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The evolution of Cape Midia's shore sector in the period 1883–2002

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Key words: shore, erosion, cliff, Cape Midia, Black Sea

Evoluţia sectorului de ţărm Capul Midia în perioada 1883–2002. Articolul de faţă îşi propune o analiză a sectorului de ţărm Capul Midia pornind de la materialele cartografice cele mai vechi (1883–1924) şi până la ultimele imagini satelitare (2002). În funcţie de acestea s-a realizat o etapizare a evoluţiei pe următoarele intervale: 1883/1924–1960, 1960–1970, 1970–1980, 1980–1989, 1989–2002. Tendinţa generală de evoluţie este una de progradare, cu valorile maxime înregistrate în intervalul 1980–1989 (58,1 m liniari de plajă). Ritmurile pentru acest interval au fost de 6,5 m/an. Dacă până în anul 1953 acest ţărm a evoluat în condiţii naturale, ulterior, prin începerea construcţiilor de la portul Midia, se realizează o modificare în circulaţia sedimentelor din lungul ţărmului, circulaţia fiind scurtcircuitată de prezenţa digurilor portuare de protecţie. Analiza combinată a materialelor cartografice şi satelitare s-a dovedit extrem de eficientă în trasarea evoluţiei pe termen lung a acestui sector. Pe viitor morfologia ţărmului va fi determinată de aportul sedimentar venit din nord şi de activităţile portuare extrem de intense.

General Data

The sea-cliff shore out of the Midia Cape sector spreads onto a ~7 km length, straight from the Buhaz Cape all the way to the Clisarig Cape. The Chituc shore, in the north, leaves the impression that it would place itself within the southern, harder structural unit. The individuality of the sea-cliff shore resides from the presence of four capes (Buhaz Cape, Midia Cape, Ivan Cape, Clisarig Cape) parted by three large gulfs (Fig. 1). The morphodynamic differences were imposed by the geological factor. If Cape Clisarig and Cape Ivan show at their bases Jurrasic-aged deposits (Bathonian and Callovian) formed out of silicifer limestone, limestone and conglomerates, the Midia Cape is composed out of much older formations (Superior Proterozoic) of green shist. Our purpose has been that of trying to retrace the evolution of this shore, starting with the oldest cartographic documents (1883–1924) ending up with the latest satellite imagery (2003).

The Midia Harbour started being constructed in the year 1953, its protection sea walls being extended afterwards between the years 1978 and 1980. Currently it can host ships up to 10.000 tdw (R. Cioran, 2001). The influence of the northern sea-wall is felt behind the redirection of the shore drift that steers clear of the sea-wall and deposits most of its sediments right at the entrance of the harbor.

The work technique

The Firing Plans (PT) have constituted the first cartographic document from which we have begun the sea-cliff shore's evolutionary reconstruction. For this particular unit we have used 2 maps, the only problem encountered being the fact that the northern area had been elevated between 1883–1884, and the southern area much later, around the year 1924.

All the maps have been georeferenced and subsequently exported into a projection type UTM Zone 35 N. All the satellite images have also been rectified and brought to the same UTM Zone 35 N projection. For each map or satellite image the water line has been digitized.

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Map	Year of topographic elevation	Scale	Map Projection
Midia Cape nr. 5644	1883–1884 northern area 1924 southern area	1: 20000	Lambert
Năvodari nr. 5643	1924	1: 20 000	Lambert
Corbul de Sus L-35-130-C-d	1960	1:25000	Gauss-Kruger
Lacul Taşaul L-35-142-A-b	1960	1:25000	Gauss-Kruger
Corbu L-35-130-C	1970	1:50 000	Stereo 70
L-35-130-C-d	1980	1:25 000	Gauss-Kruger
L-35-142-A-b	1980	1:25 000	Gauss-Kruger

Image	Recording Date	Resolution
Landsat TM	August 1989	30 m
Landsat TM	August 1992	30 m
Landsat ETM	July 2000	15 m
ASTER L1B	March 2002	15 m
Ikonos quik look	September 2003	13 m

The region's nomenclature

The names of the capes and those of other key points have been extracted primarily out of the first map (PT), where the denomination *"Clisarig Cape"* clearly stands out for the last southern cape of the shore. Starting with the old name attributed to the Corbu Lake (Gargalic Lake), we also state that the name (Gargalic Cape) is also being used to define the same southern cape. The second cape shows up under the name of *"Dumitru Ivan's Nook"*, but it is frequently utilized only in its shortened form of *"Cape Ivan"*. The third cape is the only one that didn't seem to cause any linquistic problems, showing up on all cartographic documents as Cape Midia. Buhazului Ponds (Gread Pond and Middle Pond) suffer a small orientation change following the forth and also the smallest cape, carrying on naming it Cape Buhaz.

Results

The comparison of the 1924 and 1960 maps marks out the presence of uniform accumulation processes for GI, as for GII and GIII the accumulation has been set down only at the northern extremities of the gulfs, the southern areas being affected by erosion (Fig. 2). This shore has evolved in natural conditions up until the year 1953, this year marking the beginning of the Midia Harbor's construction, materialized through its protection sea-walls. On the 1960 map, only two of these sea-walls seem to appear, the northern sea-wall sustaining itself by Cape Clisarig having a 1,5 km length and the southern one having a total of 1,2 km length. All of these arrangement projects have modified the shoreline, especially next to Cape Clisarig. Thus, we find it very difficult to percentually quantify the antropical activity in reference with the seashore's default processes. Nevertheless it is certain that after 1953 all of this seashore will strongly be antropically controlled.

The maximum accumulation rates have been recorded in GI, where the waterline has moved 115 m since 1924 to 1960. For GII these rates have been of 78 m (1924–1960). The most intense waterline retractions have occured in GIII: 180 m (1924-1960). Based on these rates we have calculated the accumulation rhythms: 3,2 m/year in GI and 0,4 m/year in GII. It would be incorrect to report for GIII a retraction (in S5) of 5 m/year rythms, because of the fact that all these changes have occured due to harbour construction works. Here we have exemplified one of the disadvantages of comparative map analysis, whenever major changes might occur at short periods of time, and their causes being far from natural (Fig. 3, Tab. 1).

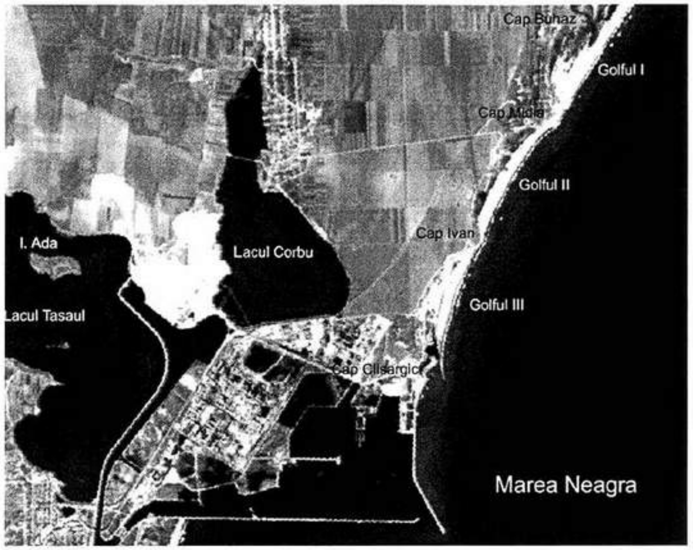

Fig. 1. The nomenclature utilized for survey

Starting with the waterline from 1924 the accumulation/erosion rates have been calculated for each individual map or image. A number of 19 marker points have been established, for which separate measurements were conducted. The final result took the form of the upper graph, in which the distances (km) are marked on the horizontal, this line actually representing the shoreline in 1924 (Tab. 2, Fig. 4).

The vertical marker 0/0 indicates Cape Buhaz, and the 0/6,5 marker indicates the northern sector of Cape Clisarig. In comparison with the latter, we can observe a general accumulation tendency, with the exception of the southern sector (Cape Clisarig) which has been affected by the Midia Harbor arrangement works. On the 1989 satellite image we can observe the emergence of a new sea-wall, at north of Cape Clisarig, having NNV–SSE orientation, and a 635 m length. In order to have an average value of the advancement/retreatement rate, the calculation of this parameter for each single interval has been done, with the following table as output:

The most intense accumulation rhythms took place between 1980–1989 period, when in GI the values have reached 11.2 mm/year (Fig. 5). As for GIII the emergence of the new sea-wall has determined the reach of the 12,1 mm/year value. The calculations for these average rhythm values, for each single interval have led to the following results:

That which strikes the most is the behavioral resemblance between GI and GIII for the 1924–2002 interval. The accumulated surfaces are almost equal: 36.4 ha for GI and 36,2 ha for GIII, while for GII the accumulated surface consists in half of the previous ones (18,4 ha). A general expansion of 91,1 ha has been recorded for all the 78 years.

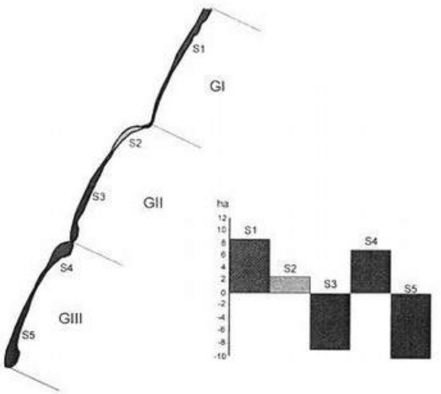

Fig. 2. The Surface difference (ha) between the water line in 1924 and 1960

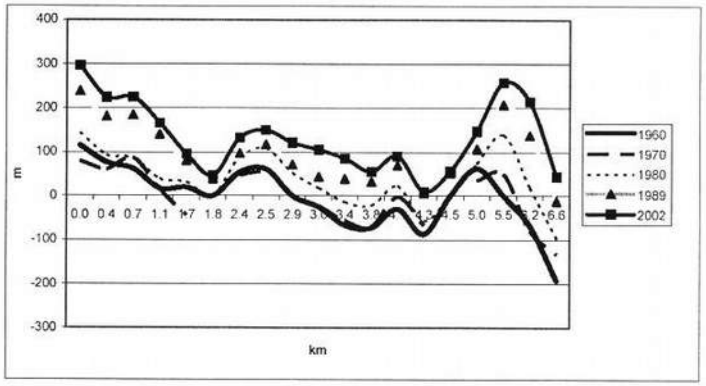

Fig. 3. Modification of the shoreline inside the 1924-2002 interval.

Interval	1924–1960	1960–1970	1970–1980	1980–1989	1989–2002
Distanţa (m)	–4,0	2,1	45,1	**58,1**	36,4

Tab.1. the values represent linear shoreline meters gained/given at each interval. The highest values belong to the 1980-1989 interval the only negative value being recorded between 1024-1960.

Conclusions

The Midia shore has evolved in a natural regime up until the year 1953. From this moment on a natural regime of sedimentary circulation is out of the question. The combined cartographic and satellite material analysis has proved to be extremely efficient in this sector's long term evolutionary tracing. In the future, shoreline morphology will be determined by the northern sedimentary addings and by the extremely intense harbors activities.

Interval	1924–1960	1960–1970	1970–1980	1980–1989	1989–2002
Ritmuri medii (m/an)	–0,1	0,2	4,0	**6,5**	2,8

Tab. 2. The accumulation/erosion average rhythm rates for the Cape Midia shoreline (m/year)

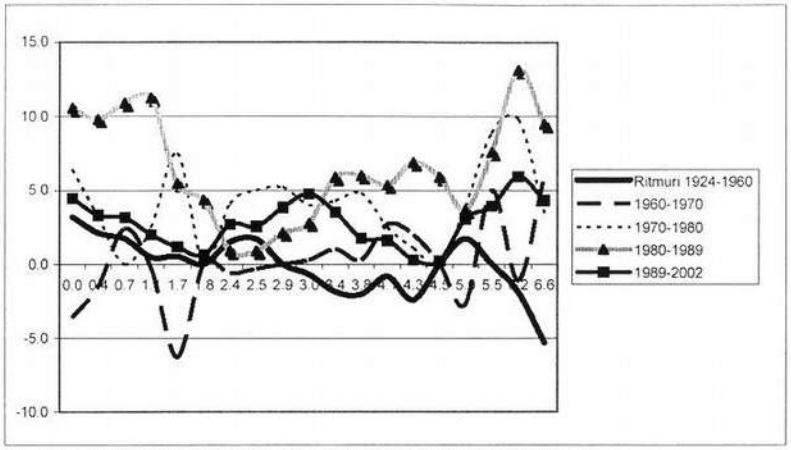

Fig. 4. The accumulation/erosion rhythm rates for the Cape Midia shoreline (m/year)

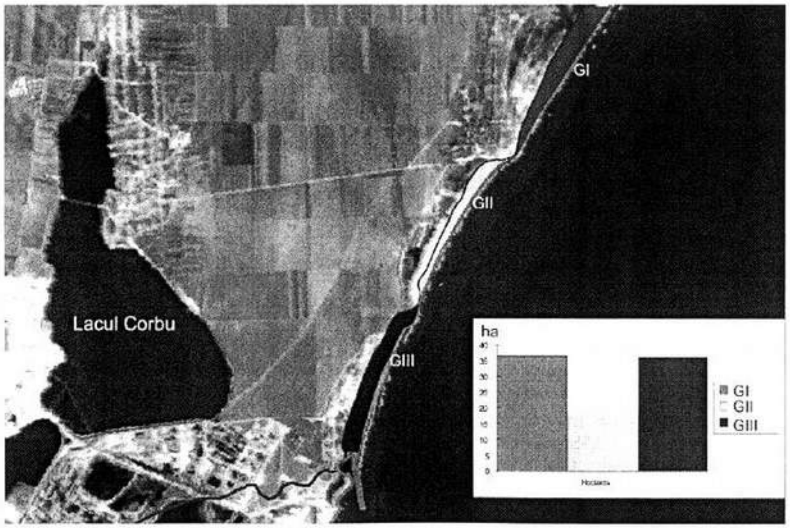

Fig. 5. The accumulated surfaces for the 1924–2002 interval

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Recent investigations regarding the beach-dune interactions on a microtidal coast in a temperate dry climate, Sfântu Gheorghe, Danube Delta Coast

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Keywords: Beach-dune morphodynamics; Aeolian sand transport; Microtidal beaches; Temperate dry climate; Danube Delta

Based on the measurement of beach-dune seasonal elevation changes from 1997-2004 period, coupled with a 16-months detailed surveying (DEM's) in two coastal polygons and more sand transport measurements over beach and foredune, this paper deals with the maritime & aeolian processes and accretion-erosion events trying to find the main features of beach-dune morphodynamics from study area. The morphological behavior of dune-beach system was analyzed depending on shoreline evolution and correlated with nearshore morphology. Medium-term trends (years) and seasonal cycles of sediment transport are estimated from analyses of the wind and topographical time series. For this 7-year interval, we identified a uniform rate of sand accumulation in foredune sector (4-5 m^3/m/year) both for the stable coasts and for progradating shoreline sectors, while the subaerial beach volume experiences dramatically biennial changes. The multiannual beach width-volume correlation is logarithmic in the case of stable shoreline sectors and a linear regression for the coasts with progradating behavior. The pattern of erosion and deposition emerged from topographical surveys, in good agreement with the sand transport measurements, prove the presence of a vigurous sand flux which remains quite high over the foredune area even if at sensible smaller rates (25-60%) than on the beach surface. This high sand flux is ddue to specific climatic and biotic conditions (low precipitation amount, sparse vegetation cover) and facilitates the preservation of a general foredune morphology which gently sloping seaward.

1. Introduction

Traditionally, the beaches that generally are hydrodynamic controlled and the wind-dominated coastal dunes have been thought as distinct and separated systems. In the last decades the accent was shifted on the beach-dune interaction (Short and Hesp, 1982; Pye, 1983; Psuty, 1988; Sherman and Bauer, 1993; Sherman and Lyons, 1994) being recognized the fact that the two environments have often a correlated morphodynamics with strong coupled sedimentary fluxes. It's registering also a general trend toward a more complex approach of beach-foredune interactions.

Thus, the first studies upon the foredune behavior related to shoreline changes (Vellinga, 1982) resulted into a model of onshore-offshore sediment exchange within a beach/foredune system without a spatial shifting of the entire profile. Researches performed by Stephenson (1978) and Fisher (1984) pointed to a landward migration of the foredunes as the shoreline is migrating inland and a periodical alongshore change of the foredunes. Further, new attempts have been made for a quantitative assessment of the alongshore changes of the foredunes (Psuty et al., 1988). The approach of foredune development from the sediment budget changes point of view within different climates is largely represented in the recent literature (Hesp, 1988, 2002; Goldsmith, 1990, Psuty, 1992, 1993; Arens, 1996b; Hellemaa, 1998).

Using this perspective, accompanied by many other distinct investigations on different controlling factors behavior and influence on beach and/or foredune development Sherman and Bauer (1993) contrived a theoretical model of beach-dune system integrated dynamics across several time and space scales.

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