Geophysical Research Abstracts
Vol. 14, EGU2012-821-2, 2012
EGU General Assembly 2012

Multiagent distributed watershed management

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Deregulation and democratization of water along with increasing environmental awareness are challenging integrated water resources planning and management worldwide. The traditional centralized approach to water management, as described in much of water resources literature, is often unfeasible in most of the modern social and institutional contexts. Thus it should be reconsidered from a more realistic and distributed perspective, in order to account for the presence of multiple and often independent Decision Makers (DMs) and many conflicting stakeholders. Game theory based approaches are often used to study these situations of conflict (Madani, 2010), but they are limited to a descriptive perspective.

Multiagent systems (see Wooldridge, 2009), instead, seem to be a more suitable paradigm because they naturally allow to represent a set of self-interested agents (DMs and/or stakeholders) acting in a distributed decision process at the agent level, resulting in a promising compromise alternative between the ideal centralized solution and the actual uncoordinated practices.

Casting a water management problem in a multiagent framework allows to exploit the techniques and methods that are already available in this field for solving distributed optimization problems. In particular, in Distributed Constraint Satisfaction Problems (DCSP, see Yokoo et al., 2000), each agent controls some variables according to his own utility function but has to satisfy inter-agent constraints; while in Distributed Constraint Optimization Problems (DCOP, see Modi et al., 2005), the problem is generalized by introducing a global objective function to be optimized that requires a coordination mechanism between the agents.

In this work, we apply a DCSP-DCOP based approach to model a steady state hypothetical watershed management problem (Yang et al., 2009), involving several active human agents (i.e. agents who make decisions) and reactive ecological agents (i.e. agents representing environmental interests). Different scenarios of distributed management are simulated, i.e. a situation where all the agents act independently, a situation in which a global coordination takes place and in-between solutions. The solutions are compared with the ones presented in Yang et al. (2009), aiming to present more general multiagent approaches to solve distributed management problems.

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