

Preamble

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Our environment is precious. Our quality of life depends on the optimal management of its resources. As we know nowadays, it is a very complex ecosystem, being the result of a wide set of species and elements that interact in a complex net. But the environment is fragile. It is well-known that the set of relationships between the different subsystems may be altered by human actions. These actions affect the biodiversity. Thus, government, industry and the public must act to avoid further damages. We must be capable of developing and applying an integrated approach to affront the problem(s) in the most efficient way.

But this is not easy. Ecosystems are complex and not well-known in their dynamics. Moreover, they present diverse scales (spatial and temporal). Problems arise when the quantity of available information is huge and nonuniform, coming from many different sources often characterized by great uncertainty and often their quality cannot be stated in advance.

Thus, government, industry, and the public call for integrated environmental management systems capable of supplying all parties with validated, accurate and timely information. An effective protection of our environment is largely dependent on the quality of the available information used to make an appropriated decision.

The *near real-time* constraint on the needed answer reveals two critical problems in delivering such tasks: the low quality or absence of data, and the changing conditions over a long period. Another associated issue is the dynamical nature of the problem.

Computers are central in contemporary environmental protection in tasks such as monitoring, data analysis, communication, information storage and retrieval, so it has been natural to try to integrate and enhance all these tasks with knowledge-based techniques from Artificial Intelligence [3, 2].

Application of Information and Computation Technology (ICT) to the environment is a very broad topic that covers the range from satellite observation to miniature sensors, from flood prediction to noise measurement. Due to the nature of environmental models, *i.e.* their complexity, nonlinearity, dynamics and spatially distributed nature, many of the classical methods of error analysis are difficult to apply as they require differentiable models.

Environmental problems require a new approach to decision support for two fundamental reasons:

1. It is impossible to solve the inverse problem *directly* due to the complexity of the systems.
2. It is impossible to solve decision problems unequivocally due to the complexities and changing nature of the decision making process itself [4].

With these problems in mind, important work has been made to develop Environmental Decision Support Systems (EDSSs) as a tool to improve complexity management, becoming a reference in environmental problems solution [6]. The majority of developed EDSSs are based on the traditional rule-based approach; this was a step ahead but it was not enough. Since the 1990s, agent-based approaches appear as a promising alternative. Agents are an approach to building a wide range of environmental applications (see for example [1]). Agents are autonomous problem-solving entities that are able to flexibly solve problems in complex, dynamic environments.

Agent-based approaches introduce a powerful metaphor, having the flexible autonomous action required to adapt to the changing conditions. Agent technology represents an alternative worth to be explored as there are many phenomena in environmental systems that can be characterized by interaction between agents and environment. Environmental applications require agents to be able to interact with numerous other agents in order to achieve their goals [5].

This book presents a collection of papers reflecting the interest and impact of agent technology on the definition and development of Environmental Decision Support Systems.

Outline of the Book. We have selected six papers that in our understanding illustrate the growing interest in the use of agent technology to solve complex problems in the environmental domain:

- Chapter 1. Agents as a Decision Support Tool in Environmental Processes: The State of the Art (*M. Aulinas, C. Turon & M. Sánchez-Marré*).
- Chapter 2. Deliberation Over the Safety of Industrial Wastewater Discharges into Wastewater Treatment Plants (*P. Tolchinsky, M. Aulinas, M. Poch & U. Cortés*).
- Chapter 3. OSM: A Multi-Agent System for Modeling and Monitoring the Evolution of Oil Slicks in Open Oceans (*J.M. Corchado, A. Mata & S. Rodríguez*).
- Chapter 4. Designing an Information System for the Preservation of Insular Tropical Environment in Reunion Island Integration of Databases, Knowledge Bases and Multi-Agent Systems by using Web Services (*N. Conruyt, D. Sebastien, D. Payet, Y. Geynet, D. Caron, D. Grosser & R. Courdier*).
- Chapter 5. A Methodology for Developing Environmental Information Systems with Software Agents (*I.N. Athanasiadis & P. A. Mitkas*).
- Chapter 6. Environmental-knowledge Management for Cognitive Agents (*L. Ceccaroni, A. Simón-Cuevas, A. Rosete-Suarez & M. Moreno-Espino*).

The first paper presents a state of the art of agent-based applications in environmental management. A wide revision of agent-based tools is presented showing the variety of approaches and problems considered.

Papers 2 and 3 consider two specific cases on *how* to manage discharges in the environment, e.g. technological depollution devices such as wastewater treatment plants and oil spills in open oceans. These are important and actual examples of problems in the interaction between human activities and the environment. Different reasoning approaches are used in both cases to offer a solution.

Paper 4 and 5 consider the design of agent-based environmental information systems in two very different contexts: (1) The fragile ecosystem of La Reunion Island and (2) in the Mediterranean context. Information systems have become the backbone of all kinds of organizations today. These papers are good examples of the next generation of mainstream information systems, which we might term *active computing*. Organizations dealing with the environment and its related problems need agent-based approaches, because of their rich representational capabilities that allow for more faithful and flexible treatments of complex fluxes of information.

Finally, paper 6 considers the knowledge representation problem. The authors propose the use of cognitive agents as a metaphor in the design of knowledge-based systems. In particular, they suggest the use of *Concept Maps* as a way to deal with the representation.

In order to be useful to the widest range of stakeholders involved in environmental studies and management, from researchers to policy makers, we decided that each paper should present an integral study of each considered problem. We have asked the authors for considerably extended versions of the originally selected papers, to assure durable relevance of the information presented in this book.

We are sure that the diffusion of environmental innovations is one way towards a more sustainable development. Our aim when editing this book is to present some innovative and successful approaches that use agent-based technologies that give answers to real environmental problems. The papers presented in this book show that the work made in this area leads to useful tools that improve our capacity for more optimal management of the impact of human activities on the environment.

We hope that the book serves as a tool for an audience, that includes post-graduate students, practitioners in consulting engineering, decision makers in national and international regulatory bodies and other researchers, to develop new scenarios for the future use of agent-based technologies, and therefore, indicating ways towards the collective construction of a sustainable future.

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Advanced Agent-Based Environmental Management
Systems

Cortes Garcia, U.; Poch, M. (Eds.)

2009, V, 173 p., Softcover

ISBN: 978-3-7643-8897-3

A product of Birkhäuser Basel