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Evaluating acceptability of groundwater protection measures under different agricultural policies

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ABSTRACT

Water resources management is often characterized by conflicts in many arid and semi-arid regions, where agriculture is the main user of groundwater (GW). Conflicts could arise among different decision-makers and stakeholders. Moreover, different policies can interact each other hampering or facilitating their implementation and effectiveness. This contribution describes a new implementation of GeSAP, an integrated modelling tool for enabling local GW management by combining the need for GW protection with socio-economic and behavioural determinants of GW use. GeSAP is based on the involvement of multiple stakeholders and the use of Bayesian Belief Networks (BBN) to simulate and explore their attitude relative to GW exploitation and their responses to the introduction of new protection and agricultural policies. In this work, GeSAP was implemented in the area of the Capitanata Irrigation Users Organization, located in the Apulia region (southern Italy). It was used to simulate the reactions of the main stakeholders involved in GW protection policy implementation and to assess the policy's effectiveness in terms of actual reduction of GW exploitation. Furthermore, the interactions between the GW protection policy and the coming reform of the Common Agricultural Policy (CAP) was investigated. The results of the application proved the capability of the GeSAP tool to assess the actual effectiveness of GW protection policy by investigating how far this policy could be considered acceptable by farmers. In addition, this study demonstrates how the effectiveness of the GW protection policy could be affected by the interaction with the CAP reform. The latter could strongly impact the balance between water demand and availability with the effect of nullifying the positive synergy between CAP and GW protection policy. Although water management issues are not explicitly mentioned among the main scopes of the CAP, this work clearly demonstrates the impact that such policy could have on farmers' decisions on water use.

1. Introduction

Groundwater (GW) resources are of strategic importance in Mediterranean countries, to support not only the needs of increasingly large urban areas but also agricultural and tourism activities. These needs are often in conflict with the characteristics of these aquifers, which are highly susceptible to overexploitation and natural/anthropic changes (COST, 2003; Polemio et al., 2009). Several phenomena are negatively affecting the GW quality, e.g. seawater intrusion in the coastal areas, and particularly in karst aquifers (Polemio et al., 2010), and point and non-point sources of pollution due to anthropic activities. The overexploitation of GW causes depletion of aquifer reserves, degradation of GW quality, lowering of the piezometric levels, and alterations in groundwater-dependent ecosystems (Voudouris et al., 2010; Pereira et al., 2009).

The increasing intensification of irrigated agriculture, and the consequent increase of water demand, is contributing to the rapid deterioration of the GW quality. In fact, as stated by many authors (Al-Senafy and Abraham, 2004; Ambast et al., 2006; Martinez-Santos and Martinez-Alfaro, 2010; Van Camp et al., 2010) in semi-arid regions, as surface waters are scarce, groundwater is heavily used by farmers to supply irrigation systems. Due to the crucial role that GW plays in supporting agricultural development, implementing policies aiming to find the right balance between

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GW protection objectives and agricultural productivity is of utmost importance (Pereira et al., 2009).

According to Ostrom (2005), GW is characterized by subtractability and excludability that makes GW protection with respect to the livelihoods of people difficult. GW is subtractable because it has a limited capacity, and the consumption of GW by one user subtracts from the GW volume available to the others. Excludability means that preventing water users from pumping water from the aquifer is quite difficult. Different attempts are mentioned in scientific literature aiming to facilitate GW protection implementation. Mukherji and Shah (2005) emphasize the role played by the continuous flow of information and knowledge concerning both the hydrogeological characteristics and socio-economic properties, and involving scientists, managers and GW users. Knűppe and Pahl-Wostl (2011) showed how the lack of vertical integration among different administrative authorities and the poor involvement of stakeholders from different levels in management decisions tend to promote conflicts, leading to difficulties in the implementation of GW protection efforts. The analysis carried out by de Loe and Kreutzwiser, (2005) in Ontario demonstrated that GW protection is not hampered by the lack of novel and innovative solutions, but rather by the existence of implementation gaps. According to their experiences, those gaps can be filled in by enhancing the technical, financial, institutional and social capacities at local level. This requires a strong interaction between the higher administrative levels, the scientific community and the local communities. Other scholars suggest the implementation of consensus support methodologies to reduce the risk of conflict (e.g. Stefanopoulos et al., 2014; Giordano et al., 2010)

Most of the policies implemented in the Mediterranean basin aim to improve the efficiency of GW use in agriculture through innovative irrigation techniques or to restrict the GW use for industries and urban demand as well through improved control of exploitation activities. However, evidence suggests that many times those policies largely failed to achieve a sustainable use of GW (Giordano et al., 2013; Portoghese et al., 2013a,b). Several scholars have argued that these failures are mostly due to an over simplification, or in some cases even the neglect, of the uncertainty and complexity associated with the water management systems (Knűppe and Pahl-Wostl, 2011; Borowski and Hare, 2007). Complexity is due to the densely interconnected networks in which decision-agents operate. The increasing uncertainty is caused by the limited knowledge of what the other decision-agents involved in the network are going to do. This makes difficult to predict whether decision-makers' choices pay off or not (Rosenhead and Mingers, 2001).

The action choices of decision agents influences and is influenced by the actions choices of the others (Brock and Durlauf, 2001). Interactions and feedbacks among a diversity of actions may also provoke unexpected, and sometime undesirable, reactions leading to policy resistance, that is, the tendency for the intervention to be delayed, diluted, or defeated by the response of the system to the intervention itself (Sterman, 2000; Sendzimir et al., 2007). Policies are not implemented in a vacuum. They rather enter in a universe of interactions among decision actors and involving actions. As an effect, decision makers have to cope with the emergence of actions, events and behaviours that they could not anticipate because of their limited understanding of the whole system, and that could strongly influence the effectiveness of their GW management policies (Giordano et al., 2013).

Starting from these premises, a GIS-based decision support system was developed in order to identify the interactions among decision agents interested/involved in GW management, and to investigate how those interactions could affect the effectiveness of GW protection policies. The GeSAP (*Gestione Sostenibile degli Acquiferi Pugliesi*) tool is a decision support system implemented in GIS and based on Bayesian Belief Network (BBN) and hydrological system features. This tool is able to elaborate and analyse different scenarios concerning the pressure on GW due to anthropic activities and the effectiveness of protection policies, taking into account the degree of acceptability due to water users' behaviour. Two main modules compose the GeSAP tool. The GIS-based module, aimed at storing and analysing climatic data, landuse, and aquifer characteristics. The second module aimed at simulating the decision-making processes of the main decision agents involved in GW management and use. The mental models at the basis of their decision-making process were elicited and structured in BBN, as described in Section 2.1. The selection of the decision-agents whose mental models were incorporated in the tool depended on the issue to be addressed. The GeSAP tool was firstly implemented to evaluate the effectiveness of GW protection policy enforced by the Apulia Region (Southern Italy). Considering that this policy was aiming to reduce the GW exploitation for irrigation purposes, the GeSAP tool incorporated the mental models of decision-agents involved in water irrigation management. The results are described in Giordano et al. (2013), and Portoghese et al. (2013a).

In this work, the GeSAP tool was used to identify potential synergies and/or conflicts between the GW protection policy and the Common Agricultural Policy (CAP) reform implementation (European Commission, 2011a,b).

In the past, the CAP has been a key driver of farming practices that in many cases caused excessive pressures and impacts on water quality and quantity status, especially when payments were coupled with the production of water intensive crops.

However, beyond any assertion of principle and the progress made, the CAP has so far offered poor instruments and few opportunities to pursue the objectives of preservation of water resources both in quality and quantity (Dworak et al., 2007). Although the new programming phase of the rural development policy, 2014–2020, strongly pushes towards integration and synergy between different sector policies, the need still remains to have policies specifically targeted to the protection of natural resources. Water quality and quantity issues were covered by specific provisions of CAP but effectiveness of integration and policies coherence between water and agricultural policies still need to be assessed (European Commission, 2012).

Water demand management is not a major concern of the CAP and CAP impacts on water quantity and quality issues appear to be limited and only assessable on regional and catchment basis (Scardigno and Viaggi, 2007). However, CAP provisions can still affect farmers' behaviour on water use by reinforcing or conflicting with the water protection policies (Giannoccaro and Berbel, 2011; Kampas et al., 2012). Significant reforms have been made in recent years to modernize the sector, to make it more market-oriented and to integrate environmental concerns into the agricultural policies. On 26 June 2013, the political agreement reached between the Commission, the European Parliament and the Council, gave a new direction to the common agricultural policy. The new CAP 2014–2020 will establish direct payments to farmers fairer and greener, will strength the position of farmers within the food production chain, in order to be more efficient and transparent.

By setting new principles and rules to establish level and distribution of subsidies between regions and farm types, the newly CAP reform will heavily affect the economic result of farms and influence the farmers' decisions concerning the use of water for irrigation, and, thus, the effectiveness of water policy measures adopted.

This study aims to identify potential synergies and/or conflicts between the GW protection policy and the newly implemented CAP. This contribution tries to address the following research questions: to which extent decision-makers involved in GW management are aware of the impacts of their decisions on other