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A System Dynamic Analysis approach to deal with complexity in water resources management: the case of groundwater protection in the Apulia region (Southern Italy)

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The increasing complexity and uncertainty of water resources management is claiming changes in the role of tools and methods aiming to support decision makers. Complexity due to the densely interconnected networks in which decision-actors operate. Uncertainty arises because of the fact that whatever action other decision agents involved in the network are going to do is largely unknown. In these complex and uncertain environments, it is very difficult to determine how effective a policy will be. Part of the difficulty resides in the fact that any action choice will influence and be influenced by the actions choices of the other actors. While these interactions among a diversity of actors may contribute to the development of beneficial adaptive behaviours, they can also result in dysfunctional dynamics, often leading to policy resistance. Action choices are not neutral, but commensurate with the problem frames held by the actors making the decisions. Our research hypothesis is that neglecting differences in problem framings leads decision makers to oversimplify the complexity of the interactions within the system to be managed, and to act as if the system is as simple as the decision makers presume it to be. Therefore, decision tools and methodologies should support the decision makers to become aware of the complexity of the interaction space, to disclose and analyse the existing interconnections, and to govern those interactions. In these circumstances, decision makers could take advantage from the interactional nature of the knowledge creation process.

In order to demonstrate the research hypothesis, a methodology based on System Dynamic Modelling (SDM) was implemented in the Apulia Region (Southern Italy) to support the implementation of the groundwater (GW) protection policy. Due to the increasing of GW withdrawal for irrigation purposes, several phenomena are drastically reducing the quality of the GW resources. In order to protect the quality of GW, the regional water authority proposed the enforcement of restrictive measures in the use of GW. The new legislation caused strong conflicts between farmers, the regional authority and the irrigation consortium due to the expected economic impacts. Due to this conflicting situation, the GW Protection policy has not been implemented yet.

This work aims to identify and analyse the main causes of the policy resistance mechanisms and to suggest potential improvements aiming to facilitate the policy implementation. To this aim, a SDM was developed as an ecology of interacting agents. The three main decision makers were involved in the model development phase. Their problem frames were elicited and structured in sub-models within the SDM. The model was then used to simulate different GW management scenarios and to analyse the interactions among the different decision makers. The SDM was particularly useful to disclose the hidden interactions, that is, the interactions provoked by differences in problem framing and ignored by the decision makers. The SDM simulation demonstrated that these interactions are at the basis of policy resistance mechanisms hampering the implementation of the GW protection policy. Based on the results of the SDM, actions to deactivate those mechanisms were identified and discussed by the decision makers.