Managing water demand as a regulated open MAS. (Work in progress)

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I. Water management as a MAS

The management of natural resources is a challenge of significant social relevance. At the core of water policy is the need to foster a more rational use of the resource and this may be addressed by creating an efficient market of water rights [4]. However the design and operation of such a market is not an easy endeavor because it needs to coexist in a complex social and legal framework.

Most water management models are based on equational descriptions of aggregate supply and demand in a water basin [2] but few include an agent-based perspective. We explore an alternative approach in which individual and collective agents are an essential component because their behavior (and effects) may be influenced by policy-making. Our focus is on water-right demand and, in particular, on the type of legal and market mechanisms that may have an incidence on that, so that water use is efficient. In particular we acknowledge the following facts: (1) that many stakeholders are involved in the market; (2) that stakeholders have different and frequently conflicting objectives; (3) that stakeholders have decision-making capabilities; (4) that there is the possibility of establishing conventions that are applicable to the actions of stakeholders, and that stakeholders are capable of complying with those conventions; (5) that these stakeholders are autonomous to comply or not, with the conventions.

With respect to demand we build on two assumptions. First, we assume that water use is granted to individual agents or to groups of individuals through *water rights* that specify the amount of water, period and type of use granted, as well as the location where that water may be extracted. Second, we assume that these rights may be traded.[1]

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[1]The Spanish Water Law and its amendments —'Real Decreto Legislativo 1/200, BOE 176' and the initiatives approved in 2001, 2004 and 2007– institute tradable water rights and the creation of "water banks" during extreme draught conditions.

In brief, we claim that one can see the use of water in a basin as a regulated open MAS and we bet on designing an agent-based market of water rights to micro-model model demand and foster efficient use.

We foresee the following potential uses for that market:

A test bed for agreement technologies. From a research perspective, our interest is on the role agreement plays in this social system, on the mechanisms that facilitate an agreement, on the management of agreements, on the normative organizational environments. Thus, we are designing a testbed to provide adequate inspiration for theoretical cogitations on agreement and for the development of the corresponding technologies [3]

A demand component of a sophisticated basin model to visualize and explore water management policies.

A prototype for an online market of water-rights.

II. *mWater*, a regulated MAS for the exchange of water rights

In this paper we only sketch a bare-bones institutional framework that regiments the market and the main ancillary activities. For the construction of that framework we follow the IIIA *Electronic Institution* (EI) conceptual model [1] where an institutional is specified through two main blocks: one that deals with ontological components (the *dialogical framework* that specifies ontology, language, roles and information model) and another for deontological components (the *performative structure* for interaction models and procedural prescriptions and *rules of behavior* for commitment-making conventions).

We should mention that our framework captures those conventions that are imposed by current legislation and become regimented in the market, but it also captures new conventions to make the market agile and contract management realistic. Thus, for instance, we keep those roles sanctioned by current legislation, but add those that make a richer market or affect conflicts. Likewise, we

keep the (totally ordered) seven types of water use, but specify a water right by a 5-tuple (location, basin district, use, volume, duration), and introduce the possibility of splitting (i.e. trading parts) and joining (i.e. trade a combination) water rights.

The procedural norms in *mWater* are specified through a nested performative structure. The top one, *mWaterPS*, describes de overall market with five active scenes and two sub-structures: *TradingTablesPS* and *Agreement-ManagementPS*. Interactions in *mWaterPS* start with an *Entitlement* process through which an individual may become a rightful holder of a water right , followed by a process of *Accreditation*, that brings that right into the market. The third scene is a Trading Hall where traders are notified of upcoming negotiations and the reaching of agreements. Actual negotiations take place in the scenes that belong to *TradingTablesPS* and once an agreement on transfering a water right has been reached it is "managed" according to the market conventions captured in *AgreementManagementPS*. Two final scenes take care of the (permanent) annulment and (temporary) suspension of rights. The *TradingTablesPS* includes a scene schema for each trading mechanism. Currently, a right-holder may opt for a standard double auction or a closed bid or face-to-face negotiation but other mechanisms may be added as needed. *AgreementManagementPS* works roughly as follows: First of all, when an agreement is reached, mWater staff checks if the agreement satisfies some formal conditions and if so, a transfer contract is signed. When a contract is active, other right-holders and external stakeholders may initiate a grievance procedure that impact the transfer agreement. *AgreementManagementPS* includes different scenes to address such grievances or for the disputes that may arise among co-signers. If things proceed smoothly, the right subsists until maturity.

III. RESEARCH OPPORTUNITIES

mWater allows us to envision the following research opportunities:

Organizational models that are dynamic and flexible enough to specify evolving regulated market scenarios. Because water's unique characteristics, *mWater* requires organization structures that restrict the way agreements are reached by fixing the social structure of the participating entities, the capabilities of their roles and the relationships among them (e.g. power, authority).

Reasoning about normative regulation and social norms for negotiation and execution of agreements and contracts. On and off-line, from an individual agent's perspective and from the market design perspective. Dynamics of norms and norm adoption.

Techniques for flexible on-demand individual and collective negotiation among humans or non-human actors (i.e., agents and services). It is often the case that a water right holder is motivated to achieve a goal (buy or sell a right) that is only possible by gaining the collaboration of others (i.e., a federation of water right holders), then it is required to generate an explicit mutually acceptable agreement through negotiation and to define detailed workflows that regulate the activities and combinations of roles in the organization as well as their associated data flow. *mWater* also requires models and techniques for judgement aggregation, argumentation, persuasion, normative reasoning and agreement planning.

Models for agreement conceptualization and patterns specification, e-Contracting. Relations among different agreements (sub-agreements), for example a situation in which in order to get a water right transfer a buyer requires to contract a transportation resource from other users.

Techniques for initiation, coordination, and supervision of different forms of agreement, contracts and grievances. Even when water right agreements or contracts are signed, the behavior of the participating entities might not be completely determined as their autonomy and selfishness might cause them not to honour their commitments if there is a potential gain in doing so. Online Dispute Resolution environments.

An approach to summarize the life-cycle of agreements in order to build long-term relationships between the water rights market participants.

IV. ACKNOWLEGEMENT

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