Participatory modeling for sustainable development in water and agrarian systems: potential and limits of stakeholder involvement

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INTRODUCTION

Public participation is increasingly advocated as a necessary feature of natural resources management. The EU Water Framework Directive (WFD) is such an example, as it prescribes participatory processes as necessary features in basin management plans (EC 2000). The rationale behind this mandate is that involving interest groups ideally yields higher-quality decisions, which are arguably more likely to meet public acceptance (Pahl-Wostl, 2006). Furthermore, failing to involve stakeholders in policy-making might hamper the implementation of management initiatives, as controversial decisions can lead pressure lobbies to generate public opposition (Giordano et al. 2005, Mouratiadou and Moran 2007).

A common approach to public participation is to hold open meetings for groups or individuals to provide input. While these strategies have been used for decades, they are not necessarily sufficient for some processes as they are frequently biased towards the interests of participants of well-organized place-based groups (Larson and Lach 2008). Hence, public participation has developed into an expanding body of knowledge that comprises a variety of techniques and practices (Martin and Sherington 1997, Sotoudeh 2003, Gurung et al. 2006). For instance, wherever significant uncertainties exist ongoing stakeholder participation might be needed to address management and governance problems adequately (Ostrom, 1992). Joint involvement of water managers, stakeholders and experts may in turn require decision support tools that build on transparency and flexibility to reach sound action plans and instruments (Henriksen et al 2007).

While participatory processes should ideally empower participants to have a direct impact on policy (Reed 2008), this can be difficult in regions where a participatory tradition is lacking. This is particularly true if competing uses make the setting at hand a conflicting one. Following upon this argument, this paper explores the role of an informal public participation process held in the Upper Guadiana basin, Spain. It is hypothesized that informal, non-binding fora might provide valuable additions to conflictive contexts, not only contributing to broaden the knowledge about the basin under consideration, but also facilitating adaptation to socio-economic and environmental challenges.

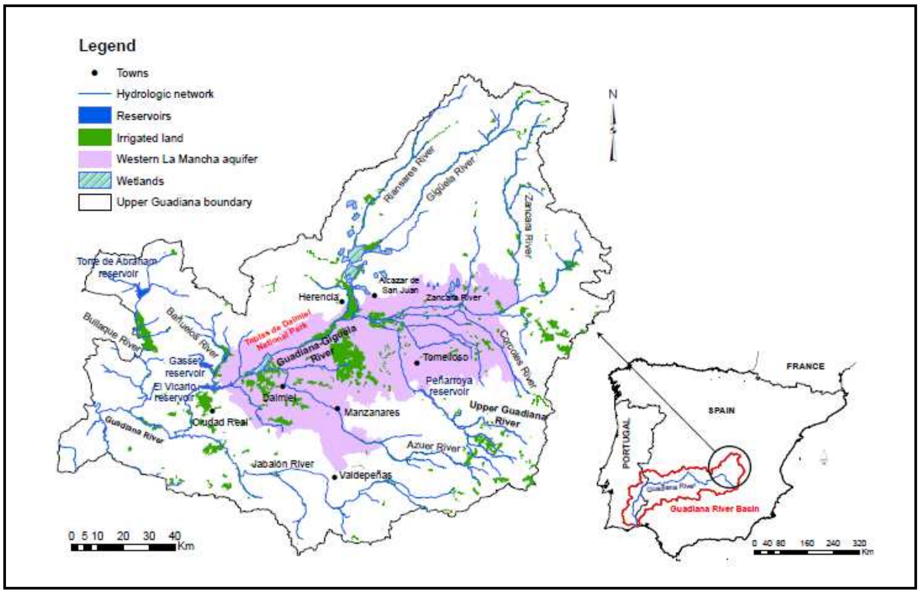
Groundwater irrigation and ecosystem conservation: an unresolved dilemma?

Water conflicts arise when there is competing access to water and, as a result, often pose major socio-economic, environmental and institutional problems (Comp.Ass.Wat.Mng, 2007; Giordano et al 2005; Llamas and Martinez-Santos, 2006). Being the most arid country in Europe water issues and regional rivalries over water are at the core of Spain’s public debates. Alike other Mediterranean countries, along Spain’s southern littoral and its hinterland, ground water has been the major source for irrigation expansion, one of the key drivers for agricultural development and hence for the stability of rural livelihoods (Benoit and Comeau, 2005; Varela-Ortega, 2007; Martinez-Santos, 2007; Mukherji, 2006). Yet, irrigation-based socio-economic welfare has come along with increased environmental degradation, aquifer depletion and loss of aquatic ecosystems.

A remarkable example of these conflicts is the Upper Guadiana basin in Spain’s central plateau, where irrigation dynamics have brought about rapid changes over the last thirty years. Like in other semiarid regions of the world, intensive groundwater use has virtually offset the effects of the region’s endemic drought problems, thus supporting irrigation-based social and economic welfare and acting as the main driver for prosperity (Llamas and Martinez-Santos 2006, Varela-Ortega 2007). Nevertheless, illegal drilling and pumping has traditionally been widespread. Uncontrolled pumping has caused unwanted environmental effects such as wetland degradation. This has been especially acute in the Mancha Occidental aquifer, where the internationally reputed and Ramsar-listed wetland ‘Tablas de Daimiel’ has progessively dried up (Llamas 1988, Fornes et al 2000, Martinez-Santos et al 2008). Figure 1 shows the geographical location of the aquifer in the Guadiana river basin.

Despite substantial public investments wetland restoration attempts have inevitably failed. This is largely because water provides a key element in the livelihoods of strong social lobbies, notably farmers. As a result water easily becomes a pivotal element in election campaigns, making it difficult to find politically balanced and socially accepted solutions. Moreover, public participation has traditionally been lacking in the basin’s management practices. Though inroads have recently been made, the aforementioned conflict may pose a significant difficulty to an adequate implementation of the WFD.

Figure 1. Geographical location of the aquifer 'Mancha Occidental' in the Upper Guadiana basin, region of Castilla-La Mancha in Spain (source: Varela-Ortega et al , 2010)



The policy context: how water and agricultural policies interact

Irrigation agriculture consumes up to 95% of all water resources available in the Upper Guadiana basin and extends over an area of around 180,000 ha (CHG, 2007). In consequence, there is a need to integrate the agricultural and water sectors within the policy context. This implies recognition of newer developments and linkages on the policy front, which include the WFD and the different reforms of the Common Agricultural Policy (CAP). The need for a joint implementation of water and agricultural policies stems from the Upper Guadiana's long-lasting lack of policy integration, which has resulted in acute ecological impacts on the wetlands, aquifer depletion and social unrest in the rural communities.

Over the past decades, irrigation expansion in the Upper Guadiana basin has been largely a policy-driven response (Varela Ortega, 2007). Along the 80's and 90's the production-based payments of the CAP encouraged irrigation intensification and, in consequence, abstractions in the Mancha Occidental aquifer intensified and exceeded its natural recharge (CHG, 2007). With the aim of bringing to a halt the aquifers' overexploitation and the degradation of the associated wetlands, the River Basin Authority (RBA) started to take explicit actions and devised an annual quota-based Water Abstraction Plan (WAP) for the area that was put into force in 1994 (CHG, 2006). The plan limited water pumping to farmers to volumes well below their entitled water rights. This water regime created long standing opposition from the farmers while also giving rise to social conflicts, illegal well-drilling and water abstractions (Llamas and Martinez-Santos 2006, Varela-Ortega et al 2010). Much like other world examples of common-pool resources management, these top-down command and control policies involve irrigators' free-riding practices and high enforcement costs (Provencher and Burt, 1994; Shah et al, 2000; McCann et al, 2005; Rosegrant et al, 2002, Schlager and Lopez-Gunn, 2006;) and the Water Authority has not been capable of bringing this policy into its full application.

In the early 90's, in parallel to the water program, a special CAP Agri-environmental program (AEP) proposed income compensation payments to the farmers who voluntarily cut down on water consumption for irrigation (Varela-Ortega et al 2003). The farmers successfully joined this program in the early stages. However, it required large sums of public funds, was not financially sustainable and its cost-effectiveness was progressively questioned. From 2003 onwards as the WFD and the new CAP were both in force, the AEP changed to match the new policy requirements. Quotas diminished and compensations offered to farmers lowered which brought the program to a near halt (Varela-Ortega et al, 2010)

At present, under the WFD requirements the RBA is committed to assure the aquifer's recharge over the established time horizon of 2015 or 2027 and guarantee its 'good ecological status'. With the purpose of responding to these objectives, the RBA has recently approved a Special Plan for the Upper Guadiana (SPUG) (CHG, 2007) that foresees to reduce water abstractions to the levels compatible with the aquifer's sustainable management. Main actions of the

SPUG are the purchase of water rights from established irrigators through a Water Rights Exchange Center, the legalization of selected illegal wells, closing unlicensed drillings, and the support of special farming programs such as reforestation and rainfed cultivation.

In turn, CAP programs have evolved, form the Luxembourg reform (EC 2003) to the recent CAP Heath Check (EC 2009) to grant farm subsidies that are decoupled from production and tied to specific environmental regulations under a cross compliance scheme. The new CAP explicitly includes water management and climate change requirements. Certainly, agricultural policies and water policies have converged to mutual environmental objectives that emanate largely from the main guidelines of the EU Sustainable Development Strategy (EC, 2001). Therefore seeking synergies between these two main policies remains crucial for water management purposes and is still not fully explored.

Research Objective and Theoretical Context

The main objective of this research is to support the transition to inclusive public participation processes in the Upper Guadiana basin with the aim of contributing to the understanding and dialogue among the actors involved. This is perceived as an achievement in itself, given the climate of conflict that exists among the main water actors, the lack of a participatory tradition in Spain and the demands established by the WFD. However, as conflicts in the area seem to originate in a lack of shared access and transparency to basic water and socio-economic data it is the aim of this research to contribute to the stakeholders' knowledge about the water and social systems. How much water is available, to which type of farmer, how much will be diverted to recover the aquifer and restore the wetlands, what will be the derived income loss to the farmers in the area and which will be more vulnerable to changing policy settings, are some of the questions addressed in this research. . For this purpose, this paper analyzes first the stakeholder participatory process, examining each of the stages involved and exploring its contribution to broaden the knowledge of the basin's water management problems. Secondly, the paper examines a participatory modeling initiative, based on the development of stakeholder-driven tools and scenarios to address the challenge of adapting to the new policy context and to balancing societal and environmental objectives.

This paper stems from the participatory modeling literature that shows how these modeling tools have been proven effective in natural resources management across various world settings (Rowe and Frewer, 2004, Giordano et al, 2005, Antunes et al, 2006, Hare et al, 2003, Webler et la, 2001, among others). Nevertheless, given the complexity and site-specific characteristics of many natural resources, choosing the right tool is always a complex task as the values and preferences of concerned actors determine, to a great extent, its ability to adapt to specific contexts (Lynam et al, 2007; Larson and Lach, 2008; Hensler et al, 2009). In general, participatory tools are not used in isolation and the proper combination of tools tailored to a specific case increases robustness of the research and consistency of results (Lynam et al, 2007; Liu et al, 2007). In water resources management, there is an increasing trend to combine participatory processes with various types of modeling structures especially in the area of climate change related water management (Purkey et al, 2008, Quinn et al, 2004, Krysanova et al, 2010), which, in the case of EU research, it is substantially driven by the WFD initiative (Videira et al, 2009; Hare et al, 2003; Varela-Ortega et al, 2010). The WFD seeks to merge integrated river basin management and planning, ecological and hydrology assessments, the use of economic instruments and cost-effectiveness of measures with site-specific public participation. In sum, the complexity, interdisciplinary nature and site-specific characteristics of many natural resources, require the development of new modeling platforms that will be able to integrate technical, economic, environmental, social, and institutional aspects into a coherent framework. It has been discussed in the literature that from the various approaches that link aspects of natural systems and the human environment by integrating key components and relationships a truly comprehensive integration is often difficult to achieve through pure data collection or process studies (Holing, 2001; Kay et al 1999; Liu et al, 2008; Kemp-Benedict, 2010). Then the gradual incorporation into modeling structures of social and economic components, such as participatory processes, to support decision-making in natural resources management provides relevant insights that help reach a better common understanding of the ecosystems resources and problems, and more balanced and equitable negotiated solutions (Olson, 1965; Romero and Rehman, 1987; McCann et al, 2005; Kragt et al, 2010; Varela et at, 2010).

This paper in framed into this type of initiative. It intends to make a step further by analyzing conjointly the conflict-prone agrarian economy and the water system in the study area. For this, the paper addresses the combined effects of water and agricultural policy scenarios within a stakeholder involvement process using two sets of robust tools, an economic model that describes the farmers' behavior and a hydrology model that captures the water system dynamics. This kind of social-water-participatory modeling is different from other types that rely on the combination of stakeholder involvement processes with a single type of modeling structure (Videira et al, 2009; Antunes et al, 2006; Giordano et al, 2007) or agent-based modeling (Becu et al, 2008).

The research was conducted within the framework of the EU funded Newater project aimed to develop new approaches to water management and further developed under the Scenes project. The paper builds on preliminary co-authored work (Martinez-Santos et al, 2007) adding more insights to the participation scope and addressed under a different methodological perspective.

METHODS

This section has two parts. First, it provides an overview of the participation process, examining each of the different stages involved. The focus then shifts to the participatory modeling initiatives that have been implemented. From an overall point of view, the participatory process contributed to identify the main policy and stakeholder-driven aspects of water management. Secondly, these were in turn used to devise a series of coherent water management and vulnerability scenarios to be tested by means of agro-economic and hydrological models.

Public participation and stakeholder involvement in the Upper Guadiana basin

Stakeholder involvement in water management fora provides the basis for sharing common problems, discuss different views and perceptions and trim down uncertainties in management decisions. Participation also contributes to enlarge the basin's knowledge and identify the main drivers for change and adaptation (Downing et al, 2006; Von Korff, 2008). Therefore, stakeholders' participation is a feature of management regimes that permits to tackle adaptation to changing policy settings and societal demands (Hollings, 2001; Gunderson, 1999;; Tilman et al, 2001, von Korff and Barreteau, 2006)

Within this context, the participatory process in the Upper Guadiana basin was designed to make sure that all relevant stakeholders took part in the discussion forum. Since most of the area's current conflicts seem to arise from the uncertainties pertaining to water data (e.g. how much water is available, how much is abstracted, how much can be abstracted in a sustainable way) the meetings were designed to enable managers and stakeholders to discuss these issues. Given the sensitive nature of the area's water politics, the research team strived to remain impartial.

Figure 2: Schematic representation of the sequential participatory process approach in the research project

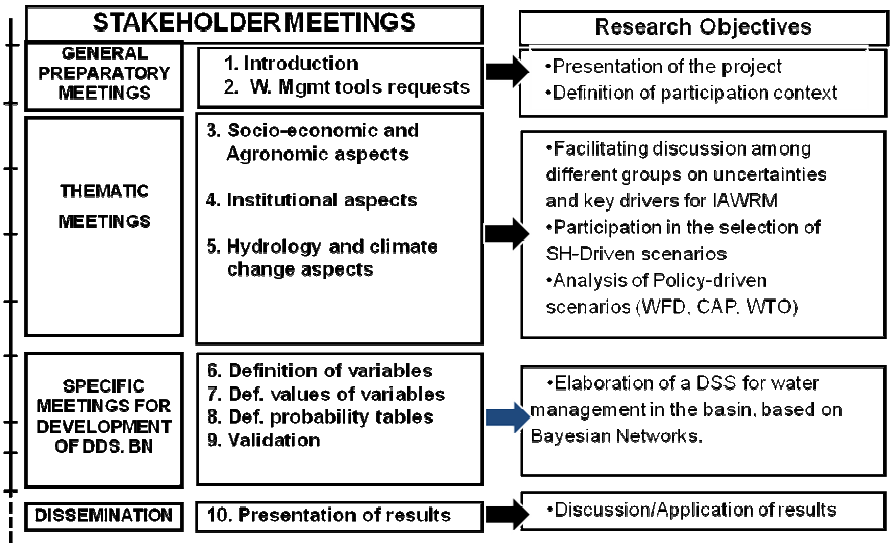


Figure 2 illustrates the participatory process. Meetings were organized following a sequential thematic course. A first introductory meeting established contact with the main actors. These were identified by the research team based on a national, regional and site-specific stakeholder mapping conducted in the preliminary phase of the Newater project and on extended previous research in the area (Llamas, 1988; Fornés et al, 2000; Varela-Ortega et al, 2006) Participants were asked to identify other stakeholders that should be present. The second meeting determined needs for research as well as the thematic orientation of the ensuing seminars. Three key issues emerged, namely agro-economic, legal-institutional, and hydrological aspects of water management. Figure 2 also shows the ensuing development of the process, a DSS Bayesian Network, which falls out of the scope of this paper. Approximately 25 stakeholders participated in each meeting, including farmers, national and local environmental conservation groups, Guadiana Basin Authority, regional agricultural departments, research centers, farmer unions, water users' associations, and private firms engaged in environment and participatory issues in the area, etc. These are shown in Figure 3.

Figure 3: The groups of Stakeholders attending the Guadiana basin participatory meetings

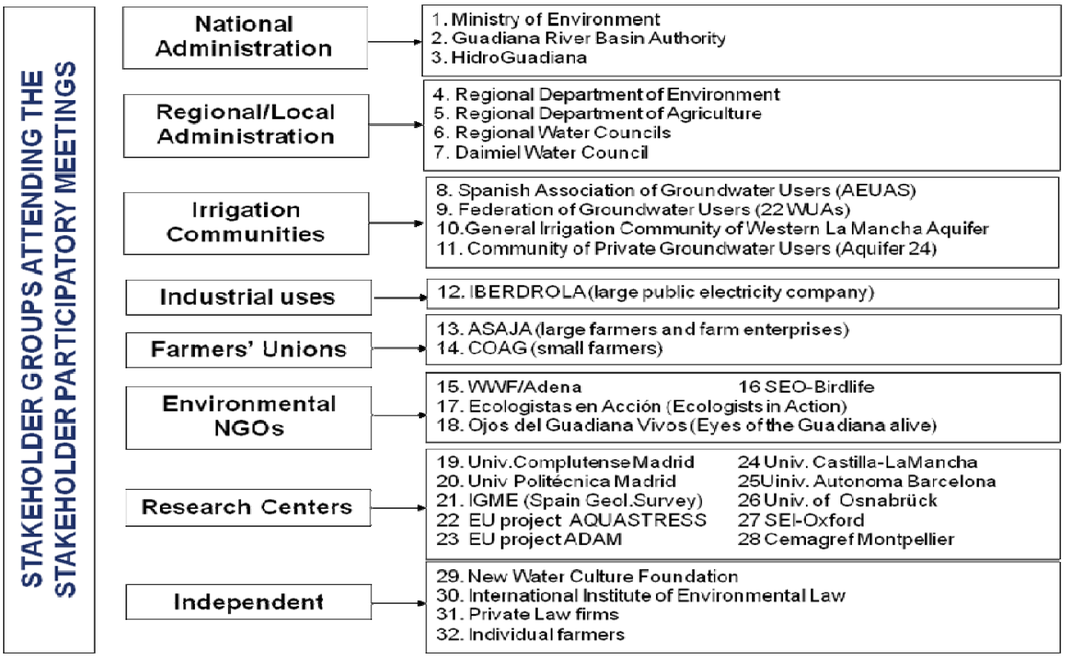
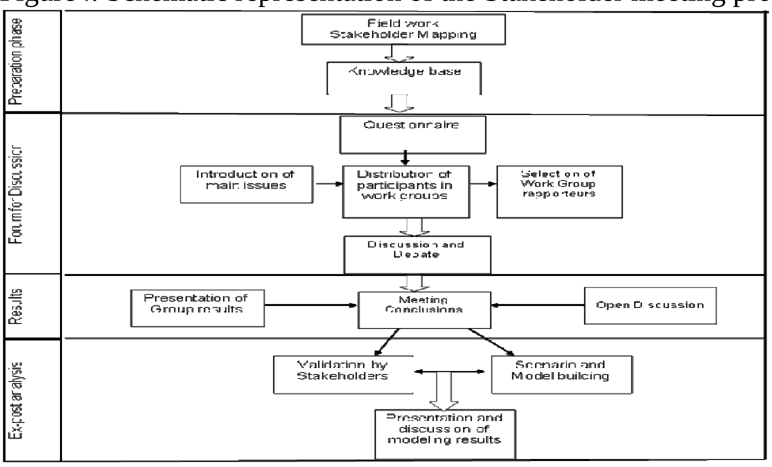


Figure 4 illustrates the basic structure of each meeting and the interlinkages with the precedent meetings. Following a preparatory phase, (in which the stakeholder mapping is common to all meetings), the research team drafted a specific questionnaire for each meeting which was used by a facilitator to conduct the meeting. Questionnaires were divided into thematic blocks, aimed at breaking down the day-long meetings into discussion sessions. Meeting participants were divided into smaller discussion groups, where an effort was made to guarantee a diverse set of viewpoints. Smaller groups ensured that everyone had ample opportunity to participate in the discussion. Additionally, the small group format helped to build trust among different stakeholders. A group rapporteur was responsible for guiding the discussion in each breakout group and reporting back to the plenary for discussion and debate. Results of the open discussions in the plenary sessions and the groups written answers to the questionnaires were gathered in meeting reports by the research team coordinator of each meeting. The conclusions of the meetings were validated ex-post by the stakeholders in the subsequent meetings. These served as the basis for the scenario building and the development of the modeling tools, which are explained in the following sections.

Figure4. Schematic representation of the Stakeholder meeting process



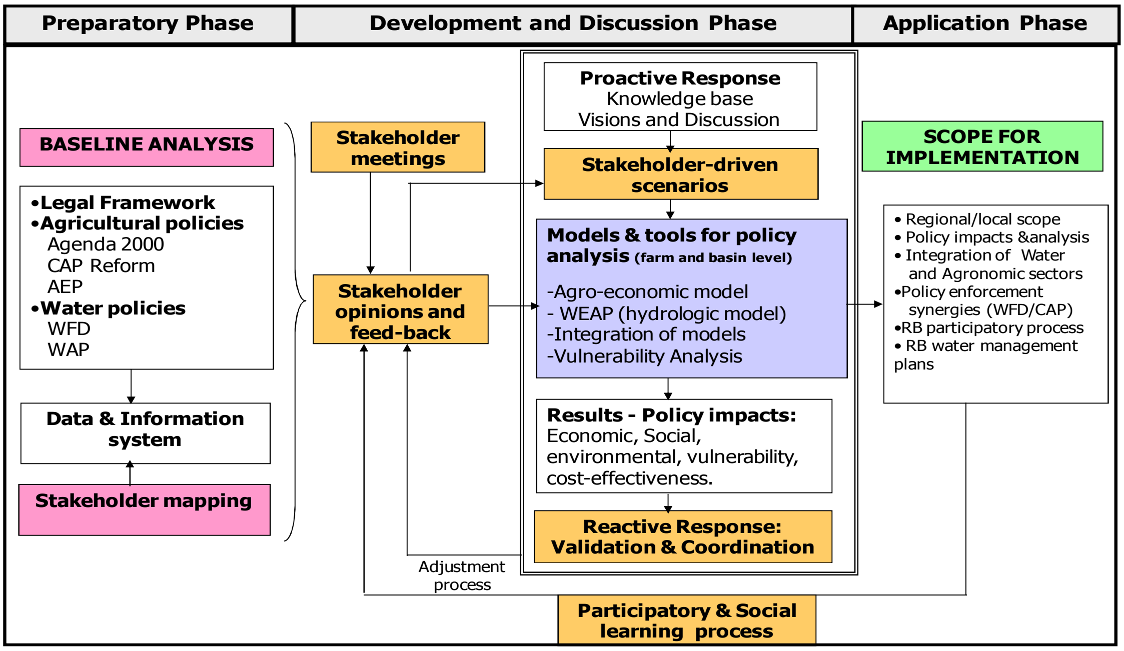
Participatory tool development

The other main feature of the project is the development of participatory site-specific modeling tools. These essentially comprise economic, agronomic and hydrological models and policy relevant scenarios to support participation in decision-making. Given the current policy context, integration between policy drivers has proven to be essential (Mejias et al 2004, Varela Ortega et al, 2008) and in this research, stakeholder meetings and discussions have prepared the grounds for selecting policy-relevant drivers. This is in turn reflected in the modeling tools and outcomes. It is worth mentioning that stakeholder involvement took place not only in the planned meetings and discussions but also through individually organized personal interviews during the field work meetings.

How stakeholders were involved in the modeling process

Figure 5 represents the participatory modeling framework Both types of models, hydrological and economic, were requested by the stakeholders and developed from scratch in order to facilitate their understanding and foster stakeholder participation (Varela-Ortega et al 2006 and Varela-Ortega et al 2007; Martinez-Santos et al 2007) . The stakeholder meetings had the objective of detecting the main drivers that determine present and future water management actions in the area. These drivers served to lay down a set of scenarios that stem from policies currently in force (water and agricultural policies) and from the stakeholders' own perceptions. That is, scenarios were both policy-driven and stakeholder-driven and were subsequently tested by the agro-economic and hydrology models. Ultimately, models were used to assess the effects of the selected scenarios on the environmental and social systems of the Upper Guadiana basin.

Figure 5. Scheme of the participatory modeling framework



The participatory modeling methodology has three distinct phases shown in Figure 5. (i) an initial phase which focuses on establishing the baseline condition and which results in a knowledge base made up of ample field work, stakeholder mapping, legal and policy settings. (ii) A second phase for development and discussion, which is the center of the stakeholder involvement and participation process. This phase includes several stages, starting with the stakeholder discussions along the participatory meetings, followed by the identification of the stakeholder-driven scenarios and the participatory model building. This part consists in the integration of agro-economic and hydrology simulation models. The last part is the iterative process of validation of models and results by the stakeholders that are in turn used for completing the participatory process. (iii) A last third phase for application and policy analysis, both at farm and basin's level. This analysis identifies the vulnerability of the different types of farm groups in the basin when different policy scenarios are applied (both water and agriculture) as well as their potential for meeting the objectives of recovering the aquifer within the time horizon established by the WFD.

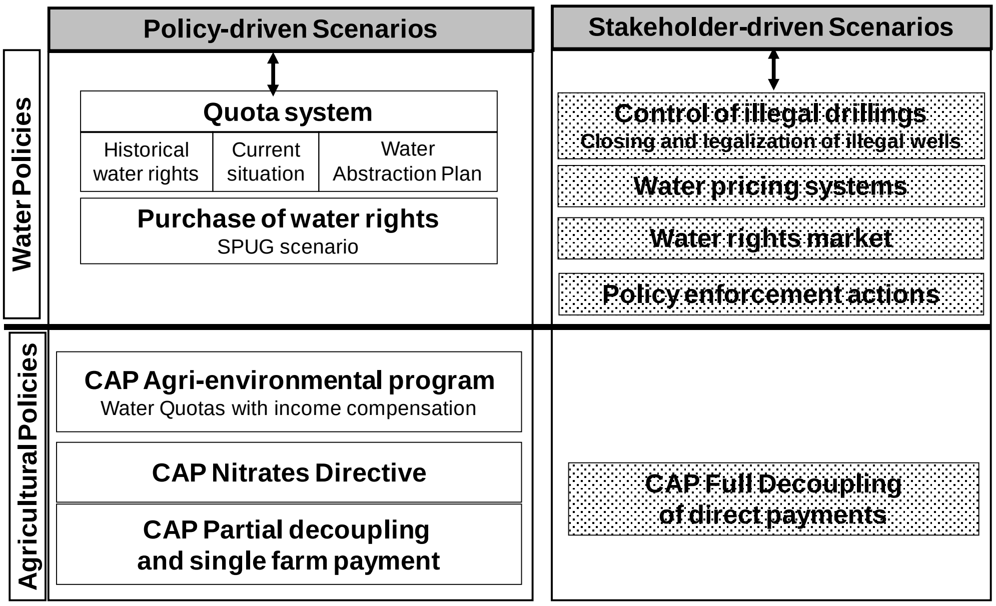
Stakeholder-driven scenario building

The scenario-building capacity of the stakeholders is one of the advantages offered by the participatory approach. Engaging stakeholders in the participatory development of scenarios and storylines is recognized as an essential tool for understanding water complex systems (Kok et al, 2006b; Kok and Alcamo, 2007, Ledoux et al 2005). Scenario development is not indented to be a forecast but if internally consistent it provides a plausible vision of the future and may foster local actions to cope with potential hazards of water regimes (Rosegrant et al, 2002; Purkey et al, 2007). In this respect, multi-scale narrative storylines and participatory local scenario development contributes to develop region-specific strategies for water stress conditions under different social settings and policy constraints (Levité et al, 2003, Kok et al 2006a; Berkhout et al 2002).

For the Guadiana setting, the development of scenarios has been one of the cornerstones of the participatory process. Figure 5 summarizes the steps involved in the scenario building process. As shown, successive stakeholder meetings allow for an iterative approach. Modeling tools and baseline information were discussed during the initial meetings, while subsequent encounters served the purpose of validating the results of modeling work. Thus the scenario-design process comprised several steps, including an initial study of the general framework that catered for hydrological, agronomic, socio-economic and political framework analyses. Fieldwork and stakeholder mapping in the study area ensued, providing a knowledge base about characteristics of farms and crops in the Upper Guadiana Basin, and about stakeholder interests and potentials. This knowledge base allowed to develop a series of questionnaires for each of the different thematic meetings, aimed at guiding the discussion on socioeconomic, institutional and hydrological aspects of water management. Discussion outcomes were used to elaborate a matrix of results. Outcomes were presented to the stakeholders for validation, and led to the elaboration of a final report for each of the meetings.

Figure 6 shows the water and agricultural policy scenarios, both policy-driven and stakeholder-driven, which have been simulated in the study. Policy drivers have been used to elaborate a set of simulations based on the public policies currently in place in the Upper Guadiana basin. As stated above, these include water policies and agricultural policies, namely the WFD requirements or the CAP programs alongside with the national water policies under different types of policy instruments. These are water quotas, agri-environmental programs, CAP partially-decoupled payments, single-farm payments and nitrates directive regional requirements.

Figure 6. Water and Agricultural policies Scenarios simulated in the economic and hydrology models



On the other hand, those drivers identified by the stakeholders have also played a part in the simulations. In the case of the economic models, these include a series of policy options. Namely, the establishment of a water rights' markets, legalizing illegal wells (Varela-Ortega and Blanco, 2008), selling water rights to a public water distribution agency (Carmona et al, 2010; Varela Ortega et al. 2010), the capacity of the water authority to enforce the legally established water quotas and the vulnerability of the different types of farmers (Varela-Ortega et al. 2007).

Hydrological modeling work caters for the most relevant of these scenarios and policy instruments for groundwater conservation purposes and aquifer's long-term sustainable management, while it also includes other potentially important drivers such as climate change and drought spells (Varela-Ortega et al. 2010).

Model building

In the case at hand, all the models stem from an explicit stakeholder request The central idea of the groundwater modeling exercise is to explore the vulnerability and the capacity to adapt of the ecological and social systems of the Mancha Occienetla aquifer to an uncertain and changing water regime. The hydrology and economic models capture a series of policy-based trade-off options between water for agricultural livelihoods and water for nature protection.

Economic modeling aims at assessing the impacts of different policy settings (shown in figure 6) on the social and economic components of the area, such as farm income, public expenditure and overall cost-effectiveness. In the case of the Guadiana Basin Authority or the environmental conservation groups, model building and results refers to the possibility of recovering the aquifer and its associated wetland ecosystems within the deadlines of the WFD. On the other hand, farmers are more interested on whether groundwater resources are more likely to run out and, in turn, whether agricultural production will continue to be their major source of living.

The model building distinct characteristic is the integration of an agro-economic model with a hydrology model, defined along a time and space horizon. Both models are, respectively, a stylized mathematical facsimile of the wide-ranging agronomic and socio-economic systems and of the complex water system. Models are able to reproduce the complexity of the dynamic behavior of the human and ecological systems and were developed by the researchers, given that mathematical modeling falls generally out of the scope of the stakeholders' participation. However, stakeholders were involved during the identification of the main drivers and the scenario design stages of the process. For the calibration and validation stages of the hydrology model, only the more technically trained stakeholders of the RBA participated. However, irrigators, farmers union's representatives and technical personnel of the regional agriculture department were directly involved in the validation of the results of the agro-economic model.

The modeling integration methodology is depicted in Figure 7 where the two levels of aggregation are specified for the farm level and the basin level analyses. The economic model represents farmers' behavior confronted with different types of water and agricultural policy scenarios. These were defined by the policy drivers identified in the participatory stakeholder meetings (see figure 6). The model is an agro-economic farm-based non-linear mathematical programming model of constrained optimization in which the objective function maximizes the farmer's utility subject to technical, economic and policy constraints. The model incorporates a risk component that considers climate as well as market prices variability. The farm-based model is up-scaled to the region's level using the statistical representation of the different farm types (Varela-Ortega et al 2008). The hydrology model WEAP21 (Water Evaluation and Planning System, SEI, 2008), has been adapted, calibrated and validated for the Guadiana river basin. Figure 8 shows the WEAP model layout for the Upper Guadiana basin (Varela Ortega et al. 2006; Varela-Ortega et al. 2010). This representation includes the major rivers and aquifers, the agricultural and domestic water demand nodes, the water supply sources and all hydrology transmission links.

The WEAP hydrology model allows the analysis of hydrological parameters under different climate and policy scenarios and its robustness has been proven in an ample selection of worldwide applications (Levité et al ,2003; Yates et al, 2005; Purkey et al, 2007; Assaf and Saadeh, 2008; Purkey et al, 2008). Integration of the hydrology and economic models permits to grasp the overall complexity of the water and socio-economic systems and has been used to address multi-level water issues in a varied number of basins over the world (Rosegrant et al, 2002; Jenkins et al, 2004; Brouwer and Hofkes 2008). It has also proven to be an effective tool for tackling Spain's multifaceted river basin management challenges (Pulido-Velazquez et al. 2008). In this case, hydro-economic modeling integration is carried out by mapping the selected representative farms in the geographical locations of the irrigation communities of the basin in the WEAP platform and simulating the same policy scenarios in both models. For a given policy scenario (e.g. the application of the decupled CAP payments or the purchase of water rights from the irrigators) , the results of the economic model related to water use in the different farm types are then used as an input to the hydrology model. Then, the WEAP model can up-scale at basin's level the on-farm water consumption results and perform the assessment, for different policy and climate scenarios, of the overall availability of water resources in the aquifer. This allows evaluating the recharge capacity of the aquifer in each of the scenarios, on a dynamic short-term and long-term basis, and thus the compliance with the WFD policy requirements along the established time horizon deadline of 2027.

Figure 7. Methodological Scheme of participatory modeling integration (adapted from Varela-Ortega et al. 2010)

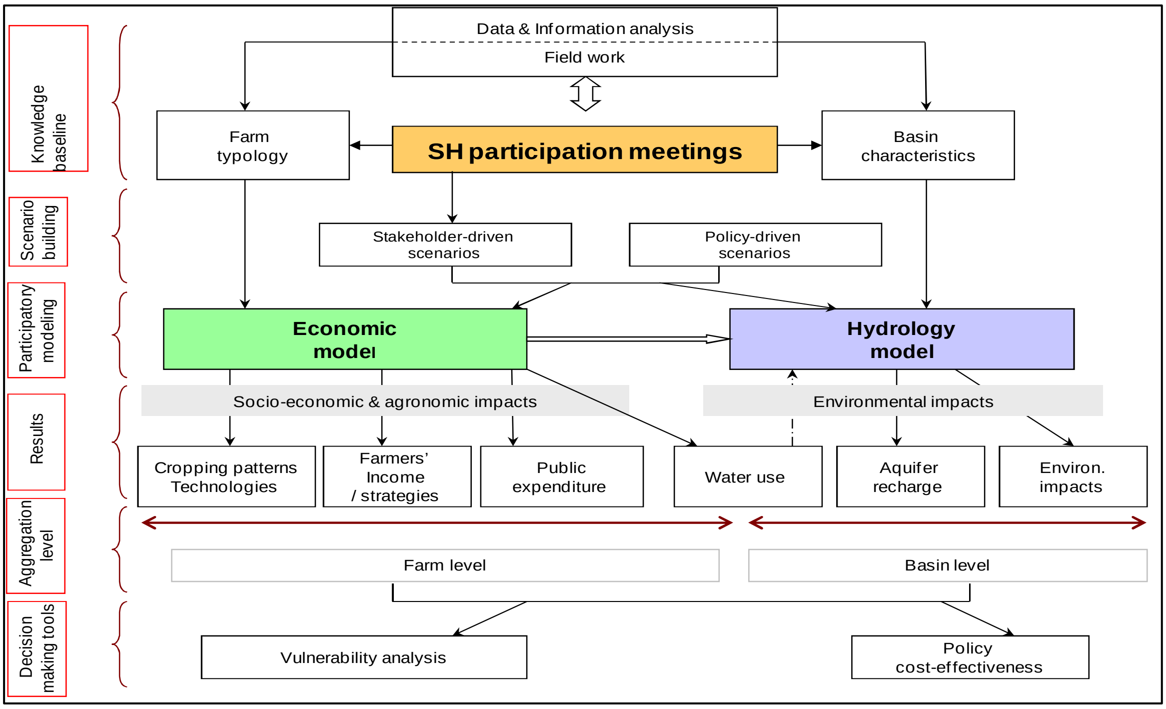
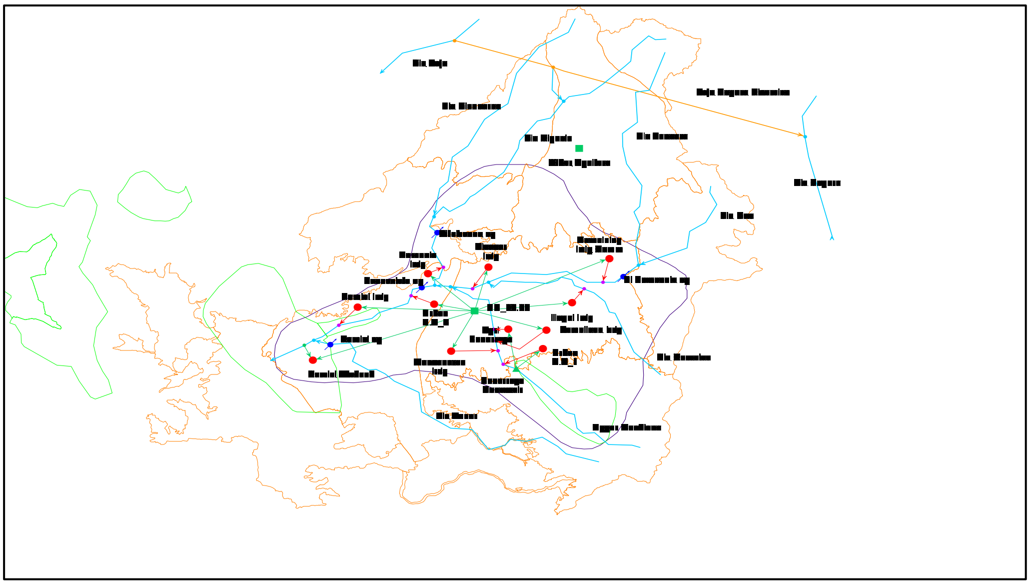


Figure 8. Hydrology model WEAP layout for the Upper Guadiana basin (contour refers to the UNESCO Biosphere reserve area) (Varela-Ortega et al. 2010)



RESULTS AND DISCUSSION

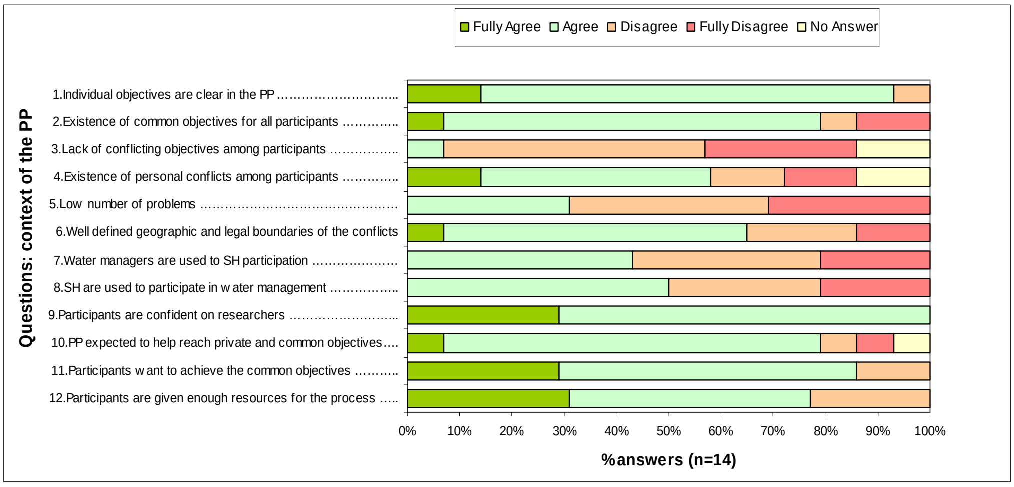
The participatory process

Results of the stakeholder meetings have been used for several purposes, as it has been explained in the previous section, mainly for linking the sequential participatory process and for the validation of the modeling tools. They are also being used by the Guadiana Basin Authority as a basis from which to develop the public participation process required by the WFD for the elaboration of the new basin management plans.

Participation throughout the entire process was fairly consistent, with representatives from the main stakeholder groups participating actively in all the meetings. Perhaps it was those without access to formal participatory structures who considered that they benefited most from this process, since they had access to decision-makers and other interest groups and were able to discuss issues and build alliances that may not have been possible in more formal settings

(Correa, 2007b). The involvement of the stakeholders in the project was evaluated during the first stages of the project by an external evaluator (Correa, 2007a). At this early stage, most stakeholders perceived that conflicts among stakeholders in the basin were high but they were confident that the public participation initiative would bring better understanding among them (Figure 9). Although participatory engagement from either the RBA representatives or the water users was very recent at the time, it was already perceived as a requirement of the WFD program. Confidence with the research team was fully expressed by all the stakeholders and their willingness to achieve common objectives was perceived by over 90% of the group's participants.

Figure 9. Summary of the Stakeholders' opinion on the context of the participatory process (PP) at the beginning of the project (2006) (own elaboration from Correa, 2007 a)



At the end of the project, a formal questionnaire-based evaluation of the participatory process was conducted during a specific stakeholder meeting held in November 2008 in Ciudad Real, one of the region's main capitals and the provincial hometown of the majority of the stakeholders. The design of the questionnaire was supported by the four-year research experience in the basin, specialized literature (Rowe and Frewer, 2000, Beierle and Cayford, 2002; Rowe and Frewer, 2004) and von Korff's methodology tailored to the basin-specific characteristics of the Newater project (von Korff, 2007). The questionnaire included a general evaluation of the participatory process, specific questions related to the context, development and results as well as an evaluation of the different modeling tools developed along the project. Being the last meeting of the project where the final results were to be presented and discussed, it attracted considerable attention. Thirty-eight persons attended the meeting, well above the usual attendance to precedent meetings. All stakeholder groups had a fairly similar representation than in the rest of the project's meetings, namely, 40% public administration officials from the water and agricultural regional departments, 20% water users associations, 10% nature conservation groups, 25% private organizations and 5% research institutions (omitting the ones directly involved in the project). The bias towards the public sector responds to the necessity of the water administration department to accomplish the river basin management plans under the participatory-based mandate of the WFD.

Based on the evaluation results, a large majority of the stakeholders considered that their main objective for engaging in this participatory four-year experience was the learning experience, with a clear tilt towards the basin's regionally based and site-specific issues. In particular, their expectations pointed towards increasing their knowledge of participatory management tools (27% of all answers), learn from other opinions and increase understanding and dialogue (26%), learn from the results of the project (18%), and much less to get acquainted with the EU global policy issues (3%). In total, the learning component accounted for almost 70 % of all answers. Finding specific solutions to the basin's problem or contributing with personal visions was not a widely perceived expectation (only 9% respectively of all answers).

Table 1 summarizes the results of the general evaluation of the process, for the whole group as well as for the type of stakeholder (ranked in a 0 to 10 scale). As it had been clear all along the project, the atmosphere of the meetings was a key element for the success of the participatory process. It is ranked the highest followed by the methods used and the results of the participatory process. This ranking holds across all stakeholder groups. Of the most directly concerned stakeholders, the nature conservation participants were less satisfied with the process than their counterparts, such as the irrigators or the water administration officials. This is not surprising if we consider that the main environmental problem in the Upper Guadiana has been the long-lasting overexploitation of the aquifer and the derived loss of he associated wetlands. Water users tend to be a more homogenous group than the rest of the stakeholders, evidenced by a lesser dispersion in their opinions (lowest SD). This result is consistent with our experience along the project meetings where irrigators showed generally a higher degree of cohesion as a group.

Stakeholder Group	Methods				Atmosphere of Meeting				Final Results of the Process			
	Max	Min	Average	SD	Max	Min	Average	SD	Max	Min	Average	SD
General (all groups included)	9	4	7.1	1.5	10	6	8.3	1.2	9	4	6.9	1.4
Water and Agriculture Public Administration	9	5	7.4	1.3	10	6	8.4	1.3	8	5	6.7	1.0
Water Users Associations	8	7	7.3	0.5	8	8	8.0	0.0	9	7	7.8	1.0
Nature Conservation Organizations	8	4	6.0	2.8	8	7	7.5	0.7	6	5	5.5	0.7
Environment and participation private firms	8	3	6.4	2.1	10	6	8.5	1.9	8	4	6.4	1.5
Research Centers (not related to project)	9	7	8.0	1.4	9	9	9.0	0.0	9	9	9	0.0

A more detailed evaluation of the participatory process is shown in Figure 10. From a general viewpoint, the stakeholders consider that, in spite of the conflicts that existed among them at the beginning of the project, they had largely fulfilled their participation objectives. Around 80% of the participants consider that the stakeholders in the basin had been well represented, that their opinions had been heard and that the process had contributed to increase transparency on the basin’s data and information. Confidence with the research team was amply reassured as well as its ability to hold the meetings in a neutral atmosphere and to provide them with all the necessary means to facilitate their participation.

Figure 10. Summary of the Stakeholders' evaluation of the participatory process: Full project assessment (2005-2008)

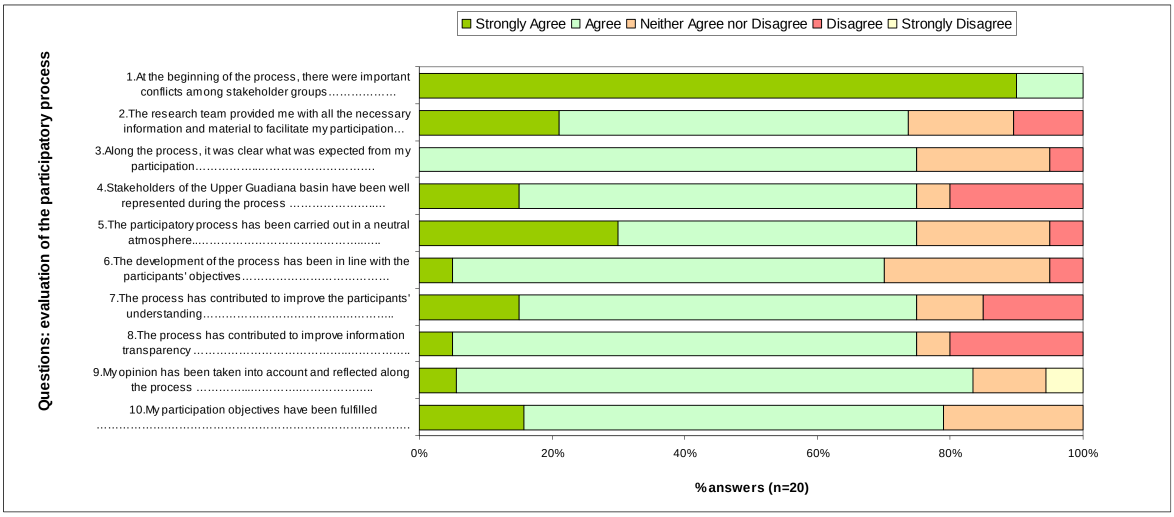
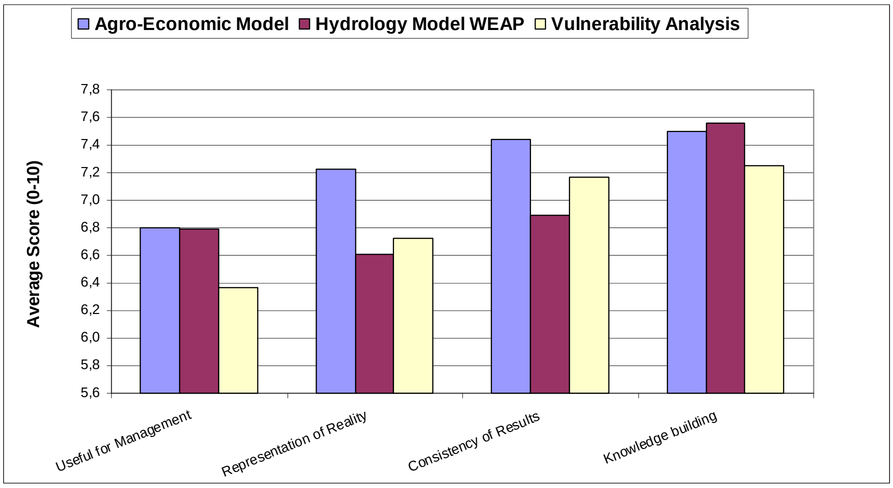


Figure 11 shows how stakeholders have valued the modeling tools that were developed along the project. The evaluation comprised different objectives, such as their usefulness for water management, how well they represent the basin’s reality, how consistent were the results obtained and how they helped to increase their knowledge about the basin. Knowledge building is perceived as the most important issue of the participatory modeling experience for all types of tools. In general, stakeholders consider that the agro-economic model has fulfilled their expectations, in the sense that it represents their agronomic and socioeconomic setting accurately and that the results are consistent with their visions. Again, this is not surprising, as this type of modeling has required an intense field work in which stakeholders have been directly involved and have interacted extensively with the researchers. Whereas in the case of the hydrology model, there was only a reduced number of technically trained stakeholders involved in the calibration and validation activities. The vulnerability analysis has also enhanced the stakeholders’ knowledge of the basin and it is perceived as a consistent tool. It is worth mentioning that this type of analysis stems from both the economic and hydrology models and it shows how vulnerable are the different types of farms (i.e how much income is lost) in different types of scenarios, including the ones that seek the recovery of the aquifer. Thus the combined socio-economic and water vulnerability results show that it is unlikely to find a win-win solution that will give way to undisputed advice for addressing the basin's water management problems.

Figure 11. Evaluation of Modeling Tools: Full project assessment (2005-2008)



However, in spite of the limitations inherent to participatory modelling (e.g. proper representation of all actors concerned, limitations of the tools chosen, as it is being discussed by Lynam et al, 2007, Hare et al, 2003; Webler et al, 2001, among others), the
results of the participatory modeling initiative have been promising. They show that the most directly-concerned stakeholders (RBA staff, nature conservation groups and irrigators) have profited from the process and enlarged their knowledge of the basin, especially in relation to the field-work based agronomic and water modeling results. Other authors have also found that the learning experience and enhanced knowledge of the water system are one of the positive outcomes of this type of research. Take for instance the recent work by Videira et al, in the Portuguese part of the Guadiana basin (Videira et al, 2009) These observations allows for optimism as water planning and decision-making in the basin becomes more open and participatory in the context of the new WFD regulatory framework.

Modeling tool development

For the purpose of illustrating the participatory modeling research, this section includes only a small selection of the results that have been obtained in the hydrologic and agro-economic modeling research (more detailed results can be found throughout different publications, among others, in Varela-Ortega et al.2010)

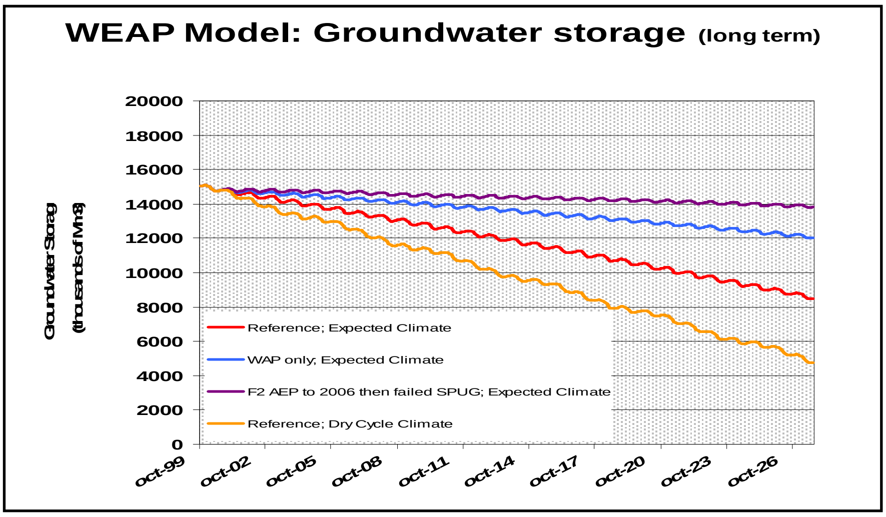
The hydrology component

Figure 12 shows the long-term simulation results of the WEAP model that will assess the groundwater storage in the whole aquifer and therefore the aquifer recovery rates for the simulated policies and climate scenarios. This simulation period was selected because all policies were in operation during those years and, therefore, it permitted the short-term and long-term comparison of the different agriculture and water policy scenarios. For these simulations, an initial storage capacity to the aquifer is set to 15,000 Mcm, a value that corresponds to the aquifer estimated storage capacity under natural conditions. As we can see, the reference scenario is the one that reduces the most the groundwater storage. This is reasonable, considering that no limitations to water abstractions or to illegal irrigation are imposed. During the period 1999-2005, groundwater storage diminished by 3,300 Mcm. These figures are within the order of magnitude of the figures provided by the Guadiana RBA, that estimates a much lower volume of abstractions for irrigation compatible with the natural recharge of the aquifer (260 Mcm per year) (CHG 2006)**.** The Water Abstractions Plan (WAP) start-up reduces the quantity of water abstracted and it supposes a 700 Mcm improvement compared to the reference scenario. The joint application of the Agri-Environmental Program (AEP) still favors the aquifer recuperation, but it is not enough to stabilize groundwater storage.

The scenario 'reference without illegals' shows the weight of illegal abstractions in the aquifer. Progressive elimination of illegal abstractions, up to their extinction in 2005, succeeds to stop the fall on water storage in the aquifer up to values that are similar to those obtained with the application of the WAP. This considers that two farm types accept voluntarily the 50% reduction in water consumption of the Agri-Environmental Program (scenario

F3&F4 AEP Program). But certainly, the scenario which best fits with the objective set is 'All AEP, no Illegals, all normal climate', that succeeds to revert the continuous depletion on the water table in the aquifer observed in 2004-2005. This will not be possible in the case of persistent drought. The long-term assessment of the aquifer recharge capacity shows that the environmental objectives of the WFD of recovering the exhausted aquifer by 2027 will be achieved only if the regional water plan, Special Plan for the Upper Guadiana (SPUG) is implemented to its full capacity. That is, in the case that farmers are willing to sell their water rights at the established purchase prices.

Figure 12. Long term results of the Hydrology model WEAP. Groundwater Storage (Varela-Ortega et al, 2010)



The socio-economic component

Figures 13 and 14 show, a selection of the results of the economic model that refer to the effects of the different policy programs on farm income and cropping patterns respectively (Blanco et al, 2010, Varela-Ortega and Blanco, under revision). Farm types were obtained in the field work analysis carried out in 2005, 2006 and 2007, and represent statistically the cropping systems in the area. These are namely, a small vineyard farm (F1), a medium-size diversified horticulture-oriented farm (F2), a medium-size, less diversified cereal-oriented farm (F3) and a large lower quality diversified farm (F4) with a larger cropping mix potential. For the purpose of integration, the scenarios simulated in the agro-economic model are the same as the scenarios of the hydrology model WEAP.

In the case that the WAP operates to its full application, all farm types will lose a considerable amount of income. The large more extensive and diversified F4 farm is less vulnerable to a sharp reduction in water availability. In fact, it is the only farm type that is willing to join the income-compensation Agri-Environmental program and cut irrigation all together. Passing to rainfed is dependent on size and crop mix potential evidencing that economies of scale operate for rainfed farming. On the contrary, the small vineyard farm F1 cannot adapt to a sharp reduction in water available under the WAP. Income loss is sharp and indicates that this type of farm is prone to cut farming activity in spite of a high adaptation of vineyard cultivation to modern irrigation technologies. As the envisaged agricultural policy reform enters the scenes (with farm subsidies fully decoupled from production) results show that rainfed farming is encouraged which provides an added strategy to cope with water shortages. In sum, there are synergies between the foreseen evolution of water and agricultural policies in the area.

Figure 13. Results of the agro-economic model: Effects on farm income (based on Varela-Ortega et al 2010)

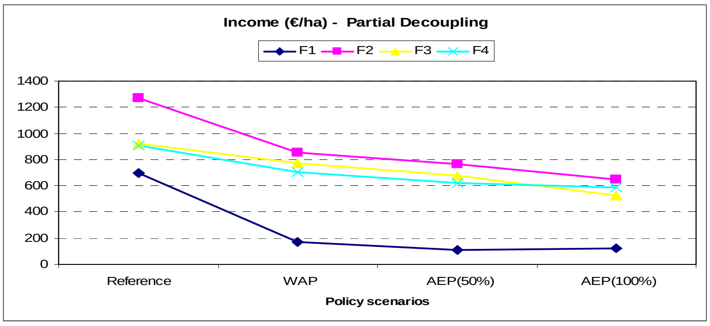
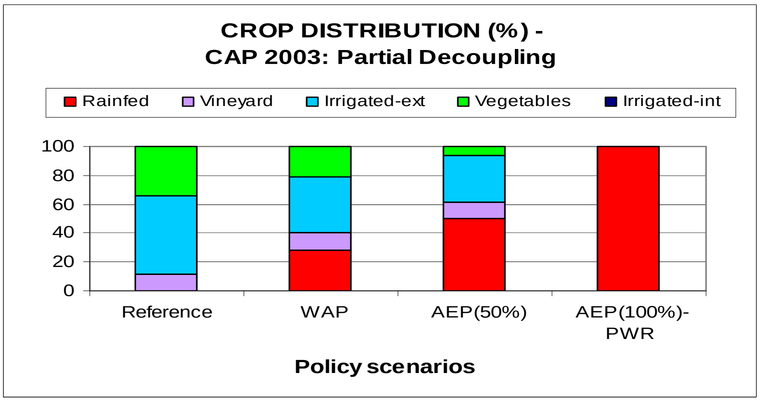
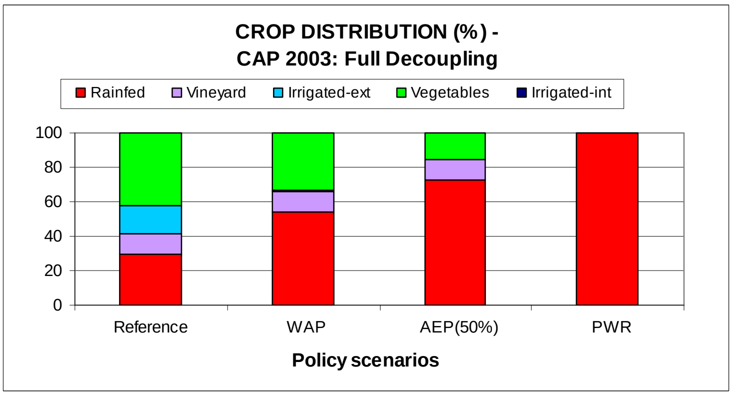


Figure 14. Results of the agro-economic model: Effects on cropping patters (based on Varela-Ortega et al 2010)





CONCLUDING REFLECTIONS

On the stakeholders' participatory process : The Upper Guadiana basin provides an example of the conflict between socioeconomic development based on intensive groundwater irrigation and the conservation of valuable wetland ecosystems. This paper exemplifies how an active and sustained participation of the stakeholders thorough an organized open non-binding forum may, despite its limitations, contribute to deal with these issues.
Stakeholder involvement is the pivotal element of the research endeavor, carried out through a series of meetings in which all key players were represented. Stakeholder discussions suggest that there is more agreement among different groups than it is apparent, particularly in what pertains to the main challenges and possible alternatives to tackle them. In fact, many of the conflicts that exist result from a lack of commonly shared information on basic management parameters, such as how much water is available and how much can be abstracted for restoring the aquifer. This has allowed for varied interpretations and for gearing public opinion in a highly emotional issue such as water. Therefore, transparency in data and information for water management decisions could alleviate conflicts and facilitate cooperation among different stakeholders and decision-makers. In this sense, the Upper Guadiana process shows that participation in the building of tools and decision-making scenarios has certainly enhance the actor's knowledge of the human and water systems. This knowledge building can help to reach consensus about different management alternatives, and the consequences of those alternatives, are shared and discussed by all

On the participatory modeling: The combined agro-economic and hydrology modeling shows that balancing the trade-offs between protecting ecological and human systems in the Upper Guadiana is not easy. Win-win solutions are not likely to occur without a considerable amount of public funding. This is hardly surprising given the long-standing nature of the problem. Meeting the objectives of the WFD of good ecological status of the aquifer by the mandatory deadline of 2027 will be difficult. Only the most favorable climate and policy scenarios may recover the water table by then, while it remains questionable whether these alternatives will be economically viable, socially acceptable and cost-effective.

Water conservation policies that are being implemented in the Upper Guadiana basin can contribute to reduce water consumption in the individual farms. However, illegal pumping may offset the effects of these policies at the basin's level even if limitations on water consumption are imposed on legal users. Thus, water savings can only be attained if additional measures aiming to reduce illegal abstractions are put into practice, such as the purchase of water rights of the new regional water management plan (SPUG).

If strictly enforced, water-saving policies may also inflict significant farm-income losses. Small farmers, whose ability to diversify the crop mix is lower, will be the most vulnerable. As these policies entail strong social opposition and hence high implementation costs, stronger stakeholder participation and awareness is crucial for the sound and socially accepted implementation of the policies.

From the perspective of water management decision-making, it seems safe to state that, overall, the modeling exercise has succeeded in enhancing stakeholder knowledge about the social and water systems by identifying the main drivers and by narrowing down some of the key uncertainties that hamper groundwater management in the area.

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