Geophysical Research Abstracts
Vol. 13, EGU2011-12515-1, 2011
EGU General Assembly 2011

Analysis of vegetation pattern evolution in a coastal area affected by salt water intrusion

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Vegetation patterns in coastal ecosystems is primary controlled by salt concentration jointly with climatic factors, such as drought and high temperatures, that limit plant growth and species distribution of coastal landscapes. As a function of sea distance and gradient of abiotic factors, different plant communities can be identified in a fuzzy arrangement. Such a fragile equilibrium is highly threatened by human activities and natural causes linked to coastal economic development, coastal drainage systems, beach erosion, etc. Past studies have been shown that the spatial and temporal variations in water salinity largely affect the spatial distribution and species composition of both woody and herbaceous vegetation in coastal environment. In addition, the predicted effects of climate change for the next 50 years, particularly sea level rise and increased storm intensity and frequency, will further impact on coastal ecosystems by inducing shifts in plant distributions from salt-intolerant to salt-tolerant species. The implementation of suitable monitoring and protection strategies is fundamental for preserving coastal environment integrity and functioning and for planning sustainable management of coastal resources.
In this framework, we studied the vegetation pattern evolution jointly with sea water intrusion and shoreline changes to assess the ecosystem status and support suitable intervention activities in a critical coastal area of Southern Italy (Ionian Coast, Basilicata Region). The investigated coast, about 40km, includes the mouths of the five main rivers (Bradano, Basento, Cavone, Agri, and Sinni) of the region, which with the surrounding forested areas are protected by the European Community.
The dynamics of vegetation patterns was evaluated through a hierarchical landscape metric analysis on an historical set (1987-2009) of land cover maps obtained from Landsat-TM/ETM satellite images. The analysis of shoreline changes was based on a multi-source data set, including panchromatic and multispectral satellite data, field-GPS surveys and aerial laser scanner acquisitions, coupled with a tidal model. Electrical resistivity tomographies (ERT) were acquired with multielectrode acquisition system in a Wenner-Schlumberger array configuration and electrodes spacing on the surface of 10.00 meters for reconstructing the geometry of the sea water intrusion front.
During the investigated period, at landscape levels we found quite low values of evenness (<0.7) and diversity ($\sim$1.0); at class level, the intermixing among classes (IJI) after a slight increasing in the first decade becomes evidently lower, whereas the mean patch size reveals a little expansion, that seems to suggest a compaction of natural vegetation. The analysis at higher detail (patch level) showed instead some areas towards the compaction and many others, including forested patches, interested by fragmentation. By overlapping the information on patch complexity (FRACT) variations with the results on shoreline changes, we found that compacted patches are mainly present along progression areas ($\sim$70%), whereas patches involved in fragmentation processes are located along the regression areas ($\sim$90%). Such a correspondence is particularly evident close to the Agri mouth and the coast between Bradano and Basento rivers. To evaluate the level of salinization in such areas, five ERTs orthogonal to the coastline were performed during the period June - July 2010. Resistivity values corresponding to layers saturated by sea water were found with different magnitude (brackish-to-saline); in particular, along the area with marked fragmentation process the vertical diffusion interests the layer active for plant roots limiting their development.
The obtained results suggest that the integration of remote sensing data with geoelectrical tomographies can be a suitable support tool for planning restoration activities by identifying the most appropriated sites for ecological and/or engineering interventions to preserve coastal environment.