Coastal and dune systems rehabilitation – The case of Quiaios-Mira coastal zone of Portugal

presented by

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Abstract

Ecological engineering is an important mean of ecosystem restoration and rehabilitation, by using functional ecosystem forces and helping the reestablishment of natural processes. Here two examples cases are presented, where human disturbances have originated a degraded ecosystem. The use of rehabilitation operations have been done in dune systems of the Quiaios-Mira coastal region of Portugal, and the used techniques are described.

The Coastland and the Dune System

The coastal landscape can be considered as a non-renewable natural resource, having a particular geomorphology. The actual coastal morphology of Portugal has been originated in a recent geological time (Pliocene, Holocene) as well by more recent natural and human actions. This was evaluated by sedimentary depositions that reveal different coast geomorphologies and dynamics during this geological period (accretion and erosion) (Carvalho, 1998). The coastline can be destroyed by natural processes such as climate changes, sea levels fluctuations, tectonic deformations and human activities. In other sites, land is rising relative to sea level from available material for dune formation.

The coastland zone is defined by a natural limit, instead of administrative, geomorphologically differentiated, and comprises a zone of the continental platform, with a variable width, that have suffer the influence of sea levels fluctuations since long time ago, and according to the LOICZ- ‘Land-Ocean Interactions in the Coastal Zone’ project since the late Quaternary (115 000 BP) (Granja and Carvalho, 1994).

The dune system is one of the existing coastal geomorphologies. It is a unit generated by sediments depositions during sea levels fluctuations. The evolution is determined by natural processes and human activities with different temporal scales. The actual dune systems of Portugal have been created during the Holocene period and have different ages along the coast (Figure 1).

Figure 1 – Geological characteristics of a coast area (Granja et al., 1999).
Soundings made in the Silvalde beach (Espinho) reveal the presence of a lagoon system dated from 2300 to 2200 BP (presence of mollusc shells of brackish water). In south of Furadouro, a parabolic dune was dated from IX century (Granja et al., 1996, 1999).

The actual dune systems morphology results from different natural dynamic processes and human interferences. Some of those systems tends to disappear, naturally or induced by human disturbances.

The Quiaios-Mira Coast Case

Location and Relevance

The Quiaios-Mira coast is a littoral territory located in Mira, Cantanhede and Figueira-da-Foz regions, district of Coimbra. It has a surface area around 18,000 ha, with sandy soils (“Areias da Gândara”). It also includes national dune forests areas (“Perímetro Florestal das Dunas de Mira”, “Perímetro Florestal das Dunas de Cantanhede”, “Mata Nacional das Dunas de Quiaios”), the last one with 6,314 ha.

This region has a high ecological importance because of the geological, animal and vegetation richness. It includes species with priority protection needs (Bern Convention, Bird Directive, Habitat Directive). 20 habitats classified as important, is a bird hibernation and migration place and is located close to other protected areas (e.g., “Ria de Aveiro”, “Reserva Natural das Dunas de S. Jacinto”). A total of 390 plants, 236 invertebrates, 13 amphibious, 15 reptiles and 185 bird species were identified and classified. Furthermore, the coastal zone gives a physical protection to inlands, protecting crop fields and villages from sand storms.

Among the differents preservation problems of this area, the erosion and destruction of sand dunes is one of concern. This is due to an overuse and ill-planned development, related with increase of road construction, illegal circulation of vehicles, illegal sand exploitation, insufficient tourism management, hunting and urban constructions. The occurrence of forest fires in backdune forest stands and the presence of invasive non-native vegetation is another problematic situation. With those ecosystem degradations, rehabilitation and preservation measures are needed.

Dune Stabilisation

The Quiaios-Mira dune system results from dune stabilisation operations done in the latest XIX century by the Portuguese government. At that time, the vegetation coverage was already very reduced, creating serious problems to crop fields and villages, with environmental, ecological, economical and social implications.

Dune systems formation and stabilisation were done mainly to allow sowing of maritime pine (Pinus pinaster) in inner side and avoid wind-blown sand. The foredune stabilisation of the Mira, Tocha and Quiaios beaches were started in 1918 by Manoel Alberto Rei of the “Direcção-Geral dos Serviços Florestais e Aquícolas” (Pinho et al., 1998). The purposes were avoid overwach, control sand displacements, protecting rural areas and avoiding environment dryness. Dune vegetation was used to stabilise these foredunes. In backdunes, maritime pine was sowed in parallel lines along the coast and 1,3 m apart each other (DGSFA, 1939).

These preservation concerns were not new at that time. Conservation labours have been established by D. Dinis king in the XIV century, in Leiria, sowing and planting around 11,000 ha of maritime pine. The first dunes vegetation recovery program has started in 1805 in “Couto de Lavos” by
Andrade Silva, and followed in Leiria on 1850 (“Administração das Matas do Reino”). A major impulse was given in 1927 and later in 1938 with the Plan of Forest Recovering (“Plano de Povoamento Florestal”). Until 1945 a total of 37,242 ha of dune systems have been covered by vegetation including forestation with maritime pine.

Figure 2 – National Forest of Leiria (includes dune forest of maritime pine).

The adopted methodology was mainly based on wood fences, perpendicular to dominant winds, to trap wind-blown sand and form foredunes. Dune vegetation was used to stabilise these foredunes.

Nowadays, dune restoration and stabilisation are done in particular situations, where destructive processes have destroyed the dune ridge and creates eroding systems, mainly from human disturbances. Blowouts have also appeared creating serious risks of dune ecosystem degradation. The aim is to reconstruct dune breaks and control further larger erosion processes at earlier stages. In eco-rehabilitation involving recreation of denuded dunes, sand-trapping vegetation such as *Elymus farctus*, *Ammophila arenaria*, *Calystegia soldanella*, *Othanthus maritimus*, have a special interest.

Figure 2 – Dune stabilisation with wood fences.

Figure 3 – *Ammophila arenaria* establishment.

**Pine Regeneration and Control of Non-native Vegetation**

One of the management activities in the “Mata Nacional das Dunas de Quiaios” (National Dune Forest of Quiaios) area was the control and elimination of non-native vegetation, particularly, of acacia trees (*Acacia longifolia*, *A. melanoxylon*, *A. dealbata*). This invasive problem becomes more serious after two forest fires, occurred in 1987 and 1993, which have promoted the expansion of acacia species. In spite of that, a program to eliminate and control acacia has carried out. The aim is to allow natural succession and enhance ecosystem functions.

Reforestation with maritime pine was done by benefit from existing natural pine regeneration. After fires, a large response of maritime pine seed source happened, as well for acacia. Thus, few years later young pine trees became suffering from competition of acacia trees, suggesting the necessity to control acacia development. This was done by cutting acacia trees with a disk saw. The
cutted material was leaved in the ground to provide a source of organic matter and nutrients, because of the presence of very poor sandy soils. Also, spontaneous scrubs remains in site to give some protection to pine trees and make difficult acacia development.

In some areas, where pine regeneration was too dense, a cleaning operation was done using a brush cutter. At same time a spacing of pine trees was accomplished by cleaning rows with 2.0 m width.

Conclusions

Besides natural dynamics of dune systems, human activities can disturb dune ecosystem leading to a necessity of an ecological engineering rehabilitation. The use of the function forces can provide a desirable low-cost and minimal intervention on rehabilitation works, and create a sustainable ecosystem (Mitsch and Jørgensen, 2004). In the case presented here, this was done by using the wind-blown force to create a foredune and helping dune stabilisation with natural vegetation.

In some terrestrial ecosystems, non-native invasive species can originate serious problems to natural forest regeneration processes. In these cases, helping the ecosystem rehabilitation and restoration is a feasible and needed action. Exotic species can lead to a standing-stage of the natural succession, delaying or making difficult the restoration of the ecosystem. In the present case, this was done by helping the desirable native tree species to survive and growth by the elimination of the undesirable competition of acacia trees with faster growth rates and space dominance strategy. This gave a successful forest dune ecosystem rehabilitation.

Acknowledgements

The author thanks information provided by the ‘Direcção-Regional de Agricultura da Beira Litoral’ and by Dr. J. Vingada of the University of Minho.

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