

REMOTE SENSING AND GIS APPLICATIONS ON THE ROMANIAN COASTAL ZONE MANAGEMENT AND REHABILITATION WORKS

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ABSTRACT

The modern remote sensing and GIS tools used in the coastal resource management will become one of the best alternatives to concentrate on the coastal vulnerability issues.

In the present work will be presented the recent development of an increased understanding over the coastal process on synoptic scale afferent Romanian shore, and will give the possibility of an advised selection of different solutions for protection and conservation of the area. The work presents the certain approaches and results on GIS/spatial analysis based on RS data, towards an erosion control within Romanian littoral, presently under intense consolidation at the sea-land interface.

The fusion of multiple, complementary image data sources (of different spatial/temporal, spectral/radiometric resolutions) and associated GIS databases, approached in a complex way, it were developed based on a geographic informational systems, and continuous upgraded within a national partnership projects. A similar system of mixed RS&GIS techniques, built within a scheme of multi-institutional collaboration, it was completed as a dynamic tool for coastal environmental education, as well a tool to asses, for a period of several decades, the sustainability and ICZM activities on Romanian coastal area.

Certain results of its implementation within several projects of reconstruction were emphasized in the synthesis.

Keywords: coastal zone sustainability, water quality, erosion processes, vulnerable areas

INTRODUCTION

The aims of the sustainable development of the coastal zone, it requires a continuous series of complex, multi and inter-disciplinary researches, related to the marine and coastal environment changes. The coastal response mapping issue relates to the study of the geomorphologic processes affected by natural and human induced environmental factors [2]. Littoral beaches quality depends on several specific geomorphologic indicators/parameters, but also its ecological, physical and geological condition. The quality level of the beach areas is also related to specific use, and is usually measured in terms of its stability, described by measured quantities and parameters, which then are

compared to international and European quality standards, ICZM objectives, marine and coastal planning strategies or criteria. Implementation of the RS&GIS techniques within a complex informational system, it permits the development of an increased understanding on coastal processes together with the possibility of selection of the rehabilitation and conservation measures in the coastal zone.

Romanian littoral had registered in the last decades certain erosive processes intensifications, illustrated by the RS&GIS long term data on behavior of the geomorphologic shore response. Thus for the erosion control were required in the last half of century, certain engineering activities, including coastal monitoring and surveillance, assessment and modeling, redesign and implementation of the hard coastal protection works, which its were gradually extended in a successive series, starting from implementation in 1936 and 1940 and continued gradually, in the periods between 1956 – 1960, 1967 – 1970, 1981 – 1985 and 1989 – 1990 until 1991, when such shore protection and coastal development works were stopped without maintenance activities till present [5]. As a continuation two Master plans were extended in 2005 by JICA (Japan International Cooperation Association) and 2011 by Halcrow Romania.

These recent actions, carried out by Project: “Reduction of Coastal Erosion on the Black Sea Coast”, includes the extension coastal erosion survey program, consisting in data collection, data integration and modeling, and also designing of specific protection and rehabilitation solutions, having as overall objectives, the environment protection and the improvement of the life standards along the Romanian southern littoral and also to increase safety some areas of severe vulnerability to erosion. For the new coastal Master Plan prepared by Halcrow Romania, the strategic vision had cover the sediments management of the entire Romanian coast, taking into account the interactions between all areas was focused both on beach restoration and on reinforcing the existing coastal defense line.

In the process of implementation, many coastal protection systems included in the Master plan, fit both technical and management solutions, soft (non-structural) and hard (structural), in an adequate final protection schemes; among these, the artificial nourishment of the touristic beaches was largely used, in the conditions of the lack of the sediment sources, in the Romanian littoral.

METHODOLOGY

The data considered in accordance with the Master Plan extension strategy were focused on the characteristics of the geomorphologic coastal parameters, such as dune zone and backshore dimensions, shoreline variations, location of critical vulnerable areas, in order to establish a baseline for geomorphologic study. Also, the coastal changes induced by waves and currents, within several coastal sedimentary cells thus emphasized the functional effectiveness of the existent hydro-technical works, it were considered among the specific administrative, as well natural, geological, sedimentological, hydrological boundaries in order to delineate the setbacks line in the area of touristic beach sector [8].

The shoreline changes assessments were used maps showing the summer accumulations of sediments and storm season retreat, thus able to include a snapshot of geomorphologic seasonal variations. The geomorphologic analysis of the shoreline changes was realized by comparing historical maps, satellite imagery, aerial-ortho-photo plans from different periods in a ArcGIS, including representations of the spatial

data (GPS measured data and data obtained by digitization) in a plane model and referenced configuration, which allowed the assessment of the geomorphologic changes of the Romanian southern beaches. The historical maps, redesigned in Stereo70 and subsequently vectorized were used to evaluate the shoreline withdrawals, corresponding to surfaces that have undergone significant changes during this period, thus highlighting different periods of shoreline evolution [7].

RESULTS AND DISCUSSIONS

The Southern sector of Romanian shore, stretching from Midia to Vama Veche, mainly affected by the coastal erosion, due to its geological structure, especially of the hard substratum consisting in a limestone plate, and to specific hydro-meteorological conditions as well, it had suffered intense modifications in several sub-sectors. Also, the sand-belts of the fourth southern shore sub-sectors, retreated with more than 40m within the period of 1981 – 2011, even if a large part of this sub-sectors were protected by coastal protection constructions, represented by several schemes of groins and parallel submerged breakwaters, it had not the expected important effects in the beach stabilization.

The main natural factors considered for the shoreline changes determinations it were represented by the sea-level rise, as well the winter storm frequencies, both directly under the new climate changes:

- **long term sea level rise** - the evolution trend of Black Sea level is ascending – the Black Sea level increasing with 1.34 mm/year (1933-1996) and 1,9 mm/year (1996-2007);

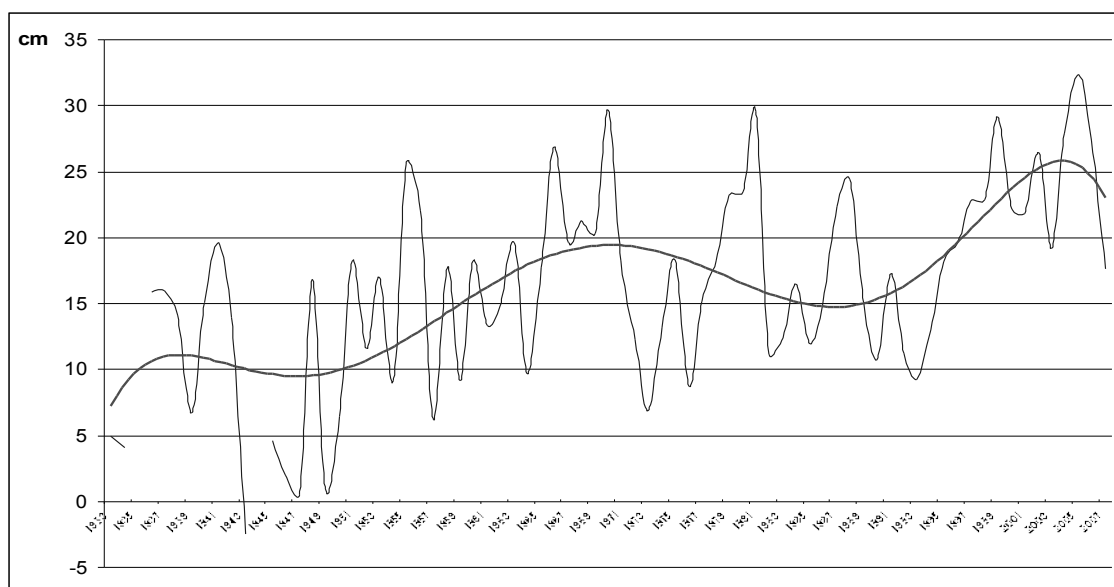


Figure 1 Sea level 1933-2007, Constanta Hydrometric Station

- **the higher frequency of extreme meteorological phenomena** (very strong storm surges in the winter season) influence through the increase of sea level during the storm, wind action that determines the displacing of the sand from the beach, the action of waves and currents.

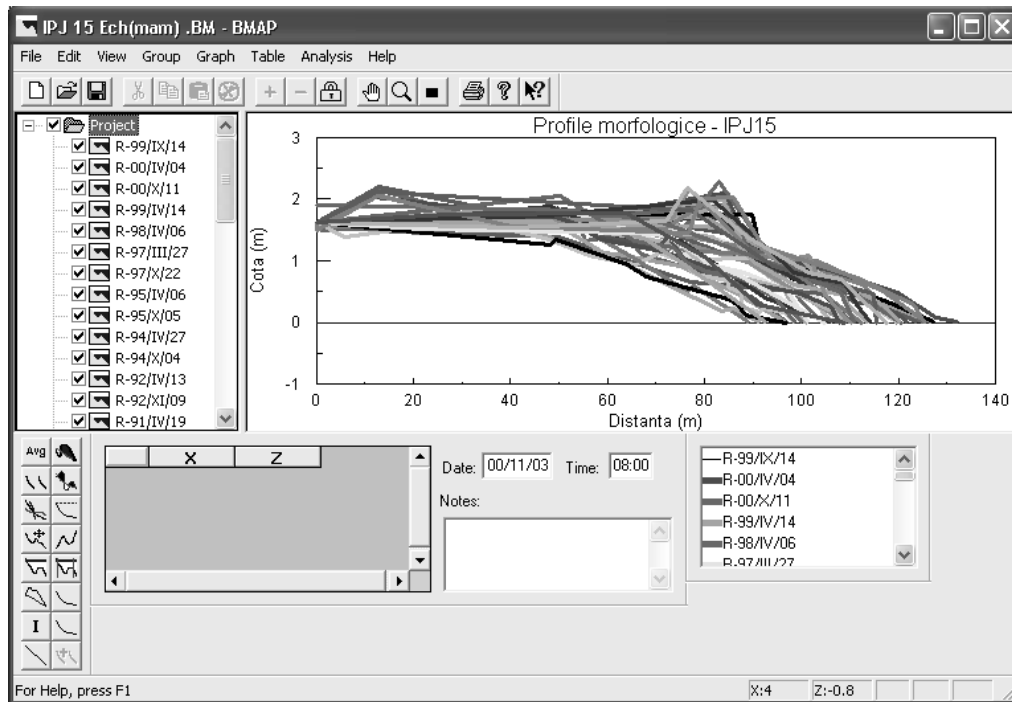


Figure 2 Multi annual profile changes

The final result of the shorelines changes obtained by differentiated processing during multiple time horizons in a map, were highlighted areas that are under a vulnerable regime of morphological changes in the time range of decades studied.

Calculation of setbacks for the beach areas were made on certain classes of erosion rate extension according to the vulnerability or specificity of the sub-sectors.

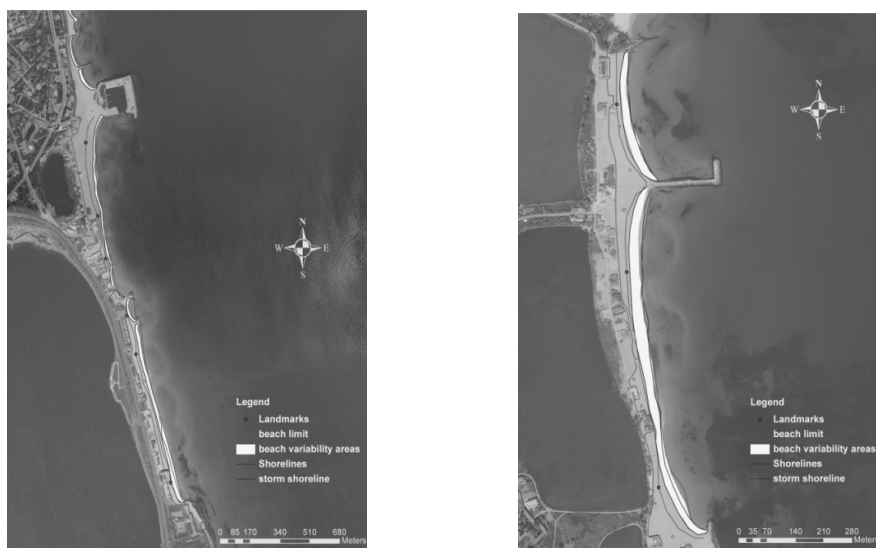


Figure 3 Consideration of the erosion rate in the setback delineation on the Romanian southern littoral (Eforie, Neptun, Aurora Cape, Venus and Saturn Sectors)

Between 1981 and 2011, the evaluation of southern coastal processes at the sea-land interface in terms of erosion/stability/accretion, accomplished through assembling the rates of modification had shown a relative equilibrated situation of beach evolution in this zone.

Intensification of erosion/deposition of the coastal beaches was evidently revealed by the maps from processed spatial data (vector maps derived from the considered spatial data), even if the quantitative results are not particularly accurate for previews 90's period. The identified vulnerable land areas with the highest erosion rate, changes of erosion and deposit processes, can be estimated from the beach surface erosion losses.

CONCLUSIONS

The implementation and optimization of the rehabilitation measures for the southern sector will have to include a better management of sandy sediments transported by the Danube river into the coastal zone of the Danube Delta, recovery of beach surfaces with sedimentary deficit, from Mamaia and Eforie, with priority, and protection of the new add sediments deposits by artificial nourishment of the southern touristic beaches, a better protection of emerged beaches in the cold season, and also the consolidation and the improvement of efficient coastal protection constructions schemes which were showed a relative functional effectiveness in the beach stabilization.

The actual *Master plan for coastal protection* had include in a modern approach the coastal ecologic domain, by considering the ecosystem based management principles related to bio-hydro-geomorphologic diminished impact on the long term estimations. Thus the actual actions for protection, updated in 2011 by an international consortium drive by Halcrow Romania, it corresponds to the existent coastal environmental conditions, and the control of the coastal erosion and the environmental quality especially for the Mamaia and Eforie sand-belts areas, it were required an appropriate implementation investigations strategies and design methodologies, such as GIS spatial analysis and numerical model, in the process of selection of the coastal protection and beach management appropriate solutions.

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REFERENCES

- [1] Diaconeasa D., Geodinamica litoralului romanesc al Mării Negre-zona băii Mamaia, Ed. Universitară, București, 2009.
- [2] Ielenicz, M., Visan, Gh., Morphology of the Romanian Black Sea shoreline. Comunicari de geografie, vol. 7. Ed Universitatii din Bucuresti, 2003.
- [3] Steede-Terry, K., Integrating GIS and the Global Positioning System, ESRI Press, Redlands, California, 2000.
- [4] Vespremeanu, E., Geografia Marii Negre, Editura Universitatii din Bucuresti, 2004.
- [5] Coman C., Postolache I., Protection measures for Romanian Shore, First International Conference Port Coast Environment, Varna, Bulgaria, 1997.
- [6] Ciortan R., Simescu T., The coastal Engineering problems on the Romanian Black Sea littoral, Ovidius University of Constanta, Annals of Constructions 3, Constanta, Romania, 2002.
- [7] *** GIS, Spatial Analysis and Modeling. ESRI Press, Redlands, California, 2005.
- [8] *** Remote Sensing for GIS managers. ESRI Press, Redlands, California, 2004.