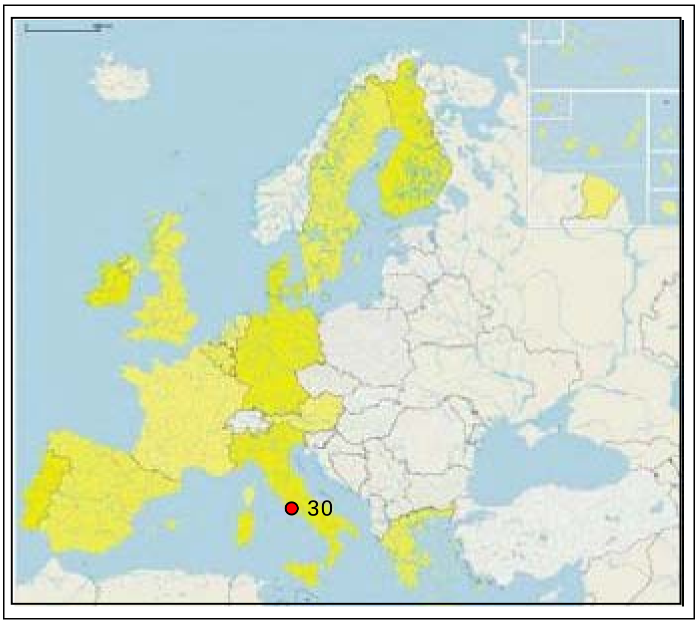
VECCHIA PINETA
LIDO DI OSTIA
(ITALY)



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1. GENERAL DESCRIPTION OF THE AREA

The Vecchia Pineta beach is on the South-eastern part of the Ostia shoreline, located to SE of Tevere River mouth. The beach section took in consideration, extended for approx. 450 m, faces the Tirreno Sea and begins from the Canale dei Pescatori mouth. There are three wharves of wooden cabins and La Vecchia Pineta restaurant on the beach.

1.1 Physical process level

1.1.1 Classification

Coastal band of the examined site is constituted by a sandy beach of reduced extension. From the land side the beach is bordered by a string of dunes slightly decreasing going towards the shore.

1.1.2 Geology

The superficial beach deposits founded uniform within the actual beach section are essentially composed of well sorted yellow grey fine to medium grained sand with some coarser material and shell fragments deposited on the foreshore.
The average grain sizes are approx. 150-200 µm.

1.1.3 Morphology

The costal girgle in the examined site is constituted by a low extension sandy beach, of approx 40 m and weak gradient nearly 1:40, bordered, on the earth side, by a series of dunes softly decreasing towards the shore-line, instead on the sea side the sounding-depth outline shows a system of one or two longitudinal bars. In a distance of 50-60m from the shoreline, for a extension of approx 400-500m, you can find the rest of submerged breakwaters manufactured with pebbles in order to protect the shore (see enclosed picture). The breakwaters appears strongly renewed by the environmental phenomena and by the interaction with the sea sounding-depth. Nowadays it appears irregular, with a transversal dimension of approx 20-30m and a water average depth lower then one meter.

1.1.4 Physical processes

Currently it doesn't exist local indication regarding the wave climate, but considering the below mentioned distribution data of the significant wave-height and considering the orientation of the normal out to the cost line at approx. 210°N, it clearly appears a higher wavy motion frequency from north direction then from south, according to the expected side of the net littoral drift.

Weather conditions of the site

Today the available wind data result from three years of measures ('86-'89) performed in the Northern part of Lazio. On annual basis (tab. 1), the wind climate shows a strong frequency predominance from NNE and NE, more then 35% of the total events, nevertheless they are joined to weak intensity winds, likely due to the breeze, as also indicated by the presence of another maximum local frequency associated to SSW and SW areas. The greater intensity events seem to be due to the areas between SE and SW also showing a good frequency, instead heavy winds can blow from NW even if less frequently. The summer climate (tab. 2) still brings to a clear majority of weak winds from NE, with a higher frequency from SW clearly associated to the summer breeze. Once again the heavier winds seem to be associated between the II and the III quadrant. As regards the storm phenomena, winds heavier then 10m/s are present in approx 4% of the cases, while only 0.2% exceed 15m/s

Table 1 – Annual distribution of the wind – Site: Northern LAZIO.

Northern LAZIO – Annual distribution of the wind											
	Wind velocity (m/s)										
Dir	2.0	4.0	6.0	10.	12.0	14.0	16.0	18.0	20.0	>20.	Total
N	0.27	0.92	0.55	0.71	0.03	0.00	0.00	0.00	0.00	0.00	2.47
NNE	1.66	4.77	2.94	2.86	0.12	0.00	0.00	0.00	0.00	0.00	12.31
NE	2.16	15.59	5.16	0.58	0.02	0.00	0.00	0.00	0.00	0.00	23.52
ENE	1.26	5.06	1.74	0.10	0.00	0.00	0.00	0.00	0.00	0.00	8.16
E	0.58	1.59	0.61	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.90
ESE	0.63	1.26	0.64	0.67	0.11	0.06	0.01	0.00	0.00	0.00	3.38
SE	0.59	1.02	0.97	2.26	0.68	0.34	0.13	0.02	0.00	0.00	6.04
SSE	0.66	1.72	1.85	2.61	0.56	0.20	0.05	0.02	0.00	0.00	7.66
S	0.62	1.69	1.79	1.81	0.33	0.14	0.08	0.02	0.00	0.00	6.48
SSW	0.56	2.00	1.96	1.13	0.43	0.25	0.07	0.02	0.00	0.01	6.43
SW	0.62	1.75	1.90	1.15	0.20	0.11	0.01	0.00	0.00	0.00	5.76
WSW	0.36	1.21	1.35	1.61	0.08	0.06	0.00	0.00	0.00	0.00	4.67
W	0.36	0.95	1.00	1.09	0.02	0.02	0.00	0.00	0.00	0.00	3.46
WNW	0.22	0.73	0.74	0.56	0.05	0.01	0.00	0.00	0.00	0.00	2.33
NW	0.22	1.09	0.59	0.18	0.00	0.00	0.00	0.00	0.00	0.00	2.08
NNW	0.11	0.41	0.16	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.70
Total	10.87	41.77	23.95	17.47	2.61	1.21	0.38	0.08	0.01	0.00	98.36
	Calme =1.64										

During the summer climate the storm frequency obviously decrease, with 2% of the events over 10 m/s and only 0.01% over 15 m/s.

Table 2 – Summery distribution of the wind – Site: Northern LAZIO.

Northern LAZIO – Summery distribution of the wind											
	Wind velocity (m/s)										
Dir	2.0	4.0	6.0	10.	12.0	14.0	16.0	18.0	20.0	>20.	Total
N	0.24	0.81	0.38	0.43	0.00	0.00	0.00	0.00	0.00	0.00	1.85
NNE	1.93	5.32	2.26	1.70	0.07	0.00	0.00	0.00	0.00	0.00	11.29
NE	2.52	13.40	2.85	0.60	0.00	0.00	0.00	0.00	0.00	0.00	19.37
ENE	1.42	4.04	0.76	0.09	0.00	0.00	0.00	0.00	0.00	0.00	6.32
E	0.64	1.30	0.39	0.06	0.00	0.00	0.00	0.00	0.00	0.00	2.39
ESE	0.83	1.15	0.48	0.32	0.01	0.00	0.00	0.00	0.00	0.00	2.80
SE	0.66	1.24	0.74	1.65	0.35	0.25	0.02	0.00	0.00	0.00	4.91
SSE	0.78	1.85	1.96	2.35	0.50	0.11	0.00	0.00	0.00	0.00	7.56
S	0.75	2.07	2.39	1.71	0.11	0.03	0.00	0.00	0.00	0.00	7.07
SSW	0.60	2.89	3.90	0.80	0.06	0.07	0.01	0.00	0.00	0.01	8.34
SW	0.85	2.42	3.57	2.10	0.12	0.02	0.01	0.00	0.00	0.00	9.10
WSW	0.46	1.46	2.15	3.25	0.03	0.00	0.00	0.00	0.00	0.00	7.35
W	0.42	1.14	1.31	1.86	0.00	0.00	0.00	0.00	0.00	0.00	4.74
WNW	0.32	0.84	0.60	0.48	0.00	0.00	0.00	0.00	0.00	0.00	2.25
NW	0.28	1.05	0.41	0.08	0.00	0.00	0.00	0.00	0.00	0.00	1.83
NNW	0.04	0.38	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Total	12.76	41.37	24.22	17.50	1.28	0.48	0.04	0.00	0.00	0.00	97.66
	Calme =2.34										

Wave-motion climate

In order to explain the cost dynamic is fundamental to take the directional distribution of the wave motion into consideration. Directional measure of the wave motion has been collected by a buoy installed, by the Ministero dei Lavori Pubblici, near to Ponza island, far 100 Km from our site. These data are not yet available, even if some not directional wave measures, collected in North Lazio coastal area, have been used in order to have some reference about wave climate.

Table 3 – Annual distribution of the significant wave. Data from approx. 50 m deep – Area: Northern Lazio.

Northern Lazio – Annual distribution of the significant wave-height													
	Significant wave-height (m)												
Dir (°N)	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**>5.5**	Total
0	2.45	0.89	0.17	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.56
45	26.98	7.36	1.97	0.44	0.05	0.01	0.01	0.00	0.00	0.00	0.00	0.00	36.82
90	6.65	3.57	1.64	0.29	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.00	12.22
135	2.87	2.87	2.03	0.71	0.38	0.15	0.05	0.04	0.00	0.00	0.00	0.00	9.10
180	5.24	3.56	2.62	1.18	0.36	0.08	0.17	0.04	0.04	0.00	0.00	0.00	13.29
225	7.50	1.58	1.05	1.25	0.51	0.26	0.13	0.08	0.04	0.00	0.01	0.00	12.41
270	5.65	1.30	0.39	0.36	0.24	0.14	0.05	0.01	0.00	0.00	0.00	0.00	8.14
315	2.58	0.93	0.45	0.30	0.14	0.04	0.01	0.00	0.00	0.00	0.00	0.00	4.45
total	59.93	22.07	10.32	4.57	1.73	0.70	0.42	0.18	0.07	0.00	0.01	0.00	100.00

If we carefully have a look at the tab. 3, disregarding NE sector where the high frequency/low intensity events are due to the simultaneous wind high-frequency, we remark that the main wave motion, as far as intensity and frequency, is from S and SW event though there is a significant frequency from W and NW. Significant wave events over 2 m appear in 3% of the cases, 3 m only in less then 1%. During the summer climate (tab. 4) the wave motion intensity highly decrease, less then 1% of the cases show waves over 2 m. The heaviest sea-storms are concentrated in SE and SW sectors.

Table 4 – Summer distribution of the significant wave. Data from approx. 50 m deep – Area: Northern Lazio.

Northern Lazio – Summer distribution of the significant wave-height													
	Significant wave-height (m)												
Dir (°N)	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**>5.5**	Total
0	1.94	0.25	0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.32
45	25.70	4.10	1.06	0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.02
90	7.06	1.61	0.68	0.04	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.47
135	3.85	2.32	1.56	0.42	0.13	0.08	0.00	0.00	0.00	0.00	0.00	0.00	8.37
180	8.16	3.93	2.11	0.42	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.67
225	13.78	2.03	0.55	0.25	0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	16.78
270	9.93	2.62	0.13	0.25	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.02
315	2.96	1.01	0.08	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.35
total	73.37	17.88	6.26	1.86	0.51	0.13	0.00	0.00	0.00	0.00	0.00	0.00	100.

Tides and currents

The tide excursion of our site is mainly semi-diurnal, with a spring-tide of approx. 0.2 m (total excursion 0.4 m),. The main tide parameters are:

- MHWS = 0.4 m
- MHWN = 0.3 m
- MLWN=0.1 m
- MLWS=0.1 m
- MSL=0.2 m

The sea currents are mainly a wind result, therefore strongly conditioned by the weather variability and, near the cost, by the structure of the bathymetric lines. With estimated current speed of approx. 5 cm/s, tides have no weight.

As for the wind current, information are available only by occasional measures performed in different periods of the same year, with measure times not exceeded 15-20 days. The measured average currents are approx. 0.05-0.2 m/s with peaks of 0.45 m/s.

The water column characteristics show a remarkable season variability due to the presence of a thermocline during the spring/summer period. However this characteristic has no weight on the slope flow. The highest value of the superficial current has been estimated at 1 m/s with a return period of a century.

Finally we want to stress that during the inspections it has been observed interstitial water filtering towards the surface of the shore-line. It helps to make this area unstable during the wave down-wash phases. This filtering is likely due to a hinterland high piezometric level. In fact it appears barely built or paved and consequently doesn't carry significantly the rain-water away.

1.1.5 Erosion

The shore erosion forecasts pointed out a global mass of approx. 220.000 m^3/year, shared in 100.000 m^3/year toward North and 120.000 m^3/year South direction, with a net difference of 20.000 m^3/year in favour of the south side. At present we do not get quantitative forecasts about the transversal transport except the direct indication of the bar strings.

During the previous decades (figure 1) the above mentioned difference was compensated by Tevere contributions but today, thanks to the works of river regimentation and ground stabilization, they are decreased helping to trigger erosion phenomena along the entire shoreline.

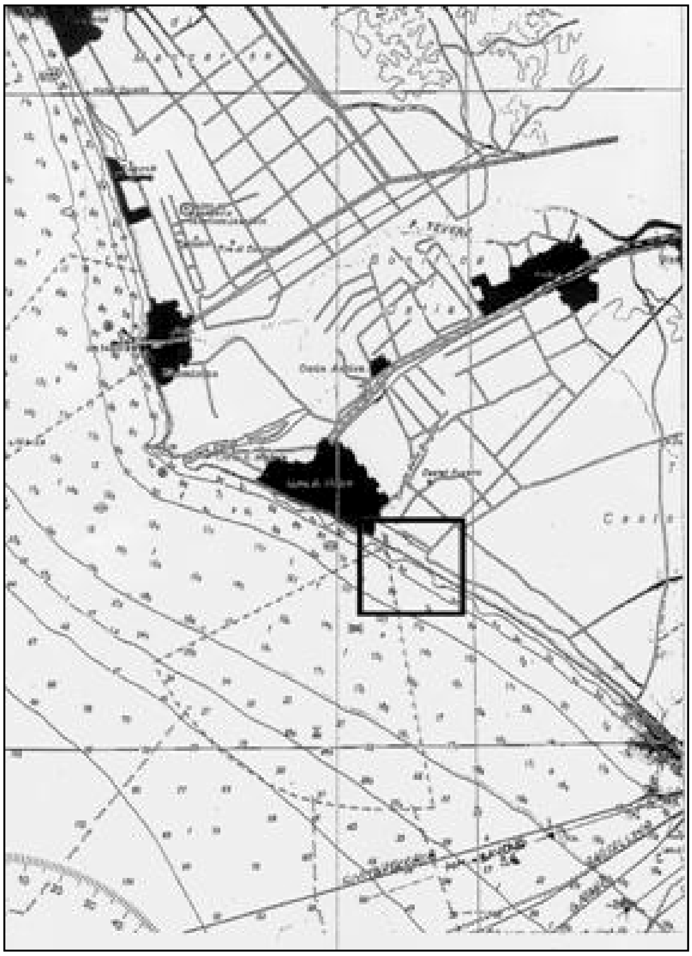

Fig. 1: Chart of Vecchia Pineta site.

Before installing the BMS system, a sedimentary deficit of 35.000-45.000 m^3/year, with an average shoreline withdrawal of 5 m/year was estimated along the 4 km long coast between Canale dei Pescatori and Castelfusano, which includes Vecchia Pineta beach where BMS is located.

1.2 Socio-economic aspects

Ostia beach means the first choice for the inhabitants of Roma, therefore tourism is the main socio-economic activity of this place. This is confirmed by the presence of three wharves, on which there are cabins, and by La Vecchia Pineta restaurant (figures 2, 3, 4).

Fig. 2: A wharve on the Vecchia Pineta beach.

This nice beach, extremely attended during the summer season, is constantly artificially renourished in order to maintain suitable dimensions for the amusing activities.

Fig. 3: La Vecchia Pineta Restaurant.

Fig. 4: La Vecchia Pineta in summer.

2. PROBLEM DESCRIPTION

2.1 Eroding sites

As above explained, toward North, the Vecchia Pineta beach bordered with the Canale dei Pescatori docks (figure 5). They protect from the coast erosion phenomena. Moving southward this phenomena become clearer because of the net longitudinal transport. It has been measured a withdrawal of approx. 25 m in 5 year (1991-1996).

Fig. 5: Vecchia Pineta site – Before artificial renourishment.

The real beach section can be shortly described as follows: starting from the Canale dei Pescatori, the almost rectilinear beach section extends for approx. 450 m toward SE and its width is around 45 m at half of tide cycle. The beach slope is very slight. In fact, between the foot of the 2 meters wall, placed as road-bed support, and the shore-line. It means approx. 1 m height.

2.2 Impacts

As above mentioned, hinterland and beach, in spite of its remarkable tourist interest, appear barely built with the exception of the restaurant and the cabins over the wharves which do not weightily interfere with the shore-line morpho-dynamic. During the autumn 1999 was performed a 45 m programmed shore-line advancing by an artificial renourishment, in order to face the withdrawal due to the erosion.

3. SOLUTIONS/MEASURES

3.1 Policy options

Following the relevant erosive phenomenon, which touched this shore-line for years, the Regione Lazio carried out a lot of intervention firstly aimed to hold the line and to a subsequently its advancing.

3.2 Strategy

It's well known that, in order to guarantee a long stability, every non-protected action must be combined with a suitable maintenance service. As regards the area between Ostia and Castel Fusano, this maintenance service consists of an annual sand artificial renourishment of approx. 15.000 m^3. In this contest, it has been carried out the installation of a new system of erosion maintenance and coast resetting, BMS (Beach Management System). This new system has a double aim:

- Shore-line stabilization and consequently maintenance low-costs.
- Get a further advancement.

3.3 Technical measures

During the previous years a lot of passive protection interventions (emersed and submerged breakwaters, groins) (figure 6) have been performed. This actions allowed stabilization and advancement of the shoreline, but at the same time helped to shift the erosion phenomena southward.

Fig. 6: Example of remains of old passive protection interventions.

In the 1998 and 1999 artificial renourishments works have been done. They consisted of two non-protected sand pouring. Firstly 160.000 m^3/Km of medium size sand have been poured to the North of Canale dei Pescatori, with a resulting advancement of 20-60 m. During the autumn 1999 the second intervention takes place. It consisted of a pouring of 600.000 m^3 of sand in the distance between Canale dei Pescatori and Castel Fusano docks. As a result 40 m was the advancement of the shore.

Finally in February 2001 the BMS system became operative. It consists of three segments for a total length of 400 m (figure 7) with a drainage duct of 160. This duct is constituted by a wrinkled and flexible pipe with rectangular windows, wrapped by a geo-textile stocking. Each segment is connected to a well with Flyght pumps. The drainage distance from the shore-line is approx. 7 m and has been placed at a depth of 2,5 m from the ground level (with the upper surface of the pipe at approx 80 cm under the medium sea level).

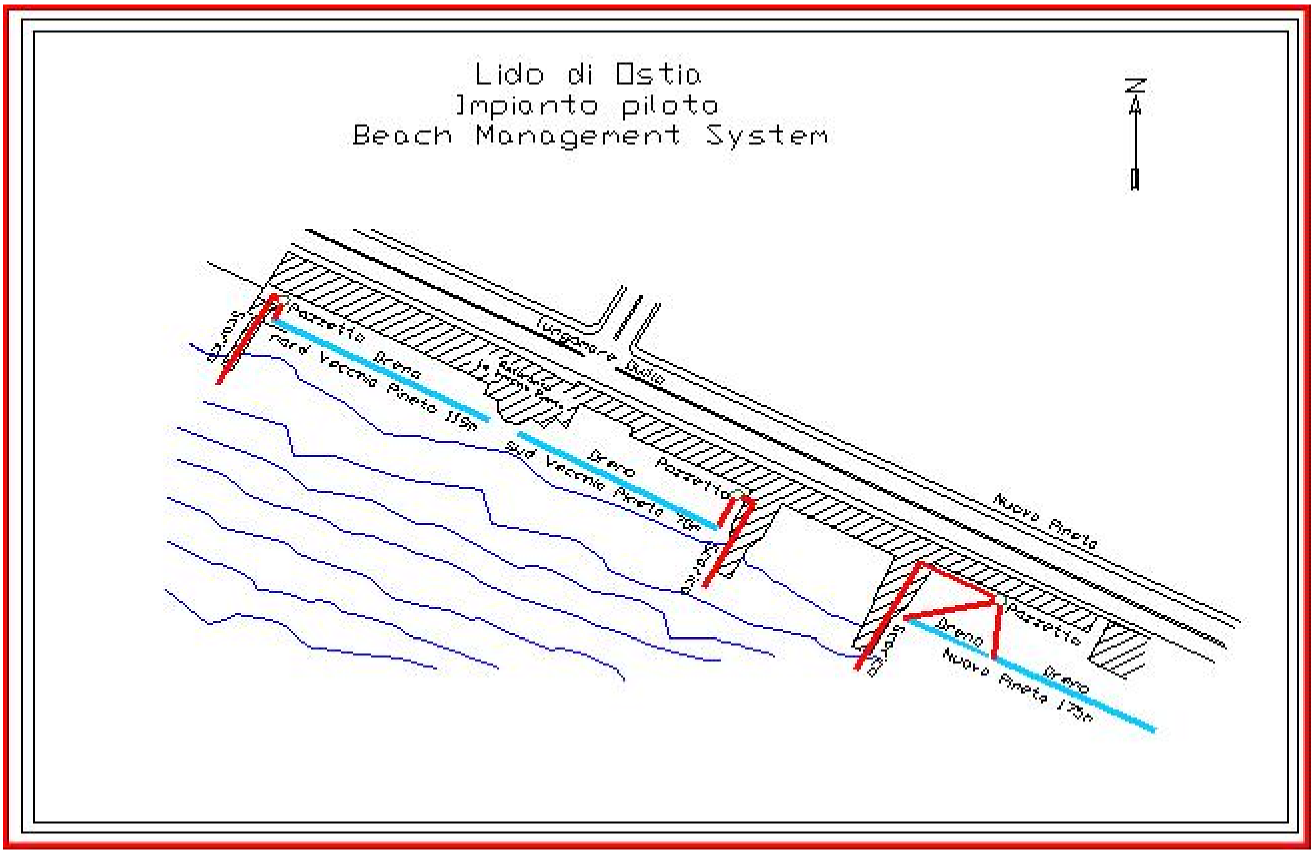

Fig. 7: Beach Management System technology on the La Vecchia Pineta beach.

The ending part of the second segment, close to La Vecchia Pineta restaurant, is placed behind one of the low bluffs. During the works some operative difficulties have been met concerning both the trench excavation for the draining duct and the well setting. In fact, during excavations surfaced some erratic boulders making a preliminary reclamation necessary.

4. EFFECTS AND LESSONS LEARNT

Up to January 2001 Regione Lazio was unable to verify the effectiveness of the carried out actions stopping the erosion phenomena, so in February of the same year it authorized the installation of the BMS technology. Even though the scheduled monitoring activity is not still started, some results immediately appeared very clear (figure 8a, 8b, 9a, 9b).

Fig. 8a: Section 2 (North) - Situation on 23 october 2000 (without BMS system).

Fig. 8b: Section 2 (North) - Situation on 22 february 2001 (10 days after BMS installation).

Fig. 9a: Section 3 (North) - Situation on 23 october 2000 (without BMS system).

Fig. 9b: Section 3 (North) - Situation on 22 february 2001 (10 days after BMS installation).

We must underline that those coastline was affected by heavy sea-storms (during the Easter 2001, for instance) having seriously tested the new system. The results were extremely positive, also proved by the fact that a neighboring beach line needed of additional interventions in order to restore the ordinary level, while the examined line, thanks to BMS system, required no interventions.

An inconvenient was represented by the breaking of the second segment behind the low bluff. In this area, after an initial normal operation, the heavy sea-storms provoked some movement of rocks, with consequent breakup of the pipe (figure 10).

Fig. 10: Section 2 (South) - Rocks on the beach.

The restoring intervention, even if allowed a normal drainage, showed no result on the beach. In fact the erosive trend restarted as well as it happened before the BMS installation. Therefore in September 2001 it was decided to completely replace and move back, in comparison to the original project, the second segment.

However the other two segments showed a good beach recover that in some point reached 20 m. In comparison with the non-protected beach the drainage effects is mostly evident in the terminal segment. The good results have been also confirmed by a large expressed wish to extend the existing installation to other sites.

Just before last summer, the BMS was switched off for administrative problems. The system did not work until the 20th of January, when it was restored. During these months the beach withdrawed of more than 20 m in front of BMS segments two and three and something less in segment one. For this reason the BMS segments two and three have been moved in a new position withtrowed with respect to the original position. In next weeks the monitoring data assessed during this period will be processed and made available.

Apart the scientific results that will follow later and on which it seems to be premature to give any judgement, the Ostia model lets us to pursue the first of the settled objectives: the technical validity, even if in general, of this kind of approach in seas with a low tide fluctuation.

5. REFERENCES