Environmental Information Systems

Oliver Günther
Institute of Information Systems
Humboldt University, Berlin*
guenther@wiwi.hu-berlin.de

The preservation of the environment has become an important public policy goal throughout the world. Citizens take a greater interest in the current and future state of the environment, and many adapt their ways of life accordingly. Companies are required to report on the environmental impact of their products and activities. Governments are concerned more than ever about their environmental resources and are establishing policies to control their consumption. To devise and implement such policies, administrations require detailed information about the current state of the environment and ongoing developments.

Moreover, an increasing number of governments start to recognize the right of their citizens to access the environmental information available. According to a recent directive of the European Union, for example, almost all environmental data that is stored at public agencies has to be made available to any citizen on demand [1]. As the last few years have shown, the tendency to exert this right is rising steadily. Citizens, special-interest groups and government agencies alike request up-to-date information regarding air and water quality, soil composure, etc.

As a result of these political and economic developments, there is a major demand for environmental information and appropriate tools to manage it. *Environmental information systems* are concerned with the management of data about the soil, the water, the air, and the species in the world around us. The collection and administration of such data is an essential component of any efficient environmental protection strategy. Vast amounts of data need to be available to decision makers, mostly (but not always) in some kind of condensed format. The requirements regarding the currency and accuracy of this information are high.

There are many parallels between environmental information management on the one hand and the data flow in traditional business applications and geographical information systems (GIS) on the other hand, However, environmental applications often combine several properties that are problematic from a data management point of view:

- The *amount of data* to be processed is unusually large. The amount of satellite imagery recorded per day, for example, is already in the terabyte range.
- Data management is usually highly *distributed*. Environmental data is captured, processed and stored by a broad range of government agencies and other institutions.
- The data management is extremely *heterogenous*, both in terms of hardware and software platforms. Data is organized according to a wide variety of data models, depending on the primary objectives of the particular agency in charge.
- Environmental data objects frequently have a *complex internal structure*, i.e., they consist of subobjects. These components may be complex objects in turn and may be associated with heterogenous types and media (including sound or images).
- Environmental data objects are often *spatio-temporal*, i.e., they have a location and a spatial extension, and they change over time.

*Spandauer Str. 1, 10178 Berlin, Germany. URL http://www.wiwi.hu-berlin.de/~guenther

- Environmental data is frequently *uncertain*. Techniques from statistics and from artificial intelligence have to be employed to manage this uncertainty.
- Because environmental issues cut across traditional subject areas, the processing of user queries may require *complex logical connections and joins*. Data is often used for purposes that are very different from the context the original data providers had intended.

In this special issue, several researchers and practitioners describe the design and implementation of environmental information systems that address these problems. While the required information technology is rarely domain-specific, it is important to select and combine the right tools among those that are available in principle. This requires a thorough knowledge of related developments in computer science and a good understanding of the environmental management tasks at hand.

David Abel and his co-workers at CSIRO are investigating the problem of integrating modeling systems into an environmental information system. This is an often cumbersome task, given the fact that the modeling software is usually Fortran legacy code that has evolved over many years. The approach of Abel et al. is to identify and exploit parallels to the database integration problem in federated database design.

The issue of metadata management [3] is discussed by Anthony Tomasic and Eric Simon of INRIA as well as by a German-Austrian team around Ralf Kramer of FZI Karlsruhe. While Tomasic and Simon concentrate on conceptual issues, Kramer et al. present a Web-based meta-information system that is used as a front-end to several national and state environmental information systems in Germany and Austria.

Another government-led effort is described by Wolf-Fritz Riekert, Gerlinde Wiest (both of FAW Ulm), and Roland Mayer-Föll (Baden-Württemberg Ministry of Environment and Traffic). Their contribution gives an overview of UIS, the environmental information system of the German state of Baden-Württemberg, and its recent conversion to a client/server architecture. Metadata plays a substantial role in this context as well, providing support for data location and retrieval.

James Frew and Jeff Dozier of UC Santa Barbara share some of their lessons from the Sequoia 2000 project, describing data management requirements from an earth scientist's point of view. They also present the design of a "database-centric" computing environment for earth system science. Kenn Gardels of UC Berkeley discusses the recent trend of geographic information systems to become truly open systems ("Open GIS") and its impact on environmental GIS applications.

By now, environmental information management has been recognized as an important application area of databases and information systems. Several conference series have been initiated [2, 5] and workshops on special topics are frequent (see [4, 6, 7] for some upcoming events). Technology transfer is working well, not least because there is an unusually high degree of cooperation between government agencies, research institutions, and private industry. The goal of this special issue is to make the database community at large aware of these developments and to provide some incentives to join this effort.

References

[1] Council of the European Communities. Council Directive (90/313/EEC) of 7 June 1990 on the freedom of access to information on the environment. *Off. J. European Communities*, L158:56–58, 1990.

[2] R. Denzer, G. Schimak, and D. Russell, editors. *Environmental Software Systems.* Chapman & Hall, London, 1995. URL http://cfc.crle.uoguelph.ca/isess97/.

[3] O. Günther and A. Voisard. Metadata in Geographic and Environmental Data Management. In W. Klas and A. Sheth, editors, *Managing Multimedia Data: Using Metadata to Integrate and Apply Digital Data.* McGraw Hill, 1997.

[4] *Joint Workshop on Metadata Registries.* Berkeley, California, July 1997. URL http://www.lbl.gov/~olken/EPA/Workshop/.

[5] H. Lessing and U. Lipeck, editors. *Informatik im Umweltschutz [Computer Science for Environmental Protection].* Metropolis, Marburg, Germany, 1996. URL http://www.iai.fzk.de/ui97/.

[6] *Second IEEE Metadata Conference.* Silver Spring, Maryland, September 1997. URL http://www.llnl.gov/liv_comp/metadata/md97.html.

[7] *Workshop on Meta Information and Data Integration in Environmental Management Information Systems.* Berlin, Germany, March 1997. URL http://www.wiwi.hu-berlin.de/institute/iwi/metabuis.