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STUDYING ENVIRONMENTAL PROBLEMATICS AND HAZARDS BY INTERACTIVE APPLICATIONS (SEPHIA)

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ABSTRACT. During recent decades the stirring up of the processes of globalization, practically in all spheres of present day civilization, has aggravated and brought numerous problems resulting from nature-society interactions. To overcome these problems, it is necessary to develop and adopt new concepts and techniques to study and evaluate the changes occurring on the earth ecosystem. For this, application of information technology via Environmental Information Systems is the best option. Much more, understanding this complexity through interactive applications will develop new strategies and ideas to manage and protect ecosystem. This paper deals with new and interactive approach to process, analysis and synthesis of environmental systems using various models and IT applications, so we could underline that environmental science and technology are therefore a vital component of productive knowledge and thus a high priority for the mankind sustainable fraternity with nature. Since years, environmental scientists and computer experts are working on different and innovative computer based modeling techniques to study the environmental problematic and hazards system and to provide the maximum accuracy in decision making or in elaborating sustainable strategies of community development. This kind of innovative techniques, some of them exemplified in the present paper (GeoGebra, AutoCAD, G.S. Surfer, ArcView GIS), can become the answer to question in those cases where the early warning, maximum accuracy in prediction and emergency is taken in account.

Key words: *Environmental Information Systems, environmental science*

INTRODUCTION

In the past century, according to the necessities at that time, the natural environment has provided to the mankind, various types of resources. The resources in question were provided in support of the rapid industrialization and urbanization. Similarly, following the same idea, as the world's population grows over time and technology implication in everyday life become more essential, human beings have progressively made greater demands on environmental resources through an unprecedented increase energy consumption, international trade and social complexity (Huang and Chang, 2003).

The actual society (information and knowledge society) in accordance with the actual changes and preocupations in the environment domain has provided various types of "informatics" resources (tools, methodologies, procedures) to manage and support the ideas and actions related to the environmental issues**.**

In this context, Informatics resources are becoming nowadays more and more important for environmental management, planning and decision-making, due to increasing need for largescale computational capability in order to handle the environmental sophisticated problematic (Avouris and Page, 1995).

To explore, for example, in an exhaustive way (exhaustive analysis) the limitation of the relation nature-society, an analysis of the environmental problematic or hazards in terms of physical, chemical, biological, geological, hydro-meteorological processes and their interactions is becoming critical, and not so extraordinary accomplished without the support offered by the environmental information systems (EISs) (Tomlinson, 1970) and environmental informatics (Avouris and Page, 1995). As we have mentioned earlier, significant efforts are required to analyze relevant observations (capta), data and information related to the environmental issues, simulate related processes, evaluate resulting impacts or scenarios and generate viable decision alternatives (Cioruţa, 2012). The system-based approaches developed in the past 3-4 decades, having as a foundation the informatics resources, have enabled us to investigate the complex interactions fundamental to the co-evolution of engineered and natural systems.

Recent advances in information technology lean towards making effective search for sustainable development strategies via integrative efforts between multi-dimensional, multi-scale data analysis and environmental system modeling (Tomlinson, 1970). This aspect can facilitate decision-makers to intimately link the knowledge with envisioned social, economic, ecological and environmental objectives, leading to a new interdisciplinary field – environmental informatics – which brings together a variety of information-technology-based measures in connection with versatile environmental monitoring networks and in association with multi-disciplinary mathematical and physical modeling skills to provide risk-informed, consensus-oriented and cost-effective solution (Gunther, 1998).

There can be mentioned a few important scientific contribution in the domain of EISs (Huang and Chang, 2003) as follows:

- traditional mathematical simulation models as useful tools for the forecasting of environmental processes;
- probabilistic method for uncertainty analysis and parameter estimation;
- numerical model for water quality simulation;
- optimization techniques which have been widely used in the field of environmental management and pollution control;
- multi-objective evaluation in environmental applications, such as solid waste management;
- integrated modeling systems with the aid of simulation, regression, and optimization analyses to design various environmental management systems for different study regimes.

Overall, it enables scientists, engineers, and managers to project consequences of management alternatives, provide planning and formulate environmental policy. In an attempt to find a balance between competing social, economic, ecological and environmental

factors in the context of sustainable development, seamless integration of information and quantitative results obtained from integrative modeling studies may exhibit the beauty of Environmental Information Systems (Checkland and Holwell, 1998).

A BRIEF REVIEW OF EI METHODS, TOOLS AND TECHNIQUES

Environmental Informatics delivers methods, techniques and tools for defining environmental problems, archiving and processing environmental data with obtaining environmental information and adequate knowledge (Cioruţa, 2012).

The advent of the IT&C systems had positively affected the availability and ease of access to large and diverse environmental databases, distributed or disseminated all over the world (Page and Hilty, 1995). On the other hand, similar progress has not been matched by the availability of models, applications and algorithms able to process these data, mostly because of the lack of standards in the annotation of the characteristics of environmental models.

Environmental informatics (EI) has been defined (Avouris and Page, 1995) as the "study and development of adequate techniques for collection, storage, retrieval and processing of complex environmental data", a definition that stands the test of time, since it is still valid after years.

Collecting, storing and retrieving environmental data is performed thanks to database techniques, while processing environmental data pertains to the field of modeling: data are used to generate information, and information to generate environmental knowledge (Cioruţa, 2012).

An EI model or application can be as simple as a database query, but it can also be a complex mathematical algorithm, solving a set of partial differential equations over a spatial and temporal domain. Thus, we see why we fail in reusing techniques for processing environmental data: databases have been intensively used and standardized over the years. Being unable to access already available models also negatively affects the ability to reuse them and to combine models across disciplines and domains, as required by sustainability studies and integrated assessments (figure 1).

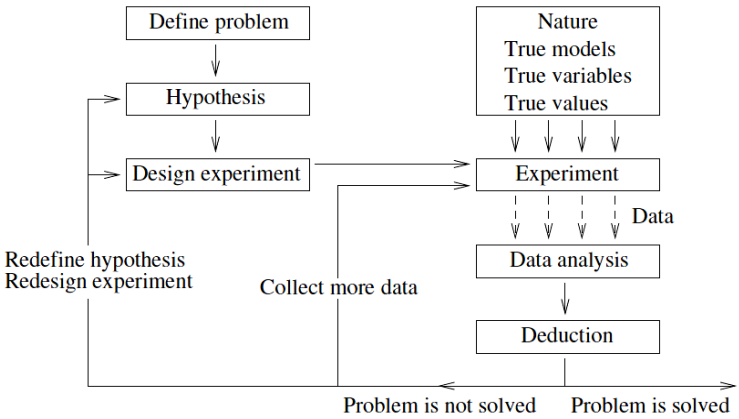

Fig. 1. *Specific steps for developing EISs and obtaining environmental information*

The techniques developed in the environmental informatics field are implemented and find their incarnation in an array of software tools, platforms and environments (Rizzoli et al., 2007). We can distinguish among (figure 2):

- data storage infrastructure software;
- data processing infrastructure software;
- environmental software development platforms and frameworks;
- end-user applications.

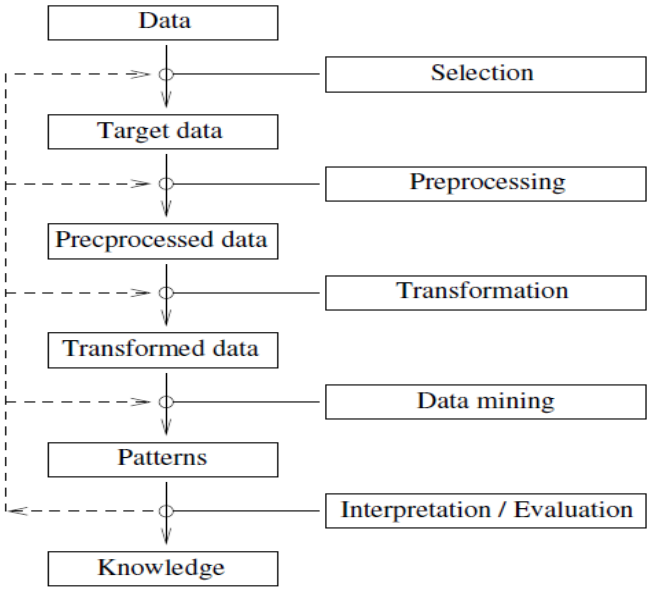

Fig. 2. *Specific steps for obtaining adequate environmental knowledge using EISs*

The main tools available in the storage infrastructure software category are *databases*. Basically environmental databases differ from non-environmental ones only for their content, because there are no major structural differences. However, there are some conceptual differences - environmental databases typically contain scientific measurements as the result of observing (monitoring) natural phenomena. Environmental data are also spatio-temporally referenced, but uncertain to some degree, as they inherit the measurement instruments' failures, biases and noise. These two points, along with the documentation of the observation process are the critical characteristics of environmental data that environmental informatics need to deal with and differentiate it with contemporary socio-economic related data management (Page, 1996).

For example, an environmental database with climate data does not simply contain time series of sensor recordings, it also needs to capture spatial-temporal references, units and dimensions of the measurements, the type and the accuracy of the sensor device, a specification on how the measurements have been taken and more others elements.

The data processing infrastructure software includes *GIS*, *expert systems* and *case-based reasoning systems*, software for *statistical analyses*, data *classification* algorithms, *simulation* tools and *optimization* algorithms; it is a very wide software class and not really a unique environmental flavor to it, but it is more the kind of application that distinguishes such software as “environmental”.

In the case according to the IT&C applications which are used to make inferences on environmental data, we could define Environmental Informatics and Environmental Information Systems by the expression "info-diversity in ecological diversity" (figure 3) (Cioruţa and Coman, 2011).

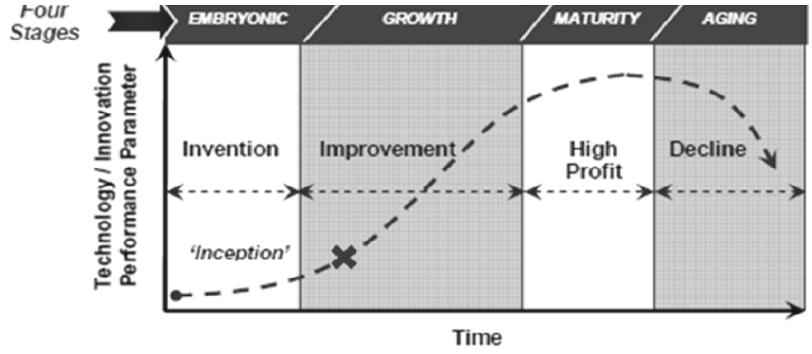

Fig. 3. *Environmental Informatics - delimited by the technology-time scale*

Environmental software development platforms and frameworks are meta-tools, analogous to integrated development environments for developing standard software applications. Some frameworks focus on specific aspects as model linking; environmental software development platforms and frameworks are used to deliver end-user applications (figure 4 and 5), providing advanced software engineering techniques to facilitate the software development process in all its stages (Cioruţa and Coman, 2011).

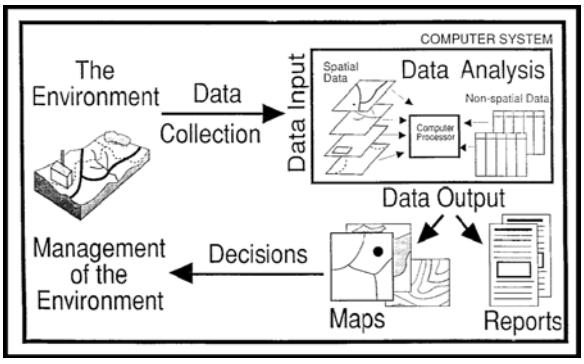

Fig. 4. *A specific way for getting information and knowledge using common environmental info-interactive applications or EISs*

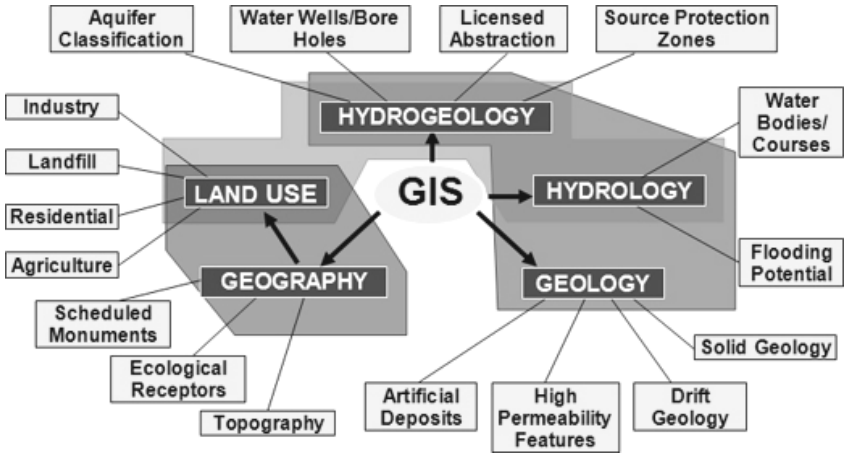

Fig. 5. *The perspective of solving different problems using GIS products*

The traditional environmental systems - models, technologies, methodologies and applications - have been challenged by the difficulties in handling dynamic and uncertain features of real-world environmental systems. Conditions for environmental management will keep changing with time, demanding periodically updated decision support. It is thus desired by users and decision makers that the research outputs be dynamic and innovative.

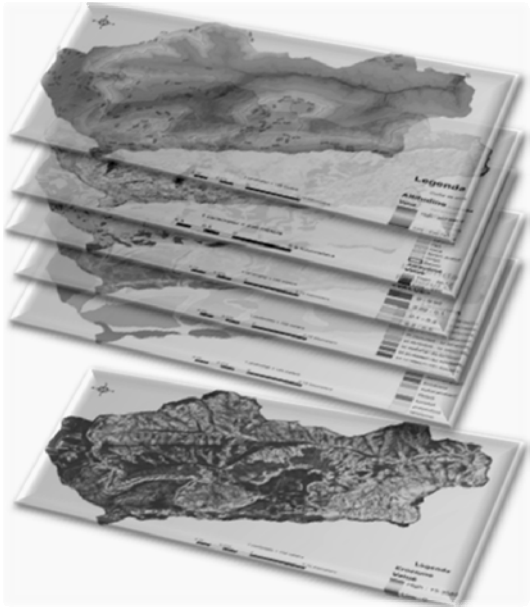

Fig. 6. *The perspective of getting multidisciplinary information and knowledge using as EISs the GIS products*

Advance in information technology area has been in extraordinarily rapid pace. There will be continuous attempt to apply new techniques and tools to environmental management; further development of high performance computing and knowledge management potential associated with artificial intelligence techniques is desired to promote long-term viability of the environmental informatics and connected applications or programs (Coman and Cioruţa, 2011).

With the recent vision we have formatted and gained from studying the multi-disciplinary area of Environmental Informatics and Environmental Information Systems, on-line real time large-scale model synthesis and data exchange for environmental engineering, research and protection will become feasible in near future in all the countries (Cioruţa, 2012).

The magnitude universe of informational activities, many forms of expression, diversity of instruments and information environment technologies have produced major changes in the way people communicate, learn, do business, solve various problems and to relate to others and the environment. This means that the provision of integrated computer software packages that allow users to input updated information into a software system, run the system and obtain updated results under the informatics environment is anticipated. Obviously, in line with this trend, more information technologies will be taken for addressing the complex environmental concerns that we cannot handle them successfully today. This must rely on fostering and nurturing a new field Environmental Informatics as a new niche in the area of environmental science and engineering.

CONCLUSIONS

Information and communications technologies have produced unprecedented changes in society in all its aspects.

Nowadays, Artificial Intelligence via interactive computational applications plays a specific and well defined role in all areas or activity domains: production, service, management, monitoring, research, public involvement in decision making, and in almost all countries (Coman and Cioruţa, 2011).

Environmental systems are based on the above considerations binding instruments in environmental science, can be defined as a collection of packet data and information, described by a series of specific indicators relevant for studying, monitoring and exhaustive exploration of the field and environmental issues. Each decade brings new challenges and new applications in environmental protection, especially SIM is involved in the activity of forecasting, selection of an alternative development to reduce the negative effects etc.

As a conclusion, it can be said that modern data analysis methods are useful tools in environmental informatics and environmental statistics. Good methods are understandable for the environmental scientists and at the same time reliable, robust and helpful for discovering important relationships in the data. In cooperation between environmental scientists and information scientists, what makes the relationship flourish is the knowledge of both sides about their field and efficient communication concerning the specific needs of a certain problem and the properties of the methods. Without these ingredients, the results of cooperation projects may not be satisfactory.

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