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# 1 **Envisioning innovative groundwater regulation policies through scenario** 2 **workshops in France and Portugal**

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8

## 9 **Abstract**

10 *Groundwater management policies will need to be revised in many Mediterranean countries, in light*  
11 *of the impact of climate change and the increasing demand for water. In this paper, we analyze*  
12 *stakeholder perceptions of three groundwater policy scenarios which respectively assume a*  
13 *strengthening of state intervention, the introduction of market regulation mechanisms, and the*  
14 *transfer of regulation responsibility to farmers. The method consists of organizing scenario workshops*  
15 *with experts, institutional representatives, and farmers. It is applied in two case studies in France and*  
16 *Portugal. From a methodological viewpoint, the research demonstrates the farmers' ability to*  
17 *contribute to an exploratory assessment of possible future water management scenarios. From a*  
18 *policy viewpoint it clarifies expectations concerning State intervention and self-regulation by farmers.*  
19 *It also provides some insights regarding the acceptability of tradable groundwater permits in two*  
20 *European contexts.*

21

22

1 **Keywords**

2 Climate change; groundwater management; water markets; self-regulation; France; Portugal;  
3 scenario workshops.

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11

1 Envisioning innovative groundwater regulation policies through scenario  
2 workshops in France and Portugal

3

4 INTRODUCTION

5 Over the last several decades, groundwater abstraction has increased considerably in northern  
6 Mediterranean countries (EASAC 2010) and even more in southern Mediterranean countries.  
7 Government agencies have not paid much attention to this ‘silent revolution’ (Llamas and Garrido  
8 2007), and groundwater development has thus taken place in an institutional setting that placed no  
9 or few limits on groundwater use (Schlager 2007). As a result, it is only after several decades, and  
10 investments made by thousands of farmers, that the consequences of these overdrafts, e.g., sea  
11 water intrusion, have started to appear, conflicts are escalating, and that establishing new rules for  
12 governing access to groundwater is seen as an absolute necessity.

13 In France and Portugal, the two countries considered in this paper, controlling groundwater  
14 abstraction is becoming an significant water policy issue. To comply with the requirements of the  
15 European Union Water Framework Directive, water authorities now have to develop a program of  
16 actions leading to the “good quantitative status” of all groundwater bodies. One of the first actions  
17 implemented has consisted of estimating the maximum inter-annual average volume that can be  
18 pumped from a number of critical groundwater basins characterized by a risk of over-exploitation. In  
19 parallel, specific efforts are made to complete the registration of all existing boreholes, including  
20 illegal ones. The next step for groundwater policy development will consist of developing and  
21 implementing new rules for sharing a limited quantity of water among economic sectors, and  
22 between users within each sector. Long-term climate change prospects will need to be considered

1 while crafting such new rules for governing groundwater allocation, as they will probably have to be  
2 enforced in a context of increased water scarcity (García-Ruiz et al. 2011).

3 For agricultural water users and their institutional representatives, the development and  
4 implementation of rules regulating access to and use of groundwater will be perceived as a paradigm  
5 shift, since most of them still consider groundwater to be an open-access good. To enhance the  
6 adequacy of regulations, as regards equity but also acceptability, and to reduce future  
7 implementation and enforcement problems, the stakeholders and users should be involved in the  
8 development of such regulations (Ostrom 1990). Their participation is essential because the policy  
9 options considered represent drastic changes that will call into question established institutions,  
10 societal values, and dominant ideologies and beliefs. Moreover, the practical (lay) knowledge of the  
11 stakeholders is essential for crafting rules that can work effectively in the context of local, technical,  
12 environmental, institutional, socio-economic, and more generally cultural constraints (Rinaudo and  
13 Garin 2005). There are very few 'off-the-shelf' groundwater regulation models that could be  
14 imported from other countries without significant adaptation to the local context. This adaptation  
15 may require a lot of creativity which is likely to be enhanced by the confrontation of multiple visions  
16 of existing constraints and possible futures.

17 This paper aims to contribute to the scientific literature which explores how to craft rules for  
18 regulating groundwater usage. It is based on two concrete case studies conducted in France and  
19 Portugal, where a similar methodology was used. This consisted of organizing workshops with a  
20 group of institutional stakeholders, i.e., local administration representatives, economic actors, NGO's  
21 staff, and scientific experts, and several groups of farmers, during which three contrasted  
22 groundwater regulation scenarios were scrutinized and debated. The paper describes both the  
23 visions that emerged from the workshops and the social learning process that took place during the  
24 workshops.

1 The remainder of this paper is organized as follows. The next section presents the participatory  
2 foresight methodology used in this study, and the two case studies - France and Portugal - where it  
3 was applied. The second section describes the three groundwater regulation policy scenarios which  
4 were constructed and debated in the workshops by the French and Portuguese farmers and  
5 institutional stakeholders. The third section shows how these scenarios were perceived by the  
6 workshops' participants, and the lessons learnt for policy making. The last section evaluates the  
7 methodology and provides some policy recommendations.

## 8 METHODOLOGY AND CASE STUDIES

### 9 *Unfolding the future in three steps*

10 The common methodology implemented in the French and Portuguese case studies was inspired by  
11 the emerging literature on scenario planning and participatory foresight for water resources  
12 management (see for instance van der Helm 2003, and Hatzilacou, Kallis et al. 2007). Foresight is  
13 defined here as a multi-disciplinary approach whose goal is to help decision-makers explore the  
14 uncertainty associated with future developments, and to assess the consequences of the various  
15 strategic choices available. The approach here consisted of exploring a limited number of scenarios,  
16 each of which describes a possible future institutional set-up for groundwater regulation. The aim  
17 here is "to illuminate the choices of the present in the light of possible futures" (Godet and Roubelat  
18 1996), rather than to make predictions.

19 A group of institutional stakeholders and several groups of farmers were invited to participate in  
20 three series of workshops. In order to enhance the envisioning capacity of the participants, we  
21 adopted a sequential approach to future exploration. The first sequence was devoted to the analysis  
22 of past trends and the exploration of the future evolution of agricultural production in the case study

1 area, at the 2030 time horizon<sup>1</sup>. Discussions focussed on agricultural system dynamics, water being  
2 considered only as a factor of production. This sequence aimed at developing temporal awareness. It  
3 also helped to reveal the common goals and shared assumptions of the participants, contributed to  
4 forging a team spirit, and generated confidence (among the participants, and with the researchers).  
5 Water-management-related issues were not specifically debated and nothing in the scenarios  
6 discussed in this first phase challenged the established water-management paradigm.

7 The second sequence introduced a major uncertainty with the prospect of climate change. The  
8 impacts of climate change on the hydrological cycle were described in detail, using the results of  
9 research conducted in the case-study areas. Climate change forecasts introduce an anomaly that  
10 challenges the prevailing mind-set and forces participants to imagine a different future in terms of  
11 farming practices and water management. In this second sequence, we asked the participants to  
12 focus on changes that might occur at the farm level (cropping and irrigation practices) while issues  
13 related to water resource management in the river basins were postponed to the third sequence.

14 The third and last sequence was devoted to envisioning possible future groundwater regulation  
15 mechanisms, under three alternative models based on (i) strengthened administrative regulation, (ii)  
16 market-based regulation, and (iii) self-regulation by the farming community. In this sequence,  
17 participants were asked to build on the results of the first two sequences. The objective was to  
18 mobilize their analytical and creative capacities and to overcome the limitations imposed by the  
19 currently established institutional framework, and also by received values, beliefs, and expectations,  
20 when thinking about the future. The present paper focuses on this last sequence; the results of the  
21 two others are described elsewhere (Maton et al. 2010, Rinaudo et al. forthcoming). The following  
22 paragraphs describe how the groups were established and the workshops organized.

23

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<sup>1</sup> The analyses of past trends and of the current situation were carried out through interviews in France and through interviews and a preliminary workshop in Portugal. The exploration of the future development of agriculture was undertaken in a specific workshop during the two case studies.

1 *Constitution of the group, and workshop organization*

2 Although the scenario-workshop method usually involves the mixing of policy makers, business  
3 representatives, experts, and citizens (Street 1997, Andersen and Jaeger 1999, Lienert et al. 2006,  
4 Hatzilacou et al. 2007), we decided to set up separate groups for various public – institutional  
5 representatives and experts on the one hand, and farmers on the other hand. We also opted for  
6 smaller groups (five to fifteen persons) in contrast to the scenario groups described in the literature,  
7 where each workshop comprises between 25 and 40 persons (Andersen and Jaeger 1999, Hatzilacou  
8 et al. 2007, Patel et al. 2007). This methodological choice was adopted to overcome the mistrust  
9 which characterizes relationships between farmers and public-sector experts.

10 To facilitate the debates, three contrasted, predefined future water management scenarios were  
11 used as material to initiate the debates. Scenario narratives were written by researchers in advance  
12 of the workshops, because we assumed that we would not have sufficient time to make trend-  
13 breaking scenarios emerge during the 4-5 hour scenario workshops. Each scenario consisted of a  
14 narrative describing groundwater management rules in 2030-2040 (see next section for a detailed  
15 presentation of the scenarios). The narratives used in Portugal and France were consistent, although  
16 adapted to the specific regional contexts. The three scenarios were clearly identified as starting  
17 points for discussion, which participants should deconstruct, criticize, and adapt according to their  
18 views. The workshops were tape-recorded to allow detailed analysis of the views expressed by  
19 participants.

20 In France, discussions of the scenarios took place during workshops held over a half-day period in the  
21 evening (6 to 11 PM), including a meal for the farmers. The workshops were organized as follows.  
22 After a brief presentation of the workshop's objectives, the groundwater-management scenarios  
23 were successively presented, using posters as support. After each presentation, the participants were  
24 invited to comment individually during a round-table session before discussing any conflicting points



1 of view. After all the scenarios had been discussed, the participants were invited to prepare  
2 individual rankings of the three scenarios according to their probability and desirability. Comparison  
3 of these pictures of the probable and desirable futures gave rise to a final group discussion.

4 A similar approach was implemented in the Portuguese case study. Prior to debating the scenarios,  
5 the research team presented the current administrative framework of water management. Then a  
6 reference scenario was presented followed by three separate presentations of the alternative  
7 groundwater-regulation scenarios, and each was discussed first in small groups and then in a round-  
8 table format. The issues of probability and desirability for each of these three scenarios were also  
9 discussed. Whereas the farmers were invited to a workshop, the experts and institutional  
10 stakeholders were met individually in face-to-face interviews. In both case studies, a final meeting  
11 was then organized with farmers and institutional stakeholders together.

12 A key feature of our approach is that, since the workshops were organized in a research context, the  
13 aim was to encourage the expression of various pictures of the future, and to facilitate the mutual  
14 discovery of differing points of view concerning the future development of agriculture, and the  
15 associated irrigation-water demand and water-management frameworks. The posture adopted by  
16 the team was thus exploratory and not normative.

17 The key features of the two case studies are presented in the following table and in subsequent  
18 sections.

	<b>Roussillon (France)</b> <sup>2</sup>	<b>Querença-Silves (Portugal)</b> <sup>3</sup>
Geography and climate	Coastal plain (700 km <sup>2</sup> ). Rainfall= 570 mm/year Mediterranean climate	Most important groundwater reservoir in the Portuguese Algarve region (317,85 km <sup>2</sup> ) Rainfall= 653 mm/year Mediterranean climate
Water resources	2 coastal aquifers: (a) Pliocene confined aquifer (abstraction= 41 Mm <sup>3</sup> /year) and (b) Quaternary shallow alluvial aquifer (abstraction= 43 Mm <sup>3</sup> /year) Large reservoirs supply water to gravity irrigation canals (agriculture)	Aquifer built of karstified limestones and dolomites. Total abstraction = 21,4 hm <sup>3</sup> /year. Large reservoirs supplying water to public water utilities (drinking water use) Multimunicipal public water supply system managed by the regional Water Utility Águas do Algarve
Groundwater uses	Drinking water (52 M m <sup>3</sup> /year) including tourism Agriculture: 15,000 irrigated ha, 4, 500 boreholes, abstraction of 23 M m <sup>3</sup> /year Industry (4 M m <sup>3</sup> /year)	Agriculture: 6816 irrigated ha (from a total area of 32 000 ha), 1784 wells, 30 hm <sup>3</sup> /year (average) Drinking water : 10 hm <sup>3</sup> / year Several data coexist and detailed data still is being constructed by ARHA and experts of the University of Algarve.
Threats to groundwater	Risk of seawater intrusion (locally observed). Declining groundwater table in confined aquifer	Risk of brackish water intrusion from the estuary into the karst aquifer

1 **Table 1:** Main features of the two case study areas.

2

3 *French case studies*

4 In France, the Roussillon groundwater basin was selected for implementing the methodology  
5 described above. Located in southern France, and covering an area of 700 km<sup>2</sup>, the Roussillon is  
6 characterized by one of the driest climates in France (average precipitation of 570 mm). The  
7 presence of relatively abundant surface and underground water resources has enabled the  
8 development of irrigation farming (about 15,000 ha irrigated), which produces mainly vegetables  
9 (tomatoes, cucumbers, potatoes, and artichokes) and fruit (peaches, nectarines, and apricots). About  
10 11,000 ha are irrigated by open gravity channels which draw their water from three rivers, two of

<sup>2</sup> Source : Montginoul and Rinaudo, 2009.

<sup>3</sup> Source : adapted from Stigter. et al. (2009) and Relatório PGBH Informação de suporte (2011).

1 which are controlled by dams. The remainder of the irrigated area relies on an estimated 4,500  
2 individual boreholes, only a few dozen of them being officially registered and equipped with the  
3 metering devices required by law.

4 Over the last decade, groundwater-management matters have become particularly fraught, for a  
5 number of reasons. First, the doubling of the population between 1954 and 2007, and the  
6 development of tourism along the coast have created a substantial increase in drinking-water  
7 demands. These needs have been met by increasing withdrawals of groundwater, leading to a  
8 lowering of the water tables and temporary restrictions on the use of boreholes, especially for  
9 agriculture during periods of drought. Long-term predictions of climate change suggest that tensions  
10 over water resources are likely to become only more severe. According to the work of the Vulcain  
11 Project, irrigation-water needs will increase (Rinaudo et al. forthcoming) and river flows are expected  
12 to fall by about 20% to 40% by 2030 (Caballero and al. submitted) resulting in increased pressure on  
13 groundwater resources.

14 This evolution is taking place in a context of changing groundwater governance. Historically, access to  
15 groundwater use has been loosely regulated in France, which has resulted in a widespread  
16 perception that groundwater is an open-access good (Barraque 2004). This situation is currently  
17 changing, with the progressive implementation the Water Framework Directive and the subsequent  
18 2006 Water Law. This law requires that a Maximum Permissible Annual Volume (MPAV) be defined  
19 for each aquifer at risk of overexploitation, and that pumping authorizations be allocated in light of  
20 this constraint. Although the law and its implementing regulations do not specify how this overall  
21 quota has to be shared among users, it certainly represents a first step towards a more regulated  
22 water-allocation mechanism. In this context, local stakeholders and government agencies have  
23 recently initiated a Groundwater Management Plan for the Roussillon aquifers. Hydrogeological  
24 studies are currently been conducted to determine the maximum annual permissible volume (MAPV)  
25 that can be pumped from the aquifer. Stakeholders and government agencies are also beginning to

1 discuss arrangements that could be put in place to share the MAPV among farmers. This discussion is  
2 taking place in a very unfavourable economic situation for agriculture (a succession of several bad  
3 economic and climatic years).

#### 4 *Portuguese case study*

5 Located in the South of Portugal, in the heart of the Algarve Region, the 318 km<sup>2</sup> Querença-Silves  
6 aquifer is the largest and the most important aquifer in the region. The main water uses are for  
7 farming and drinking water, with more limited use by golf courses and industries. This aquifer is  
8 located in one of the most popular seaside tourism areas of Portugal, in which there is a tenfold  
9 population increase during the summer months. Farmers grow mainly citrus fruit, and overall their  
10 farms face marketing difficulties. In the summer of 2005, the extreme drought Portugal was going  
11 through brought this aquifer to record low levels, and pumping was restricted because of fears of  
12 saltwater intrusion. While there is as yet no evidence of groundwater overdraft, the Regional Water  
13 Administration of Algarve is keen to ensure that it does not occur in the future. In a 2009 report, the  
14 administration considered the Querença – Silves aquifer to be at risk of overexploitation, with water  
15 extraction exceeding 90% of the recharge (ARHA, 2009). Moreover, recent research has produced  
16 simulations showing that climate change could exacerbate the problem, resulting in seawater  
17 intrusion (Stigter et al. 2009).

18 In Portugal as in France, groundwater is privately owned, while most surface water has been placed  
19 in the public domain. However, overexploitation reported in the south has led to changes. In 1966, a  
20 new civil code gave Government the ability to subject groundwater use to regulations, but this was  
21 not enforced until 1977, when a decree-law (No. 376/77) created a licensing system for water  
22 abstraction in the southern areas where aquifers are the only significant resources. The licensing  
23 system was expanded to cover the whole country in 1995, with varying levels of restrictions. Thus the  
24 trend is towards greater administrative control of private water rights, rather than towards

1 redefinition of groundwater as a common property subject to user rights, which would lead to user  
2 boards like those proposed in Spain (Barraque, 2004).

3 The Portuguese case study was carried out while the just established Regional Water Administration  
4 of Algarve (RWAA) was developing its Regional Water Management Plan, in compliance with the  
5 Water Framework Directive. A specific groundwater management plan was not planned at the time.

6 The RWAA is the agency that issues licenses for the use of water and determines the maximum  
7 permissible volume that can be pumped per borehole. These regulations work well on paper but not  
8 in practice. Even though the RWAA has a Geographic Information System that supports the issuing of  
9 groundwater licenses, there are still a significant number of unregistered boreholes (ARHA, 2009).

10 Furthermore, many water users do not have metering devices or do not use them, in spite of an  
11 obligation to send this information to the administration every three months. All of these are  
12 considered serious or very serious infractions, which can incur penalties ranging from €25,000 to  
13 €2,500,000 (the maximum penalty for not registering the borehole). Since control by the  
14 administration is very weak, the farmers are unconcerned about complying (as they say: “no one  
15 does it”). A recent campaign of compulsory well registration was implemented in an effort to change  
16 this state of affairs, resulting in an almost systematic declaration of wells by farmers (currently  
17 19 626 declared wells in the Algarve region). Farmers harshly criticize the current system of water  
18 use regulation, as they find it ignores their needs, e.g., the volumes authorized are considered to be  
19 insufficient in the summer months. Another issue worrying farmers is the establishment (in 2009) of  
20 a new tax on water abstraction. Although the tax level is very low, farmers see it as a first step  
21 towards the enforcement of groundwater payments, something they deem unfair considering the  
22 already high electricity costs and their significant investments for well construction.

23

24

1 GROUNDWATER REGULATION SCENARIOS

2 In both France and Portugal, groundwater policy is currently at a crossroads where three different  
3 models may be chosen to develop national groundwater regulation policies. The first model consists  
4 of developing direct administrative regulation, with systematic registration of abstraction points, the  
5 issuance of permits, the definition of groundwater rights, and the awarding of concessions. The  
6 second model consists of relying on economic instruments, such as water pricing or tradable water  
7 licenses, to regulate the use and allocation of groundwater. The third model is self-regulation,  
8 consisting of establishing semi-autonomous groundwater users' associations (GWUAs) with the  
9 internal capacity of organizing groundwater regulations, supported by higher-level authorities  
10 (Lopez-Gunn and Cortina 2006). Three narrative storylines were developed to introduce and to  
11 arouse debate on these three models with institutional representatives, experts, and farmers. These  
12 storylines are briefly presented below.

13 *Scenario A: the Regulatory Approach*

14 This scenario assumes that groundwater becomes entirely regulated by the State. Drawing on  
15 approaches implemented in Spain with the *Regimen de Explotacion* (Lopez-Gunn 2003) and in some  
16 groundwater basins in western states of the U.S.A. (Schlager 2006), this scenario assumes that a  
17 government agency registers all groundwater abstraction points, issues permits, defines  
18 groundwater rights (volume per year), and awards concessions. It further assumes that farmers  
19 provide detailed information (at the plot level) on where they use water and for which crop, in a  
20 framework similar to what is currently done for obtaining Common Agriculture Policy subsidies. The  
21 government agency then checks that the declared irrigated areas and cropping patterns are  
22 consistent with the authorized water use. The enforcement problem is dealt with by the use of  
23 sophisticated remote-sensing technology coupled to a Geographic Information System. Satellite  
24 images are regularly acquired and analyzed to identify and map all irrigated areas. The volumes used

1 in each field are estimated using the same images. This information is integrated into a numerical  
2 land registry in order to compare actual water use with legal water entitlement. In the event of  
3 inconsistency between declared and estimated water use, a field inspection is carried out. Severe  
4 sanctions apply in cases of non-compliance, the sanction consisting of a fine proportional to the  
5 excess water used. One of the problems associated with this scenario is the lack of flexibility:  
6 newcomers (young farmers) are unable to obtain a concession until another farmer relinquishes a  
7 license – possibly providing incentives for farmers to drill illegal wells or to engage in informal water  
8 trading.

9 *Scenario B: Tradable Water Permits*

10 The second scenario retains all the assumptions of the regulatory scenario and further assumes that  
11 water concessions can be traded among farmers. Both short- and long-term exchanges can take  
12 place. Transactions are approved and registered by a regulatory authority which checks that the  
13 transaction has no third-party impact. Details of all transactions are published by the regulatory  
14 authority (price and volumes exchanged) to ensure transparency. Specific measures are  
15 implemented to prevent speculation, mainly consisting of recalling dormant licenses from farmers  
16 who have not directly used them for several consecutive years. The main questions raised by this  
17 scenario are related to the functioning of water markets (type of farms likely to actively engage in  
18 trading, type of exchanges that would take place, namely short- or long-term sales), and to the social  
19 acceptability of considering trading water concessions in a legal framework in which water is  
20 considered to be a common good (France), and the risks of market failure in both the French and  
21 Portuguese contexts.

22 *Scenario C: Self-Regulation*

23 The third scenario is inspired by various examples around the world where water users have  
24 successfully organized themselves into associations to safeguard groundwater resources (Lopez-

1 Gunn 2003, Lopez-Gunn and Cortina 2006, van Steenberg 2006, Schlager 2007) and to prevent the  
2 tragedy of the commons from happening. The example of the Ground-Water User Association  
3 (GWUA) established in Eastern Mancha (*Junta General de Regantes de la Mancha Oriental*) was  
4 specifically studied when constructing this scenario (Calera Belmonte et al. 1999, Lopez-Gunn 2003,  
5 Martín de Santa Olalla et al. 2003).

6 This scenario assumes that GWUAs are established and made responsible for the allocation of the  
7 Maximum Permissible Annual Volume (MPAV) among farmers. The GWUA develops the internal  
8 capacity to register boreholes and to monitor the volumes of water used by its members, without  
9 State interference. Membership in a GWUA is mandatory for any farmer wishing to exploit  
10 groundwater (the State ensures compliance with this). The GWUA, which is responsible for enforcing  
11 the overall quota (MPAV) controls the individual behavior of its members. A Groundwater Tribunal,  
12 composed of elected farmers, is established to arbitrate conflicts, and to impose penalties on  
13 offending farmers (illegal wells or over-pumping). Government Agencies are asked to intervene only  
14 if the Tribunal's order is not carried out. The main questions raised by this scenario are related to the  
15 assumption that GWUA can effectively monitor groundwater access and use by its members, and to  
16 the assumption that self-adjudication and enforcement of sanctions can work.

17 RESULTS: WHAT DID WE LEARN FROM THE SCENARIO WORKSHOPS FOR POLICY FORMULATION?

18 *Lessons learnt concerning the definition and enforcement of individual water rights*

19 The regulatory scenario is perceived as a rigid and authoritative solution that may escalate the  
20 conflicts between the authorities and the water users. In both case studies, farmers and stakeholders  
21 stressed that a major constraint that limits the scope for this scenario is that there is insufficient  
22 shared knowledge of the aquifer boundaries, the volume that can be extracted, and the risks of  
23 deterioration. Owing to this lack of scientifically sound information, water rights defined by the State  
24 are likely to be contested. In the Roussillon, this problem had already been identified in interviews



1 conducted several years ago (Montginoul and Rinaudo 2009). Surprisingly, farmers are not opposed  
2 to strict water-use monitoring carried out via a combination of meters and the use of remote-sensing  
3 imagery. In France, farmers consider this as being an unavoidable development in the short term  
4 (five years) which is totally consistent with the practices of Government agencies responsible for  
5 implementing the European Common Agricultural Policy. No conflict is expected concerning the use  
6 of remote sensing as a monitoring tool, in contrast with what Lopez-Gun (2003) reports from  
7 Western Mancha. Portuguese farmers would also accept stricter monitoring systems in a context of  
8 scarcity but they want to be better informed about such a system and also require greater  
9 transparency and equity in its implementation (mix of scenarios A and B). The necessity of penalties  
10 is not contested; however, in the case of over-pumping, French farmers suggest replacing financial  
11 sanctions by a reduction of the quota authorized for the following year (as is already happening in  
12 the Vendée county in western France for instance, and in the Eastern Mancha aquifer in Spain). For  
13 Portuguese farmers also, penalties are not contested, but it is definitely a sensitive topic. For  
14 farmers, penalties should be avoided given the difficult economic situation of agriculture, but the  
15 State could instead withhold all public subsidies (CAP in particular) from offending farmers. Penalties  
16 for infraction should be the very last resort.

#### 17 *Lessons learnt concerning trading of rights*

18 Overall, French and Portuguese farmers all express major concerns related to the ethical implications  
19 of establishing a market for water rights. They firmly oppose considering water as a commodity that  
20 can be traded. As one farmer puts it, “*we can sell everything but not water*”. Also, they are  
21 particularly concerned by the assumed separation of land and water property, fearing that this would  
22 lead to the concentration of water rights in the hands of a few better-off farmers, resulting in the  
23 abandonment of large tracts of land. Concerning small farmers (who refer to themselves as  
24 “peasants”), the scenario somehow threatens their own existence, whereas it opens new prospects  
25 for large farmers (who were not well represented in our groups).

1 After having made clear that this scenario was not a desirable outcome, the French farmers, who  
2 agreed to discuss this scenario in detail, acknowledged that it was not totally improbable. To support  
3 this judgement, they spontaneously quoted the existence of similar cap and trade mechanisms used  
4 for the regulation of greenhouse gas emissions. They also mentioned that similar markets already  
5 exist in agriculture for regulating the allocation of certain production rights, e.g., vine plantation  
6 rights, milk quotas, shellfish concessions, etc. Finally they agreed that tradable water rights should be  
7 considered and debated, given that these could appear on the policy maker's agenda in the future.

8 From that point in the discussion, some of the workshop participants clearly shifted to an exploratory  
9 mode, making an effort to envision how the mechanism would work. They identified a number of  
10 situations where trade could offer flexibility (for instance during the first 4-5 years of orchard  
11 plantation farmers could lease their water rights since they would not fully use them). They agreed  
12 that trade could be beneficial to farmers in specific situations. Trade would most probably remain  
13 limited and consist of long-term (or definitive) transfers (sale of water right after retirement),  
14 although short-term transactions (from a few weeks to a 1-2 years) might also take place at the  
15 margin. Participants were quite imaginative in identifying potential problems and drawbacks,  
16 including prohibitive transaction costs and third-party effects generated by the concentration of  
17 water rights in specific geographic areas. Tradable water rights were also expected to increase the  
18 complexity of land markets and to increase the resources needed by young farmers entering the  
19 sector (purchase of water rights in addition to land, machinery, etc.). A clear risk of speculation was  
20 pointed out, assuming that some farmers (market gardeners) might purchase water rights, use them  
21 during wet years, and speculate during drought years. Last but not least, farmers were concerned  
22 that water rights could be transferred to cities, for instance by farmers retiring, resulting in the  
23 progressive disappearance of agriculture. In conclusion, some of the farmers agreed that a system of  
24 tradable water permits could be established, provided that water permits would remain linked to the  
25 land and exchanges were limited to short-term leases of permits.

1 *Lessons learnt concerning self-regulation*

2 In the two case studies, farmers clearly expressed the desire to be more closely involved in decisions  
3 defining groundwater regulation rules. However, some differences emerged between the French and  
4 Portuguese farmers.

5 In Portugal, farmers did not believe that Groundwater Users' Associations could take over the  
6 groundwater regulation responsibility, citing the lack of trust among them. Bonding social capital  
7 seems to be fairly weak within the community, given past experiences of failed collective action in  
8 associations and cooperatives, whose leaders are often accused of favoring some associates and  
9 even of corruption. For these farmers, collective action for the self-regulation of the aquifer was  
10 viewed as possible only in a critical situation, such as a serious lack of water or in reaction to a more  
11 threatening alternative that might be imposed by the State, such as a higher water abstraction tax,  
12 for instance. The Groundwater Tribunal was also criticized. It should not be made up of farmers only  
13 but should rather include a wide range of representatives, including some external to agriculture to  
14 insure its independence and impartiality. It should also be led by a professional judge, not by a  
15 farmer. They nonetheless pointed out some advantages of self-regulation such as the greater  
16 proximity to the local reality of those managing the aquifer, which they contrast with the "State's  
17 technocrats", and their greater participation in decisions that are important to them, e.g. the rules  
18 for allocating quotas. They emphasize that these associations need to be a bottom-up creation, as  
19 associations created by the State are doomed to fail. Concerning the representatives of government  
20 agencies, these are strongly dubious of the capacity of farmers to get organized and to devise and  
21 implement groundwater-governing institutions, although they are in favor of such a system, within a  
22 wider governance framework defined by the State. One representative went so far as to say that the  
23 State should test self-regulation in a site such as that of the Querença-Silves aquifer.

1 In the French case study, workshop participants were much more supportive of the self-regulation  
2 principle. This is probably due to the positive experience with the irrigation associations which have  
3 been successfully managing gravity-irrigation canals. Representatives from government agencies  
4 adopted a very positive attitude, agreeing with the idea of giving up part of their powers and  
5 recognizing the right of users to devise their own institutions. Farmers also supported the scenario,  
6 although they were fully aware that a large number of the social problems arising from diverging  
7 interests and the effective implementation of the rules would shift from the authorities to the  
8 farmers' organization. Beyond their general support, farmers expressed a number of concerns on the  
9 implementation of the proposed scenario. First, they said that it was unlikely to become a reality  
10 until a serious crisis occurred, triggering collective action. Crisis was understood as a situation where  
11 agriculture would be designated as responsible for (or even the culprit in) the emerging water crisis,  
12 forcing farmers to engage in collective action to defend their interests; or a situation where water  
13 shortage might reach such an intensity that sharing water would become a survival issue, forcing  
14 farmers to act collectively.

15 French farmers also pointed out that the scenario breached the fundamental principle of separation  
16 of powers, as the farming community itself would be in charge of formulating the regulating rules,  
17 interpreting those rules, adjudicating conflicts, and implementing penalties. They called for the State  
18 to remain involved in the adjudication and enforcement of sanctions, suggesting that the Tribunal  
19 could, for instance, be composed of State representatives and farmers in equal proportions. This  
20 position was reinforced by the relative lack of trust, reflecting fears that a group of farmers would  
21 hijack the collective organization for their personal benefit, by influencing the decisions of the  
22 tribunal or the enforcement of sanctions. They also believe that self-monitoring is unlikely to be  
23 effective, since "neighbors do not denounce neighbors". Last but not least, the farmers claimed that  
24 the supporting role of public authorities in the establishment of a self-regulating institution was  
25 inadequately defined in the scenario, GWUAs being perceived as operating in a vacuum. Overall, the

1 farmers were somewhat uncomfortable with this scenario as they felt that it was driven by the  
2 State's desire to shed the burden of managing a common good. This supported the conclusions of  
3 previous research work which emphasized the role of higher authorities in effective self-regulation  
4 arrangements (Schlager and Lopez-Gunn , Lopez-Gunn and Cortina 2006).

5

## 6 DISCUSSION AND CONCLUSION

### 7 *Summary of participants' perceptions of scenarios*

8 When asked to describe how water management is likely to evolve in the future, French stakeholders  
9 and farmers quoted most of the items contained in the self-regulation scenario (C). They do not  
10 believe that the State will intervene in water management as described in regulatory scenario (A),  
11 and most of them consider the development of the water markets scenario to be very unlikely (B).  
12 Overall, Scenario C is considered to be highly desirable by more than 90% of the participants.  
13 However 30 to 40% of participants also find that some of the assumptions included in Scenarios A  
14 and B should be considered, and included in a hybrid scenario.

15 For Portuguese stakeholders, the state should continue to play a crucial role in the management of  
16 groundwater. Although they call for greater involvement of farmers in groundwater regulation, the  
17 participants did not support the self-regulation scenario. The Water Market scenario is categorically  
18 dismissed by most participants, who consider it unethical.

19 In short, the outcome of the participatory foresight conducted in the two countries has enabled the  
20 identification of certain key elements which could be taken from the various scenarios and combined  
21 to formulate a preliminary basis for discussion with stakeholders. In Portugal, this scenario would be  
22 based on the regulatory scenario, farmers being granted a much greater participation in the  
23 definition of the rules of use, monitoring, and sanctions. In France, the self-regulation scenario could

1 serve as a basis for discussion provided the role of the State is clarified (and partly reinforced as  
2 regards the adjudication and enforcement of penalties). The workshops also identified one form of  
3 trading which might be considered as acceptable (in France) provided land and water property rights  
4 remain linked. Overall, the debates highlighted the need to create an institutional culture in which  
5 groundwater users are perceived as potential co-managers, not just as users safeguarding their own  
6 private individual uses, as already stressed in other contexts (Agarwal 2001).

7 From a methodological point of view, the research presented above has demonstrated farmers'  
8 ability to contribute to an exploratory assessment of possible future water-management scenarios, in  
9 two contexts where water is not an immediate source of concern for agriculture but only an  
10 anticipated future challenge. Significant positive changes in attitudes took place during the  
11 participatory process, with farmers opening up to a diversity of possible futures. In France, for  
12 instance, some of the farmers who were initially unwilling to consider basic changes, such as the  
13 installation of meters and the allocation of individual quotas, have been able to discuss, evaluate,  
14 and provide very meaningful comments and suggestions on highly innovative water-management  
15 scenarios, e.g., water markets. However, this does not mean that they would accept the  
16 implementation of the scenarios, but they were at least able to discuss them.

17 Farmers, experts, and institutional representatives alike appreciated the opportunity for debate  
18 offered by the scenario workshops. Overall, all of the participants said that they found the discussion  
19 time valuable. The workshops offered them a unique opportunity to think about the consequences of  
20 long-term changes, something which neither farmers nor institutional experts have time to do, being  
21 trapped within their present constraints and short-term objectives. Another key motivation for  
22 participants was the opportunity offered by the workshop to listen to each other's opinions, in a  
23 strategic, behavior-free context, i.e. having the possibility to freely express all their ideas without  
24 concern for the defense of specific vested interests. This was emphasized by the institutional experts,  
25 who are used to meeting in arenas where they have to defend vested interests and entrenched

1 positions dependent on their institutions, with regard to short-term political and economic issues  
2 (Rinaudo et al. forthcoming). Portuguese farmers also appreciated learning from scientists, in  
3 particular on issues related to the dynamics of the aquifer, climate change and its effects on cultures,  
4 and water-management institutions. The choice of a methodology that consisted in conducted a  
5 series of participatory foresight workshop has generating some social learning. It is however unclear  
6 if this process will be continued by authorities or farmers themselves after the research project ends.

7 Concerning the use of predefined scenarios, participants found the three scenarios useful as a basis  
8 for discussion, recognizing that exploring possible futures would have been very difficult if not  
9 impossible without such support. However, some participants regretted that scenarios were  
10 presented as static descriptions of three different possible future situations, without considering  
11 possible transition paths from the present to the futures considered. Naturally, this methodology is  
12 not flawless, and other types of foresight techniques could be used, explicitly considering transition  
13 paths in the scenario description (Poumadère et al. 2008) or using facilitating tools such as role-  
14 playing games or experimental economics. This type of alternative approach has already been used  
15 in another case study conducted in Morocco ([ref. to Faysse, this issue](#)), and is currently being tested  
16 by the French research team, as an extension of the work presented in this paper (Lenouvel et al.  
17 2011).

## 18 REFERENCES

- 19 ARHA, Questões significativas da gestão da água, Região Hidrográfica das Ribeiras do Algarve,  
20 Participação Pública, Informação de Suporte,, Janeiro 2009  
21 Agarwal, B. 2001. Participatory Exclusions, Community Forestry, and Gender: An Analysis for South  
22 Asia and a Conceptual Framework. *World Development* **29**:1623-1648.  
23 Andersen, I.-E., and B. Jaeger. 1999. Scenario workshops and consensus conferences: towards more  
24 democratic decision-making *Science and Public Policy* **26**:331-340.  
25 Barraque, B. 2004. Groundwater management in France: from private to common property ? *in*  
26 *Managing common pool groundwater resources : an international perspective*  
27 Caballero, Y., and al. submitted. Vulnerability of mediterranean hydrosystems to global change: an  
28 assessment method. *Global and Planetary Change*.

- 1 Calera Belmonte, A., J. Medrano Gonzalez, A. Vela Mayorga, and S. Castana Fernandez. 1999. GIS  
2 tools applied to the sustainable management of water resources: application to the aquifer  
3 system 08-29. *Agricultural Water Management* **40**:207-220.
- 4 EASAC. 2010. Groundwater in the Southern Member States of the European Union. European  
5 Academies Science Advisory Council.
- 6 García-Ruiz, J. M., J. I. López-Moreno, S. M. Vicente-Serrano, T. Lasanta-Martínez, and S. Beguería.  
7 2011. Mediterranean water resources in a global change scenario. *Earth-Science Reviews*  
8 **105**:121-139.
- 9 Godet, M., and F. Roubelat. 1996. Creating the future: the use and misuse of scenarios. *Long Range*  
10 *Planning* **29**:164-171.
- 11 Hatzilacou, D., G. Kallis, A. Mexa, H. Coccosis, and E. Svoronou. 2007. Scenario workshops : a useful  
12 for participatory water resources planning ? *Water Resources Research* **43**:1 à 12.
- 13 Lenouvel, V., M. Montginoul, and S. Thoyer. 2011. From a blind truncheon to a one-eyed stick:  
14 testing in the lab an optional target-based mechanism adapted to groundwater withdrawal.  
15 Pages 23 *in* Conference of the European Association of Environmental and Resource  
16 Economists, Rome, Italy.
- 17 Lienert, J., J. Monstadt, and B. Truffer. 2006. Future Scenarios for a Sustainable Water Sector: A Case  
18 Study from Switzerland. *Environmental Science & Technology* **40**:436-442.
- 19 Llamas, R., and A. Garrido. 2007. Lessons from intensive groundwater use in Spain : Economic and  
20 social benefits and conflicts. *in* G. M. a. V. K.G., editor. *The agricultral Groundwater*  
21 *revolution: opportunities and threat to development*. CAB International, Oxford.
- 22 Lopez-Gunn, E. 2003. The role of collective action in water governance: a comparative study of  
23 groundwater user associations in La Mancha Aquifer in Spain. *Water International* **28**:367-  
24 378.
- 25 Lopez-Gunn, E., and L. Cortina. 2006. Is self-regulation a myth? Case study on Spanish groundwater  
26 user associations and the role of higher-level authorities. *Hydrogeology Journal* **14**:361-379.
- 27 Martín de Santa Olalla, F., A. Calera, and A. Domínguez. 2003. Monitoring irrigation water use by  
28 combining Irrigation Advisory Service, and remotely sensed data with a geographic  
29 information system. *Agricultural Water Management* **61**:111-124.
- 30 Maton, L., J.-D. Rinaudo, Y. Caballero, A. Richard-Ferroudji, D. Rollin, and P. Garin. 2010. Que pensent  
31 les agriculteurs et les acteurs institutionnels des impacts du changement climatique sur  
32 l'agriculture des Pyrénées Orientales et des adaptations possibles ? Résultats d'une  
33 démarche participative *in* *Agir en situation d'incertitude*, Montpellier.
- 34 Montginoul, M., and J. Rinaudo. 2009. Quels instruments pour gérer les prélèvements en eau  
35 souterraine? Le cas du Roussillon. *Economie Rurale* **310**:40-56.
- 36 Ostrom, E. 1990. *Governing the commons: the evolution of institutions for collective action*.  
37 Cambridge University Press, Cambridge.
- 38 Patel, M., K. Kok, and D. S. Rothman. 2007. Participatory scenario construction in land use analysis:  
39 An insight into the experiences created by stakeholder involvement in the Northern  
40 Mediterranean. *Land Use Policy* **24**:546-561.
- 41 Poumadère, M., C. Mays, G. Pfeifle, and A. Vafeidis. 2008. Worst case scenario as stakeholder  
42 decision support: a 5- to 6-m sea level rise in the Rhone delta, France. *Climatic Change*  
43 **91**:123-143.
- 44 Rinaudo, J.-D., L. Maton, I. Terrasson, S. Chazot, A. Richard-Ferroudji, and Y. Caballero. forthcoming.  
45 Combining scenario workshops with modeling to assess future irrigation water demand.  
46 *Agricultural Water Management*.
- 47 Rinaudo, J. D., and P. Garin. 2005. The benefits of combining lay and expert input for water-  
48 management planning at the watershed level. *Water Policy* **7**:279-293.
- 49 Schlager, E. 2006. Challenges of governing groundwater in U.S. western states. *Hydrogeology Journal*  
50 **14**:350-360.



- 1 Schlager, E. 2007. Community management of groundwater. *in* G. M. a. V. K.G., editor. The agricultural  
2 Groundwater revolution: opportunities and threat to development. CAB International,  
3 Oxford.
- 4 Schlager, E., and E. Lopez-Gunn. (2008) Collective systems for water management: is the Tragedy of  
5 the Commons a myth? Pages 43-58 *in* Rogers et al. (eds.), editor. Water Crisis: Myth or  
6 Reality? Balkema Publishers, The Netherlands.
- 7 Stigter, T. Y., J. P. Monteiro, L. M. Nunes, J. Vieira, M. C. Cunha, L. Ribeiro, J. Nascimento, and H.  
8 Lucas. 2009. Screening of sustainable groundwater sources for integration into a regional  
9 drought-prone water supply system. *Hydrology and Earth System* **13**:1185-1199.
- 10 Street, P. 1997. Scenario workshops: A participatory approach to sustainable urban living? *Futures*  
11 **29**:139-158.
- 12 van Steenberg, F. 2006. Promoting local management in groundwater. *Hydrogeology Journal*  
13 **14**:380-391.

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