WHEN IS IT REALLY WORTHY TO USE GIS IN ENVIRONMENTAL PLANNING?

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Introduction

There is a huge variety of definitions given to the Geographical Information System – GIS. However, to illustrate the main point of this article, the definitions can be classified as **descriptive** vs. **analytical**. To exemplify, a **descriptive** definition is: "*organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. Certain complex spatial operations are possible with a GIS that would be very difficult, time consuming, or impracticable otherwise*" [8]. The definition lists the components and operations performed by GIS, without emphasizing the ultimate endpoint of these operations. An **analytical** definition is "*decision support system involving the integration of spatially referenced data in a problem solving environment*" [1]. The definition explains the core principle of their operation (integration of information layers based on their geographical reference) and endpoint (resolution of problems). Moreover, the use of GIS by other disciplines than geography, eventually non-spatial, led to a self-standing science – GIScience (from GIS – Geographical Information System, and science), defined by Michael F. Goodchild ([5], [6]) as "a multidisciplinary research enterprise that addresses the nature of geographic information and the application of geospatial technologies to basic scientific questions".

The first documented GIS was the map of the Yorktown battle (1781) made by the French cartographer Louis-Alexandre Berthier. Modern GIS appeared in 1969 in Canada as a creation of Roger F. Tomlinson, who finalized the implementation of Waldo Tobler's principle 'Map In, Map Out' (MIMO), started in 1959, and consisting of transferring all paper maps in a digital form [9]. ESRI launched its first product, named ArcView, in 1981 [11]. The development of modern GIS is marked by revolutions; ArcGIS 8 introduced a new concept, 'interoperability', consisting of compatibility with other products and applications, possibility of being used in an environment where users can change data (documenting changes), and manner of delivering the final products [4].

Nevertheless, in Romania (and many other south-east European countries) it took a long while to accept GIS, and even today there are professionals who do not fully understand their capabilities, and see them as some 'other' mapping software. For most average users, mapping seems to be the only final output of a GIS. Furthermore, static maps are preferred to those pinpointing processes. This is true especially in planning; even when the first step (requiring a GIS-based plan) is taken, very few realize that in order to become operational, a GIS-based plan needs constant updating. The lack of free reliable data is part of the problem; most times the price prevents individual users or small companies obtaining the data; in other cases, the procedures are too complicated and lengthy, being dominated by the bureaucracy.

Despite of these limitations, the present paper aims to document the use of GIS in the process of elaborating the environmental studies aimed at substantiating the urban and spatial planning process, underlining their limits and benefits, and encompassing an experience of five years and almost 30 urban and spatial plans, resulting into a creation of a novel methodology based on using CORINE data for this purpose.

Methodology

A recent study introduced the term '**global change**' to coin all anthropogenic impacts affecting Earth, including changes of land cover and use, climate change and modifications in the use of energy [2]. Jensen [10] showed that land cover describes what lies on the ground surface from a biophysical viewpoint, while land use indicates how the humans utilize each parcel. However, the definition was amended by Petrişor *et al.* [13], to specify that land use shows a detailed classification of natural systems and the use of artificial ones by human communities. In the European Union the three-level CORINE classification is used [3]; the first one indicates land cover, while the last two show a more or less detailed description of land use in man-dominated systems or typology of natural systems [13]. Recent studies have shown that socio-economic phenomena are the core drivers of land cover and use changes [13].

The methodology developed in support of the planning process relies on the use of CORINE data to reflect the current status and transitional dynamics driving its changes. In the first case, Petrişor [15] proposed, based on the spatial scale, a correspondence between the units (systems) used in ecology, geography and spatial planning, including their corresponding diversity, shown in Table 1.

Table 1. Correspondence of system hierarchies in geography, ecology and spatial planning in relationship to their spatial diversity and environmental classification schemes ([15], modified).

Hierarchy of ecological systems	Hierarchy of geographic systems	Hierarchy of territorial systems	Environmental classification	Spatial diversity
Structural and functional sub-units of ecosystem	Nano- and micro-structures, house/ block, company/ unit/ section, street/ street segment	-	-	α, ω
Ecosystem	Geosystem, geofacies, geotope, local system	NUTS V (LAU II)	CORINE III	α, ω
Regional ecological complex	Natural region, geographical region, regional system	NUTS III	CORINE II	ß, γ, ω
Macro-regional ecological complex	Domain, zone, national/ supra-national, continental system	NUTS II, NUTS I, national territory, continent	Relief units, CORINE I-II, EU biogeographical and ecological regions	γ, δ, ε, ω
Ecosphere	Geosphere, planetary system	Globe	Global biogeographical regions	ω

Results and discussion

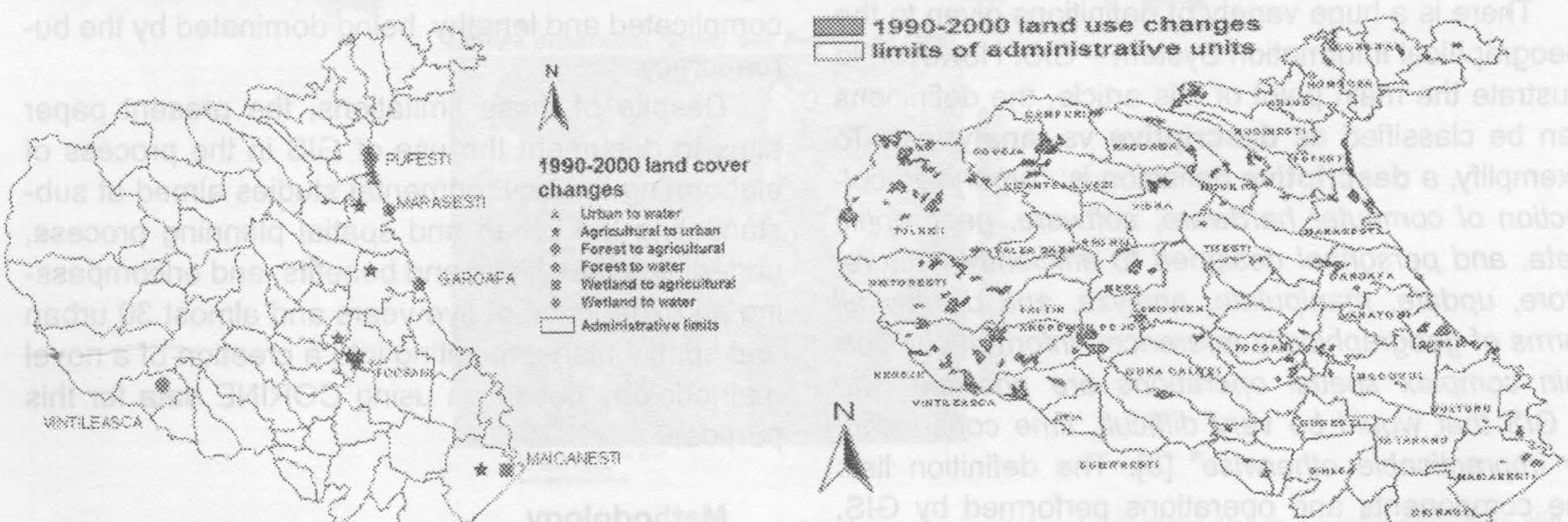

Fig. 1. Images from Vrancea County Spatial Plan illustrating the use of CORINE data to illustrate the transitional dynamics affecting land cover and use change at different scales. Land cover changes show the more important transitional dynamics (left), while land use changes give the extent of phenomena, especially deforestations (right).

The practical relevance of this correspondence is given by the ability to use data available for each environmental classification at a given territorial level (indicated by the NUTS classification) to accurately describe its environmental status. The great advantage of the CORINE classification is the availability of free data, but the fact that the methodology and spatial resolution changed across time and the production of data at large interval of times (imposed by applying an unique methodology at the continental scale, with an iterative correction process) makes them suitable only for assessing long-term changes of large systems [14]. An example of shifting from one level to another is provided in Petrişor [12] with respect to the spatial plan of Vrancea County, Romania (Fig. 1): land cover changes are represented punctually, using different symbols and pinpoint important trends, such as the intensive urbanization around Focşani, the county residence, and floods occurred during 1990-2000 across Siret river. On the other hand, land use changes are figured fully, to suggest the overall intensity of phenomena; they allow for pinpointing specific phenomena, such as the deforestations from the northeastern part of the county.

The previous experience shows that the environment can be described, for planning purposes, at any level by: ecological or biogeographical zoning and relief units, land cover and/or use, including changes (CORINE data, with the appropriate level), elevation, hydrography, climate (including predicted climate changes, as underlined by DIVA-GIS data), soils, fauna and flora, including protected species, natural protected areas, and zoning with respect to the natural hazards: floods, landslides, earthquakes [16]. Out of them, only fauna and flora do not rely on spatial data. For all others, spatial data were collected and made available through many European and international programs.

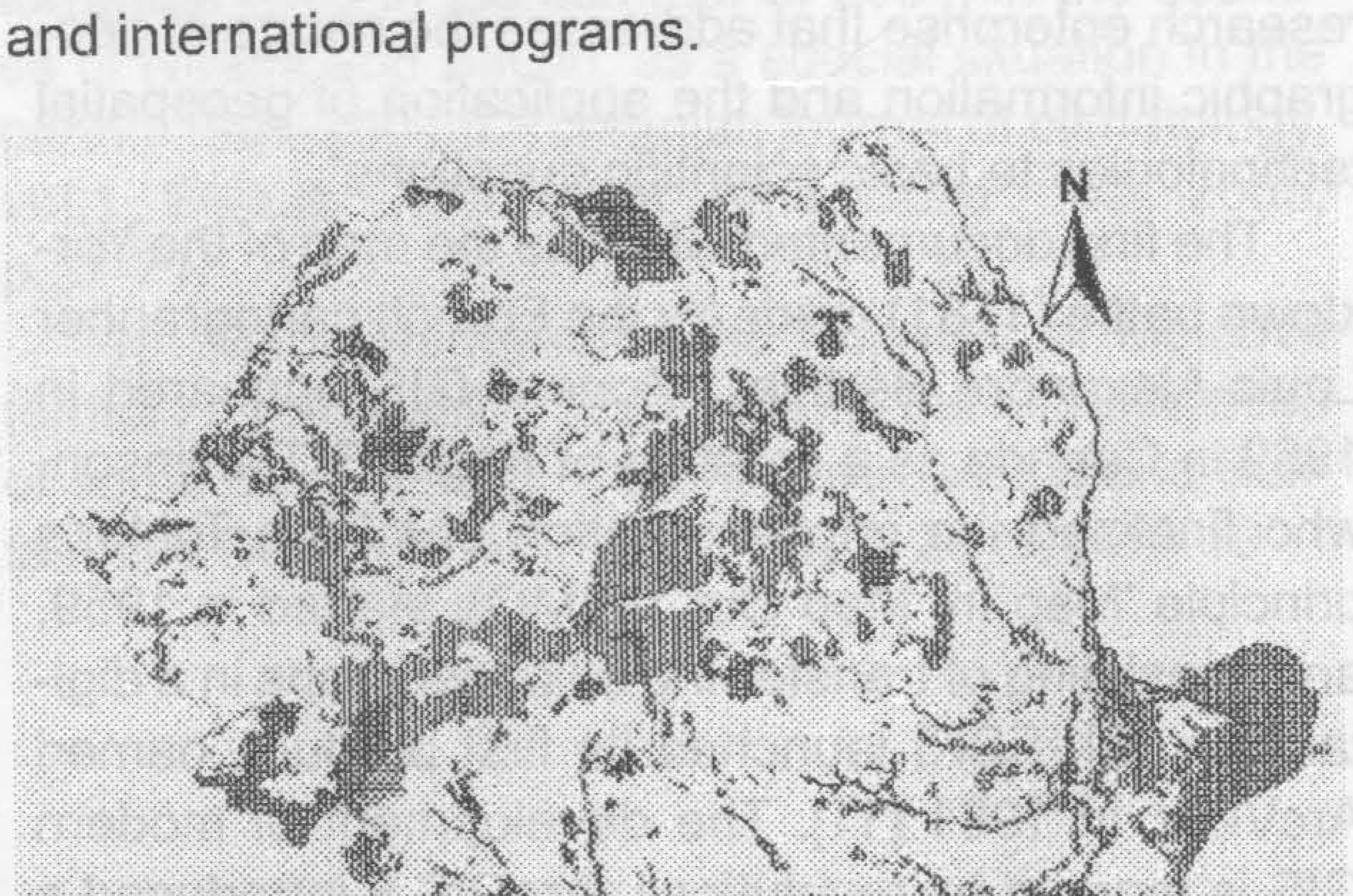

Fig. 2. Overlapping of the major categories of natural protected areas of national and international importance.

A specific issue encountered in planning with respect for the natural protected areas relates to overlapping. Previous studies have shown that 96.19% of the area occupied by the different categories used in Romania before the adoption of NATURA 2000 overlap with the new sites, and two new categories (SCIs and SPAs) overlap 49.61% [7]. According to computations based on the most recent available data, the overall overlapping percentage is 75.09 (71.54 for NATURA 2000 only, and 49.89 for all other categories only) – Fig. 2.

Conclusions

The results underline the benefits of geospatial technology in the environmental planning associated with the elaboration of spatial plans. The use of actual data in conjunction with the analytical ability of a GIS allow for accurately describing the current status and underlining the main transitional dynamics determining its change. Nevertheless, there are limitations referring to the availability and cost of data, especially at the urban scale, which needs continuous updates. For this reason, the current GIS technology serves better spatial planning than urban planning.

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Summary

When is it really worthy to use GIS in environmental planning?

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Geographical Information Systems have been in place and used worldwide for a long time; the first typical GIS was created in the 1800's and the first modern digital system in 1980's. However, the technological gap between the East and West prevented the use of GIS for civil applications in Romania for a long time. Even nowadays, the lack of trustworthy, public and free data in an open system hinders their usage, despite of the attempts of managers, who have started to understand the potential benefits of GIS as a support tool in the decision making process. The present paper documents the usage of GIS in environmental studies aimed at substantiating spatial planning, underlining their limits and benefits, and encompassing an experience of five years and almost 30 urban and spatial plans, resulting into a creation of a novel methodology based on using CORINE data to pinpoint the main transitional dynamics determining land cover and use changes. Both are conditioned mainly by the socio-economic, political and administrative transformations. The results allowed for underlining the benefits of geospatial technology, but also its limitations; the best and most relevant use of CORINE data is confined to large systems and long periods of times.

1 table, 2 figures, 16 references