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Conservation of dune systems: contributions from morphodynamics and vegetation ecology

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Abstract

Coastal areas are extremely dynamic and sensitive systems which undergo geomorphological changes that reflect the conservation status of both aeolian forms and plant communities. Recently, several studies have been performed in order to correlate aeolian forms (as the landscape supporting framework) and associated vegetation complexes. Evidence shows that a close relationship exists between dune vegetation and coastal dune types, supporting the idea that they can be used as the background for bioindication models of erosion and stability in the coastal zone. In this paper, we discuss results from recent studies and identify the main indicators of coastal processes and related dynamics. We stress that coastal planning and management require integrated studies, including the knowledge from several scientific approaches.

Keywords: Coastal stability; Geoforms; Plant communities; Sedimentary dataset.

Introduction

Coastal areas suffer shaping due to natural processes like sea level changes, coastal processes, climate, sedimentary budget and neotectonics, which result in changes like coastal advance or retreat (Granja *et al.*, 2000; Favennec, 2002; Soares de Carvalho *et al.*, 2002). In spite of the recognized importance of anthropic influence on inland beach migration, the so-called 'coastal/beach erosion' is now accepted to be mostly due to natural causes, the human influence being complementary and with limited impacts when compared with natural processes.

Cyclic natural geomorphological transformations in the coastline are being studied through the use of georeferenced aerial photographs complemented by the study of sedimentary sequences. Vegetation analysis also gives important information about the conservation/evolution status of littoral areas. In fact, the close relationship between geomorphology and plant communities along the dune system is being documented by several authors who stress the importance of integrated studies in order to achieve well-supported knowledge on coastal areas.

Coastal systems: vegetation *vs.* geoforms

The close relationship between coastal geoforms and vegetation is nowadays widely accepted and is being used as a diagnosis and evaluation tool of the conservation status of coastal systems. This method relies on the fidelity of sand dune vegetation types to specific biotopes within dune systems, and can be performed by using:

1) presence/absence of specific vegetation types (*e.g.* Granja *et al.*, 2000);
2) abundance of species and of character-species in each vegetation type; and/or
3) the occurrence of vegetation types in 'secondary' (=atypical) positions within the dune system (*e.g.* Loidi, 1994; Araújo *et al.*, 2002).

Embryonic dunes (foredune system) are closely associated to beach dynamics, so they can be considered efficient indicators of recent coastal evolution. It is possible to distinguish several scenarios concerning the contact between beach and dune system:

1) absence of embryonic dunes – these situations distinguish coastal areas under continuous erosion phenomena and can be recognized according to both geomorphological (contact between beach and dune system is performed by cliffs) and phytosociological (absence of *Euphorbio-Agropyretum junceiformis* vegetation) features;
2) presence of stable embryonic dunes – in this case, due to a balanced sediment budget, the contact between the beach and embryonic dunes is gradual and smooth, and *Euphorbio-Agropyretum* communities are well represented; and
3) accretion *vs.* regression phases – frequent situations in which accretion phases alternate with regression ones.

Modifications in the foredune system (both geomorphological and ecological disturbances) induce changes in the entire dune system as higher accumulation of mobile sand in its internal face results in dramatical ecological changes in the plant communities of interior dunes:

1) an increase of vegetation types which are normally typical of embryonic (*Euphorbio-Agropyretum*) and foredunes (*Otantho-Ammophiletum australis*); and
2) a decrease of character species of both the *Iberidetum procumbentis* (typical perennial vegetation) and the annual communities of interior dunes (*Thero-Airion*), whereas character species of both the *Euphorbio-Agropyretum* and the annual pioneer vegetation of highly mobile foredune sands (*Linarion pedunculatae*) typically increase. Anthropic influences (*e.g.* stepping and driving on dunes) act as a complement of natural causes and may favour both the disruption of embryonic and foredunes, and the replacement of *Iberidetum procumbentis* by annual nitrophilous formations of class *Stellarietea mediae* (Araújo *et al.*, 2002).

Conclusions and conservation remarks

In conclusion, we stress that natural dynamics strongly influence aeolian forms present in dune systems, as well as their plant communities. This close relationship between dune types and plant communities should be widely used as a diagnostic tool for both conservation and planning purposes. The main advantages of such approach are:

1) the integration of geomorphological and biological data, allowing a more complete diagnosis of the coastal segment;
2) the performance of accurate evaluations of current preservation status and near future trends of dune system dynamics; and
3) the possibility of establishing reliable indicators to monitor the geomorphological changes, as well as changes in plant communities, generated by both natural and anthropic causes.

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