



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
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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

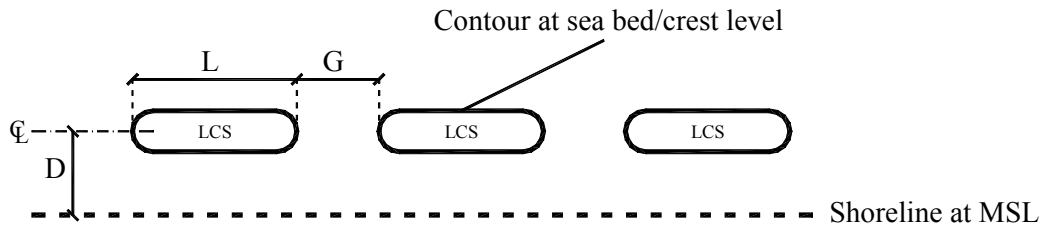
Participant code and who to contact.	EIT Michela Soldati
E-mail	Soldati@ambra.unibo.it
This date (today, mm:dd:yyyy) and revision number (A..Z).	22/03/2001A
Location of LCS.	Lido di Dante (Ravenna)
Start date, length and/or end of works. Have there been any later changes? If so, when?	Start Autumn 1995 End Spring 1996 Minor works have been done about every year since 1997
Design life - the minimum length of time the beach management scheme is designed to last.	10
Which tools and regulations are used for the design formulae (mathematical models, model tests, engineering experience, standards, recommendations).	Engineering experience, standards
Who fund the work (e.g. Public Administration or private company)?	Ravenna Municipality
Costs.	4.100.000.000£ 2.117.500 euro

B: Geometry and construction materials

B1 System layout (aerial view)

Are shore attaching structures present (e.g. groins)?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Are emerging head islands present?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

The following sketch concerns only shore parallel LCS; if the layout is different you must insert another sketch and specify parameters like the ones suggested. If a picture is available please insert it too.



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	180	meters
L_{SB}	Length of LCS at sea bed	780	meters
L_{CL}	Length of LCS at crest level	770	meters
G_{SB}	Gap between LCS at sea bed	0	meters
G_{CL}	Gap between LCS at crest level	30	meters
n	Number of LCS in system	1	

Remarks

It's only one element (length 770m) interrupted by a surface opening, 30m wide and 1m deep from the LCS crest level.

B2 Bathymetry of sea bed and beach

Please insert a dimensioned sketch if possible.

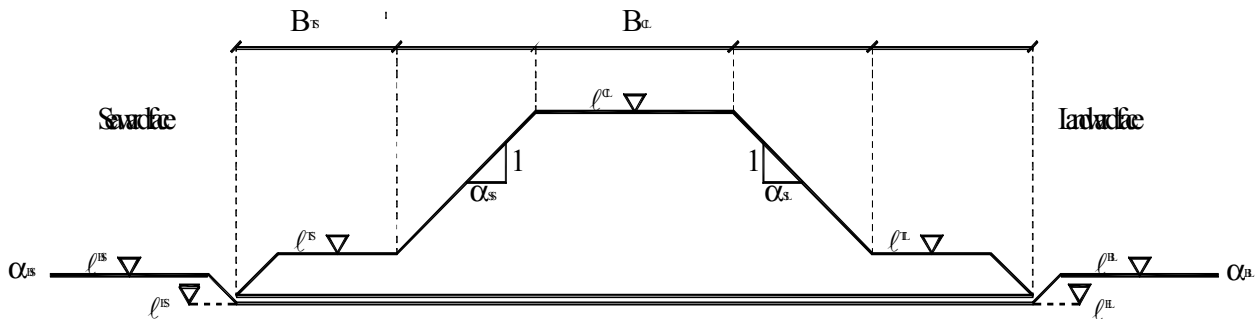
Description of bathymetry when LCS were build

Is detailed information (measurements) available? If so, please explain.

At least one bathymetry and beach profile survey every year since the construction are available.

B3 Trunk cross section/contour geometry – outer profile

If shore attached structures perpendicular to shoreline are present, please insert a sketch with typical longitudinal section and typical selected cross sections. Specify parameters as the ones given below. If the layout does not fit the following sketch please insert another sketch.



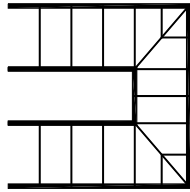
Parameter	Description	Fill in box	unit
α_{BS}	Steepness of sea bed, seaward	1:214 (0.46%)	
α_{BL}	Steepness of sea bed, landward	1:66 (1.5%)	
α_{SS}	Steepness of slope, seaward	1:2	
α_{SL}	Steepness of slope, landward	1:1	
l_{BS}	Level of sea bed at seaward toe	3.10-3.30	meters
l_{ES}	Level of excavation, seaward	0	meters
l_{TS}	Level of toe, seaward	0	meters
l_{CL}	Level of crest	0.5	meters
l_{BS}	Level of sea bed at landward toe	2.70	meters
l_{ES}	Level of excavation, landward	0	meters
l_{TS}	Level of toe, landward	0	meters
B_{TB}	Width of toe, at the bottom	24	meters
B_{TT}	Width of toe, at the top	21	meters
B_{CL}	Width of crest level	12	meters
B_{BL}	Width of bottom level	18	meters

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

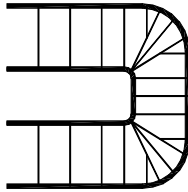
The toe is 0.50m height

B4 Round head contour geometry

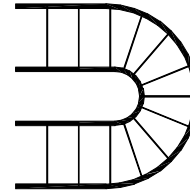
Rectangular



Intermediate



Circular



What is the shape of the round head?

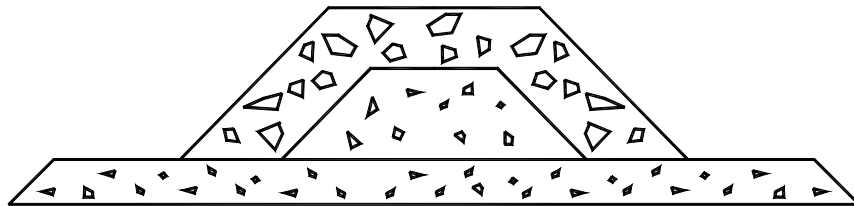
Rectangular

Intermediate

Circular

B5 Description of layers

Please insert a dimensioned sketch with the typical cross-section composition.



For each layer, please provide the following information.

ARMOUR

Parameter	Description	Fill in box	unit
	Material (e.g. quartzite, concrete)	Limestone	
	Shape of blocks (e.g. quarry rock, sea stones, cubes)	Quarry rock	
ρ_r	Mass density of material	2500	kg/m ³
D_{n50}	Nominal diameter	0,8	meters
Gr	Grading of the material (D_{85}/D_{15})	1.58	
	Geotextile between layers?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	

BEDDING LAYER

Parameter	Description	Fill in box	unit
	Material (e.g. quartzite, concrete)	Limestone	
	Shape of blocks (e.g. quarry rock, sea stones, cubes)	Quarry run	
ρ_r	Mass density of material	2500	kg/m ³
D_{n50}	Nominal diameter	0.7	meters
Gr	Grading of the material (D_{85}/D_{15})	?	
	Geotextile between layers?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	

Remarks (e.g. details on geotextile)

Geotextile is used between bedding layer and seabed as bottom protection.

It's made by polyester.

B6 Construction method

How have the stones been placed?

Dumped with barges

Placed with barges

Land based operation

Other:

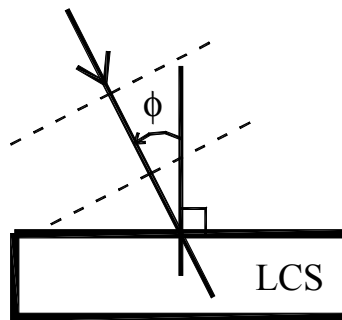
Sequence of operation.

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	3.21	meters
T_s	Design significant period	7.5	seconds
ϕ	Design wave incidence angle	0	radians

TR	1 y		2 y		5 y		10 y		25 y		50 y		100 y	
Dir	H_s	T_s	H_s	T_s	H_s	T_s	H_s	T_s	H_s	T_s	H_s	T_s	H_s	T_s
60°	3.6	7.4	4.0	7.8	4.5	8.1	4.9	8.3	5.4	8.7	5.8	9.0	6.2	9.2
90°	3.5	8.4	3.9	8.7	4.4	9.1	4.9	9.6	5.4	10.1	5.8	10.5	6.2	10.7
120°	2.8	7.8	3.3	8.4	3.8	8.9	4.2	9.4	4.7	9.9	5.1	10.3	5.5	10.8

Remarks (provide information on wave statistics and wave spectra if available, e.g. H_s corresponding to return periods 1 month, 1 y, 10 y, 50 y. Please specify the source of the data)

See table above. Source data offshore platform for methane extraction provided of recording wave data.

C2 Water levels

Tidal water level variations

Parameter	Description	Fill in box	unit
HAT	Highest astronomical tide level	1.1	meters
MHWL	Mean tide high water level	0.84	meters
MWL	Mean water level	?	meters
MLWL	Mean tide low water level	0.76	meters
LAT	Lowest astronomical tide level	0.6	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 if available

Littoral current direction: N-NW

Surge generated currents

Description & statistics if available (e.g. mean velocities as function of water depth/distance to shore line)

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

Description of the coast (e.g. bar type coast with gentle slope or plane coast with steep slope)

It's a bar type coast with gentle slope.

There's a double littoral drift system: one offshore southward, due to the present of the river, and one northward closer to the shoreline.

In the north of the area there's a river mouth that provides sediment supply.

In front of the area there's an offshore platform for methan extraction.

D1 Sea bed material at surface

Parameter	Description of sea bed material	Fill in box	unit
	Material (e.g. quartzite)	Quartzite	
ρ_r	Mass density of material	?	kg/m ³
D _{n50}	Nominal diameter grain size	0.154	mm
Gr	Grading of the material (D ₈₅ /D ₁₅)	4.3	

Remarks (provide grain distribution if available)

Seabed material at a depth of -2.0m

D2 Beach material at surface

Parameter	Description of beach material	Fill in box	unit
	Material (e.g. quartzite)	Quartzite	
ρ_r	Mass density of material	?	kg/m ³
D _{n50}	Nominal diameter grain size	0.206	mm
Gr	Grading of the material (D ₈₅ /D ₁₅)	4.4	

Natural supply?

Yes No

Supplied by beach nourishment?

Yes No

Remarks (provide grain distribution if available)

D3 Sediment transport

Description of the sediment transport (e.g. direction and amount of transport, distribution over the coastal profile)

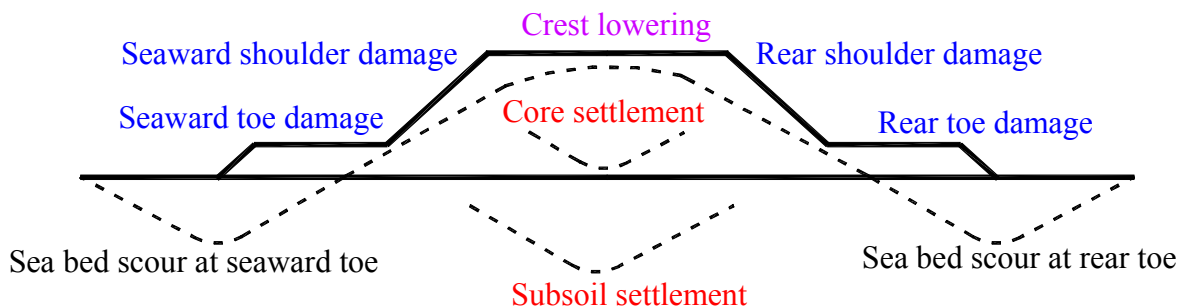
Transport towards south of about 22500 m³/y

The following parameters must be completed only if artificially nourished and different from sea bed material.

Parameter	Description of artificial sediment	Fill in box	unit
	Material (e.g. quartzite)	Limestone-Quartzite	
ρ_r	Mass density of material		kg/m ³
D_{n50}	Nominal diameter	0.25	mm
Gr	Grading of the material (D_{85}/D_{15})	2.06	

E: Structural performance

E1 Definition of failure modes



Please e-mail 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. If so, please type the filename in the box.

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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?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Problems caused by breakage?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Description of the condition of the materials

Nothing has been seen.

E3 Settlement of the structure

Description of settlements of core/subsoil (e.g. instabilities in foundation, internal erosion). Please specify settlement in meters.

Some of the stones rolled down and other were added on the structure's crest

E4 Local erosion of sea bed/scour

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

Around the north roundhead there's a scour -2.5m deep whereas at the south roundhead there's a scour -2m deep.

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

Nothing observed

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)

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	$D(\%) = \frac{n_d (\text{number of displaced units})}{\text{Total number of units}} \cdot 100$	0	%
The strip displacement	$N_{od} = \frac{n_d}{L/D_{n50}}$, L is the length of LCS	0	

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: beach renourishment
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	<input type="checkbox"/>	Moderate	<input checked="" type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Seafood collecting	Intense	<input checked="" type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Wildlife watching	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input checked="" type="checkbox"/>	DK	<input type="checkbox"/>
Sunbathing and similar	Intense	<input checked="" type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Scuba diving	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input checked="" type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Sailing and similar	Intense	<input type="checkbox"/>	Moderate	<input checked="" type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Other (specify)	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>

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

Fishing (recreational)	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input checked="" type="checkbox"/>
Seafood collecting	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input checked="" type="checkbox"/>
Wildlife watching	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input checked="" type="checkbox"/>	DK	<input type="checkbox"/>
Sunbathing and similar	Intense	<input checked="" type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Scuba diving	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input checked="" type="checkbox"/>
Sailing and similar	Intense	<input type="checkbox"/>	Moderate	<input checked="" type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>
Other (specify)	Intense	<input type="checkbox"/>	Moderate	<input type="checkbox"/>	Scarce	<input type="checkbox"/>	Absent	<input type="checkbox"/>	DK	<input type="checkbox"/>

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?

Intertidal and subtidal assemblages are dominated by mussels (*Mytilus galloprovincialis*) and green algae (*Enteromorpha intestinalis* in the intertidal zone and *Ulva laetevirens* in the subtidal zone). Other species observed in the intertidal zone include anthozoa (*Actinidae* spp.), bivalves (*Mytilaster lineatus*, *Ostrea* spp.), gastropoda (*Patella coerulea*), polychaeta (*Serpulidae* spp. and *Sabellidae* spp.), cirripedia (*Chthamalus* spp, *Balanus* spp.), ascidiacea (*Ascididae* spp.), filamentous algae (including *Polysiphonia subulata*, *Polysiphonia breviarticulata*, *Ceramium diaphanum*, *Cladophora vagabunda*) and encrusting algae. Intertidal assemblages are under investigation, and detailed descriptions are available as reports, master theses, and manuscripts in preparation.

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

Data concerning the structure of macrobenthic assemblages are available from sediments on the landward side of the structure. Macrobenthic assemblages are dominated by the bivalve

Lentidium mediterraneum. Other abundant species are the bivalve *Chamalea gallina*, several species of polychaetes including *Glycera convoluta* and *Prionospio caspersi*, several species of crustacea, including *Cumacea* sp., and gasteropoda. A description of sediment assemblages can be found in Bacchiocchi et al. (1997, Proceedings of the third International Conference on the Mediterranean Coastal Environment: pages 39-50).

No quantitative data are available about fish assemblages. Nevertheless information from fishermen in the area suggest that dominant species around the structure include *Mugil* spp., *Boops boops*, gobids. Crabs including *Pachigrachus marmoratus* and *Eriphia verrucosa* are also very abundant on and around the structures

Were any environmental changes observed following the construction of the structure (e.g. increase of water turbidity, floating algal debris)?

At Lido di Dante the construction of the structure has been associated to repeated renourishments of the beach, thus it is difficult to attribute the changes observed to the presence of the structure rather than to the works of renourishment. In any case, the major change observed was a reduction of the average grain size of sediments on the landward side of the structure. As a consequence, water turbidity also slightly increased. Floating algal debris, mostly from green algae, also appeared.

H: Coastal protection performance

H1 Bathymetry and beach evolution

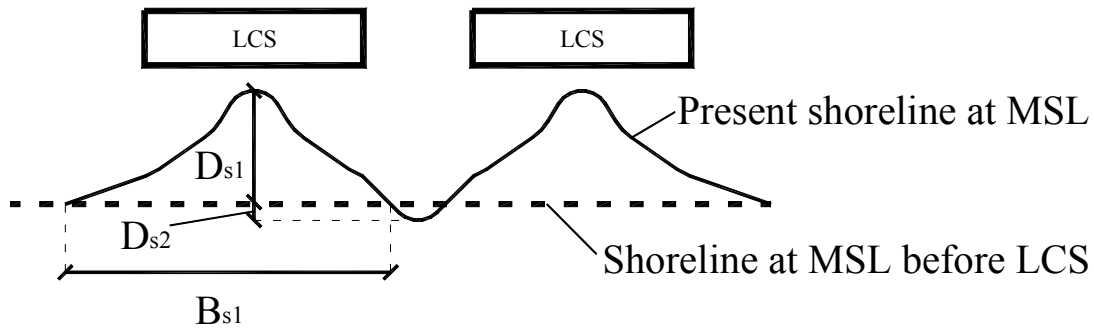
Description of historical beach evolution before LCS was built (10-20 years).

Erosion of the coast in the whole area mainly due to less fluvial supports and subsidence.

Description of beach evolution after LCS was built up to now.

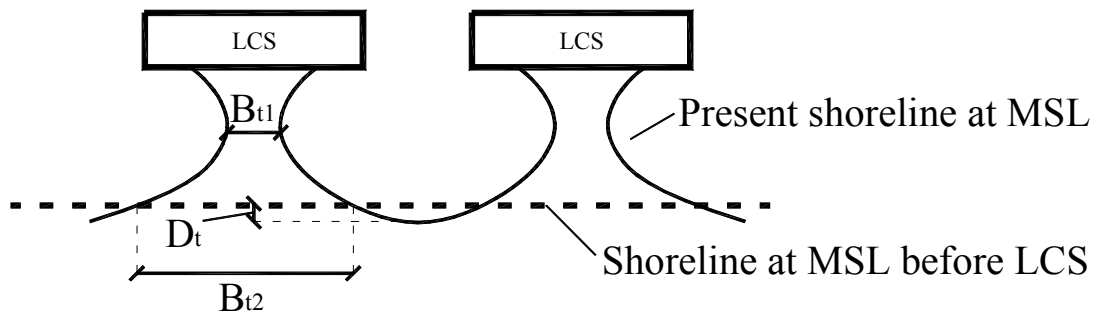
Accretion of the coast in the protected area, but erosion in the north and south area, out of the structure.

H2 Salient formation



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

H3 Tombolo formation



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

H4 Renourishment

Description of renourishment (add more fill) (e.g. amount, how often)
 Beach renourishment up to a depth of -1.15m , with 51000 m^3 of sand.

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
