Chapter 17
Conflict Analysis Using Fuzzy Decision Support System: A Case Study in Apulia Region, Italy

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ABSTRACT
In the real world, environmental decision-making takes place in a highly interconnected environment, in which neither the decisional ramifications of a management action, nor the complexity of its impact, can be neglected. Thus, the role of decision support systems is changing. They are now required to facilitate the debate among the different actors, and to support knowledge and information sharing as a basis for achieving a consensus. In this work, a multi-agent system is proposed, which was developed to support the debate concerning the management of a river basin. The system, based on the sequential implementation of knowledge structuring and analysis methods, is able to support decision-makers in identifying other actors with whom to cooperate and/or negotiate in order to increase the effectiveness of management actions. Moreover, it is also designed to support the negotiation process itself and the achievement of an acceptable consensus, and to facilitate the exchange of information and knowledge, contributing to the collective learning process. The system was implemented to support the process by which a consensus was achieved concerning the reuse of treated wastewater for irrigation in the Apulia region (South Italy).

INTRODUCTION
Decision-making in water resources management is widely acknowledged in literature to be a rational process, based on appropriate information and modelling results. Traditional approaches to decision-making focus mainly on the generation and evaluation of alternatives, given a present state and a desirable state. The alternatives are considered as means by which to reduce the differences between these two states, (i.e., to transform the current system into the target configuration [Rosenhead and Mingers 2001]).
Traditional approaches consist of systematically-ordered thinking concerned with means-definition in well-structured problems in which desirable ends can be stated (Rosenhead and Mingers 2001). They assume the decision-makers are interested in using the best available information for quantitative and qualitative evaluation and for the comparison of the alternatives (McDaniels and Gregory 2004). In these conditions, the decision-makers’ role is to order the possible outcomes of a decision situation and choose the strategy according to their preferences (Timmerman and Langaas 2004) and the available information.

Our knowledge of the complexity of water system processes is increasing, together with our awareness of their uncertainty, which is mainly related to the unpredictability of the effects of water management on system dynamics. The complexity is due to the existence of strongly interconnected networks in which decision-makers have to operate. Thus, it is not possible to ignore the extreme ramifications of the decision. It becomes important to take into account the so-called “Ecology of Action” (Morin, 1994), according to which when an action is implemented, it enters a universe of interactions and feedbacks which could impede the achievement of the decision goals, or worse, could lead to unintended consequences.

Taking into account these issues, managing means interpreting and reacting to the flux of interacting events and ideas of the real world (Checkland 2001). In this perspective, there is no unique definition of the problem, but each individual has his/her own perspective in defining and interpreting a problem situation (Lane and Oliva 1998). In real situations, the most demanding and troublesome task is to define the nature of the problem, rather than its solutions (Rosenhead and Mingers 2001).

It is not be possible for any decision-maker to deal with a problem situation adopting a neutral, objective approach. His/her personality traits, experiences, knowledge and interests will affect what is noticed and what is taken to be significant (Checkland 2001). Differences in cognitive models cause communication barriers that prevent mutual learning and understanding (Kolkman et al. 2005). Thus the perspective of the single decision-maker, who is able to significantly impact the system with his/her own decisions, has to be overcome. Rather a process of debate should take place among the different actors, characterised by their interests and concerns (Guimãres Pereira et al., 2005).

As a consequence, the role of decision tools in the context of environmental decision-making processes is changing. They can play a twofold role. On the one hand, decision tools should support knowledge elicitation from different decision-makers, and make it accessible in order to inform the debate; on the other hand, they are the shared platform through which this debate is organised, and through which the different sources of knowledge that may emerge during the process are integrated (Guimãres Pereira et al., 2005). During the debate, individuals continually negotiate and re-negotiate with others their perceptions and interpretations of the real world outside themselves, leading to a social construction of the problem domain (Pahl-Wostl 2007). The quality of such decision processes is potentially greater than that of traditional approaches, since different knowledge and perspectives are taken into account and integrated.

Starting from these premises, in this work a decision support system able to facilitate the debate among different decision-makers was developed and implemented experimentally. The system was designed to support decision-makers in identifying other actors with whom cooperate and/or negotiate in order to increase the effectiveness of management actions. It is subsequently able to support the negotiation process and the achievement of a satisfactory consensus level, and to facilitate the exchange of information and knowledge contributing to collective learning during the decision process. It was decided to base the system on a sequential implementation of knowledge elicita-
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