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# Land Unit definition for potential distribution of endangered species

**Abstract**

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In Europe several mapping techniques exist to lay out plant distribution. Most of them, however, are focused on actual and not on potential species distribution range. Spatial predictions become more important for rare and endangered taxa because their conservation is related to existing as well as potential biotopes. The large part of detailed distribution models applies advanced statistics on a large data-set of environmental variables. Data-input availability limits the choice of the prediction model for species distribution and application of results in a detailed scale. Distribution pattern accuracy determinates its applicability in environmental management (for tracing edges, defining protected areas, etc.).

A simple distribution model for endangered taxa is outlined here, based on ecologically homogenous units (land-units) defined with a deductive process. Land-units defined with a hierarchical classification approach are usually employed for modelling phytocoenosis distribution. The spatial model used is based on main structural factors: bioclimate, lithology and landforms. The data set is implemented with land-use information.

This model was tested with two case study in Sicily: Erica sicula subsp. sicula and Abies nebrodensis. The former is nowadays confined only to Mt. Cofano (W Sicily) but was reported also from Mt. San Giuliano (Erice) and Marettimo Island (W Sicily), the latter occurs with a natural population of 32 individuals in the Madonie Mountains (N Sicily).

This predicting method allowed to identify suitable areas for reintroduction or where the taxa could still occur and floristic investigation should be focused.

## Introduction

Spatial predictions become more important for rare and endangered taxa because their conservation is related to existing as well as potential biotopes.

Spatial prediction of vascular flora distribution is often based on a large variety of statistical models. Many reviews (Franklin 1995; Guisan & al. 2000; Austin 2002) provide some currently used statistical formulation for predictive habitat distribution modelling in ecology.

The development of a huge scientific production in this field (Hill 1991; Buckland & Elston 1993; Carpenter & al. 1993; Lenihan 1993; Huntley & al. 1995; Franklin 1998; Skov 2000; Guisan & al. 1998, 2000), is related to the importance that these instruments own in maps and floristic atlases preparation. Infact, these, optimising the available resources, make field survey planning easier.

In conservation biology, field surveing of rare species can be useful for specific habitat monitoring, habitat fragmentation evaluation and ecological network location.

The large part of predictive models is based on statistical models (Elith & al. 2006) adjusted by building processes in order to encrease predictive capacity accurancy of actual taxa distribution.

All these methods are based on the theoretic assumption that species distribution is based both on enviromental variables (fundamental niche) and on biotic variables (realized niche).

The interaction between the species and in particular the competition plays a key role to modelling realizing niche of plants. Biotic data generally used for spatial prediction, as measures of abundance, presence/absence, presence-only data, is not directly related to ecological processes (Engler & al. 2004). Austin (2007) points out the difficulties of including into the models as predictor the absence of data in a GIS layer.

Concerning enviromental predictors Guisan & Zimmermann (2000) distinguish between indirect variables, direct variables and resource varibles and stress that indirect variables (slope, aspect, elevation, topographic position, habitat type, geology) are "most easily measured in the field and are often used because of their good correlation with observed species patterns".

A methodologic approach to ecological spaces definition is used in phytosociology where the vegetal community expressed as species combination (vegetal association) is strictly related to the biotope ecology (Pignatti 1994). In this the phytocenosis becomes the biotic compound of the ecosystem directly perceptible and, at the same time, gives direct information on environmental characteristics.

The correlation vegetal association-environment is direct, not the same can be said for the contrary. In fact to an ecological structure does not correspond a single association but a group of associations that forms a series of vegetation. The series of vegetation, therefore, can be considered the biologic unit more accurately related to environmental and human factors of the territory.

This is more clear in territories where plant distribution is influenced by human activities that with different land uses produce new distributive patterns. In these contexts modification of plant landscape are so pronounced to make difficult the recognition of actual models of relationships between biotic variables, environmental variables and geographical distribution of plant population or community.

On the contrary it seems more realistic to recognize the distribution patterns of vegetation series identifying "tessere" or land units (Rivas-Martinez 1976; Géhu 1986). Land units fixed according to landscape ecology approaches (Bailey 1996; Blasi & al. 2000), represent territorial areas ecologically homgeneous with the same type of natural potential vegetation. The land units are determinated by hierachical classification systems that identify more levels on the basys of relevant ecological factors with spatial and time scales gradually of higher detail (Klijn & Udo de Haeas 1995; Blasi 2005).

Distributive multiscale pattern of environmental variables that characterize the habitat of a species fits to different species with different distribution ranges.

In this paper the distribution of some plants is related to the land units in order to map out areas of potential distribution in a dynamic sense. Land units (potential patterns) and the land use (real pattern) are also considered for real distribution definition.

## Materials and Methods

The procedure is based on the habitat location on biological and environmental variables.

For environmental variable, a multi-scale approach is used recognizing Ecosystem units by ecological classification of hierarchical characters (Bailey 1996).

The nomenclature of these Ecosystem units follows Blasi & al. (2000) but their characterization is based on different criteria.

The use of environmental variables is suggested by data availability for GIS processing. We used climatic, lithologic and morphologic (DEM) data.

The Ecosystems Units used are:

Land Region (scale > 1:250,000) based on Macro-Climate,

Land system (scale 1:250,000-1:100,000) based on Lithology + Macro-Climate,

Land sub-system (scale 1:100,000-1:25,000) based on detail Bioclimate + Lithology + Macro-Climate,

Land unit (Scale < 1:25,000) based on geomorphology (slope) + Bioclimate + Lithology + Macro-Climate (Fig. 1).

Each taxon, according to its auto-ecology, has a distribution that can be related to Ecosystem units. These units vary from land region for species with large distribution to land unit for species with punctual distribution, in relation to the distribution of the species.

The correlation is established between the taxa occurrence, biotope and ecosystem unit.

Information on biological characteristics of a territory can be obtained from soil cover maps realized according to naturalistic classification criteria as, for example, Corine Biotopes maps. These maps, drawn above all following physiognomic-structural criteria, reproduce not only natural and semi-natural landscape elements but also human elements as cultivated and built areas.

Two species have been chosen as case studies: *Erica sicula* subsp. *sicula* and *Abies nebrodensis*. The former is nowadays confined only to Mt. Cofano (W Sicily) but was reported also from Mt. San Giuliano (Erice, W Sicily) and Marettimo Island (W Sicily) (Giardina & al. 2007), the latter occurs with a natural population of only 32 individuals in the Madonie Mountains (N Sicily) (Raimondo & Schicchi 2005).

## Preliminary results

Potential distributions drawn show a larger area than the actual one. These data are summarized in the maps of Figures 2 and 3.

The relict population of *Abies nebrodensis,* consisting of only 32 plants, occurs scattered on an area of about 200 hectares (Raimondo & Schicchi 2005);from the data processing the area of potential distribution is 2,200 hectares spread in the Supra-Mediterranean bioclimatic belt on Quartzarenite substrata.

Environmental units recognized for *A. nebrodensis* can be used, in the future, as preferential localities for planting the progeny of this species grown in nurseries.

*Erica sicula* is actually known only from Mt. Cofano (NW Sicily) (Giardina & al. 2007) covering about 25 hectares. According to the elaborations it has a potential distribution of about 1,800 hectares located along the NW coast of Sicily and the N slopes of the island of Marettimo in the thermo.mediterranean bioclimatin belt on carbonate substrata.

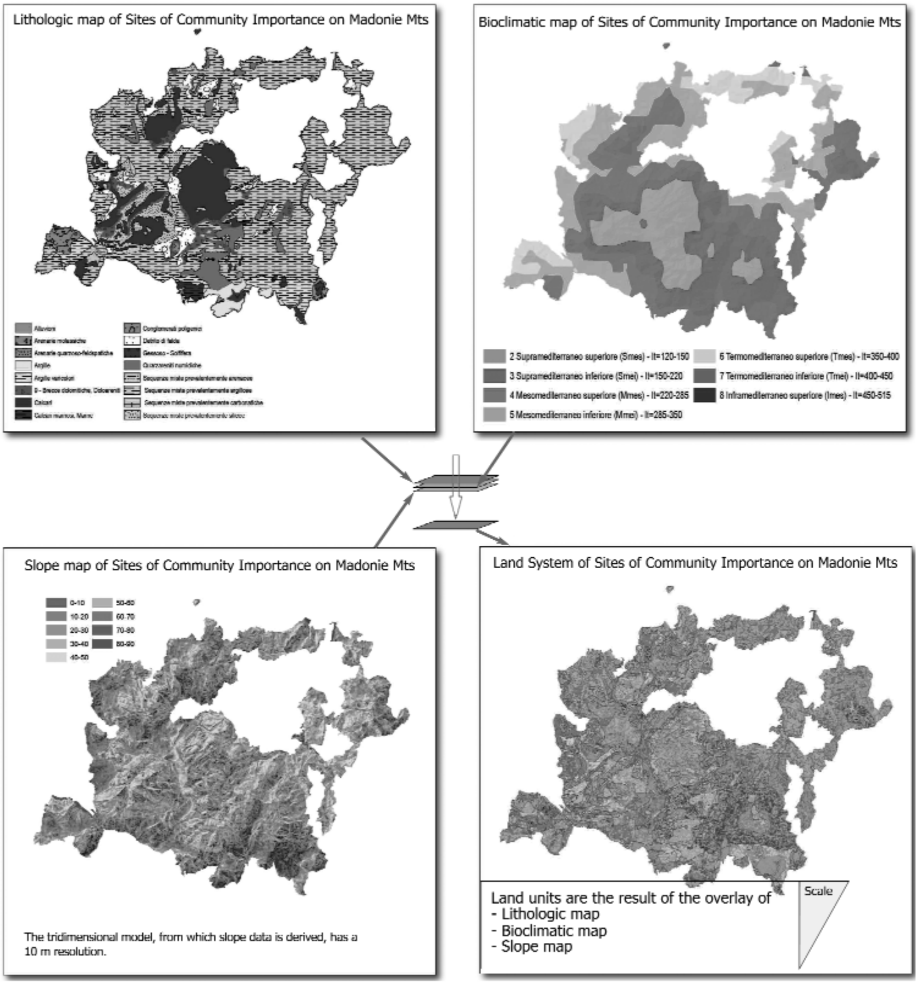


Fig. 1. Procedure illustrating the land classification. Macro-climate not represented because homogeneous on the whole area.

The environmental units found for *E. sicula* subsp. *sicula* are localities where the taxon could be found. Future floristic investigations, aimed in new populations finding could be used for further improvement of the technique.

## Discussion and conclusion

The method here summarized aims to find potential areas, in the dynamic-vegetational sense, in which the species is not actually occurring but the environmental variables are suitable for its presence.

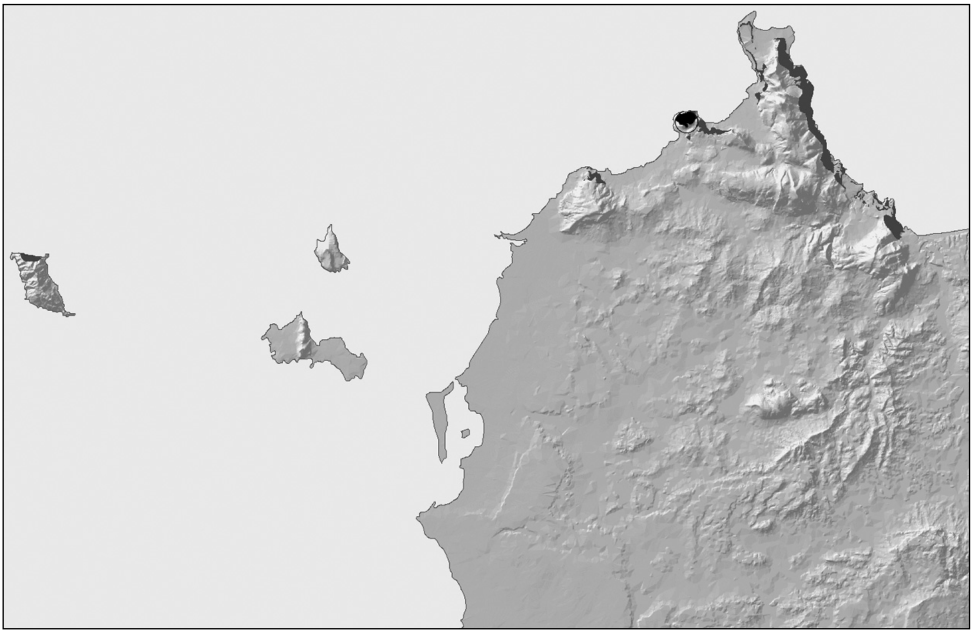

Fig. 2. Potential distribution mapping of *Erica sicula* subsp. *sicula*.

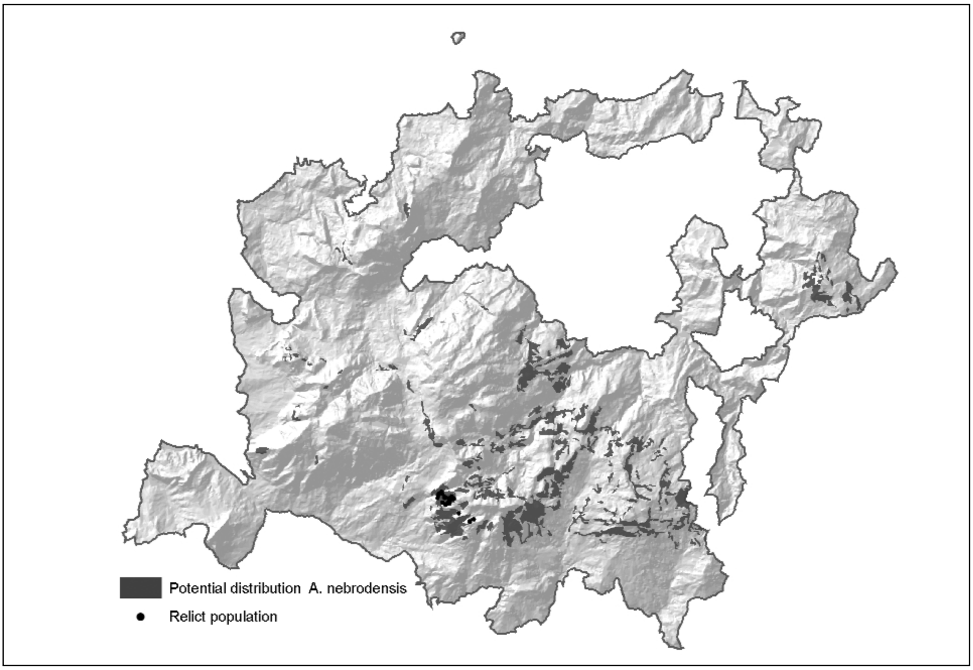


Fig. 3. Potential distribution mapping of *Abies nebrodensis.*

Different statistical models for spatial distribution prediction exsist. These need statistical formulations that give a validation between model prediction and field observation.

In the analyses here summarized are not considered only habitats in which it is possible to find the species, but localities where the species is actually missing owing to the human pressure. This approach is necessary, for example, when there is the need of finding suitable localities for reintroduction as for *in situ* conservation programmes.

Concerning the spatial pattern, the choice to use a scale classification system of hierarchized landscape in order to define potential habitats has been dictated by several reasons. Above all was choosen a method already in use in the definition of potential vegetation (Blasi 2011) that properly fits to landscape management. In this sense we tried to integrate single taxa conservation with the wider landscape conservation using common criteria and nomenclature.

The hierarchized criterion used can be used to different spatial scales in comparison to the target species and to the problem that have to be solved. The emendation of the methodology originally proposed by (Blasi & al. 2000) and after modified by Blasi & al. (2005), is related to variable selection and GIS layer structure in relation to good spatial quality environmental data availability. This to make the method more user friendly in planning and management of natural resources also from the user point of view.

The conceptual model, already used for distributive models definition of potential natural vegetation, modified for habitat distribution model gave satisfactory results. The proposed method based on empirical observations results theoretical correct more than statistically accurate, pointing out the easiness of technique use that makes it a decision making support tool in biodiversity management and conservation actions.

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