A MAS Decision Support Tool for Water-Right Markets (Demonstration)

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ABSTRACT

We present a MAS decision support tool, as an open and regulated virtual organization, that uses intelligent agents to manage a flexible water-right market. The application goal of this tool is to be used as a simulator to assist in decision-taking processes for policy makers. The simulator focuses on demands and, in particular, on the type of regulatory (in terms of norms selection and agents behaviour), and market mechanisms that foster an efficient use of water while also trying to prevent conflicts among parties. Technically, it contributes with a testbed to explore policy-simulation alternatives under an agreement-technology perspective, thus promoting agreements fulfillment.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

General Terms

MAS applications, decision support systems

Keywords

e-institutions, e-market, MAS simulation, agreements

1. INTRODUCTION AND GOALS

Water scarcity is a major concern in most countries due to the precarious balance in types of use, the increasing number of conflicts over water rights and the need of accurate assessment of water needs. Experts agree that more efficient uses of water may be achieved within an institutional, decentralized framework where water rights may be exchanged voluntarily to other users in exchange for some compensation, and always fulfilling some pre-established norms [5, 6].

From a hydrological perspective, related work focuses on sophisticated basin simulation models for water management, hydraulic resources and sustainable planning [1, 4, 5]. Although these works have successfully bridged the gap between the state of the art in water-resource systems and the usage by practitioners at the real-world level, the gap can still be narrowed from a social perspective. The underlying idea is to consider social aspects, such as different norms typology, human (mis)conducts, etc., which may lead to a win-win situation in a more efficient use of water. This requires the use of intelligent agent technology, including trust, cooperation, argumentation and, in general, agreement technologies.

This paper contributes with the application of a flexible water-right market, *mWater* [3], with a twofold objective. First, to deploy a virtual market to study the interplay among intelligent agents, rule enforcing and performance indicators within a decision-support tool. Second, to provide a playground for the agreement computing paradigm to easily plug in new techniques and assess their impact in the market indicators, which is very interesting.

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2. THE *MWATER* SYSTEM

mWater uses a multi-tier architecture, which relies on an electronic institution model (see Figure 1). Our institution is specified through a nested performative structure with multiple processes and five agents roles (see [2, 3] for further details). The essence of our market relies on the trading mechanisms and grievance structures. The former implements the trading process itself, which entails the participation of the buyers/sellers and staff agents. Since the agreement execution may turn conflicting with third party agents, the grievance structure is necessary to allow normative conflicts to be solved within the institution.

In the persistence tier we have designed a relational database that comprises the complete information about basins, markets and grievances. The business tier is the core of the system and allows us to embed different AI techniques (e.g. trust and data mining for participants selection, planning to navigate through the institution, collaboration and negotiation to enhance agreements and minimize conflicts, etc.) thus ranging from a simple to a very elaborate market. In order to simulate how regulations and norms modify the market behaviour and to evaluate their effects, we include a deliberative module in the staff agents to reason on regulation matters. We also provide a useful functionality for participants: a constraint programming formulation to navigate through the electronic institution and an optimization process to assist the user on the negotiation process, being able to reach the best result. The presentation tier, i.e. the *mWater* GUI, is intuitive and highly interactive. It offers an effective way for the user to configure a given simulation with the following data: (i) the starting and finishing date for the simulation; (ii) the water users that participate in the market (different types of water users lead to different results; e.g. a group in which water users do not trust other

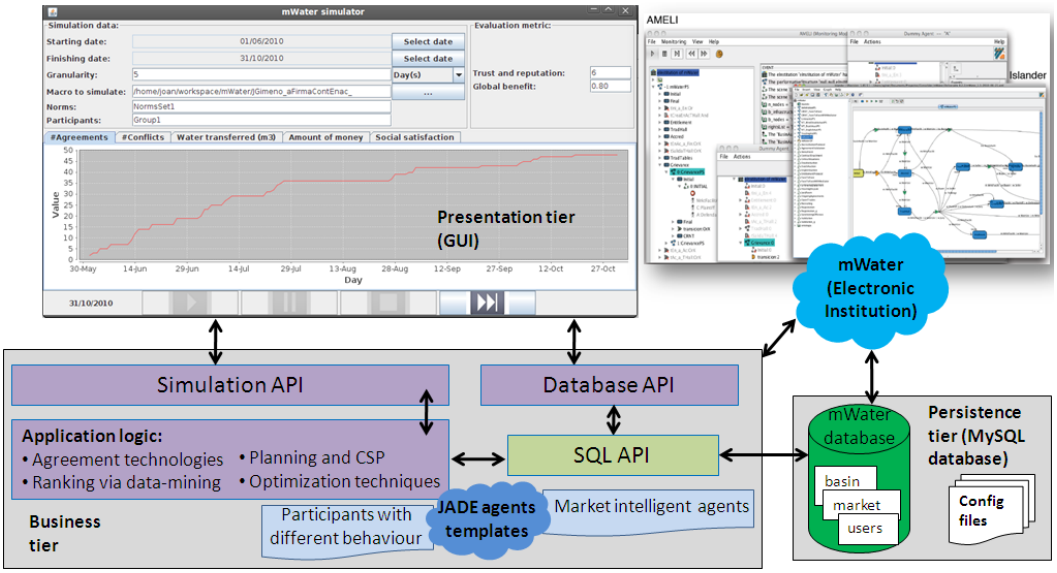

Figure 1: Multi-tier architecture of the *mWater* system and the main technologies used

members of the group results in a low number of agreements and a high number of conflicts); and (iii) the regulation to be applied in the current simulation. The GUI displays graphical statistical information, which is also recorded in the database, that indicates how the market reacts to the input data in terms of the number of transfer agreements signed in the market, volume of water transferred, number of conflicts generated, etc. Apart from these parameters, we also display different quality indicators based on "social" functions to asses values such as the trust and reputation levels of the market, or degree of water user satisfaction among others.

3. TECHNICAL DISCUSSION

As a testbed to explore techniques and technologies from the agreement computing standpoint, *mWater* provides answers to different issues:

Norms. How to model and reason on norms within the market, how the regulations evolve and how to include new dispute resolution mechanisms? Ensuring norm compliance is not always possible (or desired), so norm violation and later detection via grievances usually makes the environment more open, dynamic and realistic for taking decisions, which is closely related to the *institutional aspects*.

Organizational issues. How beneficial is the inclusion of collective roles, their collaboration (and trust theories) and how the policies for group formation affect the market behaviour?

Collective decision-making, social issues and coordination. Argumentation (rhetorical and strategic aspects), judgement aggregation (not only from the social choice perspective), reputation, prestige and multi-party negotiation are essential elements that have a relevant impact in the market performance.

Integration with other tools. As a simulator, *mWater* allows water-policy makers to easily predict and measure the suitability and accuracy of modified regulations for the overall water market, before using other operational tools for the real floor. This provides an appealing scenario to manage the water resources effectively.

Applicability to other markets. Our experiences show that this framework is generic and valid for other markets and, at this moment, scalability is not a big concern.

4. ACKNOWLEDGMENTS

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