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Multitemporal analysis of landscape metrics for monitoring forested patterns in coastal and mountainous areas

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The role of forested areas for the maintaining of an acceptable landscape balance is crucial. As an example, they contribute to higher biodiversity levels directly and to cleaner fluvial waters indirectly, thus, the degradation of such ecosystems has strong repercussions on many ecological processes. In order to preserve their natural stability, monitoring forest temporal dynamics is very important for a correct management, particularly, in fragile Mediterranean environments that are highly vulnerable to both natural and human-induced perturbations.
For analysing the evolution of forested patterns, especially in areas with a strong human presence, landscape metrics are a basilar tool since they allow for evaluating the structure of landscape patterns at different spatio-temporal scales and the relationship between natural environment and human environment.

Starting from this premise, we selected a set of Landscape Metrics to evaluate the temporal dynamics of forested covers in two different environments (coastal and mountainous) located in Basilicata Region, Southern Italy. The first one (area A) is located along the Ionian coast and is largely characterized by evergreen forests; in such an area, even if many sites are protected by the European Community (SCI), forests are subjected to a strong incidence of human activities mainly linked to agriculture and tourism as well as to frequent fire events and coastal erosion processes that favour salt-water intrusion. The second one (area B) is a high heterogeneous mountainous area, which also comprehends alluvial planes. The particular configuration of the territory allows for the presence of a very rich faunal and vegetation biodiversity; thus, it is partially under the protection of a National Park, but there are also many critical anthropical activities (e.g. oil drilling, agriculture, etc.).

The landscape ecology analyses were performed on multi temporal land cover maps, obtained from hybrid classifications of a time series of Landsat-TM subscenes: for area A, we used five images covering the period 1987-2006; and for area B, three images covering the period 1993-1998. The analysis of landscape structure and dynamics were performed by elaborating metrics based on patch number, size, shape and arrangements of different land cover types.

At landscape level, area A provided quite low levels of Evenness (SHEI<0,70) and Diversity (SHDI∼1.0) for the analyzed period. Metrics at patch and class levels, particularly for patch dimensions (MPS), complexity (FRACT) and Interdispersion (IJI) showed a little expansion of the urban sites and no important changes for the large agricultural areas. On the contrary, for natural areas a process of fragmentation has been revealed for coniferous forests in the period 1987-1998 when they show an alternation with a less structured and herbaceous vegetation.

For area B, the landscape level shows, in the studied period, stable high values of Evenness (SHEI>0.80) and medium values of Diversity (SHDI∼1.8). Metrics for patch and class levels reveal, instead, an increment in size and complexity for anthropical vegetation and a decrement for natural forested areas (mainly beeches) accompanied by a high variability of the transitional areas located along the edges of forested sites. On the whole,

the combined interpretation of metrics at different levels of landscape structure and at different time steps revealed an increasing trend of forest isolation and fragmentation, which can enhance their sensitivity.

The obtained results for both areas suggest that the institution of protected areas is not a complete solution for the maintaining of forest ecosystems balance without a correct management of the surrounding areas. In order to increase the connectivity among forested patches and, more in general, to improve the ecosystem functionality, the ecological analysis of satellite time series represents an operative tool for an efficient intervention planning, such as the location of the most suitable sites for ecological restoration activities.