Geographic Information Science for geo-knowledge-based governance

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SUMMARY
Introducing geo-knowledge in traditional e-government can improve land-use governance. It can help citizens to perceive the state of the environment and accept constraints on land use and planning strategies more readily. It naturally implies the availability and usability of good Geographic Information (GI). The main aim of this paper is to improve the introduction of GI-based-governance concept: geo-governance, a combination of land use government with land geo-knowledge. Growing interest in Geographic Information and the success of GIS technologies have stimulated the development of new application fields, technologies, hardware and software to meet a very wide range of requests from both the scientific research community and the environmental policymaking community. The present paper describes the final result of applications, e-governance applicable, conducted using GIS: by analysing thematic maps, it is possible to find solutions to critical environmental, social, economic, anthropogenic and other situations; in other words, all kinds of situations related to the territorial management, or governance.

KEYWORDS: Geographic Information Science, e-governance, territorial analysis.

INTRODUCTION
In the common sense electronic government is perceived from citizens as a set of on-line systems for quality improvement in the provision of public services. At this level, the geographic component embedded inside major part of usable electronic information, cannot be fully perceived from users. If we draw out such geographic component, we could change a large part of commonly used data into geo-data. Improving the introduction of the geo e-government concept is the innovative aspect and the main aim of this short paper: we have to conjugate the land government with the land geo-knowledge. Inside this context, the application shown in this paper constitutes just an example of territorial geo-governance addressed to make possible EMAS (Eco-Management and Audit Scheme) regulation’s application to a territory through the GIS tool utilisation. The work presented in this paper refers about the GIS contribution to the "New Tuscia" LIFE02 ENV/IT000111 project, for which it was specifically created. In this project EMAS (Eco-Management and Audit Scheme) regulation is applied to a territory instead of to economic organisations in private and public sectors. The EU Eco-Management and Audit Scheme is a management tool, for all economic public and private sector, to evaluate, present and get better their environmental performance (www.europa.eu.int). Although the innovative aspect of this job stands in this new way and field of application, EMAS regulation cannot constitute the principal aim of this article, which target is to refer about the GIS utilisation in order to address some rules/advices to follow the EMAS’ directives. The project planners decided the GIS use to integrate environmental policy in territorial economic and social planning via an innovative application of the EMAS EC/761/2001 regulation on the local scale. This choice was based on the understanding that the EMAS regulation, conceived for industrial enterprises, can address the needs of environmental protection together with needs of industrial, agricultural and social development. The study and the assessment of these territorial-social-economic situations can be performed at one and the same time by using a GIS (Finzi and others, 2004). To have a real effect on the territory's government, a good governance needs to have in hand all the information to overcome: the inadequate knowledge of the environmental impacts of different human
activities; the rigidity of administrative boundaries; the traditional compartmentalisation of territorial planning. Another fundamental aspect that should distinguish good governance from any other traditional environmental management systems is the importance placed on GI regarding the different environmental situations, on their monitoring, and on dialogue with citizens and all parties concerned. Promoting the use of GISs by local authorities, planners and organisations, closely involved in territorial management, is also intended to overcome the difficulty that local authorities generally have in defining an integrated policy for the socio-economic development of their territory. Nowadays socio-economic development means also environment’s protection and then it should include environmental improvement goals as, for instance, reducing the direct and indirect impacts of industrial and agricultural activities, transportation, etc. as well as localizing the sources of environmental suffering. As the territorial aspect of the problem resulted very clear the NewTuscia GIS was created at the GIS Laboratory of ENEA-Casaccia’s Environmental Protection and Development Section as a contribution to the preliminary environmental study conducted by the LIFE New Tuscia project. The project was financed by the European Commission and the beneficiary was the Project Promotion Committee1.

GI-governance

More and more GIS applications are being chosen as contributions to search for solutions in many different fields, including the environment governance. In this sphere, the paper intends to give a further contribution to a series of activities whose purpose is to privilege the use of GIS technologies in the new field of geo-governance. In fact, GIS technologies use can improve the study and the search for problems solutions related to the socio-economic and environmental aspects typical of any kind of territorial management. To solidify these trends, in recent years GIS methodologies have been the object of continuous incentives aimed at making them capable of meeting demands from the territorial-management world. A tool like GIS, if made available to the various levels of the public administration, would already be a long step towards a so discussed and publicised good governance realisation (Caiaffa, E., 2003).

The purpose of this paper is thus to present the contribution of GIS techniques to environmental studies and analyses e-government applicable. The application described here, with its high potential for use, is an example showing why GIS solutions are increasingly used for territorial studies and governance. In fact, thanks to wider and more ramified information on the subject and to greater awareness of the importance of environmental quality, people have come to understand the value of integrating environmental analysis in traditional territorial management.

Any environmental analysis system involves multiple studies and researches to gather and process data of very different kinds which study is competence of different disciplines. Its success thus depends on the quality of the integration, processing and interpretation of a large data and information amount. Precisely because of the strongly interdisciplinary nature of studies that analyze all the environmental parameters, the need to use integrated, computer-bases systems has become clear to many institutions and administrations. GISs are used in data collection, integration and processing phase as well as during the phase in which the results, obtained through the interpretation of the available data and information, are rendered in graphic and symbolic form on thematic maps.

1 The project's original participants are the Viterbo Provincial Administration (project co-ordinator); the Bracciano and Martignano Park Authority; the townships of Allumiere, Anguillara Sabazia, Bracciano, Canale Monterano, Manziana, Tolfa and Trevignano Romano (Province of Rome); the townships of Barbarano Romano, Bassano Romano, Blera, Capranica, Oriolo Romano, Vejano and Vetralla (province of Viterbo); ENEA; and ISI (Impresa Sviluppo Innovazione s.c.a.r.l.) of Bracciano. They were later joined by the Ecolabel Ecoaudit Committee of the EMAS Italy Section, APAT (Environmental Protection and Technical Services Agency), ARPA (the Latium Region's environmental protection agency) and the Southern Etruria Archaeological Superintendency.
The results, obtained from processing and mapping such data with a GIS, communicate to the map reader certain information – inherent in the graphic representation and otherwise difficult to perceive – that makes environmental situations immediately, clearly and directly visible.

GIS CONTRIBUTION IN ENVIRONMENTAL ANALYSIS

Using a GIS to perform an environmental analysis, aimed at formulating and implementing an environmental improvement plan through interpretation and subsequent application of the EMAS regulation, is a strongly innovative idea. Such a study of a territory naturally requires collecting, harmonising and processing data from different disciplines. Accordingly, the project set up a team of experts\(^2\) responsible for collecting and managing the data from their own fields to be inserted in the NewTuscia GIS.

To correlate certain aspects indicated by the different disciplines, the data collected by the team members were analysed in a GIS environment and gave rise to the definition of specific themes from which to draw preliminary information on certain features of the territory in question.

The initial reading of the environment’s state, in the target territory, has involved information and data useful for identifying significant environmental impacts. The data collected, entered in the GIS and then processed for the specific study reported in this paper, concerned different fields and expert competences.

GIS data entry

One of the first problems solved in creating the NewTuscia GIS was how to link (geo-referencing) the data, gathered from the townships and provinces concerned and from other sources, to the territory. This required a demanding effort to harmonise the data on subjects such as water, civic uses, archaeological/cultural sites, etc. In some cases it was also necessary to pinpoint (figure 1) the location of the objects characterising the individual subjects, before plotting them on the relevant digital map. The “NewTuscia” GIS also made it possible to create a product that can be not only consulted, but also updated and used to:

1. provide a valid support for assessing and adjusting programs and actions on the territory;
2. enable monitoring of future actions;
3. achieve environmental-improvement objectives.

The construction of the NewTuscia GIS is the example of how, in seeking solutions for territorial data integration and processing, GIS solutions are more and more privileged in order to make possible to analyse and find solutions to critical environmental, social and economic problems: in other words, all the situations involved in territorial management and governance.

Map output

The NewTuscia GIS has produced 36 thematic maps (Caiaffa, E., and others, 2004) that give a preliminary view on environmental state in the project's target area. The purpose of this short paper is not to display all of the 36 maps, but to show how, with the GIS aid, it was possible to integrate and correlate a series of environmental data with a series of social and economic data, thereby demonstrating the validity of the choice to manage such data through a GIS that enables users to read the present state of the territory and its current and future performance.

\(^2\) Members of the ENEA working group: Emanuela Caiaffa, Angelo Correnti, Antonio Disi, Fausta Finzi (LIFE project leader), Mauro Gamboni, Mario Montini, Fabio Musmeci, Carmine Perrone Capano, Loris Petrelli, Caterina Salvadego, Giuliano Sciocehetti. Gabriella Scapaticci of the Southern Etruria Archaeological Superintendency; Patrizia Menegoni of EP srl, Rome; and Francesco Frattarelli of SIT srl, Rome, collaborated on the project.
In this short paper are shown only two of all thematic maps\(^3\) suitable to draw out specific kind of territorial situation or vocation.

![GIS target area with Via Clodia’s ancient layout](image)

**Figure 1:** GIS target area with Via Clodia’s ancient layout

### Displaying the results

Because preliminary nature of the performed elaborations we are able to deduct some results that for the present have only an observation meaning. How many and what are the results of possible data correlations and combinations it is difficult to decide now. Nevertheless by reading the major part of produced thematic maps, we are able to draw some unexpected observation we can reassure in a general good judge of the target area environmental conditions. On writer opinion, in the target area

\(^3\) The developed thematic maps are: principal physical features of the target area (contour lines, lakes, hydrographic network, etc.); classification of townships by number of residents per hectare; the suburban bus network and classification of the principal nodes in the transportation network by number of passengers in transit; classification of the territory by land uses (six Corine Land Cover classes); land-use percentages of total township area; archaeological restrictions; areas subject to environmental protection; areas subject to civic use; operating quarries, closed quarries and planned quarries; annual per-capita generation of solid urban waste; use of water resources; water supply in litres per resident per day; sewer network coverage; classification of townships by percentage of residents served by water purification plants; land classification by slope brackets; land classification by type of surface rock; hydrogeologic complexes and permeability of surface formations; risk of landslides and/or floods; watertable depth; richness of Corine habitat; birds: wealth of nesting species; amphibians: *Anura* species wealth indicator, *Urodela* species wealth indicator; reptiles: *Squamata* species wealth indicator; vegetation: abundance of *Orchidaceae*, abundance of rare and/or protected species, extra-zone plant formations, forest formations; livestock: equivalent population per hectare of pasture, nitrogen release index, phosphorus release index, methane emission index (Finzi and working group, 2004).
itself, there are so different environmental conditions produced by different human activity coming from ancient territorial vocation. By data from Corine Land Cover inventory (six classes), intersected with the Land Cover statistical data, it is possible to calculate an indication of the territory percentage use in each township area. It is relevant that, in relative near areas, inside the target area, three are so different land utilizations to induce us to think an historical cause of them. So the major part of the Allumiere and Tolfa territory is wild and pasture dedicated and just in this area we have a concentration of handicraft commercial activities linked with cattle-breeding and respective skins manufacture. Furthermore, in this area we also have an inhabitant percentage less then others municipalities as Anguillara and, for example, Bracciano. This could be due to the presence of the Bracciano lake that has ever called many people thanks various activities lake correlated (for example fishing) and that nowadays attracts an elevate percentage of touristic presences. During data elaboration we drew out a lot of others environmental conditions that it is possible to see combined and correlated each other by GIS tool (Caiaffa, E., and others, 2004), even if it is premature to define them like a complete environment analysis study. Among the data used to prepare a territory-wide environmental analysis program, Corine Land Cover data play a very important role.

![Figure 2: Processing and displaying Corine Land Cover data](image)

Land-use data will be all the more useful, for characterising the territory to which they refer, if they are linked visually to other data, for instance the amount of land effectively devoted to each use (figure 2). This result is obtained with the data charting technique offered by the GIS. In the example, the technique was used to create bar charts of the Land-Cover statistics for each township. Each chart shows the percentages of township land in the six Corine Land Use classes. It is interesting to see, via the GIS, how the different land uses are distributed over the target area and how they represent the "vocation" of the territory to which they refer (figure 2). For example, the histograms for the townships of Allumiere and Tolfa show higher values for wooded land (grey bar) and for farmland, including crop fields and pastures (black bar). By contrast, the townships of Capranica and Vetralla have higher values than the others for "woody farmland" (dark grey bar): these data highlight the presence of many nut trees in the area.
Conclusions

In recent years, nearly all of scientific and policymaking communities have changed their approach to the analysis of socio-economic and environmental problems, and have come to recognise the importance of the geographic context of the anthropogenic, social and economic factors involved. Environmental analysis, aimed at identifying any problems in the target area and proposing recovery and/or rehabilitation actions, is doubtless a matter of priority in modern governance. The ideas and solutions presented in this paper see the GIS as a tool for producing integrated and dynamic knowledge to be provided to policy-makers, decision-makers and citizens: a technologically advanced tool capable of investigating and assessing a large number of environmental and social factors in the new geo-knowledge-based society. GI introduction defines a new type of information/knowledge that can serve as a common language for people operating in different disciplines or with different responsibilities. Moreover, if we hope to shorten the distances between the scientific community, policy-makers and citizens in a new type of geo-knowledge-based society, it is time to think a new way to approach information. The geographic component contained in much commonly used data can transform them into geo-information, a new kind of knowledge linked to the territory and its physical, environmental and socio-economic dynamics. In this perspective, Geographic Information can be used as a common language capable of linking and highlighting the many aspects that make up a good territory governance: a new way of "doing governance" which must be combined with the territory knowledge. "Governance of the territory = knowledge of the territory," and then "knowledge of the territory = governance of the territory."

The ultimate goal, that the ideas set out in this paper hope to further, is to establish the GIS, with all the high potential contained in its applications, as one of the tools regularly used to monitor the processes involved in an innovative e-governance of a territory.

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