Supporting participative decision process in water management

Irene Pluchinotta[*], Raffaele Giordano[**], Alexis Tsoukiàs[*]

Abstract

Water management is an important public policy issue. It faces high level of conflicts, complexity and uncertainty. There is an increasing interest in enhancing multi-agent decision-making processes to overtake binding mercantile business. The development of dynamic decision-aiding tools and the analysis of interactions architectures are fundamental premises for a successful debate in water governance. These issues are faced by concepts such as Ostrom's action arena and Ostanello-Tsoukiàs' interaction space. The current paper reflects on the interaction space to support collective decision processes and develops a system dynamics model exploring how policies can influence the architecture of interactions in the agricultural water management of the Apulia Region (Southern Italy).

Keywords

Interactions space, Water management, Supporting collective decision-making, Participation, System dynamics.

[*] LAMSADE-CNRS, Université Paris Dauphine, Paris, France
[**] Water Research Institute (IRSA), CNR, Bari, Italy

The need of participation in water management

Water management (WM) faces numerous problems such as the disparity of interests of multiple decision-makers and the complex networks of governance and distribution. The balance between the allocation of a limited resource and its preservation is a central issue in public policy. The management of a limited and shared resource is a complex challenge (Ostrom, 2005), and as such it often introduces conflicts, especially under scarcity conditions (e.g. UNESCO, 2002; FAO, 2012). Drought leads to a radicalization of negative conditions, exasperates the occurring interactions and increases imbalance between water demand and water availability. As a common-pool resource linked to basic human needs and geographically highly distributed, water is used by several competing actors and owned by no one. Besides, when agents are completely independent from each other, interacting solely by the fact that they use the same resource, the standard problems of overexploitation and free-riding arise. WM requires tools to support the detection, analysis and reduction of conflicts among different users and uses (Giordano *et al.*, 2007), through a not binding mercantile business. In this context, this paper assumes that water market as the only way to allocate water could lead to inequalities, to exhaustion and to abuse (Ostrom *et al.*, 2012). The above-mentioned issues generate the need to enhance decision practises within a participatory framework. Two decades of research into the management of common-pool resources suggests that, under particular conditions, local communities can manage shared resources sustainably and successfully (Hess and Ostrom, 2003). These findings are considered revolutionary, in that they were able to challenge the long-held belief in the Hardin's *tragedy of the commons* (1968). According to Ostrom (2012), the tragedy is not inevitable when a shared resource

is at stake, if communities interact and operate in a collective way avoiding the market rules constraints. As a result, the role of decision tools in this context is changing, since it is widely recognised that there should be no single decision-maker, but rather a process of debate among different agents (Guimarães Pereira *et al.*, 2005). Decision tools should be capable of capturing the decision-making as it is, not as it should be, focusing on the limited cognitive capabilities of human agents (the Simon's bounded rationality, 1956). Consequently, there is an increasing interest in supporting multi-stakeholders decisions in WM.

Interaction spaces

Multi-stakeholders decision aiding focuses on providing an analyst with methodological support that allow to facilitate groups to structure and exchange views. Existing structures such as action arenas (Ostrom, 1986) and interaction spaces (Ostanello and Tsoukiàs, 1993) allow studying how the establishment of local regulations, may help escaping from market regulations in the case of commons goods and facilitating agents interactions. Action arena is defined as "the social space where individuals interact, exchange goods and services, solve problems, dominate one another, or fight". The key idea of Ostrom is to understand a society as a structure of nested action situations and involved participants (Pahl-Wostl *et al.*, 2002). The Ostanello and Tsoukiàs' interaction space (IS) is a descriptive model that could support participative decision-process. IS is "a formal or informal structure that is governed by a number of rules and is aimed at providing a field of interaction to a finite set of actors" (Daniell *et al.*, 2010). The concept of IS has been introduced in order to represent an abstract meeting structure, a collaborative space, where a meta-object is

identified as the articulation of the participants' problem representations. Such a formal model, IS can provide a useful basis for understanding the dynamics of multiple stakeholders decision processes, providing a conceptual framework for a suitable evolution of the IS, improving transparency and participation. A detailed description can be found in Ostanello and Tsoukiàs (1993).

Agricultural water management in the Apulia Region

Starting from these premises, a methodology capable to analyse the IS and to support policy analysis in a participatory WM has been developed using a system dynamic model (SDM). Briefly, the construction of the model starts with the identification of involved agents with their resources, objects and attributes. The consecutive steps involve the definition of interactions and interdependencies between these elements (adapted from Ostanello and Tsoukiàs, 1993). Finally, snapshots of the ISare simulated using the SDM. The simulated behaviours are based on field observations and on the stakeholders' participation. Considering a brief overview, the SDM has been applied to analyse the interactions between multiple decision-makers concerned by the groundwater (GW) management and protection, as well as between them and the physical and economic elements. Within the case study, the stakeholders are Farmers, the Water Manager and the Regional Authority. The Water Manager has to deal with the water scarcity and with the water request from each Farmer. Farmers have to share the same resource. Each Farmer chooses the right cropping plan in order to maximize her/his profits. Farmers' decisions also concern the selection of the water source, i.e. GW or water provided by the Manager. Due to economic drivers, they mainly choose the GW. The GW

overexploitation brings about social and environmental problems and the Regional Authority needs to protect GW quality. The SDM is aimed to represent the existing situation, understanding the system macro behaviour through its internal decision sub-models. The SDM allows observing the evolution of the interactions among the agents. The SDM demonstrated how the decisions taken by each agent referring exclusively to her/his own individual understanding of the IS provoked unexpected reactions, leading the system towards an unsustainable evolution. Scenarios with different policies have been simulated. For the aim of this paper, it is important to underline that, in the business-as-usual scenario, the involved agents are interested in different configurations of the IS: some agents have passive behaviour, as their goal is not linked to a particular IS snapshot. The actions of the active agents influence the involvement and the decision process of the others. In conclusions, the analysis of the IS evolution is needed in order to make the agents aware of the role played by each other and their interdependencies. This improved understanding is the *sine qua non* condition to support participatory decision, aiming to identify creative solutions.

Conclusion

The WM system is a set of physical and abstract networks where decision-agents operate and many interactions take place between individual and collective agents, either directly or via the environment and the use of the resource. Neglecting the WM complexity could hamper the ability to manage the system itself. In this paper, challenges in WM have led to the discussion on the developed method for enhancing the understanding of interactions in multi-stakeholders decision-making processes, for an improved

management of a common resource. In our case study, the SDM was used as a platform for modelling interactions and interdependencies between multiple decision-makers, in order to support participatory decisions. The SDM was used also to identify the neglected interactions, in order to combine hydrological, socioeconomic and behavioural determinants of water use. The research effort is not aimed at providing the optimal solution for water allocation. Instead, the goal is to show to the decision-makers the possible consequences of their actions choice, according to different criteria: economic drives, vision disparities, water savings. The results of this work could be used as a starting point for future research activities dealing with the complexity of WM and policy design.

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