

## GIS applied to landscape valuation and management in coastal areas

Ângela Lomba<sup>1</sup>, João Torres<sup>2</sup>, Henrique Alves<sup>3</sup> & João Honrado<sup>4</sup>

<sup>1</sup>M.Sc., CIBIO-Universidade do Porto, Rua do Campo Alegre 1191, 4150-181 Porto (Portugal)

angela.lomba@carlosbernardino.com

<sup>2</sup>Lic., CIBIO-Universidade do Porto, Rua do Campo Alegre 1191, 4150-181 Porto (Portugal) joao.torres@fc.up.pt

<sup>3</sup>Lic., Parque Biológico de Gaia, EM. 4430-757 Avintes (Portugal) hmalves@mail.telepac.pt

<sup>4</sup>Ph.D., Faculdade de Ciências & CIBIO-Universidade do Porto, Rua do Campo Alegre 1191, 4150-181 Porto (Portugal) jhonrado@fc.up.pt

### Abstract

In recent years, several methods have been used to achieve a diagnostic method for the conservation of coastal areas. With the development of GIS technologies, the close relationship between geomorphology, vegetation and human pressure in coastal areas has been the subject of many studies. In this paper, we discuss the application of GIS technologies in the analysis of vegetation data in order to survey and value sand dune habitats in the Mindelo Ornithological Reserve (ROM), a highly humanized coastal area in North-western Portugal.

### 1. INTRODUCTION

Coastal areas are sensitive and dynamic systems, suffering high natural and human pressures that promote erosion processes. In recent years, several approaches have been used to address this critical subject, including geological, geomorphological, engineering and biological studies (Araújo *et al.*, 2002; Honrado *et al.*, 2002; Loidi, 1994). Recently, natural hazards and strong dune system destruction alerted both populations and the scientific community to the need of integrated studies. This paper describes a procedure for the integrated use of several ecological criteria in landscape valuation and management of coastal areas, using the case-study of Mindelo Ornithological Reserve (Vila do Conde), a small coastal area near Porto (North-western Portugal).

### 2. METHODS

Several studies have revealed a close relationship between coastal vegetation and landscape disturbance (Araújo *et al.*, 2002). In fact, integrated analysis of coastal geoforms and plant communities allows the establishment of a quite efficient diagnostic procedure to evaluate the conservation of littoral areas.

#### 2.1 Geomorphology

Natural geological processes are valuable clues in the understanding of plant communities within current landscape patterns. In the coastal zone, geomorphology assumes a central role, because of the existing relationship between geoforms and coastal dynamics. Thus, coastal geoforms are indicators of the stability/instability of these fragile systems. The geomorphological characters of the study area were analyzed according to standard methods (Soares de Carvalho & Granja, 2002).

#### 2.2 Vegetation

Data regarding floristic values and plant communities have been collected during years 2002-2004

in Mindelo Ornithological Reserve. Plant communities were studied according to the concepts and methods of Integrated Phytosociology (Rivas-Martínez, 2002), which can be applied to landscape valuation in order to establish planning and conservation measures, and to define the most important conservation areas (Loidi, 1994; Asensi, 1990; Costa *et al.*, 1987). Loidi (1994) proposed an algorithm that includes both ecological and socio-economical criteria in the analysis and valuation of natural vegetation. The algorithm is applied to each vegetation unit in order to construct a map of phytocoenological value. This map is then used to define important conservation areas and to establish priority spots.

#### 2.3 Human impact

The destruction of coastal dune systems in the Atlantic littoral areas of Portugal brought severe damages to littoral human populations and led to the destruction of important ecological values. Thus, several engineering structures were constructed, aiming to stop coastline regression. However, some of these structures have clearly contributed to erosion processes and, therefore, they must be reconsidered within the framework of integrated coastal management studies. Analysis of land-use evolution patterns is another approach used for understanding the impact of human pressure on coastal dynamics.

#### 2.4 Management of geographic data

GIS technology is nowadays an important tool that allows the analysis of several factors that affect the landscape and the establishment of models and scenarios for landscape evolution. Therefore, digital geographic data resulting from the ecological interpretation of aerial photography were analyzed using ArcMap® software.

### 3. RESULTS AND DISCUSSION

#### 3.1 Coastal vegetation and geoforms

A close relationship was observed between the presence/absence of plant communities and related geoforms in the area. For example, the almost complete absence of well developed formations of sea-couch (*Elymus boreoatlanticus*) was clearly related to the absence of embryonic dunes resulting from severe erosion.

A significant negative influence of human pressure on geoforms and vegetation was also observed, particularly in grey dunes.

#### 3.2 Landscape valuation

Using Loidi's valuation algorithm (Loidi, 1994), the conservation value of each cartographic unit, corresponding to natural habitats as described in Annex I of EU "Habitats" Directive, was assessed (figure 1).

Results from this valuation procedure stress the importance of coastal dune systems and sub-coastal riparian ecosystems in the area. It is interesting to note that grey dune vegetation and riparian galleries are considered priority habitats by the "Habitats" Directive. Important areas for the conservation of natural habitats were also identified (figure 2), allowing the establishment of management plans based on integrated scientific studies.

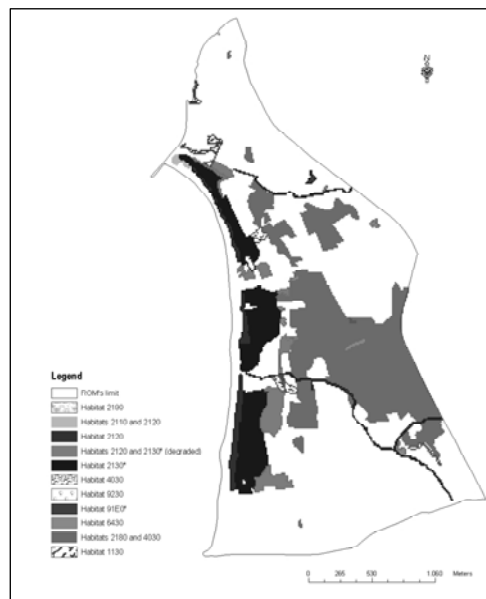


Figure 1 – Natural habitats in the ROM.

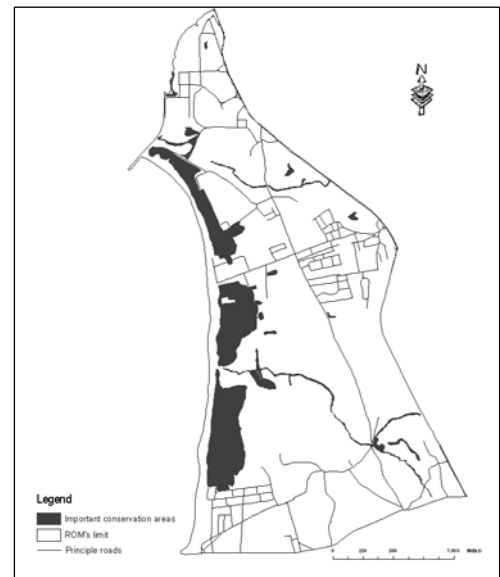


Figure 2 – Important areas for conservation in the ROM.

### REFERENCES

- Araújo, R., Honrado, J., Granja, H., Pinho, S. & Caldas, F. B. 2002. Vegetation complexes of coastal sand dunes as an evaluation instrument of geomorphologic changes in the coastline. "Littoral 2002", 337-339. Porto.
- Asensi, A. 1990. Aplicación de la Fitosociología a la Evaluación del Territorio. X Jornadas de Fitosociología: Granada.
- Costa, M., Perez, M<sup>a</sup> R. & Soriano, P. 1987. La Vegetación como Elemento de Diagnostico y Valoración en la Conservación del Litoral. Colloques phytosociologiques 15, 281-298.
- Honrado, J., Pereira, R., Araújo, R., Santos, G., Matos, J., Alves, P., Nepomuceno Alves, H., Sousa Pinto, I. & Caldas, F. B. 2002. Classification and mapping of terrestrial and inter-tidal vegetation in the Atlantic coast of Northern Portugal. "Littoral 2002", 211-215. Porto.
- Loidi, J. 1994. Phytosociology applied to nature conservation and land management. in Song, Y., Dierschke, H. & Wang, X. (eds.). Applied Vegetation Ecology. Proc. 35<sup>th</sup> Symposium IAVS in Shanghai. East China Normal Univ. Press.
- Rivas-Martínez, S. 2002. Fitosociología Dinámico-Catenal (Fitosociología Integrada o Paisajista). Folia Botanica Matritensis 19, 1-5.
- Soares de Carvalho, G. & Granja, H. (2002). Paleogeofórmicas como suporte da Paisagem Costeira Actual. Encontro Técnico sobre Conservação de Dunas. Conservação dos Sistemas Dunares. Parque Biológico de Gaia