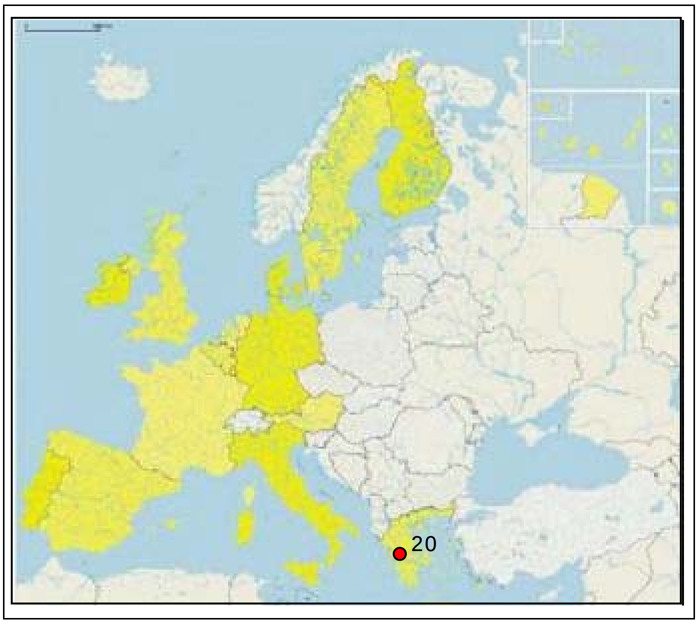
MESSOLOGI LAGOON AREA
(GREECE)



Contact:

Kyriakos SPYROPOULOS

TRITON Consulting Engineers

90 Pratinou Str.
11634 Athens (GREECE)

Tel: +32 10 729 57 61
Fax: +32 10 724 33 58

e-mail: kspyropoulos@tritonsa.gr

1. GENERAL DESCRIPTION OF THE AREA

The Messologi – Aitolikon lagoon is located in the region of Aitoloakarnania in Western part of the central continental Greece at the position:

Longitude: 21^o 04” E
Latitude : 38^o 15” N

Fig.1: Map of Greece.

The lagoon measures a total area of 140 Km^2, and is protected by the RAMSAR convention and the EUR – 79/409 EC directive. It has a maximum length of 15km with a maximum width of 7Km. The depth of East – Central part of the lagoon ranges between 1,0 – 1,5 m but in the largest part of the lagoon depths do not exceed 0,5m. The shallow waters of the lagoon are protected by sand barrier islets, which form a barrage interrupted by barrier inlets through which the water of the lagoon meets the sea - water of the Patraikos Gulf.

Fig. 2: Map of the project area.

1.1 Physical process level

1.1.1 Classification

The coastal area of the lagoon consists of medium sand. The average diameter of the sediment is between 0,20 – 0,60 mm (d_{50} = 0,20÷0,80mm).

1.1.2 Morphology of the coast

The different ecosystems included in the ecosystem of the Messologi wetland are the following:

- Shallow water lagoons with depths ranging from 0,2 – 2,0 m which form the largest part of the wetland. Their total area is 150km2. Sandy silt is the main type of bottom sediment.
- Extensive mud lands enclosing a wide variety of minor organisms, which are the main source of the food for the migrating bird population.
- Salt marches, which lay close to the lagoon wetland the fauna of the salt marches being unique in the area.
- Barrier islands, which form the border between wetland and the sea of the Patraikos Gulf. Dunes cover several parts of the barrier islands with heights up to 5,0 – 6,0m. The island that form the barrier protecting the lagoon are from West to East Louros, Tholi and Prokopanistos between which small tidal inlets appear.
- Small islands inside the lagoon, which add to the diversity of the ecosystem.

The maintenance of the diversity of the ecosystem is essential for:

- The ecological balance in this environmental sensitive sea.
- The natural biodegradation of the large quantities of nutrients from the neighboring agricultural activities.
- The viability of the fishery industry.
- The existence of the barrier island is essential for the protection of the ecosystem from wave action. The observed erosion at the region between the eastern part of Tholi up to the Western boundary of the barrier was assumed to seriously threaten the ecosystem of the lagoon and the associated activities.

1.1.3 Transport agents

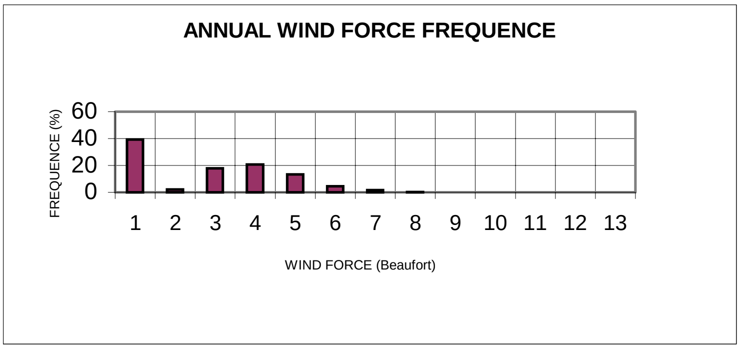
Wind data

Wind data measurements come from the nearest meteorological station of Araxos situated 12km SW of the site provided wind data for the period between 1961-1980.

The following table (Table 1) presents the percentage of annual duration of wind forces:

Table 1: Percentage of annual duration of wind forces.

	WIND DIRECTION							
WIND FORCE	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**
1	0,20	0,30	0,42	0,09	0,25	0,30	0,32	0,22
2	1,67	2,51	2,81	0,43	1,69	2,37	4,44	1,86
3	1,26	3,99	3,36	0,30	1,96	2,04	6,23	1,61
4	0,55	4,61	2,63	0,19	1,11	1,14	2,48	0,61
5	0,15	2,05	1,24	0,03	0,43	0,28	0,39	0,05
6	0,03	0,74	0,41	0,01	0,21	0,16	0,10	0,01
7	0,00	0,15	0,08	0,00	0,02	0,01	0,00	0,02
8	0,01	0,05	0,02	0,00	0,01	0,00	0,00	0,00
9	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00



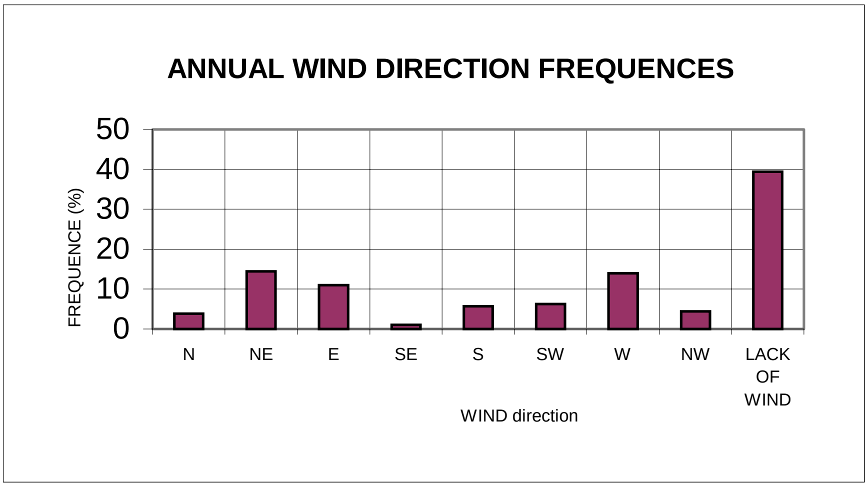


Fig. 2: Annual wind direction and force.

Tidal data

The tidal data come form the Port of Patras and refer to the period 1958-1978.

In more details:

Table 2: Tidal Data.

Area of tidal measurements	**PORT of PATRA**
H.A.T.	0,40 m
M.H.W.L.	0,80 m
M.W.L.	0,90 m
M.L.W.L.	0,98 m
L.A.T.	1,60 m
Max range	1,05 m
Mean range	0,18 m
Min range	0,01 m
Tidal range	1,20 m

Additionally, the fluctuation of the water level in the area was measured during the period from April to December 1988. The statistical analysis of the results indicated that the tide ranges between 0,30 – 0,70m. From the analysis of the time series of tidal fluctuation apart from the presence of the astronomical components, the effect of barometric pressure was also evident. The correlation of barometric pressure with the changes in water level indicated that the response of the sea level to changes in barometric pressure is instant. From the analysis of the harmonic components it was concluded that the tidal fluctuation in the area follows a mixed pattern with a governing semidiurnal component.

Currents data

The near shore current measurements were performed at three different locations and for a month period using an automatic current meter. The depth in all three of the locations was 1,5m. The locations of the measurements were the following:

- ***Location P1***: At the Eastern part of the Louros island, close to the inlet Between Louros and Tholi.
- ***Location P2***: At the middle of the Tholi island.
- ***Location P3***: At the Eastern part of the Tholi island.

The governing current is parallel to the shoreline with an alternate direction depending on the tidal phase. This indicates that the currents are of tidal origin.

Furthermore, it was concluded that the pattern of velocities is of the semidiurnal type. The majority of the measurements had a magnitude of 4cm/sec. The maximum value of the currents observed is presented in the following table:

Table 3: Maximum observed currents velocity.

Location	**P1**	**P2**	**P3**
Velocity (cm/sec)	6	10	14

Waves

The geographical site of the Messologi lagoon provides physical protection from the wind-generated waves coming from the N, NE, E SE, W and NW direction. For the rest geographical directions the calculation of the *Fetch Effective* (according to the "SHORE PROTECTION MANUAL- Volume II/1984) leads to the following table:

Table 4: Fetch Effective values.

DIRECTION	**FETCH EFFECTIVE (Km)**
SW	46
W	135

The wind-generated waves have been calculated as:

Table 5: Wave characteristics.

DIRECTION	Hs (m)	Ts (sec)	Lo (m)
SW	2,25	6,10	58,50
W	3,20	8,20	105,50

1.1.4 Sediment transport

The main source of sediment is the long-shore transportation caused by inclined wave attack and wave breaking. Limited cross-shore sediment transport, due to tidal currents, exist but does not contribute significantly to the sediment budget.

1.1.5 Sedimentary budget

The recent construction of three hydroelectric dams along the Aheloos river, resulted in a significant change of the sediment balance of the coastline creating an intensive erosion of the "strip islets". It was a matter of time before the strip islets protective barrier would be breached and the lagoon to be subjected to a major ecological disaster.

1.1.6 Driving forces

Wind generated waves approach the exposed beach being inclined with respect to the sea-bottom contours. Wave-breaking which takes place at extended breaking zone initiate erosion processes. Thus the wave action is considered as the main responsible factor for the gradual reduce of the coastal width since the wave energy instead of transferring the river induced sediment is dissipated along the coast causing erosion problems.

1.1.7 Cause of problem

Mainly, natural erosion due to coastal processes. As explained above the available for transportation sediment has been dramatically reduced due to manmade works upstream the river, the estuary of which is responsible for the islet formation.

1.1.8 Impacts / Effects

The loss of the barrier islets would be catastrophic for the protected lagoon ecosystem. Besides the economic consequence would have been dramatic since the major activity of all the communities surrounding the lagoon is related to fishery.

1.2 Socio-economic aspects

1.2.1 Demography; population rate

No data available.

1.2.2 Major functions of the coastal zone

Near the coastal zone of the area to be studied, there is not industrial development. The main developed activities are related to the aqua farm situated to the Messologi lagoon.

1.2.3 Land use

The barrier islets are a protected area. No human activities are allowed.

1.2.4 Assessment of capital at risk

The existing of the barrier islets is vital for the aqua farms operation, which are located in the lagoon water area of Messologi.

2. PROBLEM DESCRIPTION

The erosion of the sandy barrier islets due to significant changes in the sediment balance of the coastline was introducing risk of ecological disaster for the Lagoon.

3. SOLUTION / MEASURES

3.1 Policy option

The policy option is characterized as a very important intervention for coastal protection from erosion.

The groin system design has been influenced by the following parameters:

- The mild beach slope, which extends the breaking zone width to some hundred of meters offshore. Clearly groins could not feasibly extend throughout the breaking zone.
- The need of avoiding extended erosion further down drift the coastline to be protected. Therefore the complete interruption of long shore sediment transportation was unable to be described.
- Shallow water depths along the coastline precluded the use of floating equipment for the construction of the groins.

The choice of groins spacing is an important factor affecting groin performance. Very widely spaced groins are not expected to form a cooperating system, while closely spaced groins completely divert long shore transport without trapping the sediment. Groin spacing is designed to ensure that the beach is not exposed to wave action at any point within the bays between groins under the design conditions.

3.2 Coastal defense measures

The main strategy that was selected is the construction of groins situated every 40,0m, vertically to the coast. The length of the groins was decided to be 20,0m with 10,0 more meters extension to the coast.

The final design for the groin system has the following characteristics:

Table 5: Groin system characteristics.

Groins length:	***30.0m***, 10.00m of which lie shoreward and 20.0m seaward of the shoreline
Spacing factor:	***1 : 2***
Space between groins:	***40.0m***
Groin crest level:	***1.3m***

The groins were constructed with a combined use of wire-mess mattresses and gabions. The wire was PVC coated for anticorrosion protection and the feeling stones were round edged in order the PVC sleeve not to be broken due to stones movement. More information about the project may be given through the following drawing and photos of the next pages.

The shorter length of the groins compared to the extension of the surf-zone was chosen in order to allow partial bypassing of the sediment in order to receive adequate sediment supply for the whole of the protection system.

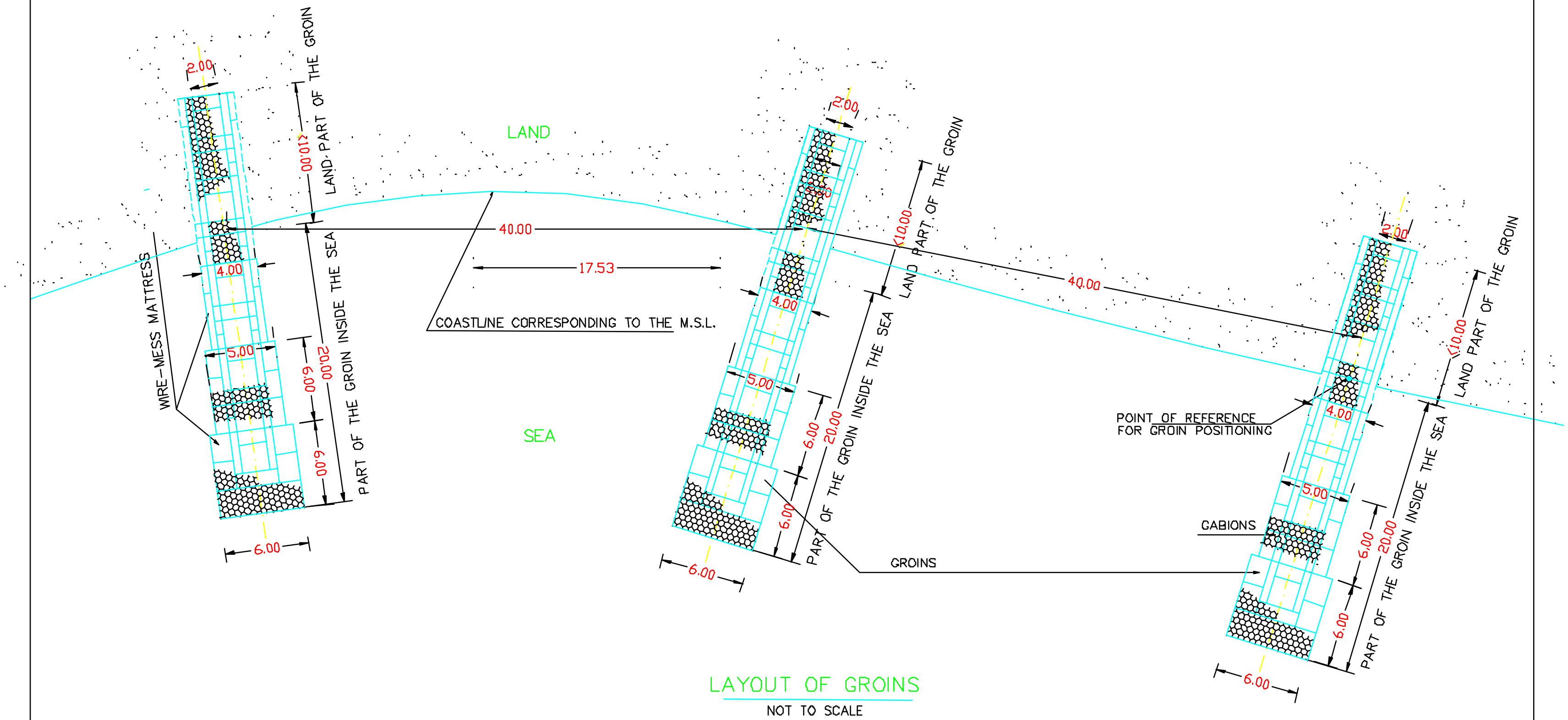
For the same reason it was decided that the whole of the remaining shoreline had to be protected otherwise the shoreline areas down drift of the groin protected system would experience severe erosion.

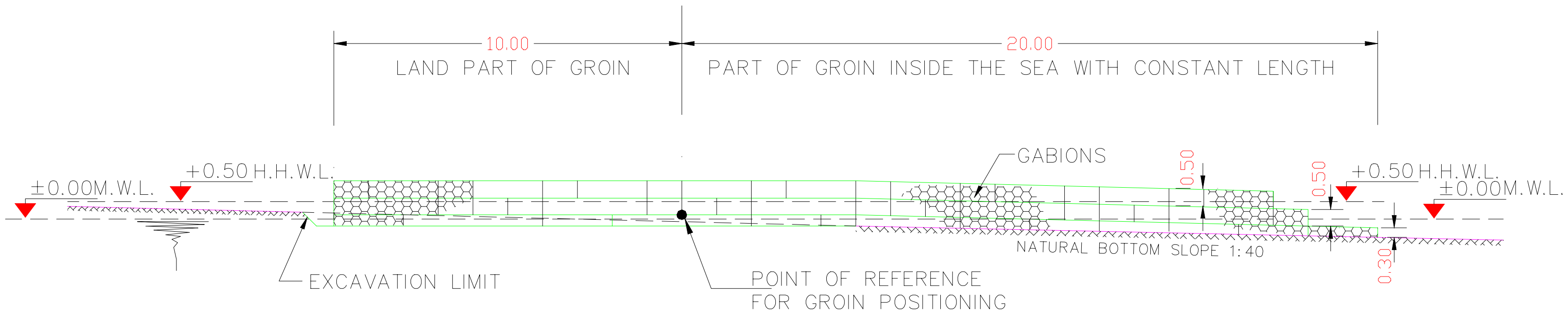
Fig. 3: Partial view of the Project.

Fig. 4: East view of the Project.

Fig. 5: North – East view of the Project (view of the river estuary).

Fig. 6: Main entrance of the Lagoon.


LAND
SEA
2.00
4.00
5.00
6.00
10.00
20.00
40.00
17.53
LAND PART OF THE GROIN
PART OF THE GROIN INSIDE THE SEA
WIRE-MESS MATTRESS
COASTLINE CORRESPONDING TO THE M.S.L.
POINT OF REFERENCE FOR GROIN POSITIONING
CABIONS
GROINS
LAYOUT OF GROINS
NOT TO SCALE



TYPICAL CROSS SECTION

NOT TO SCALE

3.3 Financial aspects.

No available data.

4. EFFECTS AND LESSONS LEARNT

4.1 Effects of measures

The sediment transport direction was clearly characterized as longshore i.e. parallel to the coastline. The construction of groins proved to be the most appropriate counter measure to the erosion problems. Sediment was trapped between the groins, being available for wave dissipation and the water streamlines were modified due to the presence of the works. The above processes resulted to the elimination of the erosion problems and building of small beaches between the groins.

4.2 Lessons learned

When cause of erosion is a spatial gradient of longshore sediment transport, construction of groins is a very effective measure against erosion problems. During construction of the works, downstream of the already constructed groins the erosion problem got temporarily worse. This was due to sediment trapping between the groins thus even less sediment was feeding the downstream coast. The equilibrium was settled after the construction of the whole groin system along the entire length of the islets' coastline.

4.3 Cost-benefit analysis

No available data.