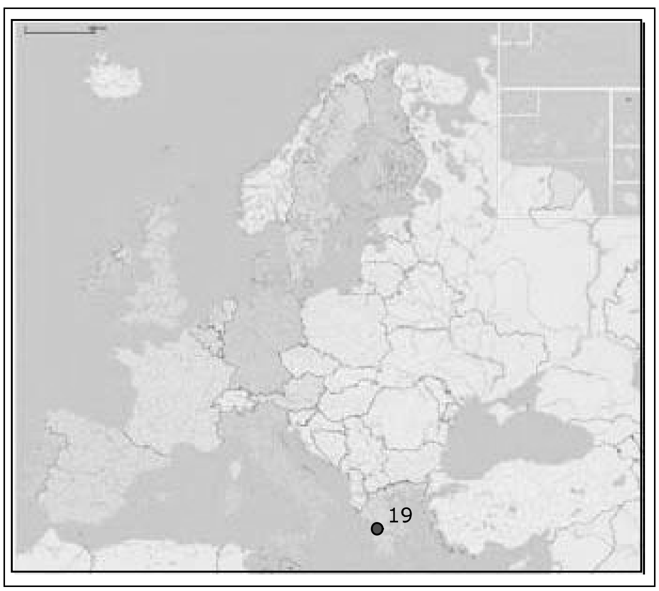
LAKKOPETRA
(GREECE)



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1. GENERAL DESCRIPTION OF THE AREA

"Lakopetra Beach" Hotel is situated in the Westside of Patraikos Gulf. Patraikos Gulf is located in the North - Westside of Peloponnese in the West entrance of Korinthiakos Gulf (Canal), which separates Peloponnese from central continental Greece (see figures 1 and 2). The studied coastal area is situated 10km East of the entrance of Patraikos Gulf. The coastal length of the Gulf is 30km. The length of the beach in front of the "Lakopetra Beach" is 300m.

Fig. 1: Map of Greece.

Fig. 2: Map of the project area.

1.1 Physical process level

1.1.1 Geology and coastal type

The geology of the wider project area indicates the presence of Holocene type alluvial sediments formed by river and water stream discharges into the coastal system as well as sediment transported by coastal mechanisms due to wave action. These sediments consist mainly of granular material such as sand and gravel.

1.1.2 Morphology of the coast

It is a planar area without morphological accidents along the coast. Typical mild slope sandy beach (2% - 3%) without any major marine works at the adjacent areas. The coastal area consists of medium to fine sand with gravel. The fine sand exists at a percentage of 90%, with an average diameter less than 0,80mm (d_{50} < 0,80mm) at a percentage of 92% and an average diameter less than 0,30mm (d_{50} < 0,30mm) at a percentage of 72%. Medium sand exists at a percentage of 7% and gravel at the remaining percentage of 3%.

1.1.3 Physical processes

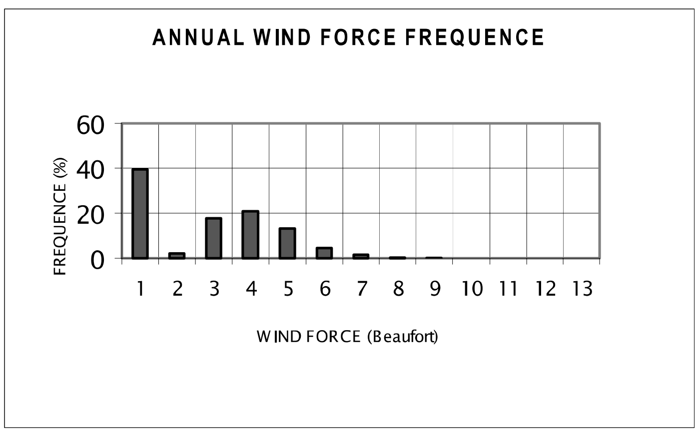
Wind data

Wind data comes from the nearest airport of Araxos. The measurements refer to the last 19 years (1961-1980). The maximum values of wind per direction are listed in the following table:

Table 1: Maximum intensity values of wind per direction.

DIRECTION	INTENSITY (BEAUFORT)
N	8
NE	9
E	8
SE	6
S	8
SW	7
W	7
NW	7

- The most frequent wind forces come from the NE and W directions.
- The maximum wind force reaches the value of 9 Beaufort.
- The most frequent values of winds do not exceed the 4 Beaufort The most frequent wind forces coming from E and NE directions are observed during the winter.
- The most frequent wind forces from W direction are observed during the summer.



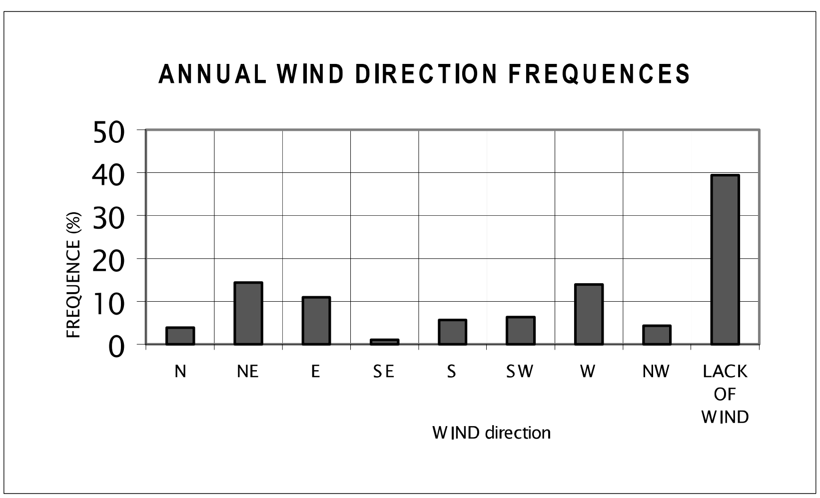


Fig. 3: Annual wind direction & force (data from Araxos airport).

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

Waves

The geographical site of the "Lakopetra Beach" provides physical protection from the wind-generated waves coming from the SE, S, SW and W direction. For the remaining geographical directions the calculation of the *Fetch Effective* (according to the "SHORE PROTECTION MANUAL- Volume II/1984) leads to the following table:

Table 3: Fetch effective values

DIRECTION	**FETCH EFFECTIVE (km)**
NW	38
N	22
NE	40
E	20

The wind-generated waves have been calculated as:

Table 4: Wave characteristics

DIRECTION	**Hs (m)**	**Ts (sec)**	**Lo (m)**
NW	1,7	5,4	45,5
N	1,6	4,7	34,5
NE	2,4	6,2	60,0
E	1,5	4,6	33,0

Near shore currents, storm surge level

Near shore current measurements do not exists. Water level rise due to storms (storm set up) has been calculated to a maximum of 0,20m.

1.1.4 Erosion

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 transport.

Sedimentary budget

The main coastline information comes from historic area-photo data. The sedimentary budget has been calculated using the energy flux method and thus the transport rates/trends as well as the direction of net transport rates has been defined.

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. Onshore sediment feeding of the coast has been diminished due to a coastal road construction. Aeolic contribution is not considered significant. Data on sea level change or other shoreline processes are not available.

Cause of problem

Mainly, natural erosion due to coastal processes. The manmade contribution is focused on the coastal road construction and the extended sand volumes that were removed for building construction purposes.

1.2 Socio-economic aspects

1.2.1 Demography; population rate

The main population found along the coast of the Gulf, belongs to the small villages situated near the coast. This population is approximately 10.000 persons in an area of 100Km^2. Nevertheless, an additional amount of tourists is present in this area during the summer.

1.2.2 Major functions of the coastal zone

Near the coastal zone area there is no industrial development. On the contrary, tourist activities have been developed for the last years.

1.2.3 Land use

Behind the area of consideration a beach resort Hotel exists. The Hotel belongs to the major Hotel Greek Enterprise.

1.2.4 Assessment of capital at risk

The beach lies in front of a big resort Hotel and erosion eventually endangers the shore facilities of the Hotel i.e. fences, gardens, playgrounds, courts etc.

2. PROBLEM DESCRIPTION

2.1.1 Eroding sites

The beach is very important for the Hotel enterprise as to be characterized as an asset for it. Recreational activities and sports take place on the beach during the summer period by hotel guests and the sea in front is the main attraction area for the Hotel residents who play and swim in it. Possible loss of the beach will automatically lead to rapid Hotel clientele decretion.

2.1.2 Impacts / Effects

The beach being exposed to wave action has been eroded due to the aforementioned reasons. The continuing erosion process was expected to result even to complete loss of the beach within the next few years.

3. SOLUTION / MEASURES

3.1 Policy options

The policy option was to move the coastline seaward with the construction of a detached breakwater system.

3.2 Technical measures

3.2.1 Historic measures

3.2.2 Type

With the construction of the detached breakwaters a sediment trap is formed on the lee side of the breakwaters thus helping the coastline to proceed seaward on the one hand and to increase the sediment budget on the other. Thus, increased volumes of sediment are offered for wave energy dissipation through sediment transport instead of erosion. The coastal defense measures can be characterized as hard.

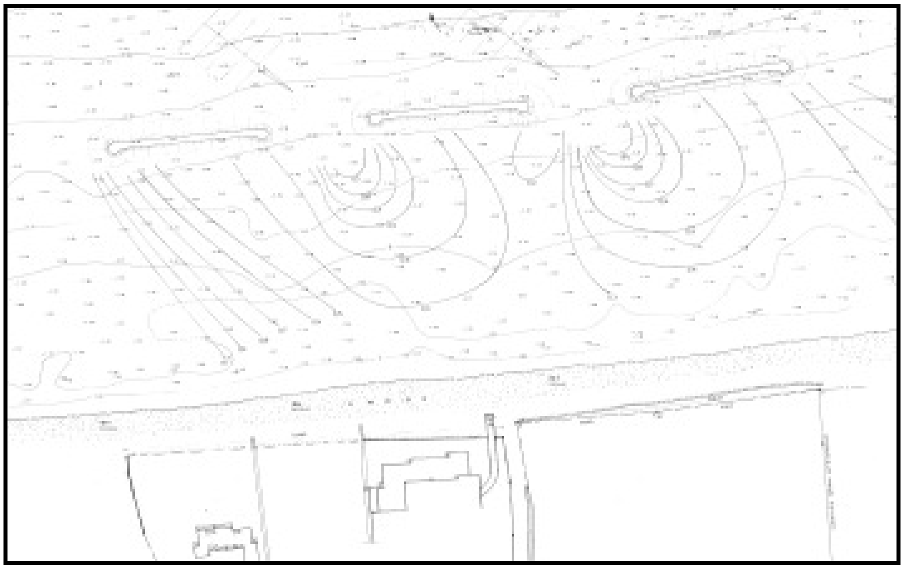
3.2.3 Technical details

The geometrical characteristics of the project works were the following:

Table 5: Geometrical characteristics of the project works

Number of breakwaters	3
Length of each breakwater	68,00 m
Space between breakwaters	43,00 m
Depth of foundation	-3,30 m
Crest elevation	+0,70 m
Distance from the coast	120,00 m

For more details, see attached drawings (Figures 4 & 5) and photos (Figures 6 to 11) of the project.



TYPICAL CROSS SECTION

ARMOURING LAYER	1.5 ÷ 2.5tn = 34.12m2
SECONDARY LAYER	150 ÷ 200kgr = 9.00m2
CORE	0.01 ÷ 100kgr = 9.91m2

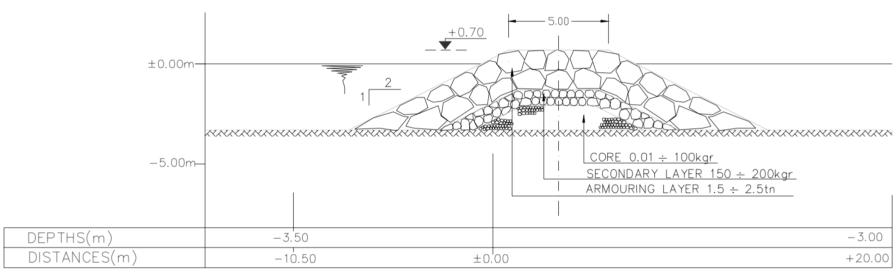


Fig.4: Survey of the project area.

Fig. 5: Cross section of a detached breakwater.

Fig. 6: View of the beach before the construction of the breakwaters.

Fig. 7: View of the beach after the construction of the breakwaters.

Fig. 8: West view of the beach before the construction of the breakwaters.

Fig. 9: East view of the beach after the construction of the breakwaters.

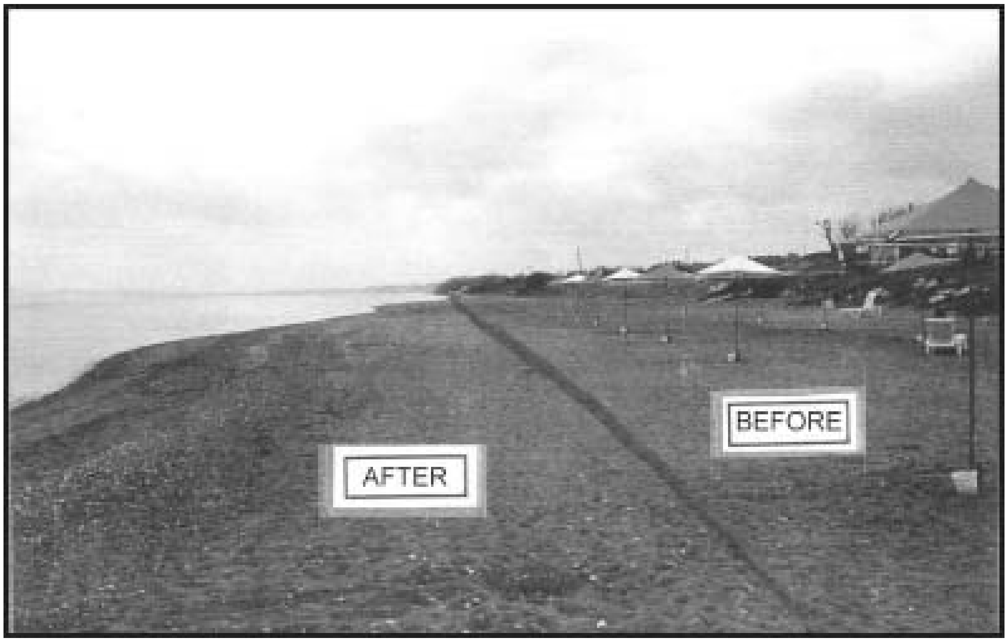


Fig. 10: East view of the beach.

Fig. 11: West view of the beach.

The cross section details are as follows:

Table 6: Cross section details of the breakwater

Layer	**Weight rang**	**Weight range (Kgr)**	**Thickness of layer (m)**
Armouging	0,75W – 1,25W	1500 - 2500	1,80
Secondary	W/15 – W/10	150 - 200	0,80
Core	W/6000 – W/200	0,01 - 100	-

3.2.4 Costs

The cost of project realization was 350,000 €.

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

After the construction of the detouched breakwaters the coast erosion stopped, and the erosion mechanism was reversed leading to formation of a new coastal zone due to accretion of sediments in the lee side of the breakwaters.

4.2 Effects related to socio-economic aspects

The coastline response was very impressive. The construction works were finished early in spring just before the beginning of the touristic period and within the same summer the width of the beach was almost doubled. The Hotel manager was very satisfied to offer to his clients an extended sandy beach.

The crest elevation of the works has been kept low in order not to heavily obstruct the sea view from the beach. However, the rubble mound works remind the manmade intervention to the natural environment.

There was not a monitoring program established due to the private origin of the project.

4.3 Effects on neighbouring regions

The coastline response can be characterized as very successful. The consequences to the adjacent coasts were not sever since the project area can be characterized as an autonomous coastal region. As undesirable effects can be mentioned the loss of marine life previously established in the natural sea-bed as well as the cover of poseidonia fields with sand.