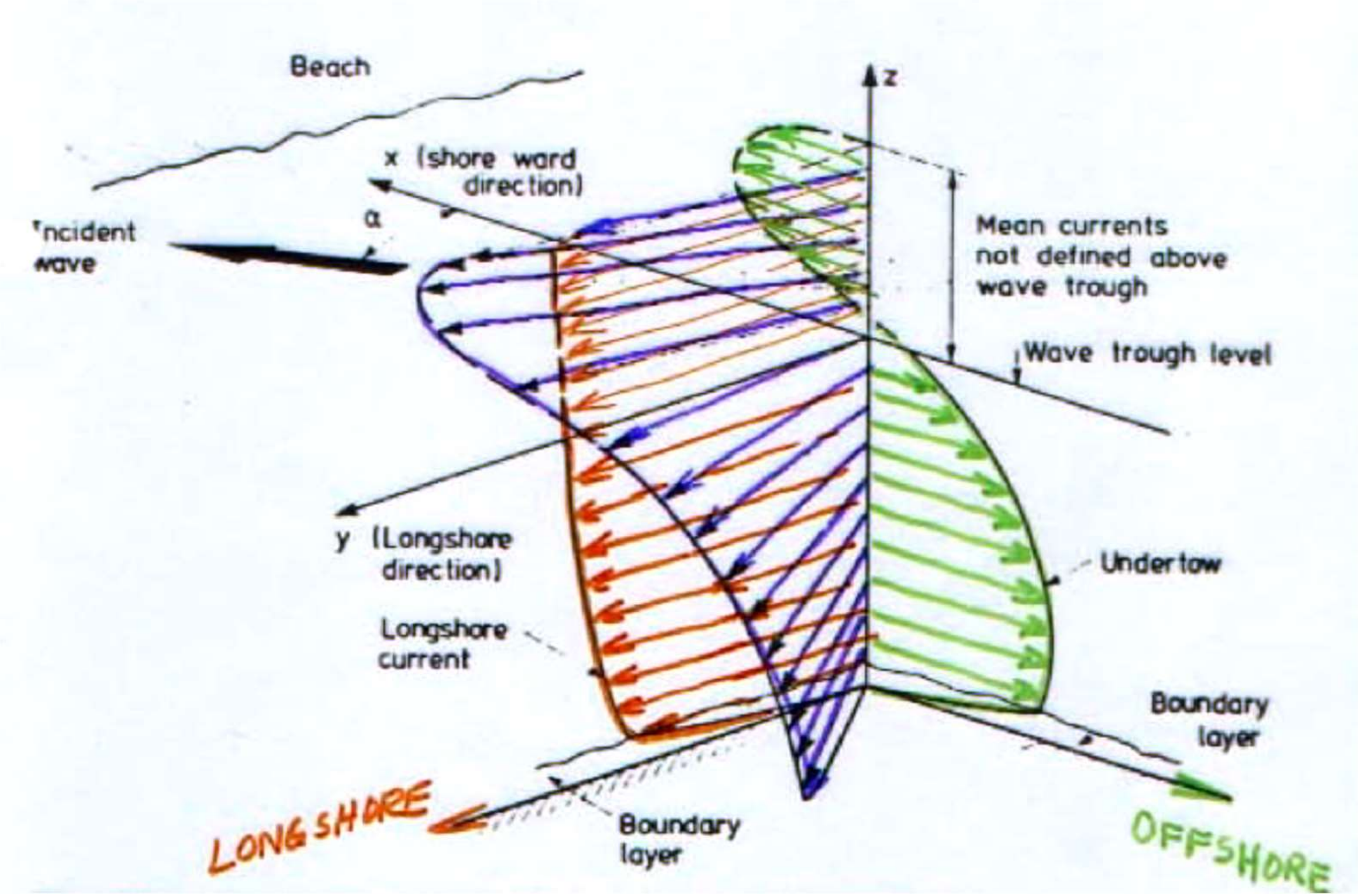



waves
breakwater
circulating
nearshore
current
shadow
zone
accretion
accretion
erosion

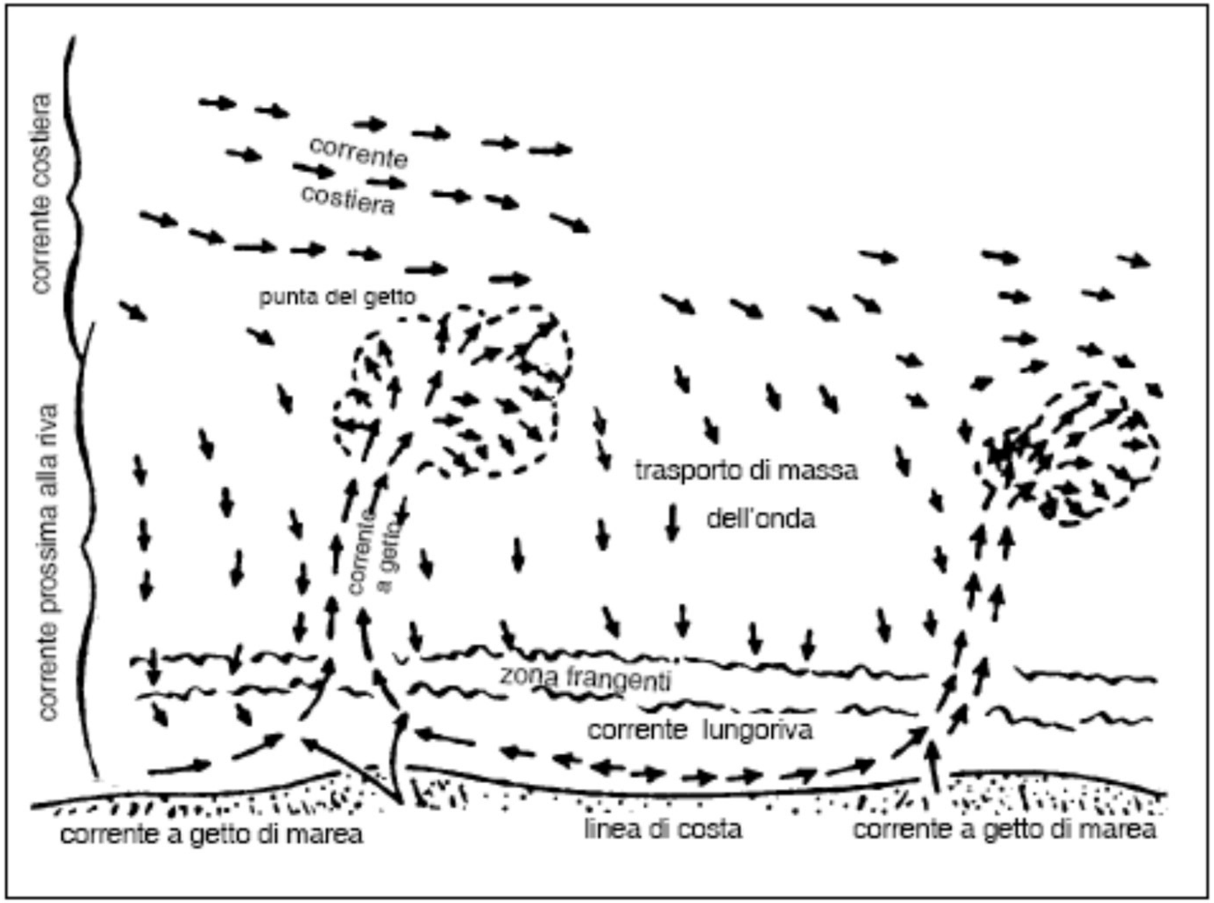
Trasporto trasversale (cross-shore)

Il frangimento dell'onda convoglia verso riva un volume d'acqua che, per bilancio di massa, tende a ritornare al largo tramite la cosiddetta corrente di ritorno o undertow.
In occasione di forti mareggiate l'undertow risulta di intensità tale da trasportare verso il largo cospicui volumi di sedimenti di spiaggia.





Il profilo a spirale della corrente come composizione della corrente litoranea, o longshore, con quella trasversale, o di undertow (da Svendsen e Lorenz, 1989)



Schema di circolazione tridimensionale in prossimità della spiaggia.
La lunghezza della freccia indica la intensità della corrente

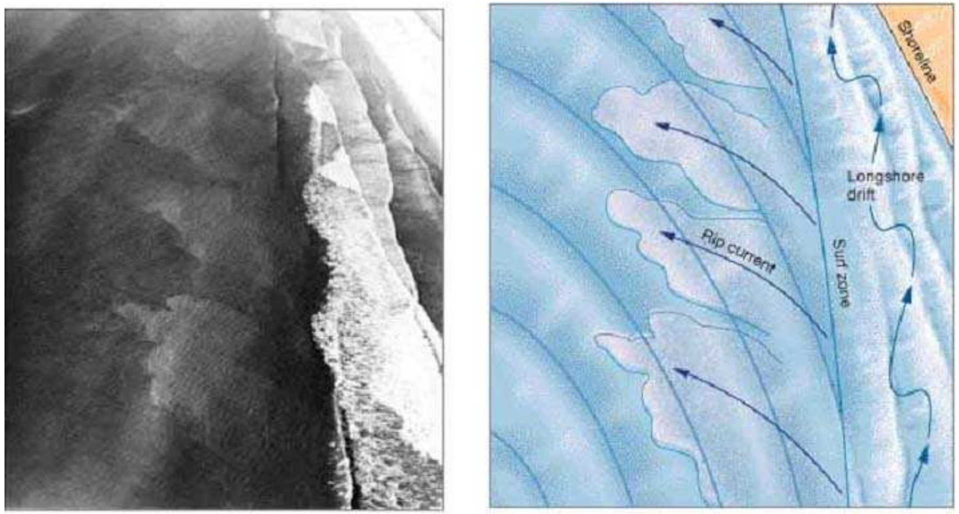
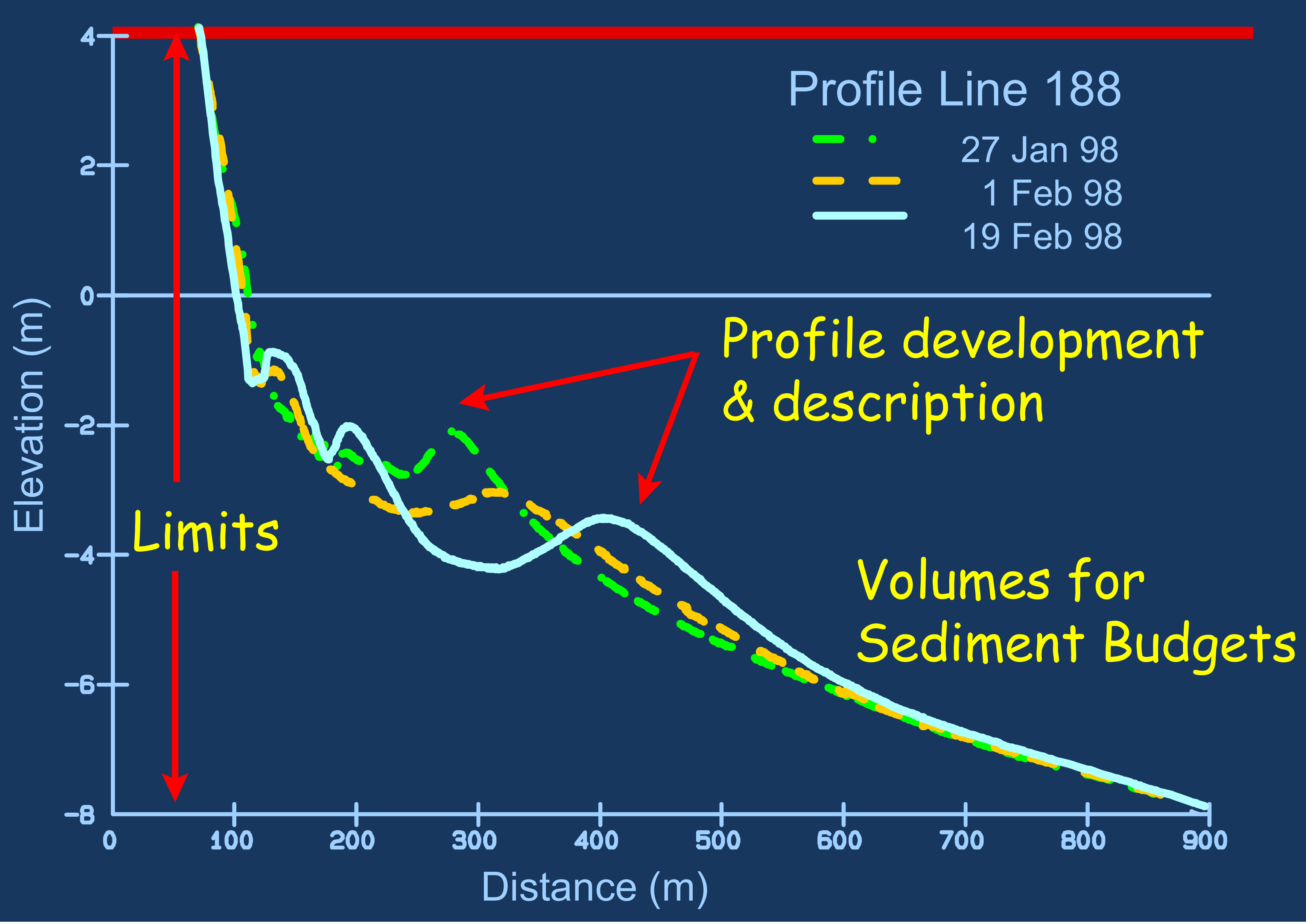


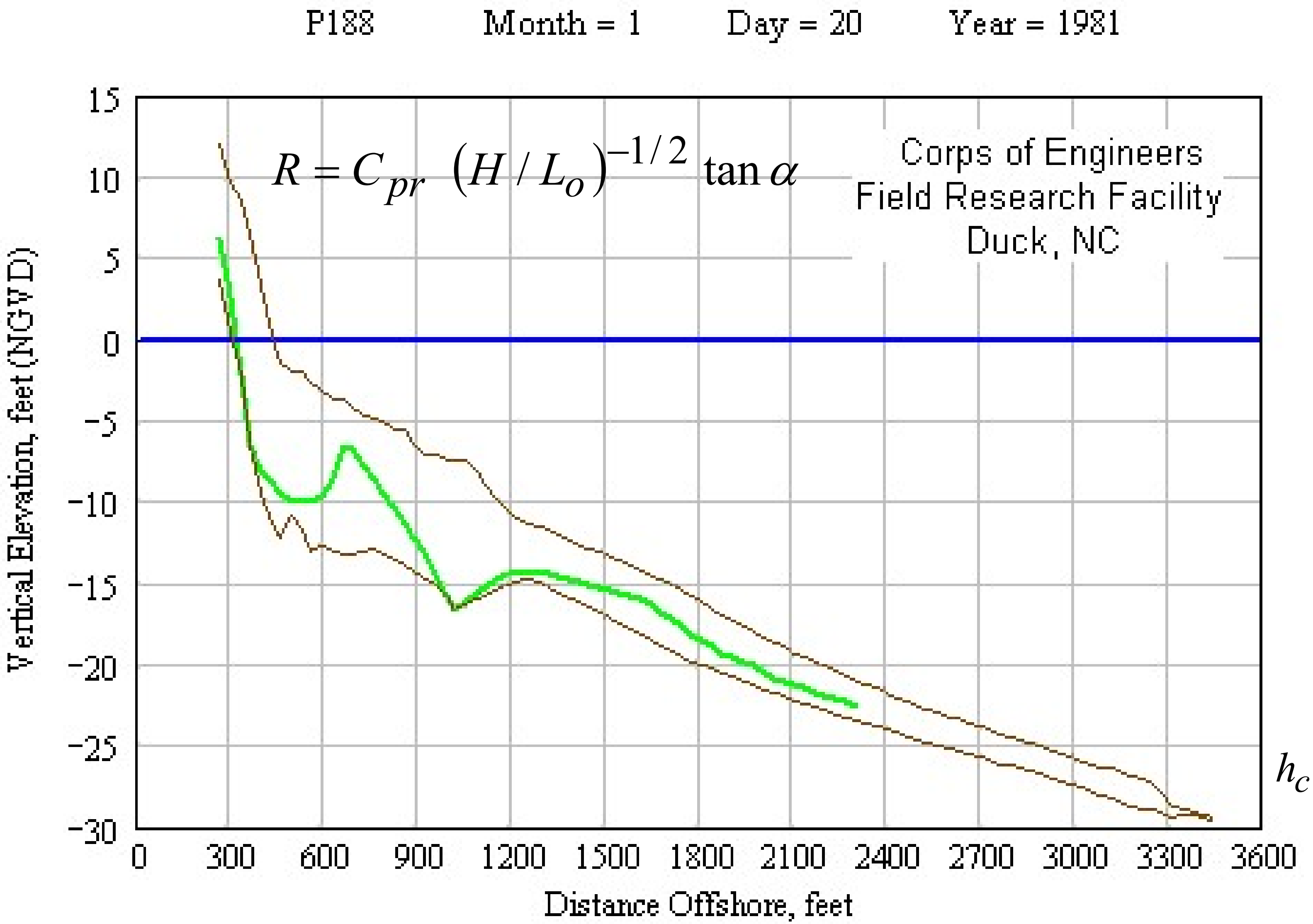
Foto in campo e relativo schema grafico delle rip currents

Foto in campo di rip currents

Active beach

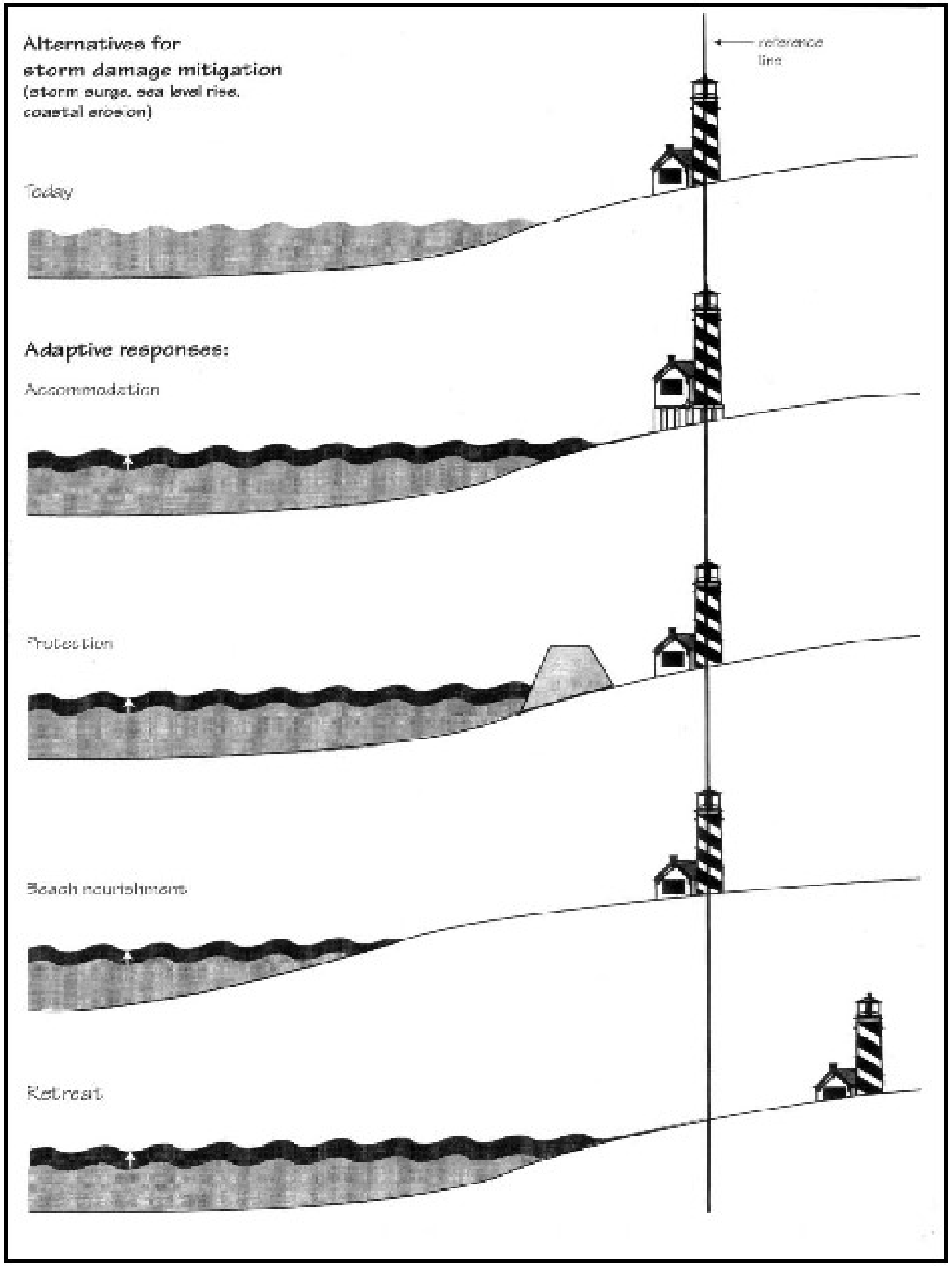


Animation of Beach Profiles 1981-1993



$$R = C_{pr} \left(H / L_o\right)^{-1/2} \tan\alpha$$

$$h_c \approx 2H_{o12}$$



WHAT TO DO ? STRATEGY ?

"no action"

adapt
(well known at areas with Hurricanes)

defence (hard or soft)

retreat

Opere marittime di difesa dei litorali

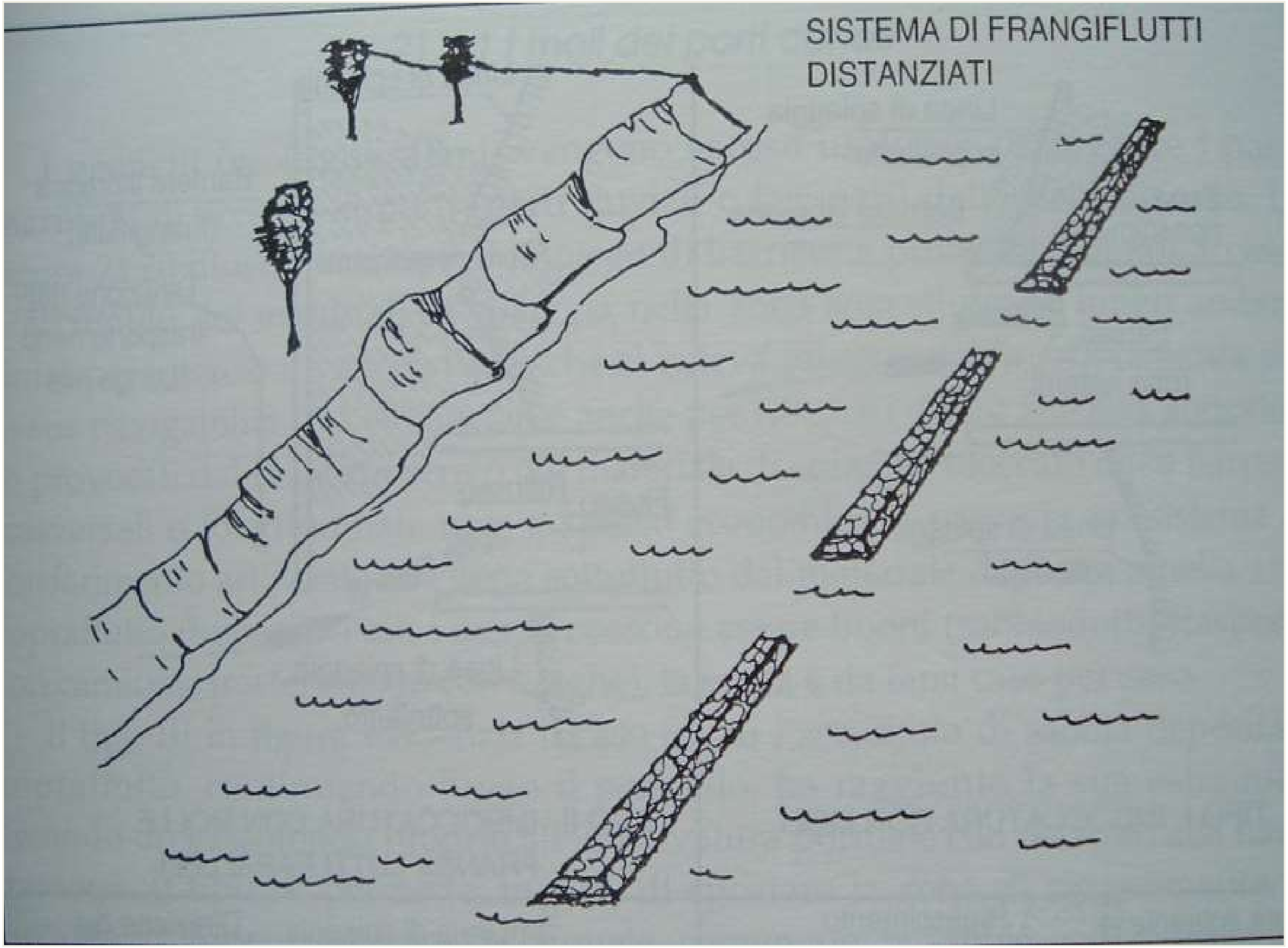
Opere rigide → Opere ortogonali (pennelli)

Opere rigide → frangiflutti paralleli e distanziati

Opere morbide → Ripascimento

Drenaggio della spiaggia

DETACHED RUBBLE MOUND BREAKWATERS



DETACHED RUBBLE MOUND BREAKWATERS

Detached breakwaters – Pescara – Adriatic Sea - Italy

DETACHED RUBBLE MOUND BREAKWATERS

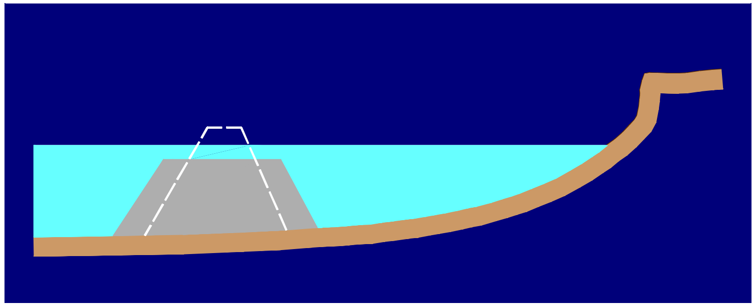
tombolos – sand beach *(Fano, Marche)*

DETACHED RUBBLE MOUND BREAKWATERS

DETACHED RUBBLE MOUND BREAKWATERS

salients – sand beach *(Termoli, Molise)*


Dighe di tipo sommerso *(reef breakwaters)*



Submerged breakwaters at Fano (PU)

- After the 1993 and '94 sea storms, the Local Office for Maritime Works of the Ministry of Public Works designed a new intervention made of 5 submerged detached breakwaters for a total length of 725 m with a submergence of 0.50 m, a berm of 12 m, a seaward slope of ½ and a landward slope of 1/1.
- The construction ended late in 1998
- The submergence at the gaps is 1.5 m to allow navigation of small boats. The breakwater was composed of natural stones weighting 3000-5000 kg; it's parallel to the original shore-line with a distance from the seawall protecting the promenade in the range of 80 to 90 m.

An overall view from an aerial photo (1999)

Dighe di tipo sommerso

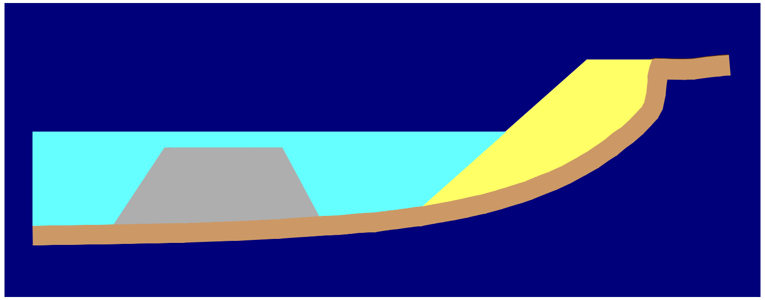
Dighe di tipo sommerso

Defence submerged structures of beach of Monte Marciano (AN)

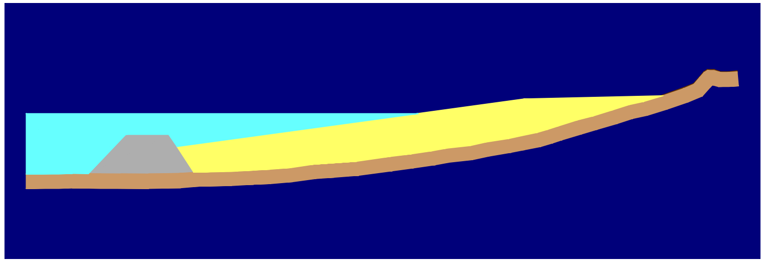
A volte si verifica un'erosione sottoflutto

Tipologie di submerged structures

RIPASCIMENTI PROTETTI DA FRANGIFLUTTI DI TIPO SOMMERSO



SPIAGGE SOSPESE

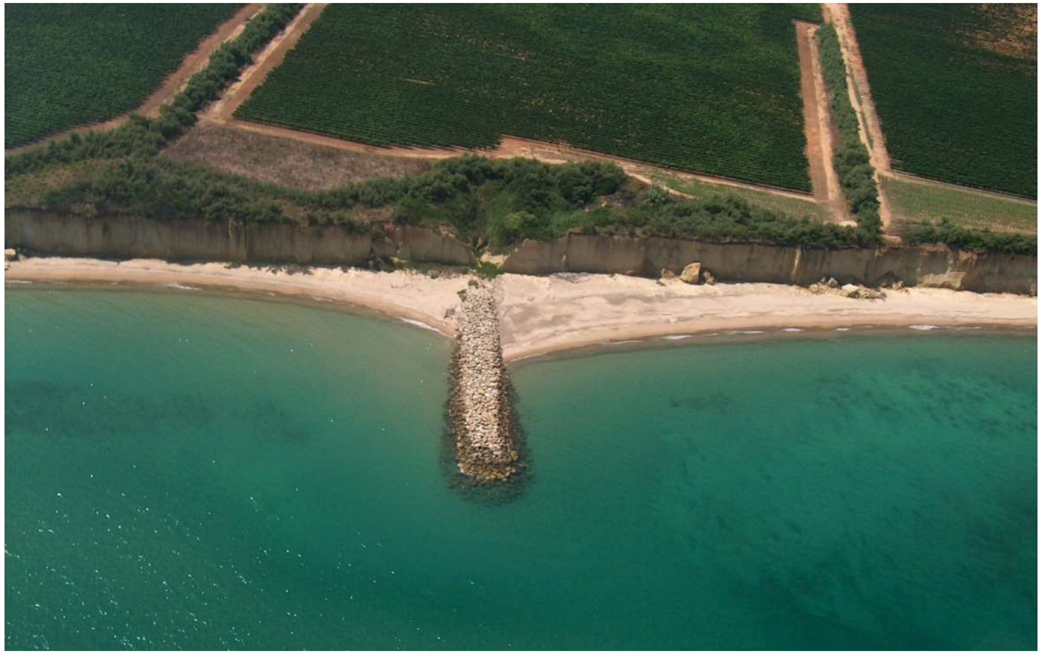


Submerged breakwaters

submerged breakwaters and groins

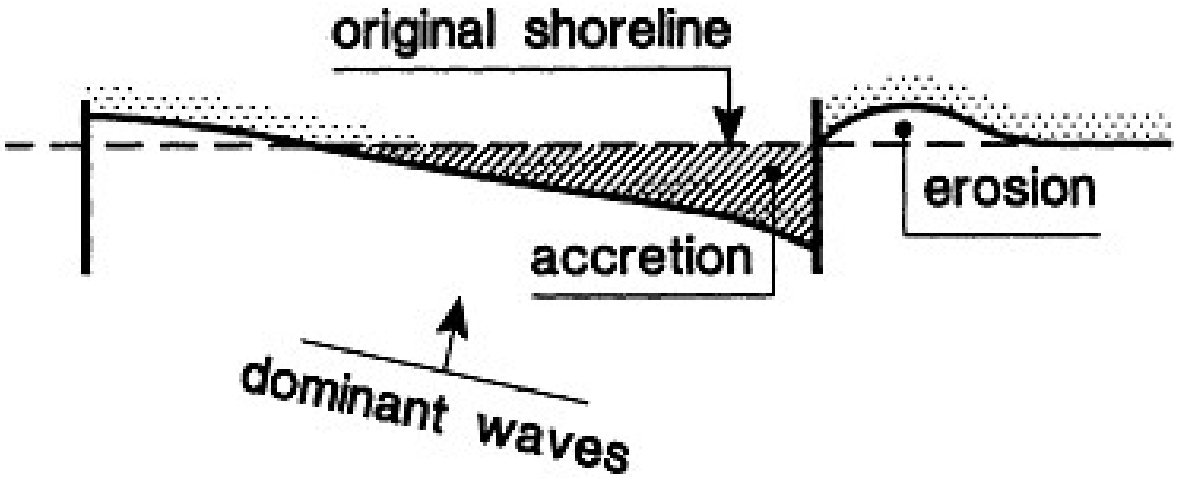

submerged coastal defence at Pellestrina - Venezia

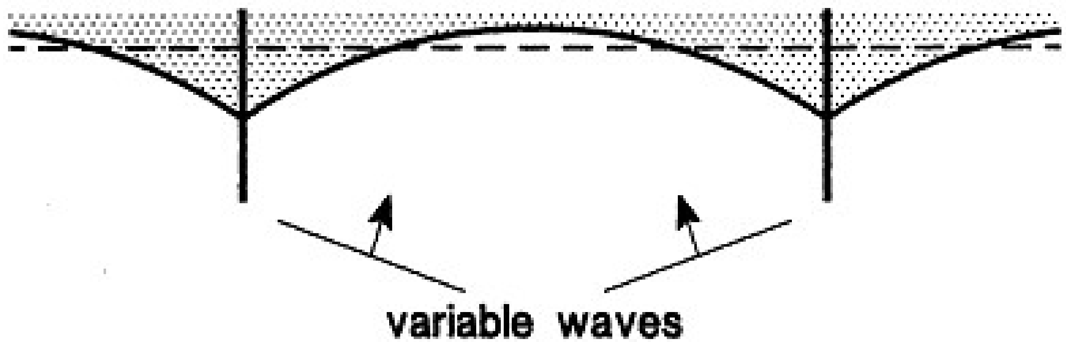
GROINS



HARD COASTAL STRUCTURES

Groins - Jesolo - Venice


original shoreline
erosion
accretion
dominant waves


variable waves

HARD COASTAL STRUCTURES

Weak points:

•profile steepening
• delayed beach recovery after storms
• increased longshore transport
• sand transport far offshore
• increase average, long-term erosion rate

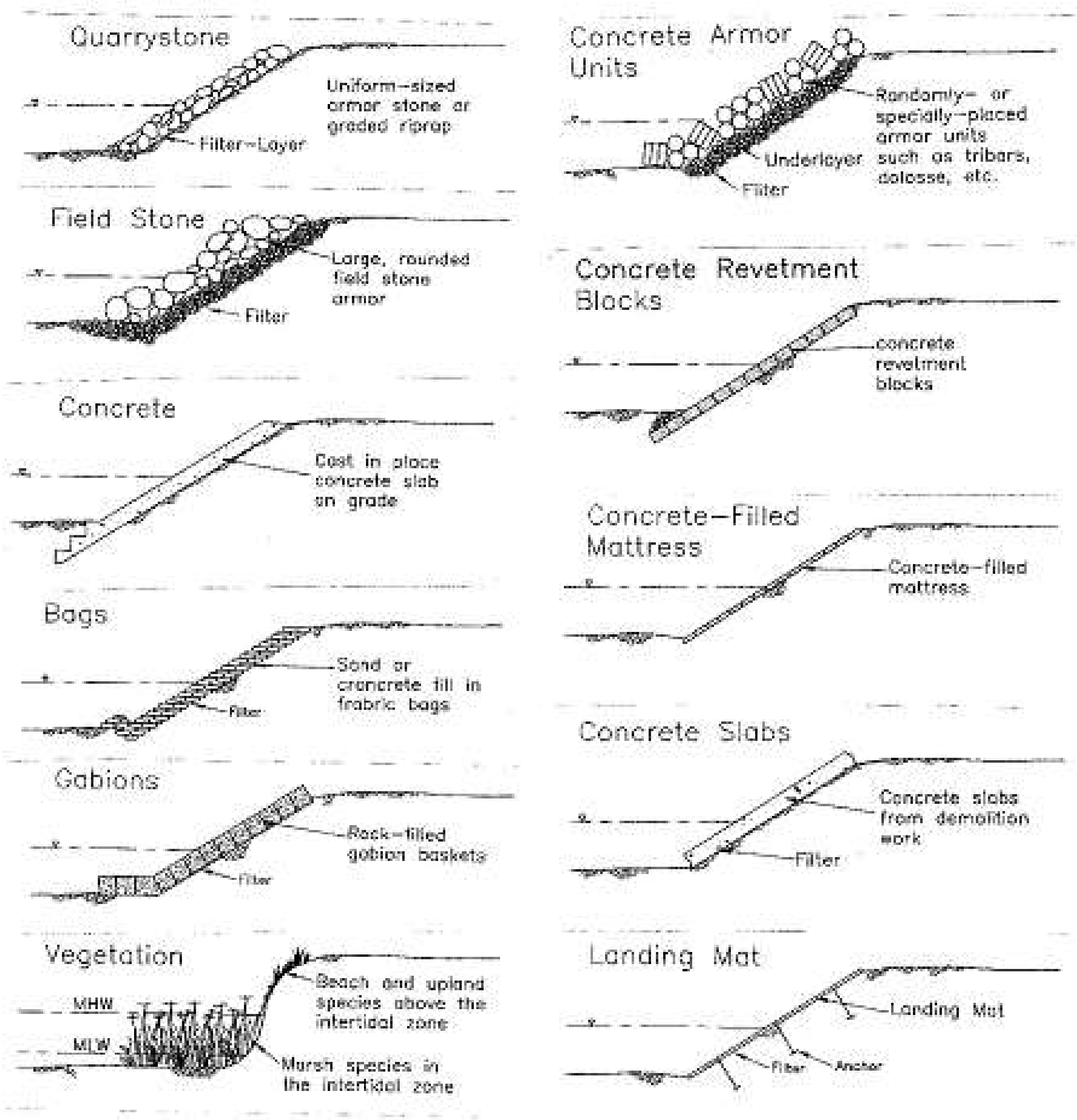


Figure V-3-8 Summary of revetment alternatives

Figure V-3-8 Summary of revetment alternatives (continued)

Caparica, Lisbon - SCACR Technical visit – June 2013

www.scacr.eu

BEACH NOURISHMENTS - SOFT STRUCTURES

"Artificial addition of suitable (in terms of beach quality) sediment to a coastal area that has a sediment deficiency in order to rebuild and maintain that beach at a certain width and height which provide storm protection and/or a recreation area"

(CBNP, 1995 – Committee on Beach Nourishment and Protection).

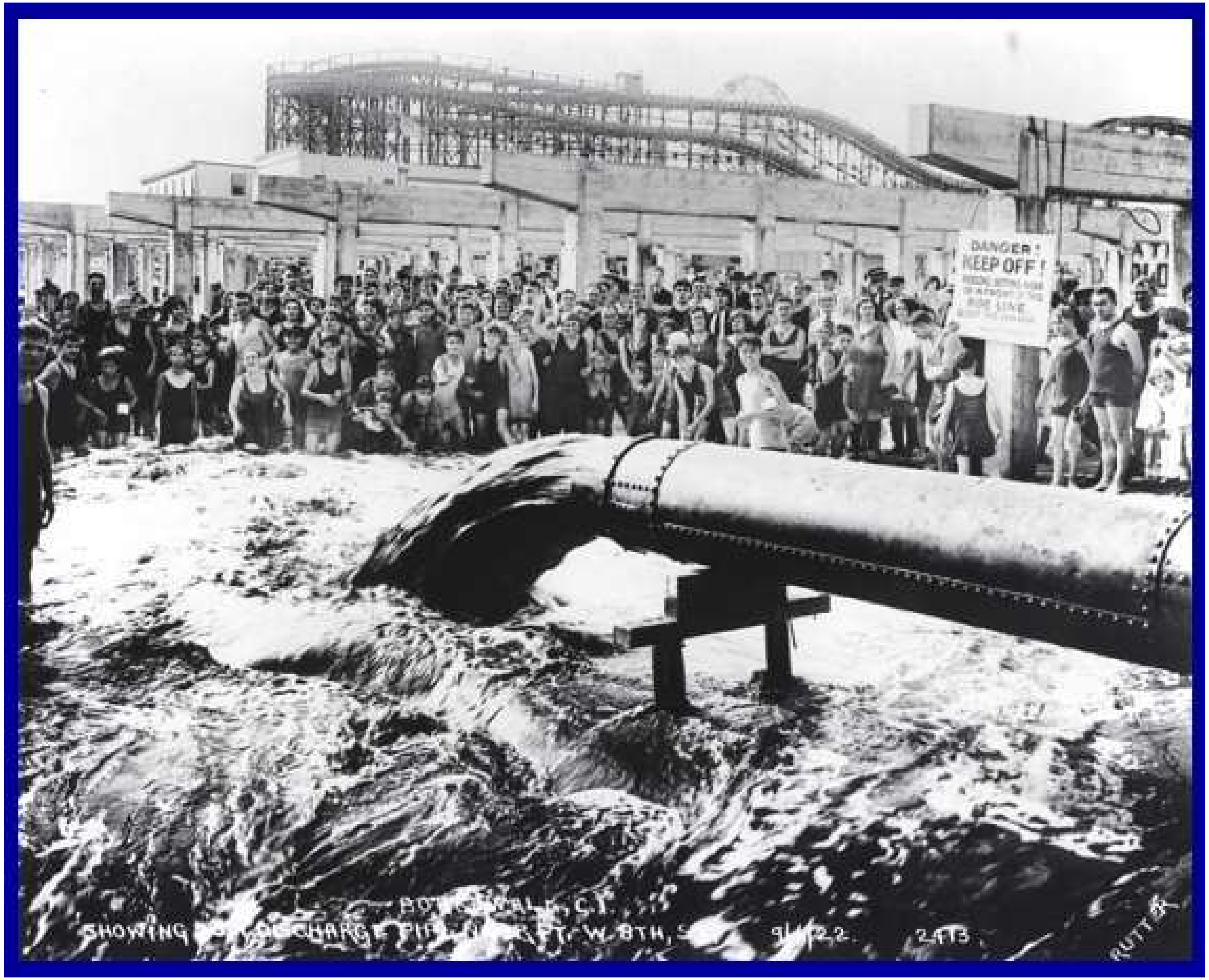
Beach Nourishment in Barcelona, spring 2008

Ripascimento

MATERIALE PROVENIENTE DA CAVE A TERRA

MATERIALE PROVENIENTE DA CAVE SOTTOMARINE

MATERIALE PROVENIENTE DA DRAGAGGIO NEI PORTI



Construction of first hydraulically pumped
beachfill at Coney Island NY, 1922

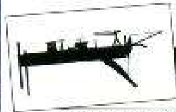
Figure I-3-10. Coney Island in 1941, on the eve of World War II. For only a 5-cent subway ride, workers from the sweltering city could relax at the beach (from Beach Erosion Board archives)

The oldest beach nourishment intervention was at Coney Island (New York), 1922-1923

VASCO DA GAMA

HOPPER DREDGERS

	Hoppercapacity
VASCO DA GAMA	33.000 m³
GERARDUS MERCATOR	18.000 m³
UNDER CONSTRUCTION (to be commissioned in January 2002)	16.500 m³
J.F.J. DE NUL	11.750 m³
ALEXANDER VON HUMBOLDT	9.000 m³
CRISTOFORO COLOMBO	7.000 m³
CAPITAN NUÑEZ	6.000 m³
SANDERUS	5.338 m³
MANZANILLO II	4.000 m³
JAMES ENSOR	3.600 m³
AMERIGO VESPUCCI	3.500 m³
NIÑA	3.400 m³
PINTA	3.400 m³
GALILEI 2000	2.339 m³

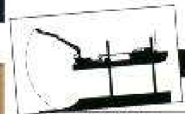


CUTTER SUCTION DREDGERS

	Dredging depth	Total installed diesel engine power
LEONARDO DA VINCI	32 m	20.290 kW
MARCO POLO	30 m	16.115 kW
VESALIUS	25 m	9.270 kW
KAERIUS	20 m	7.150 kW
ORTELIUS	20 m	5.140 kW
MERCATOR	20 m	4.890 kW
DIRK MARTENS	18 m	2.380 kW
HONDIUS	16 m	2.625 kW
PETRUS PLANCIUS	10 m	1.140 kW

SELF-PROPELLED SEAGOING SPLITHOPPER BARGE

	Hoppercapacity
VERRAZZANO	2.000 m3
MAGELLANO	
NIJPTANGH	
GEELVINCK	1.800 m3
WESELTJE	



BACKHOE DREDGER

	Max. dredging depth	Bucket	Engine
JEROMMEKE	18 m (standard) 22 m (optional)	4,5 to [illegible] m³	736 kW


KRANKELOON
ANTWERPEN

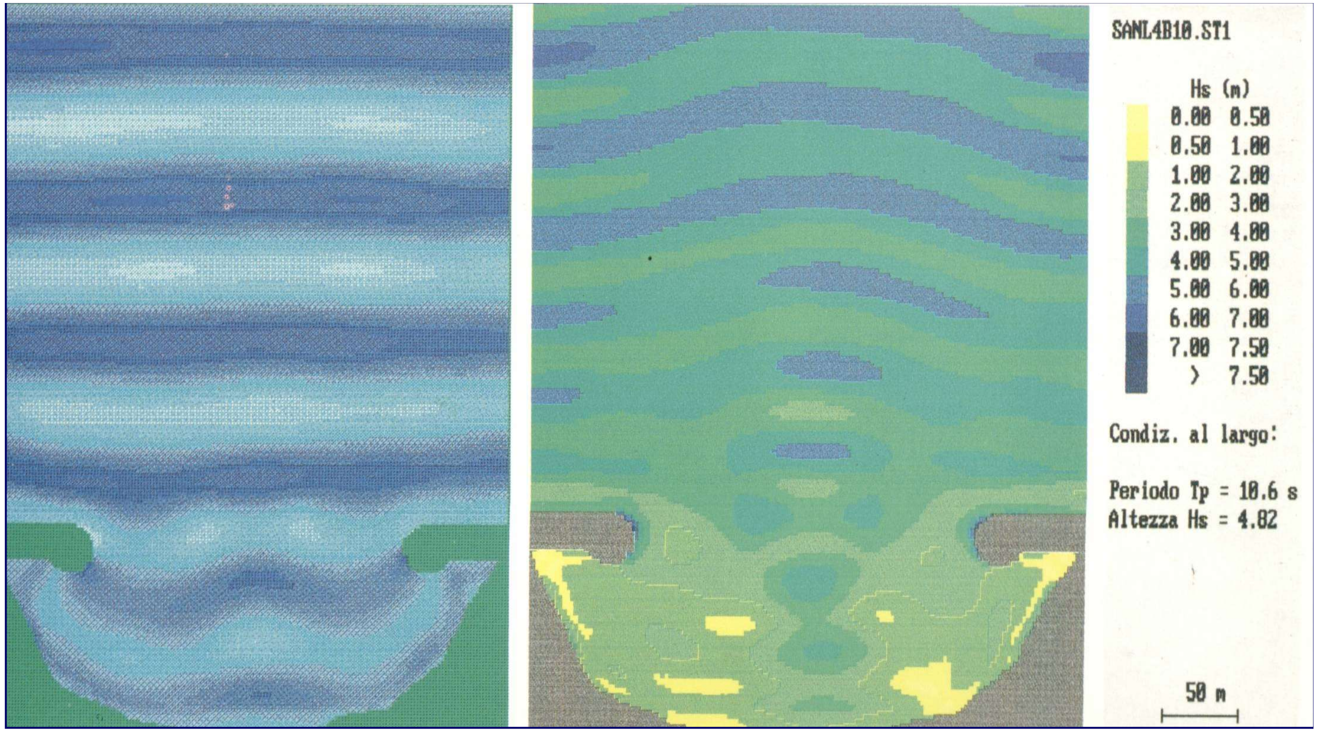
The Beach الشّاطئ

Torre del Mar.
Málaga.

DESIGN

OPTIMIZATION

STUDY



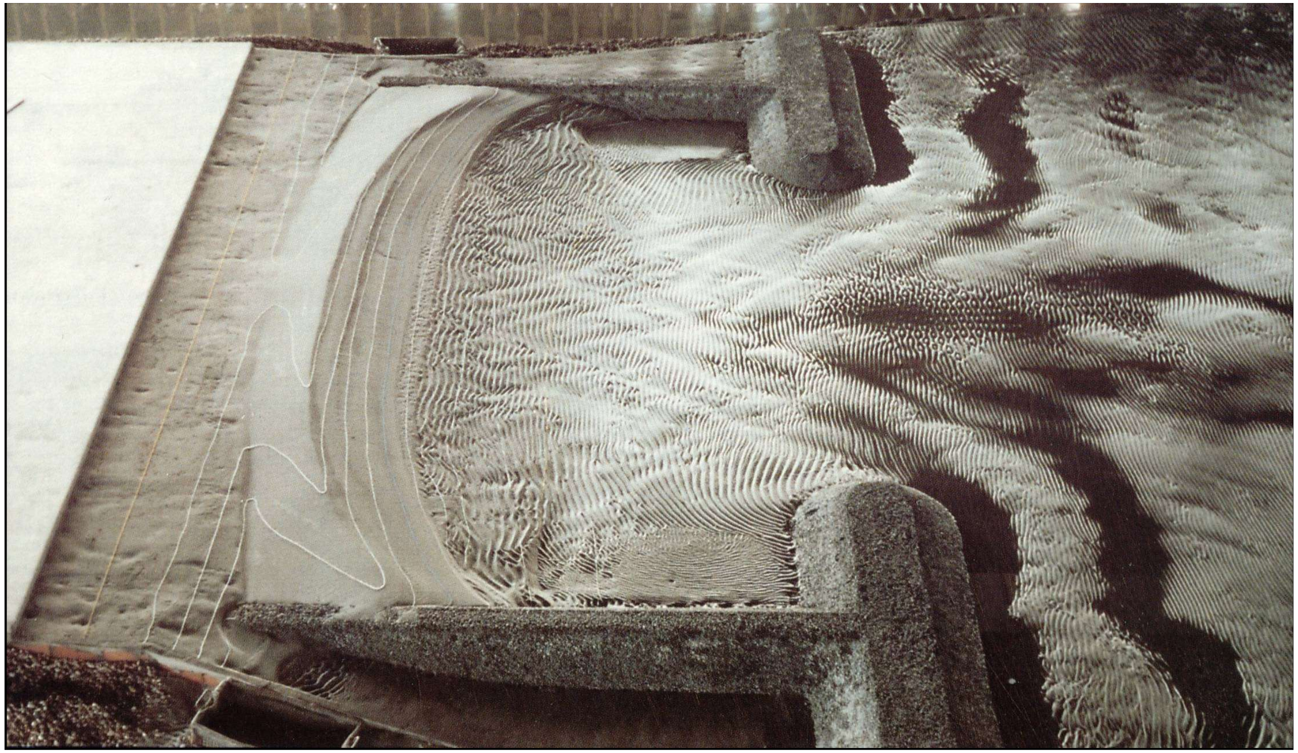
Numerical model

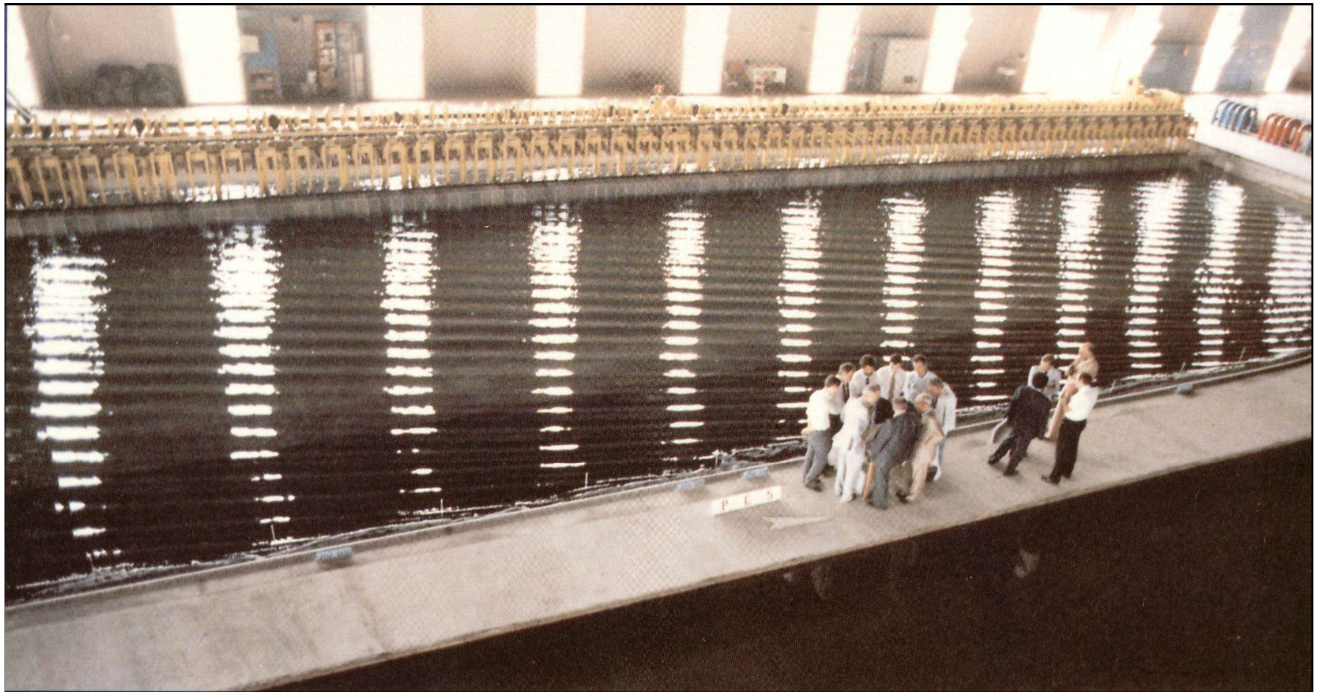
Wave flume physical model tests

DESIGN

OPTIMIZATION

STUDY





3D physical model

tests in a wave basin

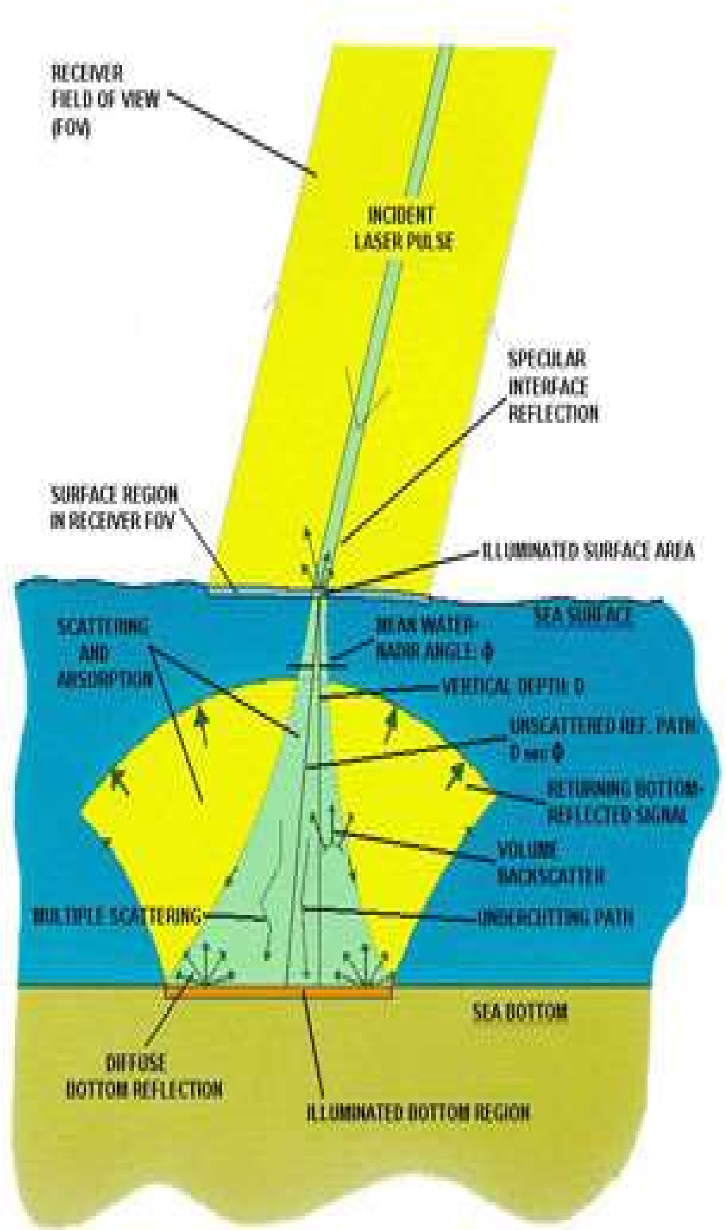
Coastal problem	Type of structures (hard and soft)
Safety	seawall (exposed sites) dune revetment dune enlargement offshore reefs and breakwaters (exposed sites)
Land reclamation	seawall (exposed sites) artificial dunes (sheltered sites) offshore reefs and breakwaters (exposed sites)
Recreational beaches	beach nourishment long groynes enclosing artificial beach/pocket beach (exposed sites) artificial headlands (sheltered sites) detached emerged breakwaters (sheltered sites) detached submerged breakwaters/perched beach (sheltered sites)
Mitigation of shoreline erosion and restoration of sand budgets	beach and shoreface nourishment offshore feeder berms detached submerged breakwaters (sheltered sites) groyne field (at sites with dominant longshore currents; near inlets)
Stabilisation of inlets	long jetties (exposed sites) detached emerged breakwaters sand bypassing methods (dredging)

MONITORAGGIO

Airborne Lidar Bathymetry Survey
(Light Detetection And Ranging)

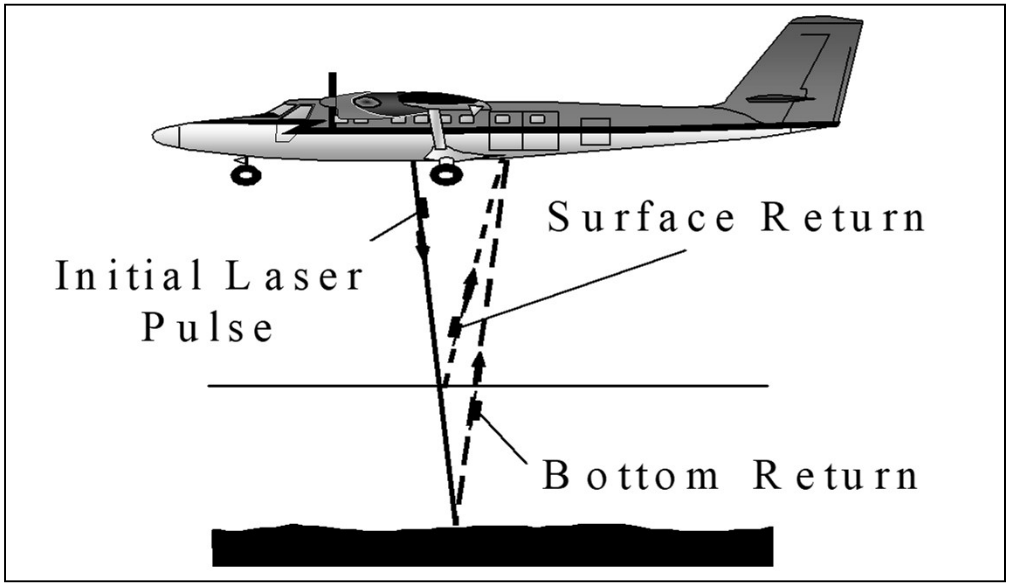
Lidar Principles

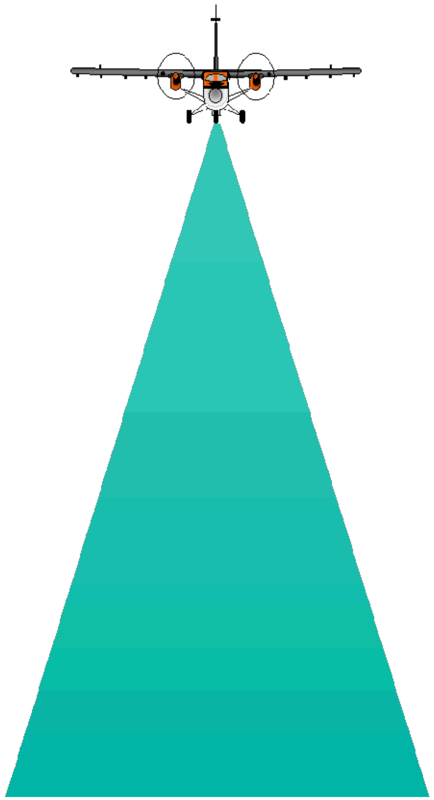
Lidar technology utilizes the reflective and transmissive properties of water and the sea floor to enable measurement of water using a laser. When a light beam hits a column of water, part of the energy is reflected off the surface and the rest, unless absorbed by particles in the water, is transmitted through the column. As the light travels through the water column and reflects off the seafloor, scattering, absorption, and refraction all combine to limit the strength of the bottom return, and therefore the system's maximum extinction depth. This depth is a function of water clarity, and is generally about three times the secchi depth.



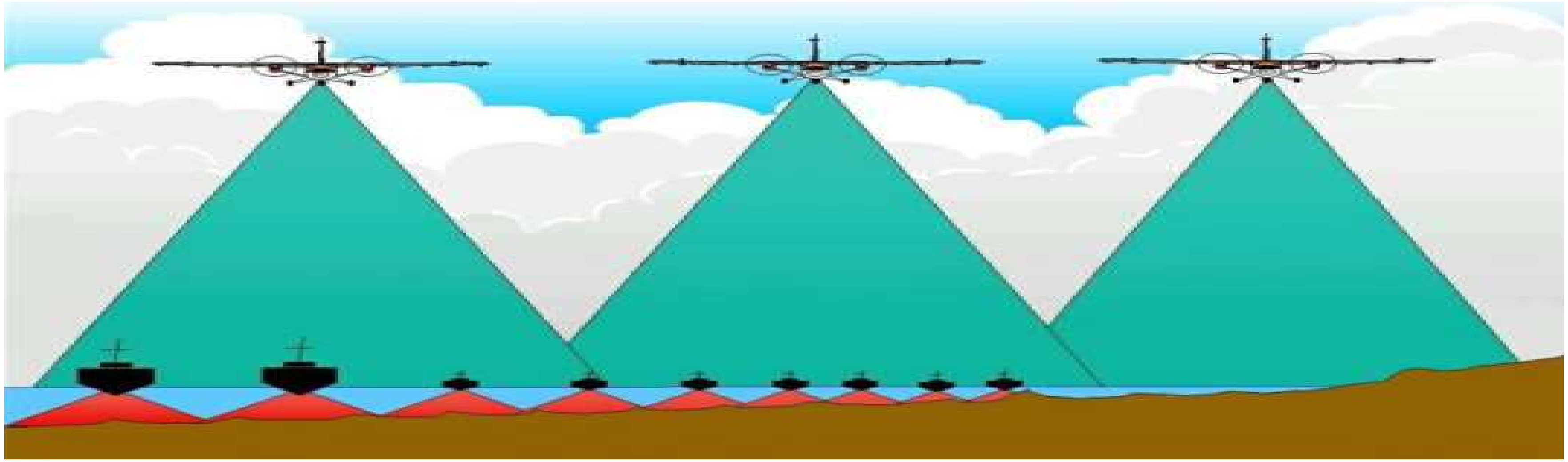
Why Use Airborne Lidar Bathymetry?

Airborne Lidar Bathymetry (ALB) overcomes the limitations of acoustic sensors in some key areas. This is not to say that ALB supplants such systems, but that it can complement them in a way that maximizes the efficiency of both technologies.





There are several key factors that distinguish ALB in comparison to acoustic methods:

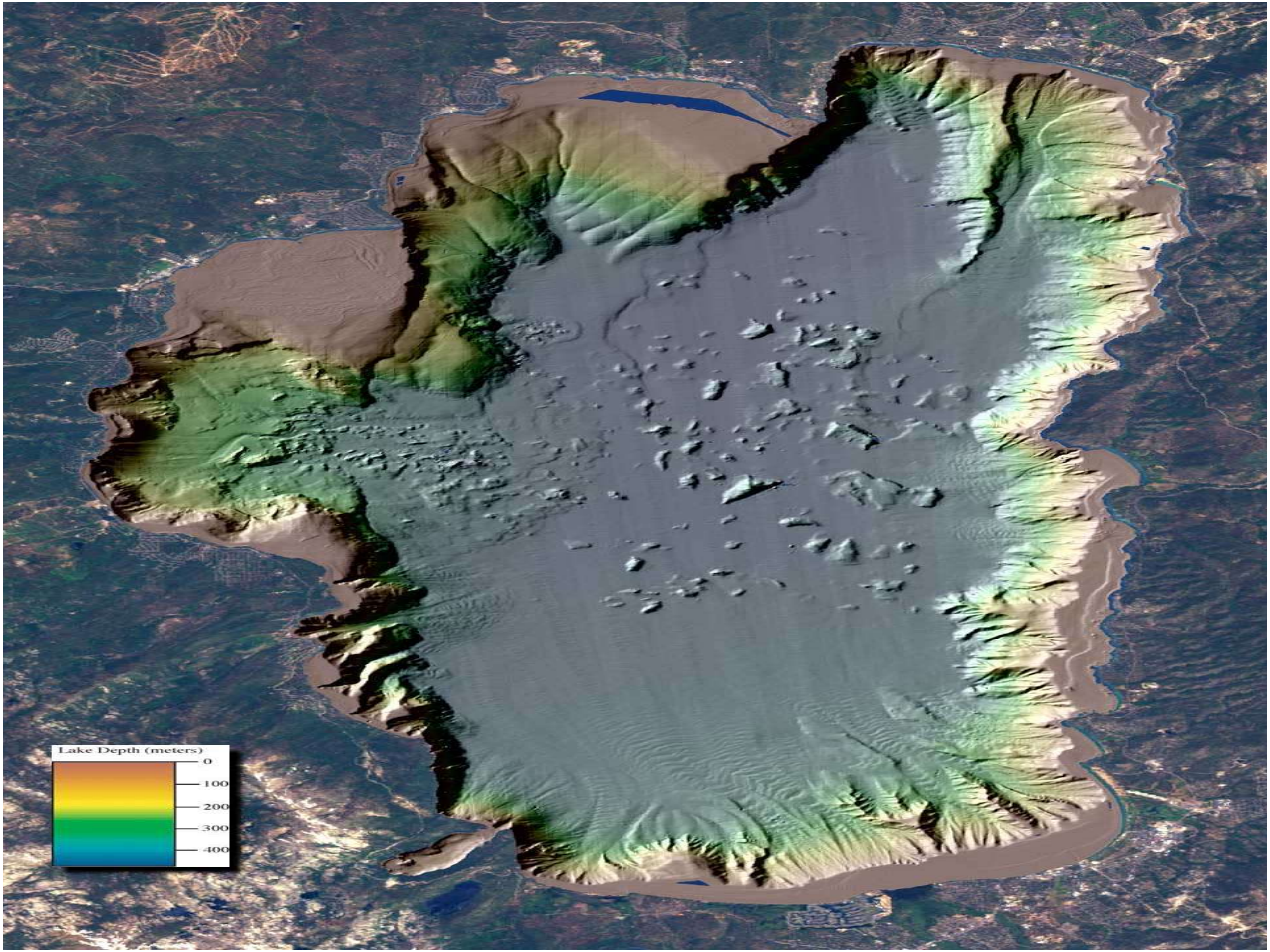


ALB is inherently mobile, making a RAPID RESPONSE to evolving survey needs possible.

It is a specialized SHALLOW WATER tool.

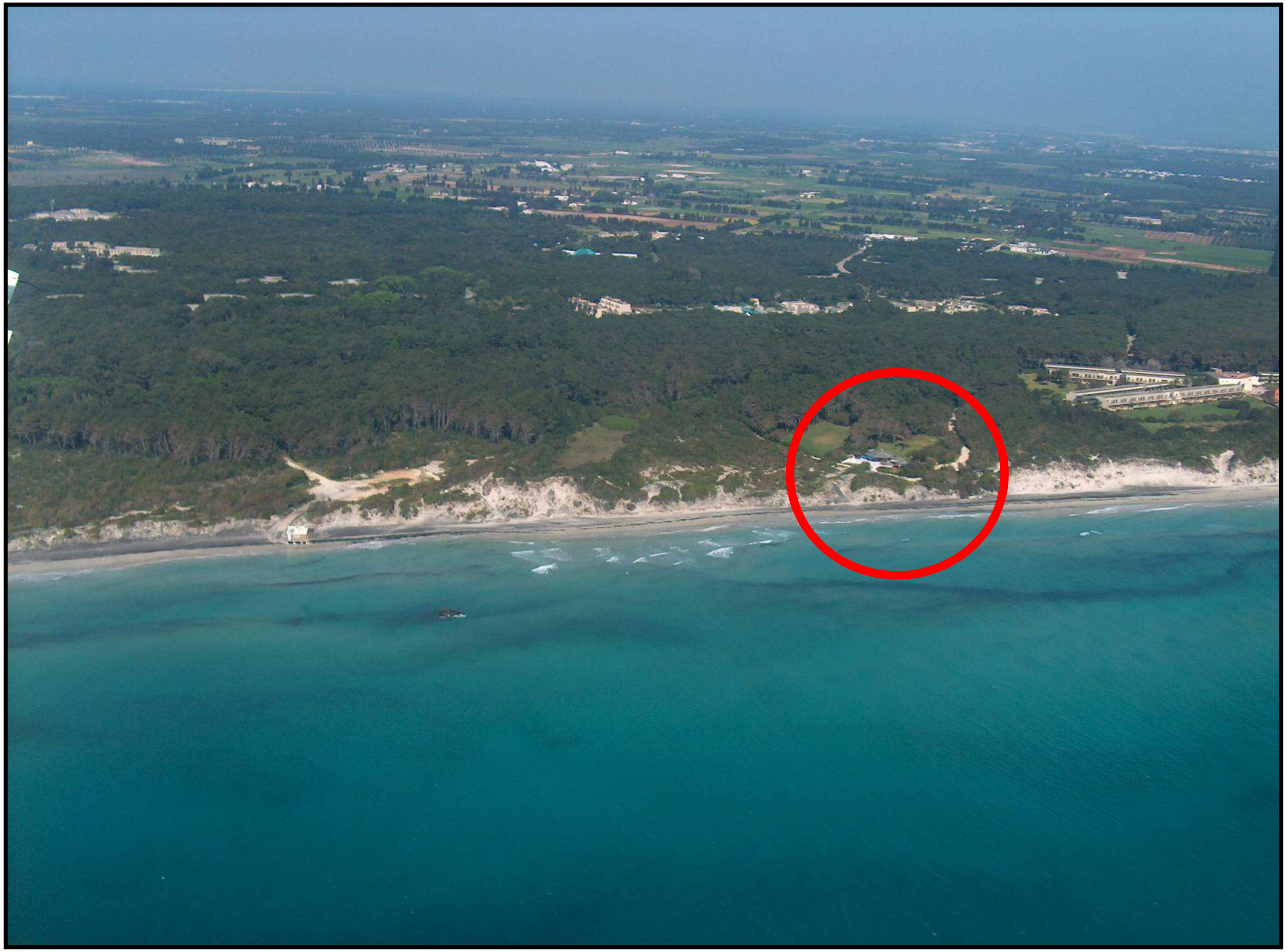
It allows surveys of hazardous coastal areas to be conducted in comparative SAFETY.

The use of a plane provides unparalleled FLEXIBILITY.
Large areas can be covered quickly providing advantages of ECONOMY.


Lake Depth (meters)
0
100
200
300
400

VIDEO MONITORAGGIO DELLA LINEA DI RIVA

L’impianto di Alimini



L’impianto di Alimini

Elaboration delle immagini

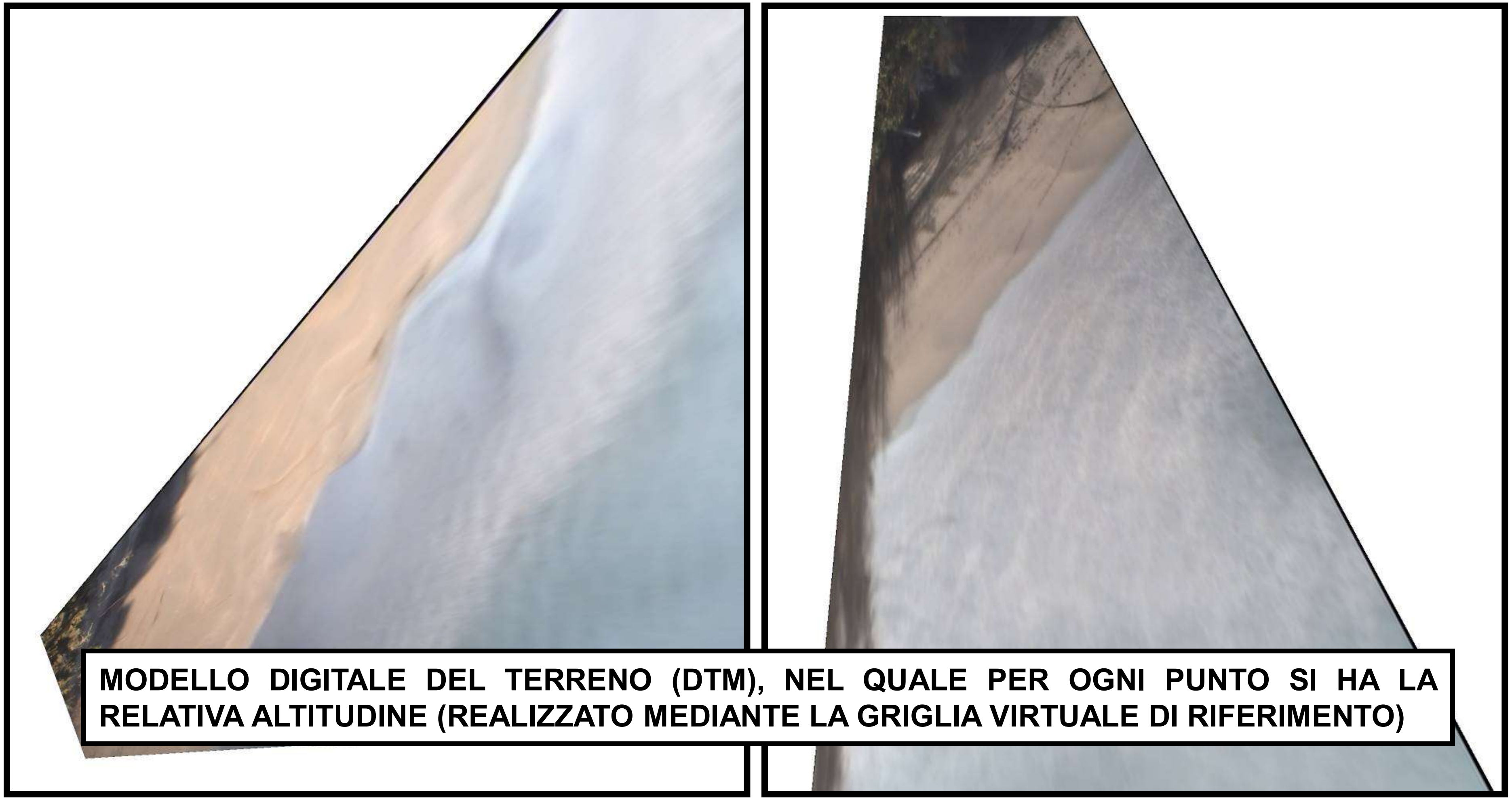
(1) Media

MEDIA DEI 20 SCATTI

DEPURATA DAGLI OGGETTI IN MOVIMENTO E VIENE MEMORIZZATA SIA IN ALTA RISOLUZIONE (BMP) SIA A BASSA RISOLUZIONE (COMPRESSA JPG PRONTA PER ESSERE TRASMESSA).


MEDIA

(2) Ortorettificazione



MODELLO DIGITALE DEL TERRENO (DTM), NEL QUALE PER OGNI PUNTO SI HA LA RELATIVA ALTITUDINE (REALIZZATO MEDIANTE LA GRIGLIA VIRTUALE DI RIFERIMENTO)

Dept. of Engineering for Innovation – Hydraulic Laboratory

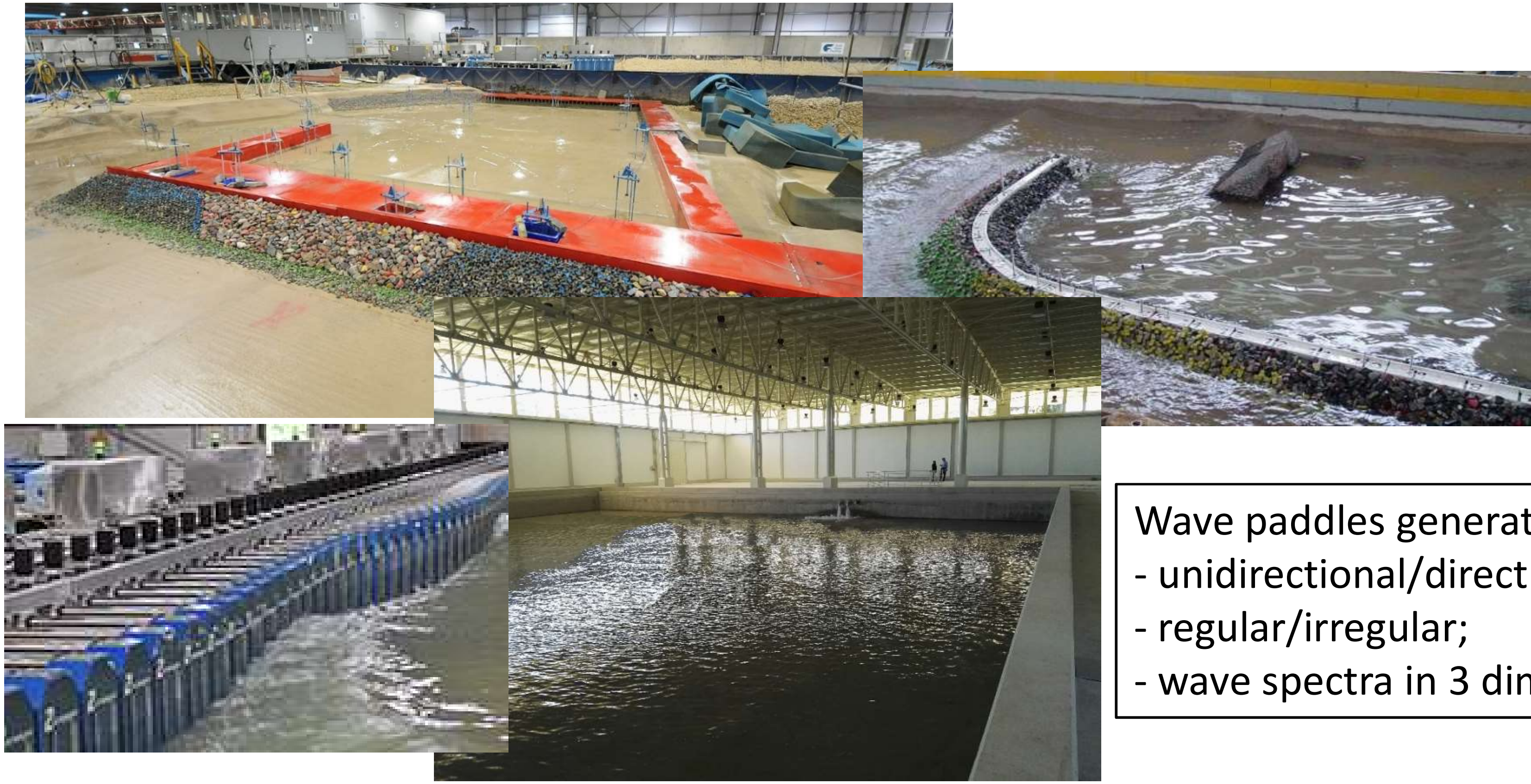
3000 sq. meters

2 levels with meeting room, 2 informatics rooms, 1 meeting area, 1 conference room, 9 office rooms

UNIVERSITÀ DEL SALENTO

Dept. of Engineering for Innovation – Hydraulic Laboratory

WAVE BASIN: 29.5 m long, 28 m wide, 1,6 m deep – 4 x 4 x 4.5 m pit for offshore studies
waves generator: 24 individually controlled hinged flaps



Wave paddles generate
- unidirectional/directional;
- regular/irregular;
- wave spectra in 3 dimensions.

Dept. of Engineering for Innovation – Hydraulic Laboratory

WAVE FLUME: 45 m long, 1.2 m wide, 2.0 m deep
the glass wall along the flume

Wave maker generates regular/irregular waves

It has a reflected waves compensation system