The Use of GIS and Remote Sensing for Landscape Character Mapping: a Pilot Study from Sardinia

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SUMMARY

A methodology is being developed based on the use of GIS and remote sensing tools for landscape character mapping in a pilot study area in Sardinia. The methodology is based on physical and cultural attributes of the Sardinian landscape using GIS as a decision support tool. In this abstract the first steps of the methodology is presented and future work is further discussed. In particular, the applicability of this methodology is investigated as a framework for the mapping and monitoring of cork oak habitats in Sardinia. This novel approach will be used in order to explore the interplay between the physical and cultural factors in the distribution of cork oak habitats in the island.

KEYWORDS: *landscape typology, monitoring, mapping, cork oak*

INTRODUCTION

Landscape as defined by Forman and Gordon (1986) is a mosaic of "interacting ecosystems". There is increasing recognition that the spatial structure of landscape elements is a factor of critical significance in determining biodiversity (Gergel & Turner 2001) and achieving sustainable development (Wrbka et al. 2002). This is also highlighted by recent European legislation (e.g. PEBDLS) which now considers the conservation status of the wider countryside, including both its biological and landscape diversity. An approach that exhibits potential for biodiversity assessment is Landscape Character Mapping. The rational behind landscape character mapping is that particular combinations of physical and cultural factors occurring in different areas result in similar landscapes. The approach is based on a series of natural (e.g. landform, geology, soils) and cultural factors (e.g. land use, settlement pattern) that are used to describe the variability in the landscape at various spatial scales depending on the research scope.

The development of landscape character assessment/mapping has been facilitated by the use of GIS as a decision support tool. This technology provides significantly increased opportunities for more detailed environmental resource inventory and analysis in space and time and shows considerate promise for extensive use in nature conservation (Gergel and Turner 2001). This abstract reports on the steps taken for the development of a landscape typology framework as a means for mapping the distribution of cork oak habitats in a pilot study area on the island. It presents the results of the first part of mapping based on physical attributes of the landscape, while the derivation and incorporation of the cultural attributes is discussed. The application of GIS can assist in the formulation of landscape character assessment and therefore land use policies through the development of an integrated spatial database of land use in Sardinia.

METHODOLOGY

The methodology employed is based on the approach developed by the Living Landscape Project at the University of Reading (Warnock 2002) incorporating the individualities of the Sardinian landscape. The system is hierarchical, based upon the successive sub-division of the mapped attributes. The landscape is divided first into physiographic units from contour and geological data. The resulting units are then further sub-divided by soil type and finally by cultural patterns to derive the building blocks of the system, the Landscape Description Unit (LDU). Figure 1 illustrates the general approach and shows how the physical and landscape attributes are successively combined to derive the Landscape Description Units. These units can subsequently be amalgamated into Landscape Types with similar physical and cultural attributes using TWINSPAN analysis (Hill 1979).

Study area

This method is being applied/developed on a 50km x 50km area at the North of Sardinia (Figure 2) close to Tempio Pausania where the Experimental Station of Cork (SSS) is located. Apart from its proximity to the SSS, the study area was selected on the basis of two criteria: the presence of diverse landscape types, in order to ensure maximum number of cork oak habitat types (e.g. forests, open pastures etc), and the presence of proposed Natura 2000 sites.

Data

The elevation map of the study was derived from a Digital Terrain Model of Sardinia with pixel size 90 x 90m. For the geology and soils of the study area the geological map of Sardinia (1996) scale 1: 250 000 and the soil map of Sardinia (1991) scale 1: 250 000 were scanned and digitised to produce two vector maps with the associated databases.

Figure 1 Sardinia and the Study area

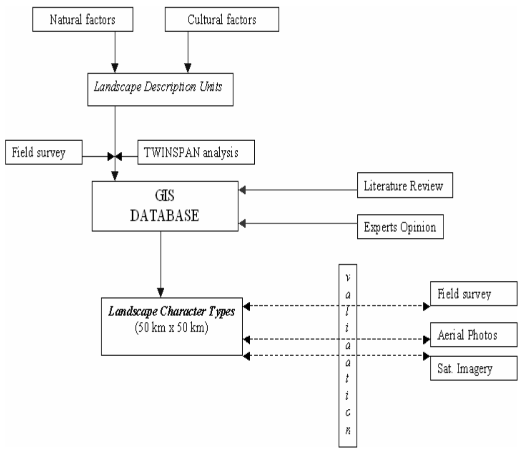

Figure 2 Flow diagram of the methodology employed

Mapping Process

Relief, geology and soil have “real” boundaries which can be readily extracted from existing published maps. Therefore these are the features that were mapped first and provide with a context to analyse the historical evolution of the landscape (Warnock 2002). A simplified map showing four landform categories based on altitude and slope and shape as follows: steep upland areas, valleys, rolling hills and steep hills was produced (Figure 3). This map was derived from the contour map and morphological analysis based on satellite data of the area. The next step was to produce a simplified geological map showing the basic structural and lithological categories and a simplified soil map. The new categories for every map used are shown in Table 1. The landform map was overlaid on top of the simplified geological base map and the terrain types were subdivided giving a new code for every resulting polygon into the GIS database describing the two characteristics. On top of the physiography map (landform and geology) the simplified soil map was overlaid and again the new polygons were given a three letter descriptive code (for landform, geology and soils). This provides the information available for the physical attributes of the landscape (Figure 4).

Table 1 Classes of the three physical factors used in the GIS overlay process

Landform	**Geology**	**Soils**
Steep upland terrain	Quaternary deposits	Overdrained infertile soils
Rolling hills	Pliocene-Pleistocene alkaline sub-alkaline deposits	Deep well drained soils
Steep hills	Tertiary Marine Sedimentary Deposits	Deep poorly drained soils
Valley bottoms	Tertiary Continental Sedimentary Deposits	Shallow soils
	Oligocene-Miocene calcalkaline volcanic deposits	Mixed
	Carbonatic and Dolomitic shelf Deposits	
	Late Hercynian intrusive complex	

FUTURE WORK

The long presence of human in the Mediterranean has been of vital importance in shaping the landscape. Therefore any landscape typology in the area should incorporate not only physical but also cultural attributes. This new integrated framework will be applied for landscape character mapping in the study area. This is more important for species like the cork oak that are associated with human activities. Profound cultural attributes/features of the Sardinian landscape which are linked with land use patterns include according to Pungetti (1996) enclosed lands (the *chiudende*), the Nuraghi systems, the caves, the monasterial properties, big estates and medieval settlements. Some of these are in particular linked with the exploitation of the cork oak and are also found in the study area. The next step in this study will be to map these patterns using the available satellite imagery and aerial photographs and incorporate them as a fourth layer in the landscape typology. The resulting map will be a map of homogeneous landscape units. These will then be classified into landscape types using multivariate analysis (TWINSPAN) and the results will be mapped into a GIS to produce a landscape character map (Figure 1).

This map will then be compared with the distribution of cork oak habitats in the study area as mapped by the SSS in order to quantify the relationship between landscape types and habitats. Remote sensing and GIS methods have been used in landscape ecology/assessment to observe and analyse the structure of the landscape using various metrics (Gergel & Turner 2001). Metrics, like the area/perimeter-relation of the landscapes elements can be used to compare the different landscape types. This analysis in combination with detailed habitat mapping where available will enable us to draw conclusions on the quality of the cork oak habitats.

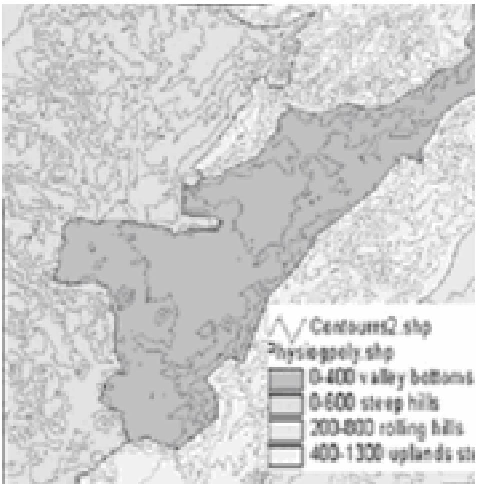

Figure 3 Landform Types in the study area

Figure 4 Landscape description units based on physical factors

In addition another important aspect in landscape ecology and management with direct implication to biodiversity is the ability to visualize change and model how a negative effect could be minimised to reduce a decline in the scenic quality of the landscape. Novel visualisation approaches for the identification, evaluation and communication of changes in the landscape are now supported by GIS and can be used to provide insights in the past or future (e.g. McLure and Griffiths 2002). This also provide a means of communication with non-expert audience where the participation of public in the environmental decision making process is desirable/necessary.

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