

Geomorphology and evolution of Ravenna's dune system (Italy)

Laura Caruso, Beatrice Giambastiani, Giovanni Gabbianelli and Lorenzo Diani

CIRSA (Interdepartmental Centre for Environmental Research), University of Bologna,
Department of Environmental Sciences, Via S. Alberto 163, 48100 Ravenna, Italy
e-mail: lcaruso@ambra.unibo.it

Abstract

During the last few decades coastal dunes, for centuries a distinctive feature of Ravenna's coastline, have been seriously affected by tourist development and human activities. Considering the importance of these structures as natural defences against beach erosion from sea storms, the main purpose of this work is to characterize the dunes and to reconstruct their recent evolution from both a botanical and a geo-environmental point of view. Another purpose is to evaluate the future natural evolution of dunes in this type of coast.

Keywords: Coastal dunes; Phyto-sociological surveys; Fugitive dust model.

Introduction

Dunes have a great role in the coastal dynamical equilibrium. They are the less expensive and more efficient type of protection against seawater ingression, mostly in the Province of Ravenna where landward areas are generally below the average sea level. Researches on this particular area outlined that, among the human activities which mainly affect the dunes, the most dangerous are: excavation of sand from the riverbeds that reduces sand supply to the beaches; uncontrolled groundwater withdrawal, methane extraction and the construction of buildings along the seaside, all these last factors cause the enhancement of the natural subsidence rates (Comune di Ravenna, 1996).

Methods

In order to evaluate the recent evolution of this environmental heritage, aerial imageries of the studied area (the coastline from Porto Garibaldi to Cervia in the years 1954, 1972, 1988, 1994 and 2000) have been analysed. A GIS has also been created.

Another important aspect considered in this study is the characterization of the vegetation present today and its comparison with the one of the past. Several phyto-sociological surveys (Braun-Blanquet, 1964) have been carried out on some of the most representative dunes of the Province of Ravenna. These surveys have allowed us to calculate the species diversity, to evaluate the degree of naturalness of each dune and to outline the evolution of the vegetation, based on the data collected in the seventies

(Giacomini, 1974; Gerdol and Piccoli, 1984). Moreover, in order to establish dunes efficiency, to work out reliable future scenarios and to define the recovery chances of some dunes, the following features have been evaluated: crest height, steepness index, lateral continuity, conservation state, sedimentological characteristics.

In two research cases (Marina di Ravenna and Lido di Classe), a FDM (Fugitive Dust Model) simulation has been carried out to evaluate their hypothetical natural evolution (Hsü, 1974; Kroon and Hoekstra, 1990; Wingers, 1990). The FDM is a software, created by EPA (Environmental Protection Agency), which calculates the aeolian transport and dust deposition. The FDM model, readapted to the dune system, allowed us to outline dune evolutionary trends and was a useful tool for a qualitative evaluation and for decision making in the management interventions.

Results and discussion

The decrease in dunes extension is remarkable: in the year 2000 the area occupied by dunes was one quarter of the total area covered in the year 1954. From the seventies until now, an increasing number of bathing establishments built on the dunes can be observed. This, in the majority of the areas, caused the complete disappearance of dune systems.

The observed vegetation communities are not clearly defined, because of the stress caused by tourism, bathing-huts, paths, game fields and bathing establishments. Such a stress had seriously compromised the naturalness of the typical succession, causing the disappearance of some species and the appearance of weeds. Another important result is that the highest diversity of species and the main stability due to the presence of the *Tortuleto-Scabiosetum* community were observed in the only dune that has been protected. The protection consists of a simple fence, which keeps tourists from approaching dunes. Thus, some protections, less invasive than the artificial introduction of stabilizing species, would surely be more effective and less hazardous.

Results from the FDM simulations show that the heaviest and most hazardous destructions occurred in the foredunes. In many cases dunes become thinner and lower and they are damaged by many wide gaps which, in the future, as following FDM simulations show, won't be able to brim and close naturally. Such damages will deeply affect the backdune areas, too: evident episodes of vegetation destruction caused by marine aerosol can occur.

Conclusions

Management of coastal endangered areas must therefore consider dunes, backshore and foreshore as three united elements of the same environment: dealing with only one of them would imply accepting consequences on the other two.

The dunes area of Ravenna became very touristic and the present huge economic interest seems not to allow any recovery of the original naturalness. Indeed, a good compromise between protection needs and beach use can be found. Measures must be planned on a long term and space scale, because many different factors such as coastal erosion, beaches use, vegetation naturalness, presence of buildings and dune position in relation to pinewood need to be evaluated.

Acknowledgement

It is with pleasure that we acknowledge the collaboration of Servin (Servizi Integrati Gestionali Ambientali) from Ravenna (Italy) and especially of Dr Giuseppe Patrizi for his helpful availability in placing the Fugitive Dust Model at our disposal and for having readapted the FDM to the beach-dune system conditions. We sincerely thank Prof. Carlo Ferrari who led the work for the characterization of the vegetation.

References

- Braun-Blanquet J. 1964. *Pflanzensoziologie*. (3rd Ed.). Berlin, Wien, New York: Springer.
- Comune di Ravenna. 1996. Studio su valutazione e conseguenze delle variazioni del livello marino medio nella costa ravennate dovute a subsidenza e ad effetti climatici. Rapporti Tecnici A-D. Ravenna.
- Gerdol R. and F. Piccoli. 1984. Sand dune vegetation in the Po Delta (N. Italy). *Ecologia Mediterranea* X(3-4):119-131.
- Giacomini V. 1974. Il paesaggio vegetale. p.187-210. In: *Influenza di insediamenti industriali sul circostante ambiente naturale*. a cura di R.E. Scossiroli, Ed. Compositori. Bologna.
- Hsü S.A. 1974. Computing eolian sand transport from routine weather data. p.1619-1626. In: *Prof. 14th Conference on Coastal Engineering*. ASCE, New York.
- Kroon A. and P. Hoekstra. 1990. Eolian sediment transport on a natural beach. *Journal of Coastal Research* 6(2):367-379.
- Wingers K.D. 1990. User's guide for the fugitive dust model (FDM). Region 10, US Environmental Protection Agency, Washington.