



# Policy instruments for decentralized management of agricultural groundwater abstraction: A participatory evaluation



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## ABSTRACT

This paper proposes and analyzes three policy instruments which can be used to enhance farmers' compliance with individual water allocations in a decentralized management context. Three regulation strategies are proposed for the case of groundwater allocations for irrigation: the first relies on economic instruments; the second is based on tools designed to promote pro-social behaviors; and the third combines assumptions from the first two approaches. They are evaluated through 16 scenario workshops involving 124 stakeholders and farmers in five French groundwater basins. Stakeholders' perceptions are analyzed, disentangling the ethical, economic, institutional, social and technical perspectives underlying the stakeholders' arguments for or against the proposed instruments for groundwater-use regulation. The analysis reveals a preference for the strategy that combines economic and social incentives.

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## 1. Introduction

Groundwater resources are increasingly being over-exploited worldwide, owing to demographic growth, rising demand for agricultural products, technological progress in irrigated agriculture and the flexibility that groundwater use provides (Giordano and Villholth, 2007; Llamas and Martinez-Santos, 2005). Although intensive groundwater exploitation supported the development of a flourishing agricultural economy (Kuper et al., in press; Shah, 2008), it also generated significant negative impacts such as declining water tables, reduction of in-stream flows, the drying-up of springs, wetlands deterioration, land subsidence and seawater intrusion (Llamas and Martinez-Santos, 2005; Schlager, 2006; Shah et al., 2003). Groundwater-management policies have been progressively developed to mitigate these impacts through a better control of groundwater abstraction. This requires shifting from an open-access regime to one of regulated abstraction. The total volume of water that can be abstracted is first 'capped': an overall water allocation is defined based on hydrogeological studies which estimate a sustainable yield, defined as the maximum level of abstraction that can be maintained over the long term without generating any significant ecological impact on the aquifer and its dependent ecosystems. This global allocation is then shared among a limited number

of authorized water users. Individual users receive a specific volume that must not be exceeded, and which, depending on the national legal and regulatory framework, is associated with a license, a concession or a use right. Such groundwater-management policies have already been implemented in a number of countries including several western states of the USA (Blomquist et al., 2004; Schlager, 2006), Australia (Ross and Martinez-Santos, 2009), Spain (Garrido et al., 2005), and Chile (Hearne and Donoso, 2005) to mention only a few. More recently, similar policies have been advocated in European countries, in particular France (Figureau et al., 2012) and the UK (DEFRA, 2013).

The main challenge faced by water managers during this transition process consists of designing and implementing policy instruments which are likely to achieve the targeted objectives in an ever-changing economic, climatic and hydrological environment. Because farmers are confronted by market and climate fluctuations, as well as unforeseen technical, environmental, personal and financial events, their demand is likely to vary from year to year, sometimes exceeding, sometimes falling below their individual allocations. The manager then needs to ensure that the sum of individual water uses remains within the limits of the total volume allocated to farmers (global allocation), i.e., that the excesses of some be offset by the moderation of others (overall compliance). The introduction of some flexibility into the allocation system is expected to yield economic benefits, as long as overall compliance is achieved.

To reach this double objective – flexibility and overall compliance – many countries have progressively abandoned the traditional

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command-and-control approach in favor of the devolution of responsibilities to Groundwater Users Associations (GWUA). The assumption underlying this evolution is that GWUAs can adapt general institutional rules to the local context, thereby increasing their technical and economic relevance as well as their social acceptability. This particularly applies to allocation rules: policy instruments aiming at increasing flexibility and ensuring overall compliance are likely to be more efficient if they are designed to accommodate specific features of the local context.

In this decentralized context, GWUAs can use a variety of policy instruments, including economic instruments and institutional arrangements. Typical economic instruments include negative incentives such as pricing, taxes, and penalties, or positive ones such as subsidies or payments. Scholars have proposed other theoretical instruments such as an ambient tax (Giordana, 2007), differentiated ambient tax (Lenouvel et al., 2011) or combined tax-and-rebate systems (Swierzbinski, 1994). Nevertheless, case studies from various parts of the world also report successful common resource regulations relying on institutional arrangements rather than economic instruments (Aoki, 2006; Lopez-Gunn, 2003; Ostrom, 1990; Ross and Martinez-Santos, 2009; Van Steenberg, 2006). A significant number of studies in experimental economics have demonstrated the effectiveness of policy instruments relying on other levers than financial motivations to reach sustainable resource management (Bochet et al., 2006; Cardenas, 2011; d'Adda, 2011; Moreno-Sánchez and Maldonado, 2010; Murphy and Cardenas, 2004; Travers et al., 2011; Velez et al., 2010; Zafar, 2011). Such tools seek to promote communication between agents, to increase the transparency of agents' behaviors, and to facilitate internal agreements. Their objective is to reinforce trust, accountability, reputation effects and adherence to social norms.

Most of existing studies evaluating such instruments are based on quantitative approaches (such as experimental economics and field experiments) to measure the effectiveness of various instruments and to test implementation variants. They however do not help understanding contextual environmental, socio-economic and cultural factors which determined the observed behaviors. The qualitative approach presented in this paper aims at offering a better and deeper understanding of these factors. This knowledge gained may then help designing instruments which are better adapted to the local context, thus more likely to be accepted and implemented by agents (Rinaudo et al., 2012). The proposed approach is thus considered as complementary rather than competing with field experiments which involve real agents such as farmers, forest users, and fishermen (Cardenas, 2011; d'Adda, 2011; Moreno-Sánchez and Maldonado, 2010; Travers et al., 2011; Velez et al., 2010).

This paper presents an empirical assessment of contrasted regulation strategies using groups of stakeholders and farmers in five French groundwater basins. The main objective is to identify factors which could facilitate or act as barriers to the implementation of theoretically efficient policy instruments in a context of decentralized groundwater management. The remainder of this paper is organized as follows. Section 2 describes three contrasted regulation strategies which could be implemented to simultaneously increase water allocation flexibility and ensure overall compliance, in a fluctuating economic and climatic context. Section 3 presents the workshop methodology used for discussing these strategies, and case studies in which it has been applied. The main findings are presented in Section 4, highlighting factors which determine the effectiveness, social acceptability and practical feasibility of the three strategies. Section 5 concludes by summarizing the findings, discussing the advantages and limits of the participatory evaluation method used in this study.

## 2. Three Regulation Strategies for Managing Groundwater-based Abstraction for Irrigation

Three contrasted policy approaches are proposed and discussed in this paper: the first relies entirely on economic instruments; the second is based on tools designed to promote pro-social behaviors; and the

third combines various assumptions from the first two approaches. These three strategies were then used as the basis for constructing policy scenarios, which were debated with stakeholders.

### 2.1. Coupling Economic Incentives

The first strategy discussed in this paper assumes that the most efficient way to influence individual behavior consists of changing the economic incentives through interventions which alter the costs and benefits of certain targeted actions. The underlying assumption is that individuals respond by adapting their decisions to maximize their individual pay-offs. Following scholars like Rapoport and Au (2001) and Sefton et al. (2007), we propose to combine the use of a penalty with a reward. The penalty consists of a tax charged to farmers who exceed their allocation and is proportional to the over-pumping; it aims to discourage free-riding (excess pumping). The revenues from this penalty system are then redistributed among farmers who withdraw less than their entitlement, each one receiving a share proportional to their water saving. The reward encourages voluntary contributions to the public good (reduced abstraction). This combination is expected to lead to an optimal level of individual contribution (Sefton et al., 2007). Rewards are funded by revenues from penalties as suggested by Rapoport and Au (2001). The system is expected to meet both the flexibility objective (since farmers may exceed their allocation by paying the tax) and the overall compliance objective. By design, the amount of reward is not known in advance, since it depends on the choice of all other farmers. This uncertainty does not prevent farmers from taking sound decisions based on a comparison of the expected utility associated to different strategic choices. Given farmers' heterogeneity in terms of production functions, risk aversion and capacity to anticipate strategic behaviors, all farmers will not take the same decision in a similar context. If the analyst has perfect information on users, he can theoretically calculate the exact level of penalty that will ensure budget and water equilibrium. In practice, the level of penalty would probably be adjusted by trial and errors.

### 2.2. Promoting Pro-social Behaviors

An abundant literature, mainly drawing upon experimental economics, has shown the limitations of incentive-based approaches. It recognizes that individual behaviors are often influenced by non-economic motives, including adherence to social norms, ethical commitment, altruism, reciprocity and inequity aversion (d'Adda, 2011; Fehr and Gächter, 2000; Masclot et al., 2003; Moreno-Sánchez and Maldonado, 2010; Rapoport and Au, 2001; Sefton et al., 2007; Travers et al., 2011). Such social preferences can be enhanced by policies designed to strengthen reputation effects, fairness, accountability, trust or moral inclusion.

The second strategy considered in this paper fundamentally seeks to exploit social preferences to promote pro-social behaviors, so as to meet the objectives of flexibility and overall compliance. The overarching objective is to “empower public-spirited motives” rather than only selfish preferences (Bowles, 2008) and to enhance social norms that can promote cooperative behaviors (Vatn, 2009). This strategy relies on two main pillars. The first consists of developing cooperation among farmers through reinforcing values such as reciprocity, solidarity and moral inclusion. The underlying assumption is that, each year, some farmers are likely to accept to relinquish part of their individual water allocation to help other farmers confronted by unusual situations. The volume they give back is made available to the GWUA, which in turn redistributes it to farmers who have an exceptional need for extra water. The internal redistribution follows general principles and rules which have been validated by the farm community; their practical implementation can however be modified each year to take into account specific events (climate extremes, market situation, pest attack, etc.). The GWUA acts as an interface between the giving and the receiving farmers, who do

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