Landscape Approach and Gis: New Ways in Teaching Territorial Sciences

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Abstract

Landscape is the object of human perceptions: being the result of the interaction of many natural and cultural components, it conditions the evolution of environment and forms the base of spatial-temporal development of a region. Therefore, it could become a "medium" to communicate the Territorial Sciences to the entire society.
By integrating different information about the geo-morphological arrangement and the land use of a region, it is possible to reach a complete knowledge of the territory: a multi-scale Landscape approach is even more adopted in the applied research.
The divulgation of scientific heritage, using topics well known and appreciated, may represent one of the new goals for the Territorial Sciences; the GIS are able to synthesize, manage and represent a large amount of data; thanks to GIS it's almost easy to reach an evaluation of the state of the studied landscapes, referring to the dual risk/resource which characterizes our country. In Italy, one of the projects aimed at conveying a recognition of the territory is the "Map of Nature", (ISPRA) that analyses the state of the environment following a holistic and multi-scale approach.
The Landscape is also the key factor to connect core ideas of geo-enviromental sciences in a synthetic and systemic way. For that reason, from an educational viewpoint, the research focuses on the experimentation of that systemic approach in classroom. It is a perspective and effective combination developing didactic units about the landscape of the local area, adapted to the Italian contest of high school, by using IBSE (Inquiry-based Science Education) instruction. That new approach enables students to use the local territory as a laboratory, consistently with goals such as the knowledge of the place where students live in everyday life, understanding of its evolution in the space and in the time, the adoption of the right strategies for the management of the territory and making of responsible and sustainable decisions. The analysis of "shapes and materials" is carried out through direct observations, analysis of pictures, analysis of topographic and thematic maps and GIS processing.

1. Introduction

Landscape is everywhere, but it needs to be understood and recognized: maps are the most complete tools to give us a deep understanding and a clear image of the studied areas. Modern technology offers new powerful tools: the GIS are able to synthesize, manage and represent a large amount of data; thanks to GIS it's easy to reach an evaluation of the state of the studied landscapes, referring to the dual risk/resource which characterizes our country.
The study of the landscape promotes enhanced students' observation, comprehension and reasoning in the world around them. Students can seek the relationships between natural and human elements that reconstruct the history of an area. This means observing, describing, mapping and understanding the evolution in space and time, caused by the action of destructive and constructive forces.
Students struggle perceiving that the earth modifies gradually over time [1].
Geological observation and geological reasoning could promote active learning and increase students' involvement in knowledge construction. Geological thinking ("geocognition") [2], improves the development of higher-order thinking skills in the classroom.
Such aims can be achieved by active learning and inquiry-based learning [3].
Technological tools stimulate the development of new and effective procedures, while providing flexible and easy to use products, suitable to communicating science: a crucial step in educational processes.
Several articles encourage the use of mobile Geographical Information Systems and Virtual Globes [4] in the classroom. It promotes students' engagement with observation, questioning and inquiry experiences [5].
Here we have some examples of learning strategies that could encourage the development of higher-order thinking skills, through the landscape study and the use of the local territory as a laboratory. It

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makes students conscious of what geologists do.

2. Landscape Analysis and Gis

The study of the landscape is a complex process: a way to reach a complete comprehension of the landscape is performed by a holistic approach that considers and integrates all the components of the studied system. Each individual landscape, at different scales, shows distinctive elements: structural, depending on physical form and specific spatial organization; functional, depending on relationships created between biotic and abiotic elements, and dynamic, depending on the successive evolution of the structure [6].

The most comprehensive definition of landscape has been given by Forman and Godron [7]: landscape is a mosaic, a heterogeneous portion of land, consisting of a set of interacting ecosystems that is repeated in space with recognizable structure.

As told before, the concept of scale is extremely important in analysing landscape: the multi-scale approach is mandatory in this perspective; at a synthetic scale (e.g. 1:250.000 scale), physiography is the feature that best approximates the results of a landscape classification performed following a holistic approach. By integrating the geologic and physiographic components and the gathered data, it is possible to identify and describe the so called Landscape Physiographic Units, as realised by the Carta della Natura project (ISPRA; Law 394/91) that analyses the whole Italian territory (Figure 1).

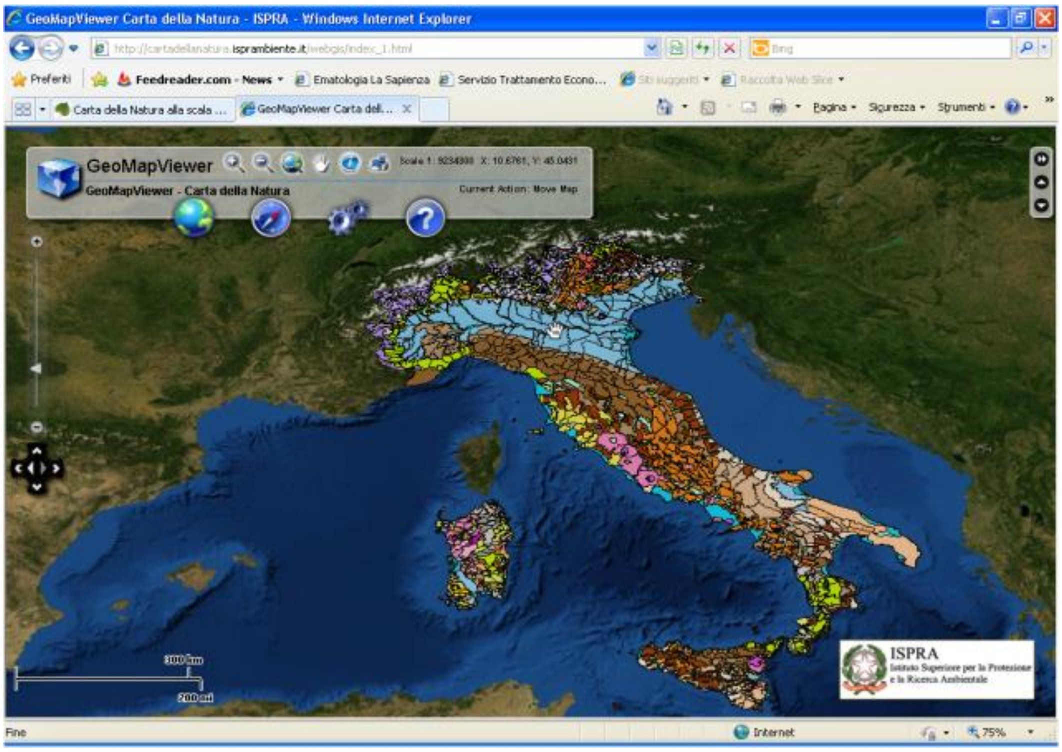

Figure 1: The Carta della Natura (Map of Nature) WebGis

Remote Sensing is the source of imagery representing a suitable data source for landscape analysis.
Briefly summarizing the protocol to produce a map such as the Landscape Physiographic Map:

• Landsat images compared evaluation
• preliminary unsupervised classification
• supervised classification
• knowledge based modelling.
• Map validation and generalization

New methodologies of analysis are developed to explore the themes and to broaden the range of research.

The potential of 3D models is widely proven, and can be further developed; among the many features of 3D, the most representative is the display of significant images: the content of information and data inherent in the model, allows the users to configure systems evolution. In the field of earth sciences, thanks to these tools it is possible to follow the changes through time of the studied portions of the planet: from the investigable past to the present, from the present to the possible future changes. The pattern of the changes over time is a powerful vector of information. As in the philosophy of GIS, 3D tool is available at different levels of detail and complexity, so it can be effective for teaching as well as for spatial planning, or in the identification and management of resources, or risks. So, 3D modelling performs an effective function in the scientific communication, playing a key role in the educational practices. It is of fundamental importance to link the modelling to reality, in order to convey the meaning of the model, not only in the spatial dimensions, but also through the diachronic one [8].

3. Landscape in Class

Student learning about maps, geologic structures, and other topics should be embedded in a realistic context rather than as a series of unrelated lessons.
From an educational viewpoint the analysis of “shapes and materials”, using the territory as a laboratory, enables students to understand its evolution in the space and time, involving geological reasoning. Students can reconstruct the most probable sequence of events that have created landscape features or rock formations by inferring past events from the present [9].
The most important goals enable students to:

- Do geological observation where they live in everyday life, exploring shapes and materials
- Do geological reasoning and gain an understanding of its evolution in the space and time, adopting the right strategies for the management of the territory and making responsible, sustainable decisions
- Not lose any aesthetic values of landscape, integrating them with other meanings (a possible multidisciplinary approach).

The study includes the analysis of shapes and materials, through

- direct observation
- the analysis of images (photos, for example): using smartphone and Google Earth for a global view
- the analysis of topographic maps or thematic
- the elaboration of a geomorphological map

In addition, using GIS, students will be able to create many new ways to manipulate these images that are not possible with the physical model.
They will be able to make direct observations and then recognize the same objects in the picture and on the map. In an integrative way they will use pictures, topographic maps, geologic maps, and rock samples from these places to reconstruct the geologic history.
The activities are constructed using a learning-cycle approach. There are various inquiry-based learning models, the most famous is the 5 E learning cycle, which was adopted here.
It comes from constructivist theories and was suggested by Rodger Bybee. The 5 E Model is an effective way to engage students in learning. “It consists of five phases: engage, explore, explain, elaborate, and evaluate. Each phase has a specific function and contributes to the teacher’s coherent instruction and to the learners’ formulation of a better understanding of scientific concepts” [10].
In each step students work collaboratively and assume an active role in the learning process.
The module for each class is composed of:
ENGAGE. The first phase includes engaging through brainstorming the concept of landscape and an analysis of technical and environmental instrumentation. The analysis and the comprehension of landforms in local territory starts from photos taken directly or researched in the literature by students. Here they formulate their questions about landforms. From that moment, the attention is focused on the Volcanos, its geomorphology and rocks; in the local context our purpose focuses on Lazio Volcano.
EXPLORE. The analysis of the landforms and the materials continues with the observation during the thematic excursion in which the local area is used as a real laboratory, examined under the guidance of an experienced geologist and using specific worksheet.
EXPLAIN. It becomes possible now to apply *geological reasoning*: crucial step in understanding the geologic history of an area requires the ability to reconstruct the sequence of events from oldest to youngest. This involves interpreting and visualizing the order of different events: students can find out differences between different types of pyroclastic deposits and lava flows. It is possible to build a simplified stratigraphic column, make inference about the depositional mechanisms, and create simplified geomorphological and geological maps using GIS (Figure 2).

ELABORATE. The work ends under the expert supervision in the classroom, the overall data is processed: it will be given a scientific meaning to the forms and to the observed outer landscape, identifying the forces that have produced the landforms. Now the geological contents (geodynamic Tyrrhenian features, geological and structural characteristics of the Lazio region, eruptive mechanisms of the Lazio Volcano) can be discussed.

EVALUATE. Eventually, students can prepare their final presentation based on their observations and inferences on the subject matter.

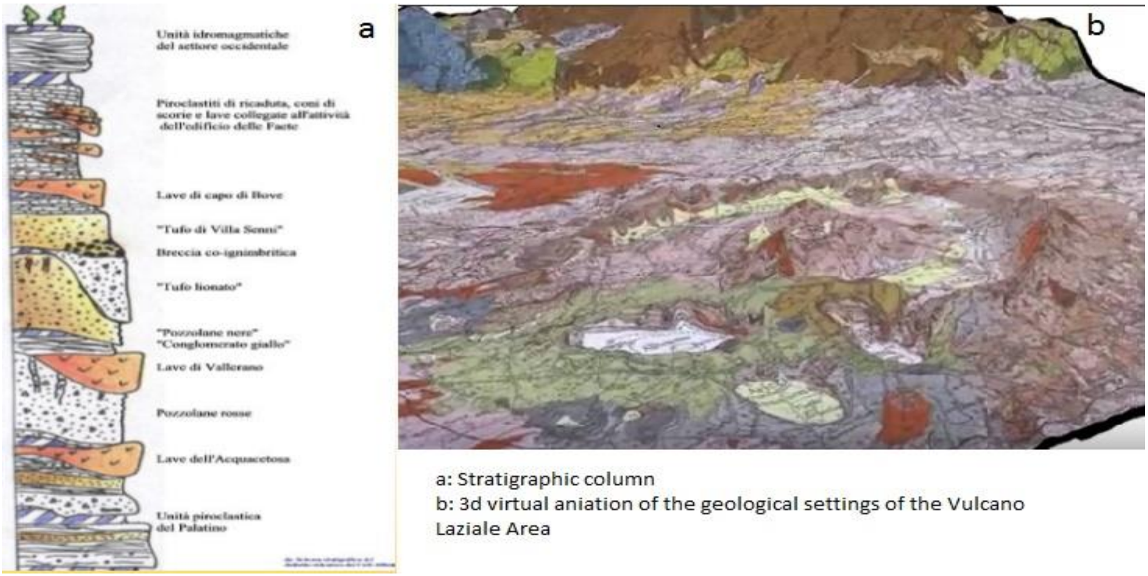

Figure 2: Vulcano Laziale Area, a: stratigraphic column; b: geological map, 3D GIS video animation, realized by Aristotele Lyceum students (Roma, Italy), within the project "A new Geography"

Methodological tools (in brackets there are tolls related to the unit about the Lazio Volcano) include:

- documenting the evidence through visual identification of geological factors and interpretation of photos and maps (topographic and geological)
- the elaboration of thematic maps (geomorphological and geological)
- the elaboration of an altitude profile
- the analysis and identification of the collected rocks samples
- the basic stratigraphic column
- the calculation of the caldera radius and rough estimate of the volume of magma erupted (in the Tuscolano-Artemisia phase)
- the comparative analysis of historical documents (the letters of Plinio il Giovane will be an interdisciplinary connection to the Latin literature through the reading of texts in Latin language), their credibility (this tool is helpful to demonstrate the validity of historical research, widely used methodology in the reconstruction of the dynamics of natural processes).

4. Conclusions

New approaches in scientific education are the focus of a desirable and necessary dynamics aimed at involving young generation in a new and active approach to science and its applications. The proposed ideas and experiences must obviously be placed in a broader and coordinated context, which provides integrating methods into the traditional school education. Moreover, the divulgation of Geosciences, using a simple as well as rigorous language, is the starting point to promote a culture of prevention against natural and anthropogenic risks.

Teaching methods must necessarily be based on cognitive processes, in order to be effective in activating a conscious knowledge, which is the base to start virtuous practices. It is necessary to launch a series of projects aimed at making the science comprehensible, opening up a spectrum of fruitful dialogues between teachers and students, as well as individuals, communities, and society. New ways in teaching sciences and new codes are just a starting point in building new bridges that connect the research world to the people.

The use of technological tools, such as the GIS, within the school activities is a representative phenomenon of a new relationship between different environments. The potential of this still must be developed, which is a new challenge for us insiders.

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