DEPARTMENT OF CIVIL ENGINEERING
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DELOS WP 1.1 Inventory on LCS, detailed description

According to DELOS WP 1.1 an inventory for existing low crested structures (LCS) must be established. As low crested structure we mean structures designed to be submerged or regularly overtopped by waves. The detailed inventory (described below) concerns shore parallel structures including shore-attached structures, which are perpendicular to shoreline if part of the scheme. This inventory will be established through a digital questionnaire located at www.delos.dk

The inventory is established in the following way:

- A brief description is given for each LCS (another document). This description should be given for all kinds of LCS.
- Some structures/locations are selected for further investigations
- A more detailed description is given for the selected structures/locations (this document). This part shall focus on shore parallel structures including shore-attached structures, which are perpendicular to shoreline if part of the scheme.

Both the brief and the detailed descriptions will be presented on www.delos.dk
For each structure the following information should be given.

A: Formalities **3**
B: Geometry and construction materials **4**
C: Local meteomarine conditions at the structure **8**
D: Sea bed and beach characteristics, incl. sediment transport **9**
E: Structural performance **11**
F: Socio-economic aspects **12**
G: Ecological aspects **14**
H: Coastal protection performance **14**
I: Problems in general **15**

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How to use this document

In this document, you can give a detailed description of a specific LCS. The description must be completed within this digital document. Just type the text in the tables, insert relevant pictures, drawings, sketches etc. and save the document. Only relevant information should be included in the document; existing non-used tables, sketches etc. present in this document must be deleted. The existing figures etc. are meant to be guidelines that can be changed for a specific environment. But please keep the structure of the document intact.

When completed, please attach the document to an email and send it to i5mkr@civil.auc.dk.

The filenames for the documents must include the participant code, the Country Code (as used on the Internet for Country Code Domains) and a Location-number between 001 and 999. It is very important that the same Location-number is used as for the brief description. The letters "det" must also be included to indicate that the detailed version of the questionnaire is used. The filenames for UB collecting information from East Italy (see special Country Code below) will therefore be "UB_EIT_det_001.doc" till "UB_EIT_det_999.doc". Each participant must provide a map of the country showing all the locations of the sites of interest, the Location-numbers must appear on this map.

Inputs come from:
UPC: Spain (Country Code ES)
DHI: Denmark (Country Code DK)
MOD & UR3: West Italy (Country Code WIT)
UB: East Italy (Country Code EIT)
AUTH: Greece (Country Code GR)
INF: Holland (Country Code NL)
UCA: non European LCS by literature study (Country Code nonEU)
UoS: U.K. (Country Code UK)

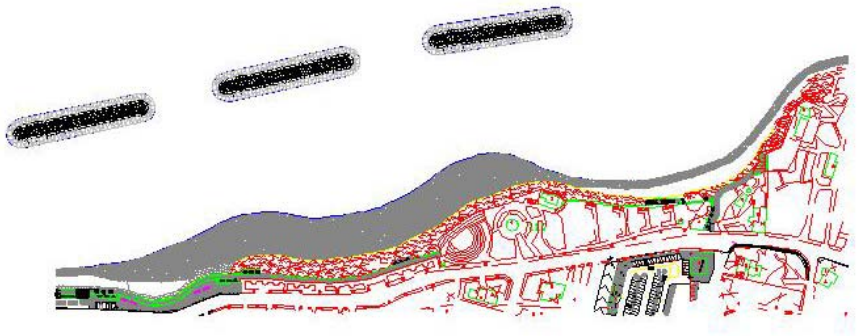
A: Formalities

Participant code and who to contact.	UB_EIT
E-mail	ferdy@platonet.it emanuela.clementi@mail.ing.unibo.it
This date (today, mm:dd:yyyy) and revision number (A..Z).	01/23/2003
Location of LCS.	Bisceglie (6_1). This site is divided in two areas: Paternostro and Carrara delle Monache. It is located in Puglia, south of Italy, along the Adriatic sea; in particular, it is located between the town of Bari and Barletta.
Start date, length and/or end of works. Have there been any later changes? If so, when?	1993-94
Design life - the minimum length of time the beach management scheme is designed to last.	10 years
Which tools and regulations are used for the design formulae (mathematical models, model tests, engineering experience, standards, recommendations).	engineering experience
Who fund the work (e.g. Public Administration or private company)?	Public Administration
Costs.	

B: Geometry and construction materials

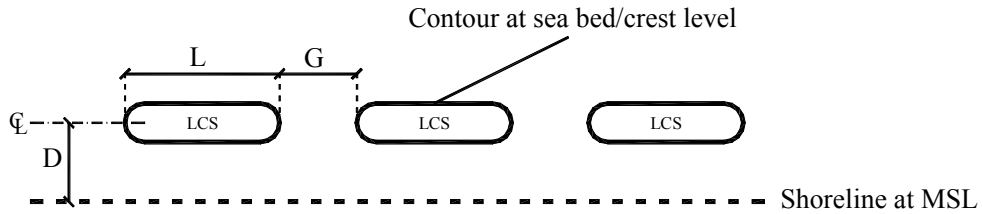
B1 System layout (aerial view)

Are shore attaching structures present (e.g. groins)?	☐Yes ☒No
Are emerging head islands present?	☐Yes ☒No



Design plan view of "Paternostro".

Design plan view of "Carrara delle Monache".



The typical layout is given at Sea Bed (index SB) and at Crest Level (index CL).

Parameter	Description	Fill in box	unit
D	Distance from shoreline	70	meters
L_{SB}	Length of LCS at sea bed	80	meters
L_{CL}	Length of LCS at crest level	65	meters
G_{SB}	Gap between LCS at sea bed	10	meters
G_{CL}	Gap between LCS at crest level	28	meters
N	Number of LCS in system	5	

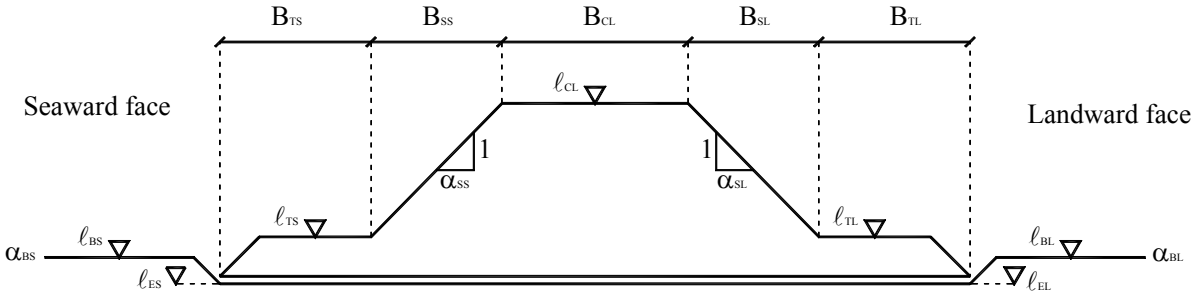
Remarks
All the interventions on the coast of Bisceglie have been done in areas north of the port. The first intervention was designed in 1993. It was completed in two years. It considered two different areas named “Paternostro” and “Carrara delle Monache”. The designed considered the construction of five submerged detached breakwaters and of a seawall. Three breakwaters were displaced at Paternostro and two at Carrara delle Monache.

B2 Bathymetry of sea bed and beach

Description of bathymetry when LCS were build

A detailed bathymetry prior the construction is available only on a paper format. It is attached to a deeper report from Univ. of Bologna and is available on request.

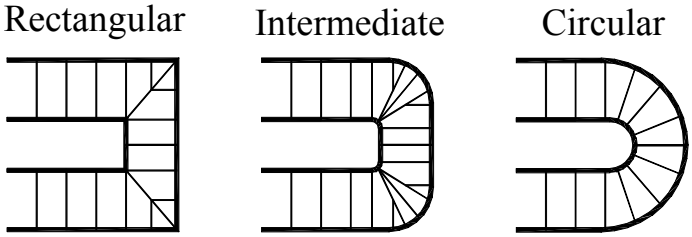
B3 Trunk cross section/contour geometry – outer profile



Parameter	Description	Fill in box	Unit
α_{BS}	Steepness of sea bed, seaward	0.18 %	
α_{BL}	Steepness of sea bed, landward	10.5 %	
α_{SS}	Steepness of slope, seaward	¾	
α_{SL}	Steepness of slope, landward	½	
ℓ_{BS}	Level of sea bed at seaward toe	- 2.7 - 4.3	Meters
ℓ_{ES}	Level of excavation, seaward	0	Meters
ℓ_{TS}	Level of toe, seaward	- 2.7 - 4.3	Meters
ℓ_{CL}	Level of crest	- 0.15	Meters
ℓ_{BS}	Level of sea bed at landward toe	- 2.5 - 4.4	Meters
ℓ_{ES}	Level of excavation, landward	0	Meters
ℓ_{TS}	Level of toe, landward	- 2.5 - 4.4	Meters
B_{TS}	Width of toe, seaward	0	Meters
B_{SS}	Width of slope, seaward	Variable	Meters
B_{CL}	Width of crest	10	Meters
B_{SL}	Width of slope, landward	Variable	Meters
B_{TL}	Width of toe, landward	0	Meters

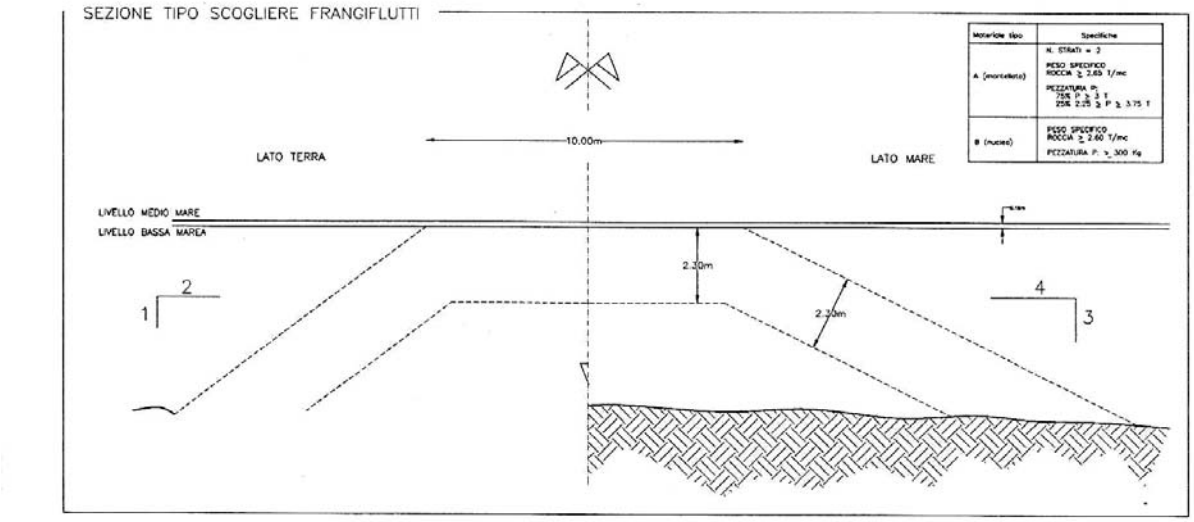
Remarks (e.g. different layout along shoreline, other important parameters).

B4 Round head contour geometry



What is the shape of the round head?
- ☐ Rectangular
- ☐ Intermediate
- ☒ Circular

B5 Description of layers



Design typical cross section

ARMOUR LAYER CHARACTERISTICS			
Parameter	**Description**	**Fill in box**	**unit**
	Material (e.g. quartzite, concrete)	Calcareous rock	
	Shape of blocks (e.g. quarry rock, sea stones, cubes)	Quarry rock	
ρ_r	Mass density of material	2650	kg/m^3
D_{n50}	Nominal diameter	1.04	meters
Gr	Grading of the material (D_{85}/D_{15})	Not known	
	Geotextile between layers?	☐Yes ☒ No	

Remarks (e.g. details on geotextile)

Thickness of the armour = 2.3 meters

CORE LAYER CHARACTERISTICS			
Parameter	**Description**	**Fill in box**	**unit**
	Material (e.g. quartzite, concrete)	Calcareous rock	
	Shape of blocks (e.g. quarry rock, sea stones, cubes)	Quarry rock	
ρ_r	Mass density of material	2650	kg/m^3
D_{n50}	Nominal diameter	0.48	meters
Gr	Grading of the material (D_{85}/D_{15})	Not known	
	Geotextile between layers?	☐Yes ☒ No	

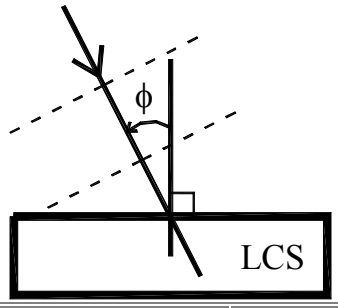
B6 Construction method

How have the stones been placed?
- ☐ Dumped with barges
- ☒ Placed with barges
- ☐ Land based operation
- ☐ Other:

Sequence of operation.
- ☐ Construction started upstream
- ☐ Construction started downstream

C: Local meteomarine conditions at the structure

C1 Waves



Parameter	Description	Fill in box	Unit
H_S	Design significant wave height	2.8	Meters
T_P	Design peak period	7.5	Seconds
ϕ	Design wave incidence angle	60	Degree

Direction	Return period (years)					
(° N)	1	5	10	25	50	100
000	3,59	4,74	5,25	5,95	6,48	7,02
030	2,82	3,66	4,03	4,51	4,88	5,24
060	2,91	3,44	3,65	3,91	4,09	4,27
090	2,37	2,86	3,05	3,28	3,45	3,60
120	3,15	4,18	4,63	5,25	5,73	6,21
150	3,72	4,50	4,82	5,25	5,56	5,88
270	2,65	3,49	3,85	4,33	4,69	5,05
300	3,25	4,48	5,06	5,84	6,47	7,11
330	3,51	4,59	5,08	5,76	6,29	6,84

Significant wave heights in meters for each direction class with various return periods for Bisceglie (source KNMI data).

C2 Water levels

TIDAL WATER LEVEL VARIATIONS			
Parameter	**Description**	**Fill in box**	**Unit**
HAT	Highest astronomical tide level	0.80	Meters
MHWL	Mean tide high water level	0.15	Meters
MWL	Mean water level	0	Meters
MLWL	Mean tide low water level	- 0.15	Meters
LAT	Lowest astronomical tide level	- 0.60	Meters

Water level statistics(If available, please provide information on design water level and tide and surge generated water levels corresponding to return periods 1 month, 1 y, 10 y, 50 y)

C3 Current

Tidal currents

Description & statistics NOT available

Surge generated currents

Description & statistics NOT available

D: Sea bed and beach characteristics, incl. sediment transport

Description of the coast :
The coastline is characterized by a vertical cliff that is highly deteriorated due to its composition and to the action of the sea waves that made unusable the road.

D1 Natural sea bed material at surface

Parameter	**Description of sea bed material**	Fill in box	Unit
	Material (e.g. quartzite)	Calcareous rock	
ρ_r	Mass density of material	DK	kg/m^3
D_{n50}	Nominal diameter grain size	DK	Meters
Gr	Grading of the material (D_{85}/D_{15})	DK	

Remarks
Rock bottom with some sandy areas.

D2 Natural beach material at surface

Parameter	Description of beach material	Fill in box	Unit
	Material (e.g. quartzite)		
ρ_r	Mass density of material		kg/m^3
D_{n50}	Nominal diameter grain size		Meters
Gr	Grading of the material (D_{85}/D_{15})		

Natural supply?	☐ Yes ☐ No
Supplied by beach nourishment?	☐ Yes ☐ No

Remarks
Prior to the intervention, the natural beach material didn't exist ad the sea waves acted on the cliff. After the intervention the sea wall represents the recreational rocky beach.

D3 Artificial beach nourishment

Description of nourishment
NOT DONE

Parameter	Description of artificial nourishment	Fill in box	Unit
	Material (e.g. quartzite)		
ρ_r	Mass density of material		kg/m^3
D_{n50}	Nominal diameter		Meters
Gr	Grading of the material (D_{85}/D_{15})		

Remarks (provide grain distribution if available)

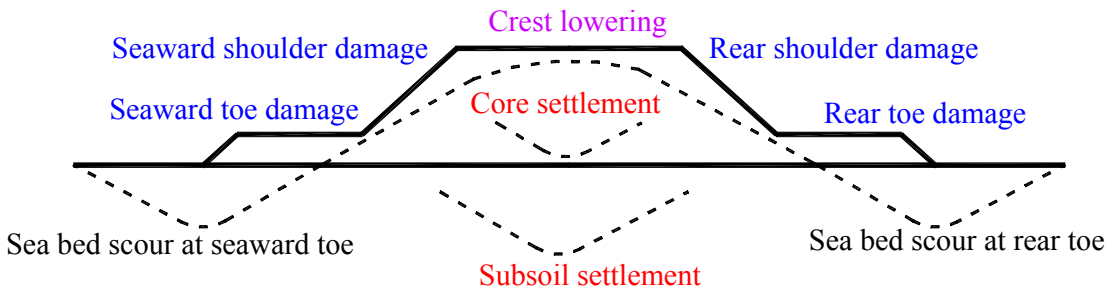
D4 Sediment transport

Description of the sediment transport (e.g. direction and amount of transport, distribution over the coastal profile)
The longshore sediment transport at Bisceglie is assumed as negligible. Any way, information to studies at near sites indicate that the net sediment transport is directed from NW to SE.

Parameter	Description of sediment	Fill in box	Unit
	Material (e.g. quartzite)		
ρ_r	Mass density of material		kg/m^3
D_{n50}	Nominal diameter		Meters
Gr	Grading of the material (D_{85}/D_{15})		

E: Structural performance

E1 Definition of failure modes



Please insert a sketch with dimensions of LCS cross-section when it was build compared to the appearance now (like the figure of failure modes) if possible.

In the following please specify damages by failure mode (see figure of failure mode definition) and amount of damage. If you know the reason for the problems/failures (e.g. extreme wave climate/water level), please type it in the description boxes.

E2 Materials

Problems caused by deterioration?	☐ Yes ☒ No
Problems caused by breakage?	☐ Yes ☒ No

Description of the condition of the materials

E3 Settlement of the structure

Description of settlements of core/subsoil
Settlements has been experienced at Paternostro breakwaters due to rocking of stones. Settlements is of about 20 cm.

E4 Local erosion of sea bed/scour

Description of erosion/scour by roundheads (please specify scour depth)

Description of erosion/scour by trunk (please specify scour depth)

E5 Erosion and instability of slopes, shoulders, crest and toes

Stage of damage
☒ No or marginal damage
☐ Moderate to severe damage
☐ Failure

Description of displacements of structural material (provide sketch if possible)
Erosion lowering of about 20 cm has been experienced.

E6 Damage parameters

The definition of a displaced unit is, when a unit is displaced by more than D_{n50}.
Try to give an estimate of the following damage parameters relevant to armour.

Parameter	Description	Fill in box	unit
The relative number of displaced units	$D(\%) = \frac{n_d\,(\text{number of displaced units})}{\text{Total number of units}} \cdot 100$		%
The strip displacement	$N_{od} = \frac{n_d}{L / D_{n50}}$, L is the length of LCS		

F: Socio-economic aspects

What regime of property has the coast at this site?
Private ☐, Public full free access ☒, Public limited access ☐, Natural reserve ☐, Don't know ☐,
Other (please specify):

Who decided that an LCS should be built at that site?
Individual, acting for private purpose ☐
Individual, acting for public purpose (e.g. Natural park administrator) ☐
Local authority (e.g. city council) ☒
Regional authority (e.g. province level) ☐
National authority (e.g. ministry) ☐
Don't know ☐
Please give name of the authority whenever applicable:

What was the main motive for building the LCS?
Coast erosion ☐
Inducing or maintaining recreational activity ☒, please specify:
Environmental concern ☐, please specify:
Other ☐, please specify:
Don't know ☐

Was that LCS part of a larger coastal management plan?
Yes ☒, **please specify: reuse of a damaged road and an abandoned urban area**
No ☐, please specify:
Don't know ☐

Public opinion on that LCS:

Construction was accompanied by public protest ☐
The public did not react ☐
Public opinion asked for the LCS ☒
Local commerce asked for the LCS ☒
Don't know ☐
Other (please specify):

Description of the coast:

Urban ☐, Densely constructed ☒, Scarcely constructed ☐, No apparent construction ☐
Are there dunes? Yes ☐, No ☐
Has commercial activity changed significantly after construction of the LCS?
hotels construction: More hotels ☒, Less hotels ☐, Unaffected ☐, Don't know ☐
bars and similar construction: More ☐, Less ☐, Unaffected ☐, Don't know ☐
advertising for the area: More ☒, Less ☐, Unaffected ☐, Don't know ☐
other (specify):

Visual impact of LCS not already described in Part B: Are there parts of the LCS visible under average conditions? Poles ☐, Cables ☐, Reefs ☒,
Others (please specify):

Water quality changes since LCS construction

Are there episodes of water turbidity since construction?
No ☒, Rare ☐, Often ☐, Permanent ☐
Were there episodes of water turbidity before construction?
No ☒, Rare ☐, Often ☐, Permanent ☐
Has water quality otherwise been affected (for example, more or less detritus accumulating)?
Please describe:

How would you qualify the following recreational activities at or around the LCS? (DK = Don't know)

Fishing (recreational)	Intense ☐	Moderate ☐	Scarce ☒	Absent ☐	DK ☐
Seafood collecting	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Wildlife watching	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Sunbathing and similar	Intense ☒	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Scuba diving	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Sailing and similar	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Other (specify)	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐

Could you describe those recreational activities before the LCS was built? (DK = Don't know)

Fishing (recreational)	Intense ☐	Moderate ☒	Scarce ☐	Absent ☐	DK ☐
Seafood collecting	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Wildlife watching	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Sunbathing and similar	Intense ☐	Moderate ☐	Scarce ☒	Absent ☐	DK ☐
Scuba diving	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Sailing and similar	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐
Other (specify)	Intense ☐	Moderate ☐	Scarce ☐	Absent ☐	DK ☐

Has that LCS had an environmental impact assessment before being built? Yes ☒, No ☐, Don't know ☐
Could you give its references and location (specify)?

Has there been an economic study on that LCS,
before it was built? Yes ☐, No ☒, Don't know ☐, References:
after it was built? Yes ☐, No ☒, Don't know ☐, References:

G: Ecological aspects

What are the dominant species on the structures?

What are the dominant species in the sediment and fish assemblages around the structures?

Were any environmental changes observed following the construction of the structure (e.g. increase of water turbidity, floating algal debris)? **No**

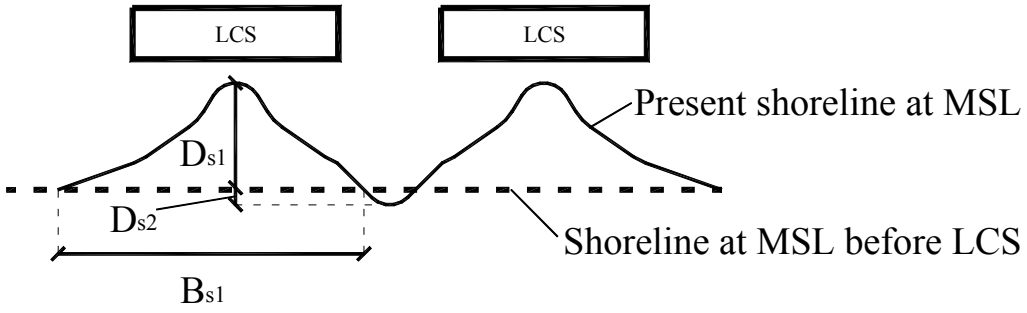
H: Coastal protection performance

H1 Bathymetry and beach evolution

Description of historical beach evolution before LCS was built (10-20 years). Damages to the cliff and road interruption

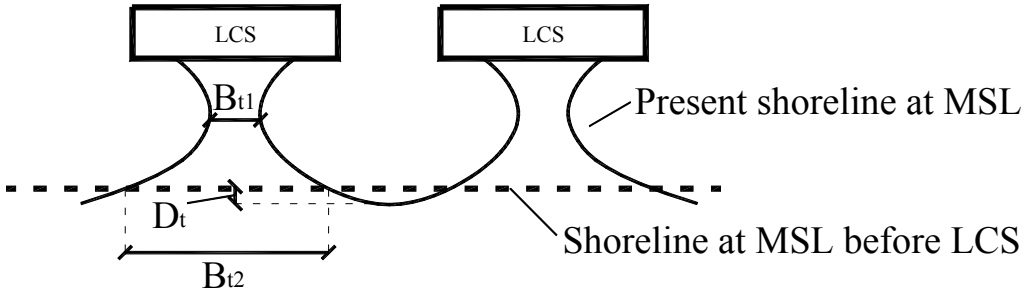
Description of beach evolution after LCS was built up to now. Due to the lack of a sandy beach to be protected, the benefits from the construction of the sea defence structures are evident in terms of reuse of an abandoned urban area. In particular the road has been rebuilt and opened to the public, it has been possible to construct an amazing amphitheatre with a surrounding park, the hotel activities had an improvement and sea wall serves to obtain a recreational rock beach were people were in danger of landslides.

H2 Salient formation



Parameter	Description	Fill in box	unit
D_{s1}	Max distance between new and old shoreline, seaward	0	meters
D_{s2}	Max distance between new and old shoreline, landward	0	meters
B_{s1}	Width of salient at old MSL	0	meters

H3 Tombolo formation



Parameter	Description	Fill in box	unit
D_t	Distance between new and old shoreline, landward	0	meters
B_{t1}	Minimal width of tombolo	0	meters
B_{t2}	Width of tombolo at old MSL	0	meters

H4 Renourishment

Description of renourishment (add more fill) (e.g. amount, how often)
No renourishment

H5 Down drift erosion

Please insert a sketch if relevant.

Description of down drift erosion (morphological impact, e.g. down drift erosion length and maximal down drift shoreline retreat)

I: Problems in general

Description of other problems/impacts

The three submerged breakwaters at Paternostro suffered a crest lowering and the soil retaining structure may be under the direct action of sea storms, although without suffering any damage. From this observation, the local administration decided to adopt the emerging type breakwater for the Salsello area (1998-2000) and the future programmed interventions.