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GEOTOURISM & GEOMORPHOSITES: THE G.I.S. SOLUTION

Lucilia Gregori & Laura Melelli
Dipartimento di Scienze della Terra, Università degli Studi di Perugia, Piazza Università 06123 Perugia
[1]lucilia@unipg.it, [2]lmelelli@unipg.it

ABSTRACT: L. Gregori & L. Melelli, *Geotourism & Geomorphosites: the G.I.S. solution.* (IT ISSN 0394-3356, 2005).
Geomorphologic research which has the geographical area of Umbria and the neighbouring territories as a subject of study, sheds light on some features possessing a relevant cultural and scientific value, known in literature as "Geomorphosites". Nowadays Geotourism is an excellent opportunity to exploit the scientific knowledge researchers have of geomorphosites as a source of didactical and economical value. The idea is to enhance the tourist attention towards geomorphosites, through the use of more traditional and better known interests.
Having this aim in mind, a more careful research was made for each geomorphosite. Different characteristics are reported as: oeno-gastronomic tours, historic-artistic values, and craftsmanship activities.
G.I.S. are the best instruments to manage and analyze geomorphologic data. In particular geomorphosites, which are mapped and spatially georeferenced have a geographical characterization so that they can be best studied through the use of G.I.S. In G.I.S. different functions are available as querying maps, or building relations in relational database (one to one or many to one) in order to obtain detailed tourist itineraries.

RIASSUNTO: L. Gregori & L. Melelli, Geoturismo e Geomorfositi: una soluzione in ambiente GIS*. (IT ISSN 0394-3356, 2005).*
Da alcuni anni, lo studio delle caratteristiche geomorfologiche del territorio, ha messo in evidenza in Umbria e nelle aree limitrofe, (analogamente al lavoro svolto in Italia e all'estero) la presenza di forme con alto valore scientifico e culturale, definite "Geomorfositi". Un nuovo approccio alla conoscenza e alla promozione di questi siti è costituito dal loro inserimento in nuove nicchie turistiche. Nasce così il "Geoturismo" ovvero un turismo che privilegia, lungo i consueti circuiti, mete con alto valore scientifico, geologico e geomorfologico, consentendone il passaggio da un ambito strettamente accademico ad uno gestionale - economico. Nonostante il più alto livello culturale del turista medio, i geomorfositi rimangono ancora un campo poco o nulla esplorato dagli attuali flussi turistici. Trovare nuovi modi per far avvicinare il turista ai geomorfositi, passando attraverso interessi più tradizionali e già testati, è lo scopo principale del presente lavoro.
I Sistemi Informativi Geografici (G.I.S.), intesi come nuovi strumenti per la gestione e l'analisi di dati geografici, rappresentano un utile mezzo per il management dei beni geomorfologici e per la loro diffusione in ambito turistico. Gli aspetti più "tradizionali", che costituiscono un valore aggiunto al bene geologico-ambientale, oltre a quelli di carattere strettamente scientifico, sono implementati nel database relazionale del progetto: gli elementi geologico-geomorfologici, le valenze storico/artistiche, culturali s.l., l'artigianato e le tradizioni popolari, il valore paesaggistico/ambientale, la progettazione di percorsi escursionistici ecc.
Il carattere territoriale dei geomorfositi (forme presenti nello spazio geografico, georeferenziabili e cartografabili), collegato ad un certo numero di attributi, li rende gli oggetti ideali per essere gestiti dai sistemi G.I.S. Utilizzando le potenzialità di tali sistemi (connessioni tra tabelle con relazioni uno a uno e molti a uno e/o formulazione di query) è possibile interrogare il database per ottenere la selezione dei geomorfositi che rispondono alle specifiche esigenze turistiche. La proprietà geografica del dato (georeferenziazione) permette inoltre, una volta avvenuta la selezione, di creare percorsi di collegamento tra i siti, che ne tengano in considerazione ulteriori caratteristiche come la fruibilità o l'accessibilità

Keywords: Geographical Information System (G.I.S.), Geomorphosite, Geoturism.

Parole chiave: Sistemi Informativi Geografici (G.I.S.), Geomorfositi, Geoturismo.

1. INTRODUCTION

New research perspectives in geological and geomorphologic disciplines have led to define and evaluate forms, known in literature as Geomorphosites. They possess a relevant scientific, cultural and socio-economic value, (Brancucci & Burlando, 2000; Panizza & Piacente, 2002a; Panizza & Piacente, 2002b; Panizza, 1992; Poli, 1999). Nowadays the research of specific methods to define these sites is one of the main aims in national and international literature (D'Andrea & Di Legino, 2003; Wimbledon, 1996). In addition the application of Geographic Information System (G.I.S.) has a not well-defined role yet. In many cases the G.I.S. systems can elaborate an interactive and real-time-updatable cartography (Carton *et al*., 2003). Also some attempts have been carried on to use G.I.S. as an analytical way to fix up a methodology for weighing different attributes of the geomorphosites. At this purpose we can obtain a model to distinguish many forms on the territory (Giusti & Gonzalez-Diez, 2000). Still we can find some difficulties in transferring themes of geomorphosites from a strictly academic sphere to a one more accessible and useful for the community. Particularly, these themes can integrate with anthropic tissue, which they belong to. Therefore, to include geomorphosites in articulate and studied tourist-didactic routes seems to be a scientific and tourist relevant purpose (Massoli-Novelli, 2003). The use of G.I.S., more than every other traditional cartographical instrument, enables to manage different attributes of geomorphosites and gives back a real-time updatable, interactive and extremely flexible data.

One of the main difficulties, linked to the diffusion of geomorphosites in tourist circuits, is their sectorial nature. Until know, the interest in this subject was restricted only to geologists, naturalists, geographers, and not extended to common people. The implementation of databases inside GIS projects takes into account the necessity of turning a bigger number of visitors towards geotourist routes.

Therefore, what can be done is to determine and study geomorphosites along well known tourist routes.

The central core of DB consists of a census and subsequent evaluation of existing additional values near a geomorphosite, like museums, naturalistic paths, historic centres with festivals and popular traditions. In the paragraph dedicated to DB structure, these additional values will be described in detail.

2. GEOMORPHOSITES IN UMBRIA

Several sites of relevant geological-geomorphologic aspects can be marked in Umbria (Fig. 1): in certain cases these had an influence onto the historic and cultural local evolution of the territory (like for Assisi, Trasimeno Lake, "Mesa" of Orvieto, Mounts Sibillini area, Marmore Falls and others). Nowadays they conjugate environmental realities and territorial intrinsic bents, potential and expressed for a synthetic vision of all possible scientific and cultural aspects, constituting an important resource and/or wealth of our territory.

Determination and census of geomorphosites in Umbria and in neighbouring areas have led to the identification of nineteen sites, some of which have been exclusively selected for their geomorphologic characteristics. Others have been chosen for the peculiarity of the related cultural and historical characteristics. The "intermountain basins" phenomenon are an interesting example of geomorphosites in central Apennines and particularly in the Umbrian one. They are wide depressed areas linked to extending plio-pleistocenic tectonics, characterizing western slopes of Apennine structures. In "Gubbio basin", the depressed area of "Gualdo Tadino", "Colfiorito Plains" and "Pian Grande" there are morphologic evidences of tectonic activity (triangular facets) and of karst morphogenesis (*polije)*.

These areas gain an important morphological role, because they are identified as tectonics depressions linked to Apennines evolution. Moreover they constitute a particularly charming landscape which can be considered different seasons as a tourist point of interest, also within a gastronomic, sports-tourist approach.

Umbrian Apennine, in virtue of a massive calcareous formation, presents picturesque landscapes and characteristic phenomena of karst morphogenesis, both hypogean and epigean, and in macro and microforms. Karst polijes show several animal species and endemic vegetable associations. Even brachy-anticline of Mount Subasio with "*mortari*" (depressions with *doline* shape set along the top of the mountain) are particularly interesting for form and dimension and have an evident scenic value. Climatic conditions inside *mortari* also allow the existence of phytosociologic associations. Among hypogean karst morphotypes the complex of Mount Cucco caves represents the broadest system of central Italy, while the hypogean cavities of Mount Maggiore Abbey, developed on the inside limestone "horizons", intercalated with a flysch sequence,

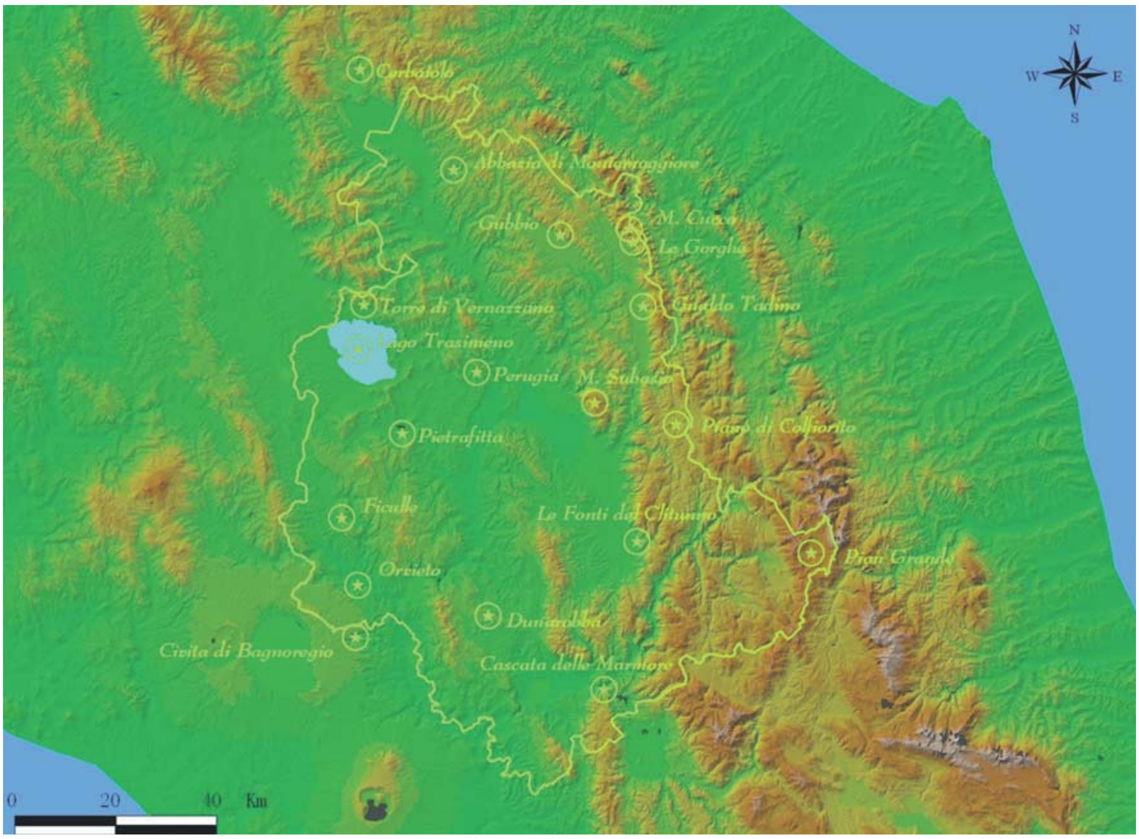


Fig. 1 - Location map.

Localizzazione dell'area di studio.

involve less known but very interesting sites, from a genetic and evolutive point of view and scientifically attention worthy as well.

In Umbria morphogenetic fluvial agent is responsible for peculiar forms as Rio Freddo gorge and for the carving of Gorghe (Fig. 2), where lithoselection phenomena permit overhang of fault gravel creating something like a “range reversal”.

These sites can be joined up in a speleological route as well as they allow an epigean hiking both along Rio Freddo “potholes” and Gorghe “wall”, where the study of geomorphologic phenomena and sport activities combine extremely well. In both cases, scientific value, extraordinary scenic impact and interesting morphogenetic processes on one hand and tourist and technical-sport use on the other, propose a very good scientific and tourist offer.

In southern Umbria there is a magnificent lithogenetic process: Marmore Falls.

The majestic waterfall, made by river Velino waters flowing into river Nera, rises artificially, thanks to a waters diversion projected and realized since Roman age. Falling processes of waters, saturated of calcium carbonate, have raised year by year a difference in level. This has happened probably already for structural reasons, increasing therefore leaving of massive travertine deposits and forming a series of karst and “pseudo karst” shapes, both of them present in travertine basin of the cliff and in the entire territory of Marmore Piano. Fruition of beauties of falls, lithogenetic processes linked to travertine deposition, “speleological” routes inside cliff caves, rafting and torrentism activities along Nera river give to this site considerable potentialities.

The Springs of Clitunno river, at the base of the village of Campello range structure, represent a peculiar site linked to interaction of fluvial processes, karts and/or tectonic, through a complex genesis and evolution of karst “*essurgenze*”. Therefore, they represent a unique landscape, extolled also by artists and poets of any age, from Plinio to Carducci.

Other geomorphosites are included in this survey because their genesis is bound to important towns, characterized by a rich cultural and historic wealth. The uniqueness of the location of some towns is due to well identifiable structural elements and morphogenetic processes whose study permits to understand for example why a city had a particular monumental and town-planning-development. Perugia historical centre, e.g., is situated on the top of the hill identified as River Tevere Paleodelta, that flowed into Tiberino Lake in plio-pleistocenic age.

Structural landforms (*mesas*) of Orvieto and Civita di Bagnoregio (Fig. 3) are the results of morphoselection phenomena which isolated ranges (volcanic tuffs) and carved the spectacular badlands near Civita.

The “dying village” of Civita represents a symbolic case of contradictory interventions to safeguard naturalistic aspects of a geomorphosite (badlands-landscape) and of its contemporary drainage work, held out of a historic centre consolidation.

Orvieto represents a spectacular example of structural cliff “lived” all along its surface and its thickness (several hollows inside the cliff were used in past times as reservoirs and cellars). In the area included between Alfina plateau and the cliff, moreover, an interesting archaeological site has been discovered, which testifies an intense human presence starting from Etruscan epoch and adds value to this site.

Fig. 2 - Gorghe Wall.
La muraglia naturale delle Gorghe.

Cerbaiolo hermitage, located on the top of a cliff involved in an important lateral spread phenomenon, or Vernazzano tower, near Trasimeno lake, leaning further to a subsidence movement, represent attractive sites for their characterizing evolutive aspects and well suitable to be put in well known tourist routes. Trasimeno lake has been included in geomorphosites list for its peculiar character of tectonic lake (the most ancient in Italy) and also for its faunistic and floristic characteristics all along its shores.

Near Ficulle/Allerona are visible particularly spectacular badlands-morphotypes, not very well-known yet, but worthy of being included in a geotouristic route, also taking into account its special character of *terroir*, giving important “wine-making” value to this zone; in these territories, in fact, the famous “muffati” wines are made and their production is linked to the local pedoclimate.

At last, in the most southern area of Umbria there

Fig. 3 - Civita di Bagnoregio: the “dyng village”.
Civita di Bagnoregio: la “città che muore”.

is the site of Dunarobba fossil forest, which is a geological and palaeontologist worldwide known site, with a high geotourist value.

The presence of several Taxodiacee tree trunks, still in their physiologic position, allows to individuate the existence of a fluvial-lacustrine pliocenic territory and a landscaping wreckage from the past.

3. THE STRUCTURE OF A G.I.S. (GEOGRAPHIC INFORMATION SYSTEM)

G.I.S. is a computer-based system for acquisition, storage, retrieval, analysis and display of spatial (locationally-defined) data. We could define geomorphosites as geographical data and we could import and analyze them like spatial objects. Every object constitutes a georeferenceable form, according to a coordinate system. In addition, their complete and detailed knowledge necessarily implies the collection of individual and characterizing attributes.

The structure of any G.I.S. instruments is representable by the formula:

$$n\ [G - A]$$

Where
n represents the number of informative layers to be implemented in a project (layers);
G is the space-geographical component used to georeference. It is referred to geometric and topologic components of the objects. It describes the shape (geometry), the location (latitude and longitude) and the spatial relantionships (topology). Topological properties of the figures do not change under bicontinuous one-to-one transformations (called homeomorphisms). Two figures that can be deformed one into the other are called homeomorphic, and are considered to be the same from the topological point of view.

The quantity A corresponds to the attributes characterizing the object. It is referred to statistical and qualitative data aspects. It describes the meaning and the magnitude of the data.

Theoretically, the variable A includes an unlimited whole of information, differing in contents and sizes (number, string, Boolean, date). The different structure indeed leaves out any correlation, and, in most cases, does not allow various layers to communicate between each other in order to effectuate spatial analysis operations. On the other hand it gives the possibility the use of traditional calculations to compare alphanumeric values. The quantity G, on the contrary, aside from the kind of object which it refers to, maintains the same construction (latitude and longitude) and it gives the possibility to exchange information between layers and the application of new spatial operators, as connection, adjacency or closeness. It is this part of a GIS structure that allows spatial analysis calculations.

The approach to the use of a G.I.S. system can be of three types: cartographic, database oriented and analytical.

In the first one, G.I.S. is only an interactive container of maps which can give back and in real time updatable cartographies. A map-oriented GIS is a display system where each input data set is a raster document and the output is always a new map. The second approach is a management system based on the amount of imported attributes (DBMS, Data Base Management System) which is considered to be the essential part of the project, and onto the operator's types applicable to analysis between different statements. The third one is based on analysis and model operations between implemented data. From this point of view, G.I.S. is a science concerning spatial information and analysis and not only a simple technology. This approach allows to realize the best from GIS potentialities.

In this research we present geomorphosites management with a database and analytical oriented G.I.S. system, in order to take advantage of the potentialities of sites for tourist purposes. The quantity G is compiled with coordinates referred to each geomorphosite, located as vector-punctual datum. The term A is articulated into a sequence of tables, whose structure is the project main element (data base oriented). These tables are linked one to another by a primary key (ID field).

The analysis is the final step of the project to find the closest facility (referring to anything providing a service like a geomorphosite, closest to a given location like hotels, roads, museums or other service areas) or to find the best route (the best way to get from one location to another or the best way to visit several locations).

4. THE PROJECT IMPLEMENTATION

Every G.I.S. project is made up of three phases: data collection, analysis and management of obtained elaborations.

4.1 Inventory application

Collection of the data is the first step to build up a project and therefore its correct evaluation is fundamental in order to obtain, at the end of the analysis processes, the desired results.

The quality of a project is not directly proportional to the quantity of imported data or to the number of effectuated analysis operations. On the contrary, the choice of initial data has to be limited to the less possible number of cartographic bases and databases required for further elaborations, also taking into account the high expenses for data acquisition. After this stage, a pre-elaboration is carried on, including eventual formats conversion, cartographic bases georeference and possible connections to pre-existing databases.

A Digital Elevation Model with pixel resolution 90x90m (Taramelli & Stark; http://geomorph.ldeo.columbia.edu/italy_srtm/2003) has been acquired in the project, covering the entire Umbrian regional territory, a topographic base, with scale 1:25.000 IGM and a road-graphs with the main regional highways.

The core of the project is constituted by a total amount of eight tables, on which the following analysis operations have been carried on.

Every table is made up of nineteen records (each record corresponds to a registered geomorphosite) and of a varying number of columns. Every record contains an ID (primary key) column, reproducing a progressive number, which is unique for each site. Thanks to this column, one can elaborate joint operations between statement data in subsequent operations. Each column field has two possible formats: a string, when it contains descriptive information related to the same column (e.g. formation type in geology) and numerical, if the information has to be quantified in order to be compared with other fields. In this case the numeric value 1 corresponds to a minimum weight of the expressed datum; 2 has a medium value and 3 a maximum one with a single score criterion based on bibliography and acquired knowledge. For those data to be inserted we have referred to the Italian National Geologic Service forms for the census of geomorphosites on national territory, introducing suitable changes considering this project aims.

Tables can be grouped in three main knots:
1) SCIENTIFIC AND IDENTIFICATIVE
2) KIND OF TOURIST INTEREST
3) USE AND VULNERABILITY

In the first group information related to localization of geomorphosites are collected, together with their soundness and scientific typology characteristics.

It includes the following tables:

A. LOCATION; with columns named:
- Toponym (string);
- Town council (string);
- Province (string);
- Region (string);
- Latitude (string);
- Longitude (string);
- Above sea-level quote expressed in meters (numerical);
- Area occupied by geomorphosites expressed in square meters (numerical);
- IGM table scale 1:25.000 (string);
- Link to eventual further additional cartographic bases (string);

B. INTEREST LEVEL, the interest level degree of each geomorphosite with columns named:
- World-wide (numerical);
- European (numerical);
- National (numerical);
- Local (numerical);

C. GEOLOGY, with columns named:
- Prevailing geological formation (string);
- Prevailing lithotype (string);
- Prevailing formation chronostratigraphic age (string);
- Shape formation age (string);

D. PROCESSES GENERATING SHAPE, with columns named:
- Tectonic (numerical);
- Gravitative (numerical);
- Fluvial (numerical);
- Volcanic (numerical);
- Karst (numerical);
- Glacial (numerical);
- Periglacial (numerical);
- Aeolian (numerical);
- Marine (numerical);
- Anthropic (numerical).

Fields have a numerical value from 1 to 3 according to the importance every process had when the form has been generated.

E. PROCESSES MODELLING SHAPE.

Fields pattern is like the one reproduced for processes generating shape.

The second group is marked with a single table, but it seems to be the most important to finalize geomorphosites from a tourist point of view, because it contains information related to better known and usual tourist interests. Numerical values, identifying for each field a minimum and a maximum value, are the results of a careful bibliographic research.

The choice of column types has been conditioned by tourist features in Umbria, but it is also possible to modify this number with different typologies for different territorial realities.

A. OTHER INTEREST, with columns named:
- Didactic (numerical);
- Cultural and artistic (numerical);
- Historical (numerical);
- Museums related (numerical);
- Hiking (numerical);
- Sport (numerical);
- Oeno-gastronomic (numerical);
- Local craftsmanship (numerical);
- Festival and local traditions (numerical).

The last group lists informations about the accessibility of each geomorphosite and about hosting facilities for tourists with different needs. Moreover, one can quantify hazard conditions to which a geomorphosite can be exposed, taking into account a future preservation of the site. Groups of data are made up of two statements:

A. USE, with columns named:
- Equipped area (numerical);
- Practicability (numerical);
- Vulnerability level (numerical).

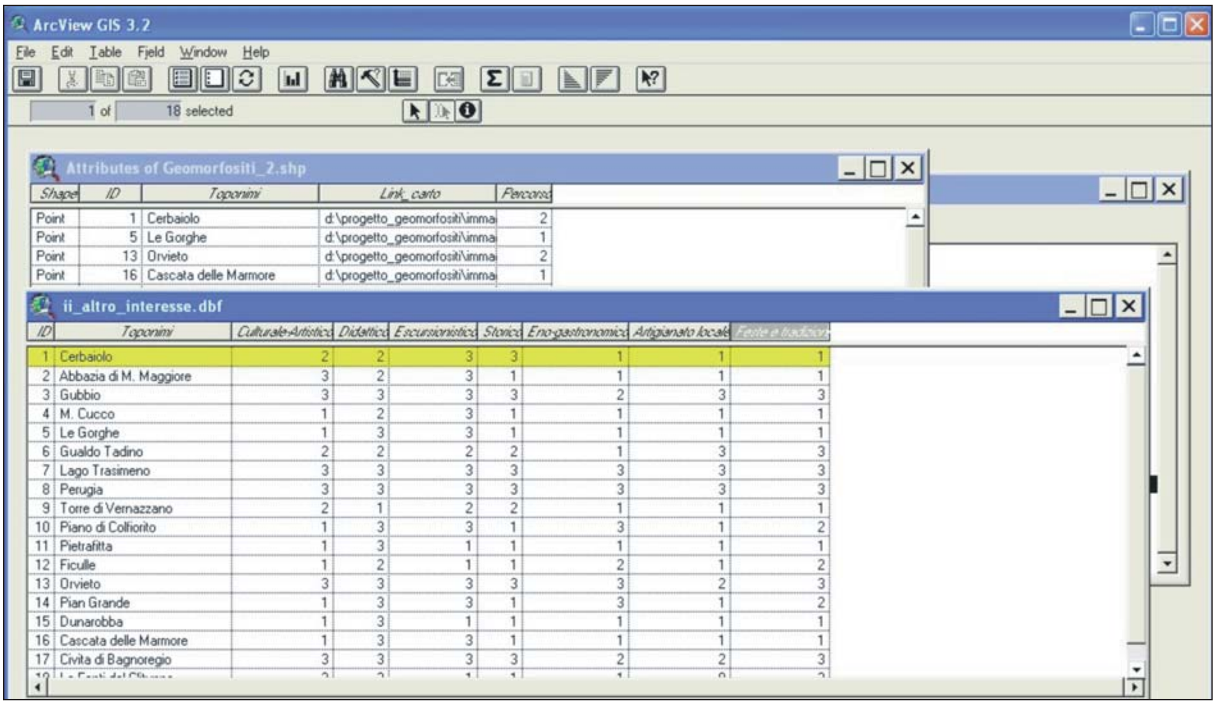
B. EXPLOITATION-PRESERVATION, with columns named:
- Preservation state (numerical);
- Risk of natural deterioration (numerical);
- Risk of anthropic deterioration (numerical);
- Protection need (numerical).

4.2 Analysis application

For this project we have used the software ESRI Arc View 3.3.

Using the column of identification codes, which are the same for each statement, it is possible to realize joint operations and queries between tables (Fig. 4 and Fig. 5).

Tables structure has the purpose of creating new and temporary tables satisfying each tourist needs. Relational DB structure is absolutely the most suitable in this way, allowing the connection of different fields through the common ID, on which one can effectuate specific queries. It is possible to question something like "Select all geomorphosites having an at least national level of interest, providing with equipped areas of a medium level and having in the closeness interesting oeno-gastronomic routes". This command is translated into simple algorithms, easy to build through specific tools of relative GIS software. Therefore it is possible to satisfy different tourist profiles. The temporary tables calculated from various queries reflects specific requirements. The tourist operators have the possibility to

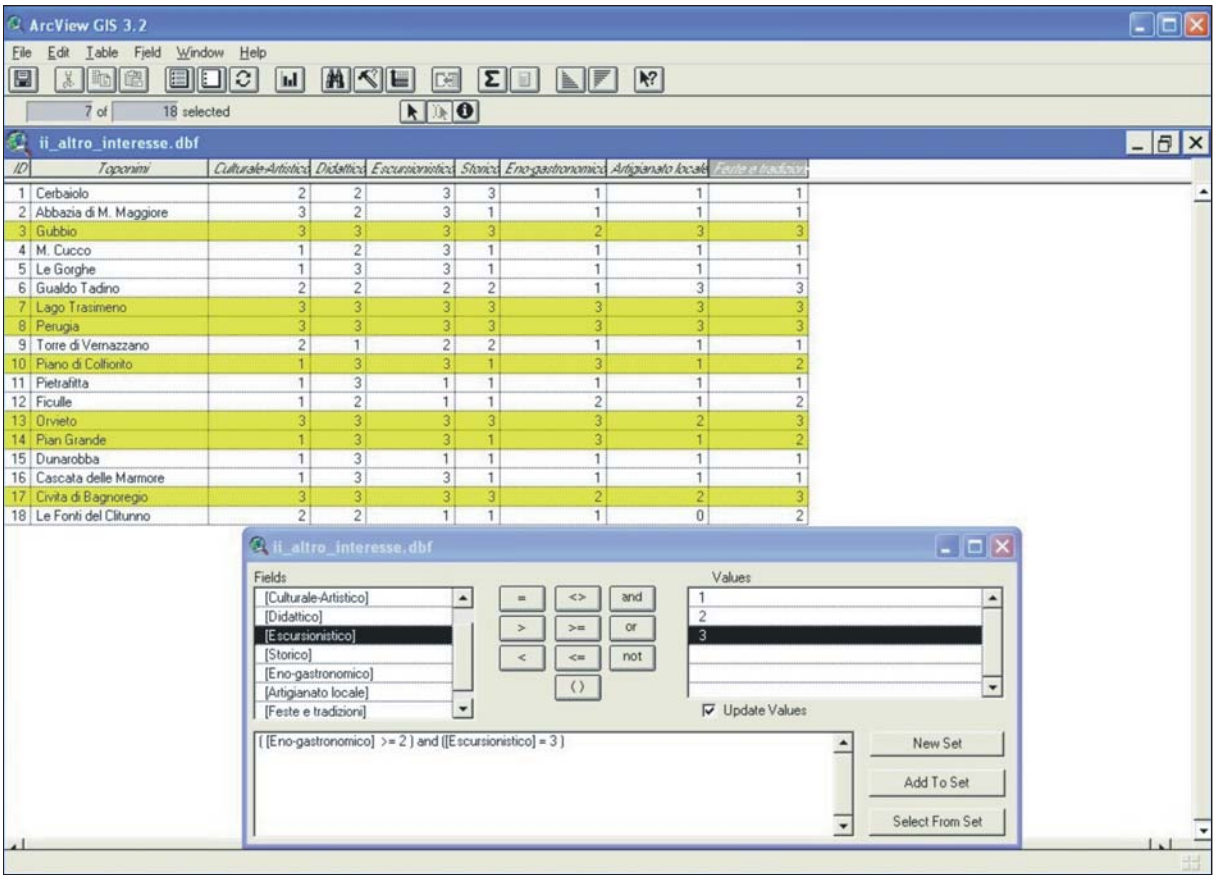


Shape	ID	Toponimi	Link_carto	Percorsi
Point	1	Cerbaiolo	d:\progetto_geomorfositi\imma	2
Point	5	Le Gorghe	d:\progetto_geomorfositi\imma	1
Point	13	Orvieto	d:\progetto_geomorfositi\imma	2
Point	16	Cascata delle Marmore	d:\progetto_geomorfositi\imma	1

ID	Toponimi	Culturale-Artistico	Didattico	Escursionistico	Storico	Eno-gastronomico	Artigianato locale	Feste e tradizioni
1	Cerbaiolo	2	2	3	3	1	1	1
2	Abbazia di M. Maggiore	3	2	3	1	1	1	1
3	Gubbio	3	3	3	3	2	3	3
4	M. Cucco	1	2	3	1	1	1	1
5	Le Gorghe	1	3	3	1	1	1	1
6	Gualdo Tadino	2	2	2	2	1	3	3
7	Lago Trasimeno	3	3	3	3	3	3	3
8	Perugia	3	3	3	3	3	3	3
9	Torre di Vernazzano	2	1	2	2	1	1	1
10	Piano di Colfiorito	1	3	3	1	3	1	2
11	Pietrafitta	1	3	1	1	1	1	1
12	Ficulle	1	2	1	1	2	1	2
13	Orvieto	3	3	3	3	3	2	3
14	Pian Grande	1	3	3	1	3	1	2
15	Dunarobba	1	3	1	1	1	1	1
16	Cascata delle Marmore	1	3	3	1	1	1	1
17	Civita di Bagnoregio	3	3	3	3	2	2	3

Fig. 4 - Example of table, reproducing different types of interests related to geomorphosites, with numerical score for each cell.

Esempio di selezione su tabella riportante i diversi interessi correlati ai geomorfositi con valori numerici in ogni cella.



ID	Toponimi	Culturale-Artistico	Didattico	Escursionistico	Storico	Eno-gastronomico	Artigianato locale	Feste e tradizioni
1	Cerbaiolo	2	2	3	3	1	1	1
2	Abbazia di M. Maggiore	3	2	3	1	1	1	1
3	Gubbio	3	3	3	3	2	3	3
4	M. Cucco	1	2	3	1	1	1	1
5	Le Gorghe	1	3	3	1	1	1	1
6	Gualdo Tadino	2	2	2	2	1	3	3
7	Lago Trasimeno	3	3	3	3	3	3	3
8	Perugia	3	3	3	3	3	3	3
9	Torre di Vernazzano	2	1	2	2	1	1	1
10	Piano di Colfiorito	1	3	3	1	3	1	2
11	Pietrafitta	1	3	1	1	1	1	1
12	Ficulle	1	2	1	1	2	1	2
13	Orvieto	3	3	3	3	3	2	3
14	Pian Grande	1	3	3	1	3	1	2
15	Dunarobba	1	3	1	1	1	1	1
16	Cascata delle Marmore	1	3	3	1	1	1	1
17	Civita di Bagnoregio	3	3	3	3	2	2	3
18	Le Fonti del Clitunno	2	2	1	1	1	0	2

Fig. 5 - Example of query to locate geomorphosites with value, related to the presence of excursion and partly eno-gastronomical routes. Yellow pointed out records represent geomorphosites satisfying this query.

Esempio di interrogazione volta all'individuazione dei geomorfositi con medio -alto valore eno-gastronomico e alto valore escursionistico. I records contrassegnati in giallo rappresentano i geomorfositi in grado di soddisfare l'interrogazione.

select only the fields linked to tourist request interests (Fig. 5). It is possible, in this way, to create temporary tables referred only to some specific geomorphosites. These geomorphosites have their specific attributes regarding scientific value and location, but above all, they have specific characteristics that satisfy the tourist interests, like cltural-artistic or oeno-gastronomic targets. It is possible to induce a larger number of tourists to visit geomorphosites if they know that they can find in the same places, traditional tourists attractions.

But operations of "selection", "connection" and "query" on statements can be developed by any program of DB management. The added value of a GIS system is, in this specific case, the capacity of positioning the obtained results on georeferenced maps (selected geomorphosites). Moreover, the importation of the project road-graphs, permits to build real routes to be inserted into tourism proposals, without forcing the visitor to follow pre-packaged and in some cases far away from his own interests trips. Network analysis tools in different GIS allow to find the best route and the closest facility to a service areas. By finding the best route it is possible to plan the visits to several locations and the related closest services. In figure 6 it is possible to observe the best routes between several geomorphosites (in blue) or the shortest road (in red).

4.3 Management system

In this phase generally thematic charts, cartograms, diagrams, graphics and statistics, and descriptive reports are produced to support decisional projects of future administrations. In the case of geomorphosites, final output aims to determine, on cartographic base (and therefore immediately receivable from tourists) sets of selected sites. Cartographic base can show several itineraries linking different sites and containing a set of additional information.

The legend enclosed in each map can be "widen" in several ways, showing information otherwise implicit on a simple paper support.

5. CONCLUSION

Geotourism is taking its first steps both in Italy and abroad. Recently cultural standard of medium tourists is increasing and therefore new realities like geosites/geomorphosites can be the object of a new interest.

Routes conjugating morphologic characters and tourist interests give the opportunity to convey a wider tourist user to geomorphosites zones. Particularly the new approach to geotourism starting from G.I.S. is founded on geographic nature of geomorphosites and contemporary on the supporting structure of G.I.S. systems, that permits to implement a project, oriented to the management of attributes of these sites. Typical operations of geographic informative systems allow, in this way, to obtain personalized destinations and routes collecting tourists' interests, and at the same time, more scientific information about the sites.

Considering the fact that G.I.S. systems are growing fast both in private and in administrative sector, that they can manage a theoretically endless number of information and can correlate new and traditional cartography, it is evident the utility of biasing the

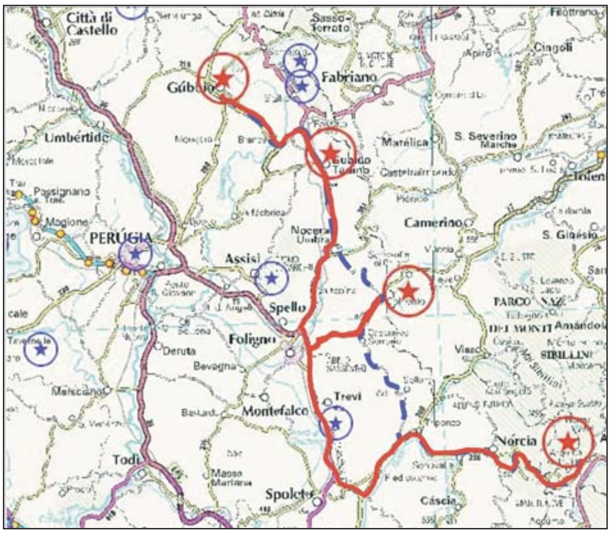


Fig. 6 - Example of a map with geomorphosites (blue targets). The geomorphosites marked with red targets are selected by a specific query (high value of hiking routes). The red line shows the best route (best accessibility) to visit all the selected geomorphosites. The blue line shows the shortest route that link the selected geomorphosites.

Esempio di cartografia riportante una serie di geomorfositi (contrassegnati da simboli in blu). I siti evidenziati in rosso sono quelli selezionati sulla base di un'interrogazione spaziale (quali sono i siti con maggior valore dell'aspetto escursionistico). La linea rossa mostra il percorso che collega i suddetti geomorfositi con strade facilmente percorribili. La linea blu, al contrario, mostra il percorso più breve tra i geomorfositi selezionati.

research towards this field.

Therefore, an increasing development of geotourism sector could boost the diffusion of knowledge within the limits of Earth Science and a planning in the distribution of tourist interest sites inside known routes and farther from traditional but still interesting tracks.

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