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ORIGINAL ARTICLE

Participatory analysis for adaptation to climate change in Mediterranean agricultural systems: possible choices in process design

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Abstract There is an increasing call for local measures to adapt to climate change, based on foresight analyses in collaboration with actors. However, such analyses involve many challenges, particularly because the actors concerned may not consider climate change to be an urgent concern. This paper examines the methodological choices made by three research teams in the design and implementation of participatory foresight analyses to explore agricultural and water management options for adaptation to climate change. Case studies were conducted in coastal areas of France, Morocco, and Portugal where the groundwater is intensively used for irrigation, the aquifers are at risk or are currently overexploited, and a serious agricultural crisis is underway. When designing the participatory processes, the researchers had to address four main issues: whether to avoid or prepare dialogue between actors whose relations may be limited or tense; how to select participants and get them involved; how to facilitate discussion of issues that the actors may not initially consider to be of great concern; and finally, how to design and use scenarios. In each case, most of the invited actors responded and met to discuss and evaluate a series of scenarios. Strategies were discussed at different levels, from farming practices to aquifer management. It was shown that such participatory analyses can be implemented in situations which may initially appear to be unfavourable. This was made possible by the flexibility in the methodological choices, in particular the possibility of framing the climate change issue in a broader agenda for discussion with the actors.

Keywords Climate change adaptation · Foresight analysis · Groundwater · Participatory processes

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Introduction

The participation of local actors in the development of adaptive management to climate change has often been considered as a cornerstone of its success (Commission of the European Communities 2007, Lim et al. 2005). The many experiments which included the participation of actors implemented—and often designed—a wide range of methods. The diversity resulted from the choices made by the teams in charge of the design and implementation of the participatory process.

The teams who designed the processes presented in the present paper faced challenges usually encountered in

broader multi-stakeholder processes (Warner 2007). For instance, Eakin et al. (2007) reported on a participatory analysis of adaptation to climate change the actors decided not to join for strategic reasons. However, a specificity of the processes concerned with adaptation to climate change is the gap between the stakes perceived by local actors and the stakes scientists perceive as being linked to climate change. Indeed, the time horizons may be completely different. People often fail to perceive major changes in the climate, particularly because such changes occur over a period longer than one generation (Hulme et al. 2009). Members of the general public may not consider themselves sufficiently involved to discuss this long-term issue (Lorenzoni et al. 2007). In addition, economic actors usually place more importance on the short term and rarely look beyond 2020 to 2030, while current climate change simulations generally cover the period between 2050 and 2100. For these reasons, climate change and even climate variability may not be a key issue for actors involved in the economy and governance of local territories (Kock et al. 2007; Mertz et al. 2009; Shisanya and Khayesi 2007).

Reports on participatory processes aimed at discussing possible adaptation to climate change generally focus on the adaptation strategies themselves. More rarely, they include an evaluation of the implementation of the participatory process *per se*, particularly the way the implementation team addressed the above-mentioned challenges. Only a few reports (e.g., Patel et al. 2007) explain how they took such challenges into account right from the start of the design process. When this is the case, the authors generally focus on cognitive issues, that is, how to support actors' understanding of the dynamics and impacts of climate change (Loibl and Walz 2010; Shaw et al. 2009). The experiences reported were often based on a single case and provide only indirect information about the factors the team took into consideration when designing the participatory process.

The present study analyses the experiences of three research teams whose aim was to define and assess strategies for adapting agricultural and water management to climate change in collaboration with local actors. It focuses on the way the teams adapted an initial common framework to design processes adapted to local circumstances, and on the factors the teams took into account when making their choices. The experience took place during the Aquimed research project (2008–2010). The aim of the Aquimed project was to develop methods to support local actors in undertaking foresight analyses and assessing adaptive management strategies related to groundwater resources and uses, in the context of climate change.

The project was implemented at three Mediterranean study sites, one in France, one in Morocco, and one in Portugal, where significant climate change is expected (Arnell 2004). The Portuguese and Moroccan study sites border the Atlantic Ocean but are considered as part of the Mediterranean area in terms of climate characteristics, ecosystems, and the fact that agriculture increasingly has to compete with tourism and urban development for land and water use. Moreover, in models of climate change, these regions are considered to be part of the Mediterranean zone.

All three study sites are in coastal regions, where agriculture makes intensive use of groundwater, and where aquifers are at risk or are currently overexploited. As a consequence, and since climate models predict less rainfall between 2040 and 2070 than between 1960 and 1990 (García-Ruiz et al. 2011), such areas will be especially vulnerable to the impacts of climate change. Indeed, the decrease in rainfall is expected to reduce aquifer recharge. Furthermore, if farmers continue to irrigate the same amount of land and types of crops, they will increase groundwater use to compensate for decreased rainfall and increased evapotranspiration. In the agricultural sector, possible adaptation actions can be implemented at farm level (e.g., changes in agricultural practices and crop choices). They can also be implemented at the regional agricultural level (e.g., more water productive agri-food supply chains). They can also include improved governance of surface and groundwater resources.

Discussing adaptation to climate change with local actors at all three study sites was not a given from the outset. All three agricultural sectors were in crisis, meaning getting farmers to discuss long-term issues when they had many short-term problems to overcome was a challenge. Furthermore, water withdrawn from the aquifer was not controlled. Apart from these similarities, the study sites were quite different, particularly the degree of overexploitation of the aquifer and the organizational set-up for water resource management.

Although the study was conducted by a different research team at each site, the three teams collaborated and exchanged both information and their experiences throughout the project. At the start, the researchers decided that although they had a common overall objective and a common framework, they would allow themselves flexibility in the design and implementation of the participatory processes to enable them to take their initial assessment of each site into account.

The research teams addressed four main issues in planning the participatory process: (1) whether to avoid or prepare dialogue between actors[1] whose relations are

[1] Here, we use the term "actor" since, as mentioned above, local actors may not initially consider they have any stakes in climate change, so the implication of the term "stakeholder" cannot always be taken for granted at the beginning of the participatory process. Even if they acknowledge being affected by a particular issue, actors may also be quite happy to leave the responsibility for handling it to the authorities (Warner and de Groot 2011).

limited or tense; (2) how to select the participants and how to get them involved; (3) how to enable discussion of issues that the actors may initially not consider to be of interest; and (4) how to design and use scenarios. These four issues were dealt with separately for analytical purposes, but in reality, they are interlinked and influence each other. For instance, the choice of the actors partly determines which topics will be discussed and how the topics are presented. Moreover, the actors' understanding of the impacts of projected climate change may influence the importance they give to the issue. Other issues were taken into consideration, such as the spatial scale of scenarios, but their analysis is beyond the scope of the present paper.

The paper is organized as follows. The study sites and the main components of the participatory processes are described in the following section. The choices made at the three study sites concerning the four issues listed in the preceding paragraph are then described. First, the choices made with respect to each of the four issues in other participatory research processes for adaptation to climate change are presented. Then, each subsection describes the original situation the researchers assessed with regard to the issue at stake, the choices that were made, and some of the consequences of these choices. This is followed by a brief presentation of the results of the participatory processes. A detailed account of each case study with its results is described in Bento et al. (2012), Faysse et al. (2012), Richard-Ferroudji et al. (2011), Rinaudo et al. (2012a, 2012b). The discussion section recalls the main factors taken into account by all three teams when designing the participatory processes, and reviews lessons to be learned in terms of responding to the increasingly pressing call to identify possible adaptations to climate change through participatory analysis with local actors.

Overview of participatory research processes

Case studies

In France, the Roussillon Plain aquifer is located along the south-western part of the Mediterranean coast. This aquifer is intensively used for drinking water, for tourism-related activities, and for agriculture. Agriculture is mainly irrigated (approximately 73 % of the land is under surface irrigation and 27 % is equipped for drip irrigation) for the cultivation of tomatoes, cucumbers, potatoes, artichokes, and fruits (grapes, peaches, nectarines, and apricots). The average farm size is 18 ha. The drop in the water tables, which began 30 years ago (Montginoul and Rinaudo 2009), is expected to continue as the population continues to increase and the farming sector progressively abandons surface canal irrigation systems in favour of wells and boreholes. In response to the increasing pressure on the groundwater, local authorities and government agencies have actively supported the establishment of a participatory forum, called the Local Water Commission. This forum brings together all major actors to debate actions to be implemented as part of a formal Local Water Management Plan. The catchment management agency is trying to introduce individual water meters and to limit groundwater withdrawals. Farmers are well organized and represented in the Local Water Commission. However, they deny the existence of a groundwater management problem and are reluctant to accept formal groundwater allocation mechanisms (Montginoul and Rinaudo 2009).

The Querença-Silves aquifer is the largest groundwater resource in the Algarve Region (south of Portugal). The aquifer is used for irrigation, drinking water, and tourism. The average farm size is 9 ha. Larger farms (generally above 20 ha) specialize in citrus production, and small farms (from 1 to 9 ha) specialize in market garden crops. Both types of farms also grow almond, olive, and carob trees. Almost all farms use drip irrigation. The use of the aquifer has not yet resulted in overdraft, and a drop in the groundwater table only occurs during periods of severe drought. However, expected increases in groundwater demand as well as a reduction in recharge may cause overexploitation in the future (Stigter et al. 2012). In 2009, as part of the implementation of the European Water Framework Directive, the local catchment management agency started work on a plan. The plan, which provides the basis for the management of surface and ground water, had a weakly implemented participatory component. Traditionally, such issues have not been subject to public debate in Portugal. Even more unusual is the participation of local actors in the design of public policies, in fact both administration staff and local actors were taking their first steps in participatory processes.

The coastal Chaouia region is situated south of Casablanca on the Atlantic coast of Morocco. Farmers grow vegetables (mostly with drip irrigation), forage, and cereal crops (see Berahmani et al. 2012, for a typology of farms). Ninety percent of farm land is privately owned (the remainder being under collective ownership); 65 % of farmers cultivate less than 5 ha, and 27 % cultivate between 5 and 10 ha. Groundwater has been intensively used for irrigation since the 1970s. Groundwater overuse has led to sea water intrusion in coastal land and to a fall in groundwater levels inland. Groundwater stress was the determining factor in the change from flourishing export-oriented agriculture to the regional crisis. Two catchment management agencies are in charge of the area but have very limited capacity for action. No groundwater management system is currently implemented or even planned. In 2009, a regional agricultural plan was designed which

included bringing surface water to part of the area. This plan was drawn up by the administration with very limited participation of farmers. Like in Querença-Silves, the few existing farmers' organizations were not formally involved in decision-making concerning water resources and agriculture.

Despite the agricultural crisis, in all three study areas, agriculture has been designated as the sector that most needs to reduce groundwater use. In Chaouia, agriculture is almost the only user of groundwater. In the two other areas, drinking water is a major component, and this use takes priority over the agricultural sector. The three cases differ in five major aspects (summarized in Table 1), and these had an impact on the way the participatory research processes were designed.

Workshops

In each study area, a series of workshops was held with farmers and staff of public organizations. All the workshops were organized in a broadly similar way (Fig. 1). The participatory processes did not include all possible dimensions of adaptation to climate change but focused on agricultural practices on the farm, types of agriculture and their regional organization, and collective water management.

In Roussillon, three series of workshops were held with each of three different groups of farmers (the exact composition of each group is described below). In the first workshops, participants were invited to comment on four regional agriculture development scenarios for 2030. The second workshops dealt with scenarios portraying future levels of water scarcity and possible regional impacts of climate change on agriculture in 2050. This information was presented to encourage the discussion of possible actions that could be undertaken at farm level to improve adaptive capacities to such changes. In the final workshops, three groundwater management scenarios for 2050 were discussed. Similar workshops were organized with staff of the public organizations in charge of agriculture and water management. The final meeting brought together the farmers and the staff of the public organizations.

A similar procedure was followed in Querença-Silves involving two groups of farmers and a group of institutional stakeholders (staff of public water authorities, NGOs, and scientific experts). An additional preliminary workshop was held with the farmers to assess past and current trends in the agricultural sector and to gather information for the design of scenarios.

In Chaouia, the first series of workshops with three different groups of farmers were dedicated to diagnosing current agricultural dynamics in their villages and identifying key driving factors. The second series was dedicated to designing scenarios of agricultural development at village level, based on assumptions regarding the driving factors. A third workshop was held with representatives of the three farmers' groups to share the work accomplished up to then and to build scenarios for the development of the whole area. A similar procedure was followed with the staff of public organizations, which mainly included staff of the Ministry of Agriculture. These preparatory workshops were followed by a joint regional meeting in which the participants presented the results of their work.

Table 1 Main differences in the three study areas

	Roussillon	Querença-Silves	Chaouia
Imbalance between groundwater withdrawal and groundwater recharge	Limited	No	Strong
Farmers' awareness of groundwater scarcity	Limited	None	Strong
Organizational set-up for groundwater management	Started	Planned	No plan
Official scenarios for agricultural development	None	None	Yes
Role of local farmers' organizations in public arenas	Presence of official planning and management platforms, but limited leverage over decision-making	Weak	Weak

Four common issues in designing the processes

Avoiding or preparing dialogue between actors whose relations are limited or tense

In situations where relations between actors are tense or actors have limited experience in exchanging ideas and opinions with other people, research-led processes have been successfully implemented with separate groups of actors (Lövbrand et al. 2009). Preliminary workshops can also be held separately with the aim of building the participants' capacities, so that later, when a joint workshop is held, social learning can take place (Daniell et al. 2011; Imache et al. 2009).

The three case studies reviewed here differed considerably in this respect, although the research teams all organized separate preliminary workshops with the farmers

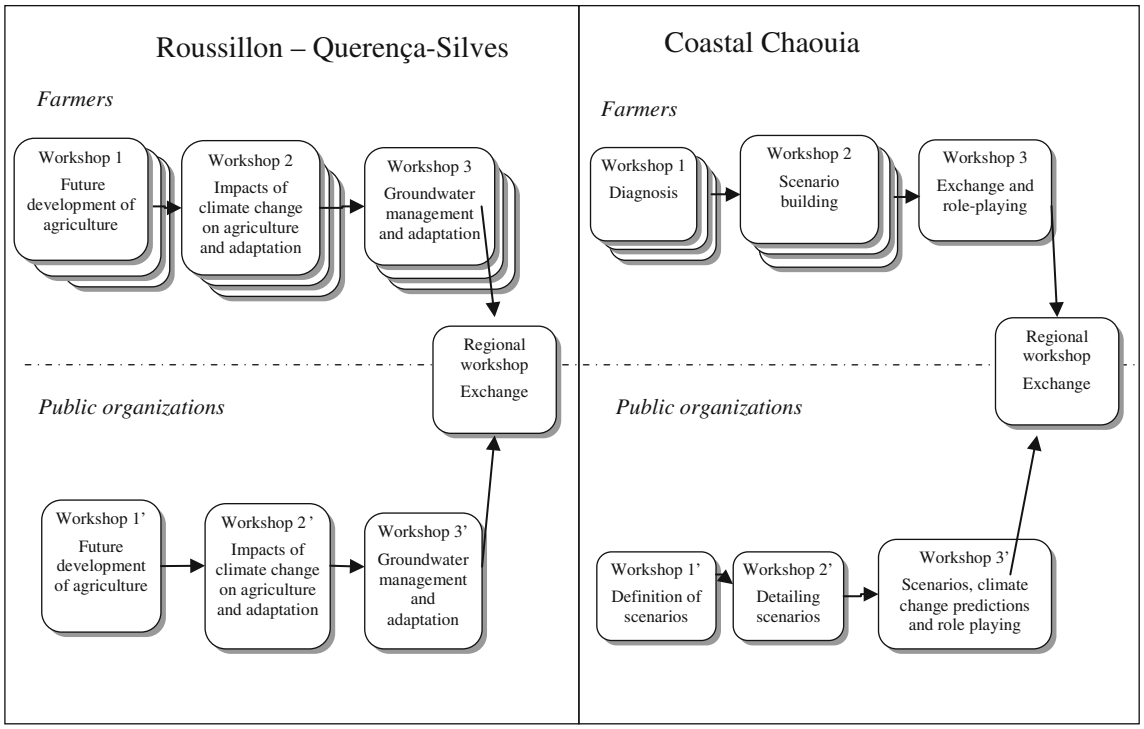

Fig. 1 Workshops held during the participatory research processes

and the staff of public organizations, followed by a joint workshop with all the actors (Table 2 lists the main differences in process design). In Roussillon, the Local Water Commission already existed as an official platform where theoretically farmers and staff of public organizations had the opportunity to discuss water management. However, relations between farmers' organizations and the catchment management agency were tense. The team considered that there was a risk that strategic behaviour would have a negative effect on discussion during workshops involving different actors. For that reason, the process was designed and presented as being mainly about organizing dialogue between actors in similar positions (e.g., among farmers) and an exchange between these actors and the research team. The aim of the final workshop, which brought together farmers and staff of public organizations, was the presentation and discussion of the results of the previous workshops. However, the initial separate workshops were not specifically geared to preparing an exchange between different actors in the final workshop.

In Querença-Silves and Chaouia, farmers and the staff of public organizations in charge of agriculture and water resource management had limited history of shared communication. Consequently, the research teams focused on preparing the groups for the final meeting and in particular on supporting farmers' capacities to interact with the staff

Table 2 Main differences in process design

	Roussillon	Querença-Silves	Chaouia
Type of dialogue desired	Dialogue between actors whose relations are not tense as well as with researchers	Dialogue between farmers and public organizations	
Farmer participants	Groups of farmers with similar characteristics, but who did not necessarily know each other		Small- and medium-scale farmers from same villages
Other actors	Ministry of Agriculture, catchment management agency, scientists, NGOs, local municipalities		Ministry of Agriculture, catchment management agency
Climate change	Discussion of impacts of downscaled climate model forecasts with all participants		Presentation of general data on predicted climate change to public organizations
Scenario design	Prepared in advance		Designed during workshops
Time frame of scenarios	2030 and 2050		2020

of public organizations. For instance, the Querença-Silves team supplied farmers with information about the water management institutions and recent changes in water policies as well as on the aquifer resources and uses. The Chaouia team helped farmers prepare their own assessment of the existing situation and of scenarios simulating future changes, as well as actions they could take to enable their preferred scenario to come true. In addition, the third series of workshops included a role-playing session for both farmers and staff of public organizations with the aim of increasing their mutual understanding in preparation for the final meeting. Farmers played the roles of staff of local public organizations to learn about their missions and means. Staff of the public organizations played the role of farmers to better understand their constraints and their margins for manoeuvre.

Group composition and mobilization of participants

In situations when many actors are present, the selection of actors to be invited to take part in the participatory process is important as it should account for the range of situations and viewpoints. In addition, the research teams have to make sure the invited actors actually come. Successful approaches have included sending the invitation through a local actor with a good reputation (McCrum et al. 2009), or building personal relations between the researchers and the actors (Thompkins et al. 2008). The location and schedules of the workshops should also be carefully selected to make it easy for the actors to attend (Patel et al. 2007).

In the present study, farmers representing a wide range of farm types were invited to participate in the workshops. In Roussillon, three different groups were created, one including farmers who had close relations with the Chamber of Agriculture, the second with farmers who belonged to the same organic production association, and the third with young farmers who had recently started farming in the region. In Querença-Silves, two groups were created, one for farmers from the eastern part of the area and the other for farmers from the western part. This distinction also reflected differences in the type of farming systems (small-scale farms producing market garden crops versus medium-scale farms specialized in citrus production). In Chaouia, three groups were created in three subareas defined by the researchers based on both water-related problems (areas affected by salinity or water scarcity) and the type of farming system.

In Chaouia, to prepare farmers to interact with representatives of public organizations in the final workshop, the researchers decided to work with groups of farmers who came from the same villages and already knew each other. Such groups could more easily reach a common view of problems, scenarios, and possible solutions, and their representatives would consequently feel more at ease presenting the results of their work. By contrast, in Roussillon and Querença-Silves, the teams did not invite only farmers who already knew each other, since the farmers' groups were not expected to share the same point of view at the final meeting. In these two study areas, the aim of the workshops was to enable the exchange of opinions and experiences without trying to reach a common position.

At the beginning of the process, it could not be taken for granted that the actors would agree to participate. In Roussillon, many farmers thought they were already officially represented. They considered the "water issue" to be the result of tightening of regulations imposed by the catchment management agency rather than to a present or future water shortage. In Chaouia, farmers did not expect much from the state, which had stopped most of its actions in the area 15 years ago. In contrast, in Querença-Silves, farmers were keen to take part, even though they did not really expect state officials to listen to them.

To prepare the process, all the research teams contacted farmers and public organizations directly and remained in contact throughout the process. The places where the workshops were to be held were chosen with great care, that is, locations that would be considered "neutral" by both farmers and by the staff of public organizations. For instance, in Roussillon, most workshops were held in restaurants; in Querença-Silves, they were held in the town hall and in a meeting room in a museum; in Chaouia, several workshops were held in a youth hostel. Workshops were also scheduled to facilitate attendance. In Roussillon and Querença-Silves, farmers' workshops were held in the evening, when work on the farms was finished for the day.

Most of the actors invited continued to attend throughout the process. Staff of public organizations appreciated the opportunity to discuss long-term issues and to be involved in a participatory experiment. Farmers also appreciated the opportunity to discuss the future of their region and to express their opinions to members of public organizations. However, some actors did not get involved in the process because they lacked the necessary motivation. In Chaouia, large-scale farmers did not take part because they thought they had already privileged contacts with the local bureaus of the Ministry of Agriculture. This absence was considered as a weakness by the staff of public institutions, but not by the other farmers, who took part because they wanted to explain their own issues. In Querença-Silves, the local drinking water company did not attend the workshops. Farmers said this absence justified their lack of confidence in public institutions, as the water company staff were obviously not interested in mutual discussions. However, in later workshops, participants no longer placed such importance on the absence of some of the public organizations.

Getting actors to discuss issues they originally considered of little interest

Many participatory processes wish to introduce topics related to climate change that may initially be considered by the actors to be too theoretical or not among their most urgent concerns. In cases where the actors (particularly small-scale farmers) are already vulnerable to climate variability, researchers often use climate variability as a proxy for future climate change. Here, by proxy, we mean a concept that enables a topic to be tackled indirectly (Morton 2007). Improving their adaptive capacity to current climate variability can help prepare actors for future climate change. When this type of approach is used, the results of climate models may not even be mentioned in the workshops (Valkering et al. 2010). Such approaches may also make a more explicit connection between the goal of adapting to future climate change and that of reducing the risk of disaster (Mitchell et al. 2010).

Preliminary interviews conducted at all three study sites suggested that many actors (particularly farmers) would not necessarily be interested in discussing climate change and water management issues. Farmers in Roussillon were familiar with the climate change issue through the media. They said that before discussing the impacts of climate change on agriculture, they first needed to discuss whether agriculture would still exist by the time such impacts were actually felt. By contrast, in Chaouia, most farmers interviewed had not heard about climate change via the media. In all three regions, the majority of farmers had not personally observed any major climate changes (Bento et al. 2009).

A decrease in surface and ground water was among the main impacts of climate change forecast in the three case studies. However, groundwater management had never before been discussed in Chaouia or Querença-Silves. In Roussillon, groundwater management was the subject of serious disagreement between farmers and the catchment management agency. But in Roussillon and Querença-Silves, the farmers had not personally been confronted with a limit to how much irrigation water they could withdraw from the aquifer due to groundwater scarcity.

To enable discussion of these issues with the actors, the three research teams decided to embed the discussion in a wider appraisal of the future of agriculture and chose agriculture as the initial topic of discussion with farmers and public organizations. The researchers assumed that because the agricultural sector was already facing a crisis, starting with agriculture would enable farmers to discuss more optimistic scenarios. This entry point was also considered a useful way to build a relationship with the farmers. In Roussillon and Querença-Silves, starting with agriculture and its future would underline how important researchers considered agriculture to be. This helped differentiate these participatory processes from those driven by public organizations in charge of water resource management. Farmers appreciated this approach since, for once in the water debate, they were not reduced to being mere water consumers and polluters. Indeed farmers often pointed out that they played a much broader social role than that of a mere economic actor using water.

While all the research teams chose agriculture as the first topic to be discussed with participants, they differed in the way they incorporated the issues of climate change and groundwater. In Querença-Silves and Roussillon, the teams aimed to progressively awaken the participants' interest and to build the trust that would make it possible to discuss climate change and groundwater management with them. Although the teams clearly announced from the outset that climate change and groundwater issues would be addressed during the process, they did not initially bring up these issues in their interactions with local actors.

After the first workshops, the Querença-Silves and Roussillon research teams prepared information on possible impacts of climate change. They hypothesized that presenting these impacts on agriculture and water resources would be more interesting for farmers than simply describing expected climate change. For that reason, they prepared information about the impacts on agriculture of future changes in temperature, rainfall, and irrigation water requirements and in the availability of surface and groundwater resources. A key asset for the project was cooperation with two other research projects, Vulcain in Roussillon (Chaouche et al. 2010) and Climwat in Querença-Silves (Stigter et al. 2012). These two projects had produced locally downscaled climate scenarios, and data were prepared in cooperation with the climate and water experts engaged in these projects. Efforts were made to present the data in an easily understandable form.

During the second series of workshops, farmers were interested in discussing predicted impacts of climate change and felt comfortable criticizing their relevance for the agricultural sector. In Roussillon, some farmers pointed out that the data presented did not include future changes in wind and frost distribution, which they considered to be an important factor influencing their farming practices and crop choices. Similar comments were made by Portuguese farmers, who also considered frost and wind have a significant impact, especially on citrus production.

Concerning groundwater management, farmers in Roussillon knew that a process to regulate groundwater use had begun, and farmers in Querença-Silves knew that such a process was about to begin. Even if in Roussillon farmers were officially against such measures, the idea that some form of management would eventually be inevitable made sense to them. It was easier for farmers to agree to discuss

groundwater management by placing the groundwater management scenarios in the distant future, that is, 2050. In the two regions, discussion of groundwater management scenarios took place at the end of the process, when farmers and researchers had worked together at least twice and had begun to get to know one another. Such discussion also made sense to farmers because at this point in the participatory process, they were able to foresee future water scarcity as a consequence of climate change.

In Chaouia, actors had difficulty imagining what could happen in 10 years. Moreover, the farmers were already vulnerable to climate variability. For these reasons, following Morton (2007), the team used climate variability as a proxy for climate change. In the first presentation of the process, the team did not mention climate change. Equally, they decided not to present the results of climate models to farmers because farmers plan their operations from a short-term perspective and it was assumed that they would not be interested in discussing possible changes in rainfall patterns 30 years in the future. The decrease in future rainfall patterns predicted by climate models and its likely negative impact on groundwater recharge were presented only to the staff of public organizations during the third workshop. Participants made only a few comments, since climate change appeared to only have long-term effects on the groundwater balance and these effects appeared to be much less serious than farmers' overexploitation of groundwater. The scenarios designed for 2020 were not modified to account for climate change.

The research team in Chaouia also decided not to mention groundwater in their first presentation of the process. Since the team chose to design scenarios in collaboration with the actors (see below), they decided that participants themselves should select which of the current key drivers of change they wished to discuss. Because the region was already experiencing a groundwater crisis, the research team assumed that water would emerge as one of the key drivers of change. Indeed, the three farmers' groups selected the water problem (water salinity or scarcity, depending on the area) as the most urgent issue. The staff of public organizations also suggested water resource dynamics was a major driver of change. With regard to groundwater management, the farmers considered that each farmer was entitled to use the groundwater available on his land as he wished. The staff of public organizations were unwilling to become involved in groundwater management. In this context, and since the time frame of the scenarios was much shorter (approximately 2020), the Chaouia research team decided not to enforce discussion of this issue. The scenarios were therefore less about regulating groundwater use than about how to best adapt agriculture to the groundwater crisis.

Design and use of scenarios

Contents and status of scenarios

Participatory methods used to discuss climate change are examples of more general participatory foresight methods (Rounsevell and Metzger 2010). All such methods can be located along a continuum with respect to the relative importance given to the type and amount of information the researchers intend to supply to support discussion with the participants and the type and amount of information the actors themselves share or create during workshops (van Notten et al. 2003). At one extremity of the continuum, after the researchers present their previously prepared climate change and socio-economic scenarios, participants are invited to identify possible adaptation strategies. This approach allows the researchers to carefully design the scenarios and particularly to incorporate simulations based on climate models (Eakin et al. 2007; Poumadère et al. 2008; Thompkins et al. 2008). It also allows researchers to think about how to communicate and how to assess simulations based on climate models with the participants (McCrum et al. 2009). In the centre of this continuum, Patel et al. (2007) provided broad socio-economic scenarios for the Mediterranean region to support actors' exploration of scenarios at local level. At the other extremity of the continuum, all scenarios are built in collaboration with the actors during the workshops. The aim of the latter approach is to increase the actors' capacity to reflect on their environment based on their own knowledge (Gidley et al. 2009; Imache et al. 2009).

In our case, the three research teams chose different positions along this continuum. In Roussillon and Querença-Silves, apart from the initial diagnosis workshop in Querença-Silves, the teams always began the workshops by presenting information they had prepared in advance. The actors were invited to criticize and possibly "deconstruct" the information and scenarios. There was no attempt to encourage participants to reach agreement on revised scenarios. Although collective revision did take place in some water management workshops in Roussillon, leading to a common scenario, this was not the original plan.

The two research teams made these choices because they had access to data, and because both teams thought that participatory design of scenarios would require more time than participants would be willing to spend in the time frame of a research project that was unlikely to culminate in important policy decisions. Moreover, in Querença-Silves, farmers explicitly asked the team for information and data. However, providing information does not mean that the process adhered to a "public education" model of communicating science (Callon 1999), whereby scientists contact the wider public only to present scientific results

that have already been validated. In Roussillon and Querença-Silves, communication techniques used in the sessions (e.g., constructing and deconstructing ideas) fit the dialogic model (Callon et al. 2009). For instance, in Querença-Silves, the team started the second and third series of workshops with brainstorming sessions in which farmers were free to talk about their personal knowledge and experiences.

In Chaouia, the researchers decided to identify drivers of change in collaboration with the actors and to build scenarios with them, and very little information was supplied by the research team. There were three reasons for this choice. First, very little local data were available to enable the research team to design scenarios (there was no precise data available on irrigated areas, nor a downscaled climate model, and the catchment management agency and hydrogeologists from local universities did not agree on the groundwater balance). Second, the research team posited that there was a risk that farmers with a low level of formal education would not feel at ease criticizing and deconstructing a scenario designed by researchers. Third, the approach chosen would enable the scenarios to be considered as the joint product of the researchers and the actors, and the latter would thus be more willing to present and defend these scenarios at the final meeting.

In Chaouia, co-production was also thought to be a way to avoid two possible stumbling blocks to a fruitful discussion between staff of public organizations and farmers. These stumbling blocks had been identified during the initial diagnosis. In public meetings, farmers had often stated that, given the steady decline of intensive agriculture, the only possible change was that this type of agriculture would have disappeared by 2020. There was thus a risk that farmers would stick to this viewpoint during the final meeting with staff of public organizations. For that reason, the team decided to identify possible positive future changes in collaboration with the farmers' groups, both during workshops and through parallel activities, such as providing support to one group whose members were considering creating a milk collection cooperative. In addition, at the beginning, the staff of the Ministry of Agriculture did not feel comfortable questioning the relevance and implementation of the Regional Agricultural Plan either with colleagues or in front of the farmers, despite the fact they doubted its relevance and the likelihood of it being implemented. The research team hypothesized that the foresight analysis could provide a space in which civil servants would feel free to imagine other possible futures while acknowledging the official scenario as one option. In the final workshop, the actors presented the different scenarios they had built with a visible sense of ownership, which created an atmosphere conducive to exchanges between the two groups.

These differences in the way the scenarios were designed also influenced their contents and status: agricultural development scenarios were more comprehensive and detailed in Roussillon and Querença-Silves than in Chaouia. For instance, in Roussillon and Querença-Silves, the scenarios used in the first workshops were embedded in a European economic scenario and the local socio-economic consequences of macro-level changes were included.

In Roussillon and Querença-Silves, the scenarios were mainly used as a support for discussion. What was important was not to choose a particular scenario, but to reach a common understanding of major drivers of change, as well as of trends and uncertainties. Policy priorities also emerged from the discussions, even though consensus had not been an objective. In contrast, in Chaouia, scenarios were the production of local actors, and it was important for each group to define desirable scenarios, as they provided the basis for an action strategy.

Time frame of the scenarios

The choice of a specific time horizon for foresight analysis is based on the need to create common ground between the time frame of climate models and the one that actors generally use to plan and make decisions. This common ground usually ranges from 25 years (Patel et al. 2007) to 50 years from the present (Eakin et al. 2007). Another option is to progressively increase the time horizon of the scenarios discussed with the participants (Poumadère et al. 2008).

In Roussillon and Querença-Silves, two time frames were used: 2030 for the first series of workshops and 2050 for the second and third series. Farmers in Roussillon participated in the foresight exercise with a 20-year time frame more easily than in Portugal (Rinaudo et al. 2012a). This time frame corresponds to the lifetime of many agricultural investments, such as orchards and irrigation equipment. After the first workshop, it was easier for farmers to move ahead 20 years to think about the consequences of climate change on an agricultural system they could already imagine would be different from the systems used today.

In Chaouia, the time frame was much shorter because both farmers and public organizations found it impossible to think at a distant time horizon. Farmers need to react to changes in their environment (rainfall, markets, diseases, etc.) very rapidly and most grew only annual crops. As a result, it was difficult for them to imagine what their farm might become several years hence. For the staff of public organizations, it was also difficult to discuss a remote time frame, since the Ministry of Agriculture designed public policies that could have major short-term impacts on the

region, but whose implementation was highly uncertain. Therefore, even with a horizon of 10 years, and given the high reactivity of the aquifer to imbalances between water uses and recharge, agriculture could follow very different pathways depending on both the implementation of the public policies and possible future rainfall patterns. The lack of data for planning regional development also made it difficult to define possible development scenarios with a longer time horizon.

Obtaining information about the past also played an important role in the preparation of the foresight analyses. In both Chaouia and Querença-Silves, the initial analysis of past changes proved to be useful in reaching a common understanding between researchers and farmers, as farmers often use the past as a reference when envisaging possible futures. It also helped farmers realize that change can happen quickly. For instance, recalling that Portugal and Spain (in the case of Spain, as a competitor of Roussillon region) joined the European Union only 30 years ago facilitated exploration of the 2030–2050 period in Roussillon.

Main results and outcomes

Assessment of vulnerability and adaptive strategies

In Roussillon, several shared priorities concerning agricultural policy emerged from the discussion of alternative future agriculture development paths during the first series of workshops. These were the following: (1) the need for public support for the development of collective agricultural organizations (especially for economic activities and water management) as individual strategies were considered to be an obstacle to adapting to change; (2) a strong policy to protect agricultural land against urban sprawl; (3) support for different forms of agriculture, as diversity enhances adaptation capacities; and (4) the development of a "high environmental performance agriculture" (including organic products). From an agricultural point of view, both farmers and institutional stakeholders were confident that technical change would suffice to adapt to any new constraints caused by climate change. In their opinion, the issue of climate change should be considered as an opportunity to rethink long-term agricultural development and water management in the region. Trend-breaking scenarios should be designed and the local knowledge of farmers mobilized. They also considered that existing water resources would suffice provided their management is optimized. Concerning the allocation among farmers of increasingly scarce water resources, in their opinion, the respective role of the state and of users should be redefined and market mechanisms introduced.

In Querença-Silves, farmers said that two changes were needed to improve the profitability of their crops. First, cooperation should replace individualism, which is currently the driving force in the profession. Second, they should receive more technical support from the public agencies in charge of water resources and agriculture. If these two changes were made, the shift from existing crops to other less water-demanding crops (e.g., almond trees) would be feasible. But in fact, the farmers did not expect water shortages. Water management by public agencies was the subject of constant criticism. Farmers accused the agencies of lack of equity and considered their participation to be indispensable for improved management of water resources.

In Chaouia, farmers and staff of public organizations agreed on a series of scenarios for the future development of the area. Actions for improved resilience of local agriculture in the face of the groundwater crisis were jointly discussed at the final workshop. These included actions envisaged in the Regional Agricultural Plan and those proposed by farmers such as (1) a change to cattle farming in zones already affected by water salinity; (2) connecting the villages to the drinking water network so they can water their livestock; (3) improving quality control and setting prices for inputs; and (4) setting up a local market so farmers are in a better position to negotiate prices with middlemen. All these actions should improve farmers' capacities to deal with the groundwater crisis in the short term. However, some actions (e.g., support for the supply of inputs and for the marketing of vegetables), if implemented alone, would entail continuing intensive use of groundwater and would thus not improve the long-term resilience of agriculture in the region.

Participants' assessment and process outcomes

Actors in the three participatory processes were generally satisfied, both because of the new ideas they encountered and because it gave them the opportunity to present their ideas to other actors. Participants interviewed after the workshops appreciated the opportunity to think about the consequences of long-term changes, something which neither farmers nor institutional experts normally have time to do, as they are preoccupied by their present constraints and short-term objectives. Another key satisfaction was being able to listen to each other's opinions in an arena where participants were not obliged to defend vested interests or the entrenched official positions of their organizations. Participants in Querença–Silves agreed that the workshops facilitated dialogue between institutions and farmers, and made each aware that the aquifer belongs to everyone and that any problems must consequently be solved together. The information about water and

agriculture transmitted during the workshops was also much appreciated. However, several Portuguese and Moroccan farmers said that the process would ultimately only be useful if the ideas discussed during the workshops (particularly during the last workshop) were actually implemented.

In Roussillon, some institutional representatives subsequently used the scenarios as discussion supports with different groups at local and even regional level. The experience gained in the Aquimed project was one of the reasons behind the decision by the Chamber of Agriculture to launch its own official foresight analysis of the impacts of climate change. In contrast, according to contacts in Chaouia and Querença-Silves some months after the process ended, there had been no appreciable incorporation of the ideas discussed during the final workshops in the agendas and methods of public organizations.

Discussion

Factors taken into account in process design

The teams took several factors into account when making choices with respect to the four issues analysed during the process design. Figure 2 shows the factors that were most important in the design of the process and how they influenced the choices made concerning these four main issues. These factors are classified under the headings: institutions, actors, natural resources, and local economy. The factors include those listed in Table 1, that is, the imbalance between groundwater withdrawal and groundwater recharge, farmers' awareness of groundwater scarcity, the organizational set-up for groundwater management, the presence of official scenarios for agricultural development, and the role of local farmers' organizations in public arenas. Most of these factors varied among the three regions. These differences were crucial in informing the decisions taken by the three research teams and culminated in different methodological choices.

The uncertainties and risks involved in the alternatives the research teams considered also played an important role in the process design. For instance, while the Chaouia team thought it was risky to arrive at the workshops with predefined scenarios and to ask farmers to criticize them, the Roussillon team considered it risky to ask actors to be involved in the time-consuming co-design of agricultural development scenarios. The specific competencies of the individual researchers also played a role in the choices made by the team concerned. Some researchers had previous experience in foresight analyses and were eager to use methods they already mastered. Intense discussions among team members took place regarding the way to design the scenarios. These discussions were very useful in making explicit the reasons for the choices the teams finally made.

Lessons on how to respond to the call for participatory analysis for adaptation to climate change

The flexibility of the process enabled the researchers to overcome the barriers to participatory analysis of adaptation to climate change described in the introduction, that is, limited actors' capacities and the actors' possible lack of interest in discussing the issue. The choices made first concerned cognitive issues. Like other processes used for participatory analysis for adaptation to climate change, they concerned the way to present information to ensure the participants would understand and agree to discuss the results of research on climate. To ensure successful participation, the research teams had to choose between presenting the results of scientific analyses of climate change upfront and finding indirect ways to discuss the results.

The three research teams also paid particular attention to getting actors involved in the process, and if necessary, embedded climate change in a wider discussion framework. The most extreme case was Chaouia, where a double reframing took place: addressing future climate change through current climate variability and discussing adaptation to the groundwater crisis rather than groundwater management. Such reframing is part of the increasingly acknowledged need to embed (or "mainstream") the issue of adaptation to climate change in local development policies (Chuku 2010).

In the future, interest in (and available funding for) participatory analyses of adaptation to climate change with local actors is likely to remain high. The differences between donors' concern for long-term development issues and local actors more short-term preoccupations are also likely to persist. In that sense, the risk of defining and implementing "participatory" processes around an agenda that has been defined by actors who are not directly involved locally will not disappear. Mainstreaming the climate change issue thus means more than simply accepting additional issues as unavoidable "detours" that make it possible to address climate change at a later stage. It means that this issue will not necessarily be the core focus of the discussion process, but will be one topic of discussion among many others, in a negotiated and generally accepted frame of discussion between actors, including researchers and donors. However, cautious framing of a discussion agenda which includes climate change may not be sufficient to ensure that participatory planning exercises generate sustained interactions between actors that succeed in finding alternatives for the future development of local territories. While the careful

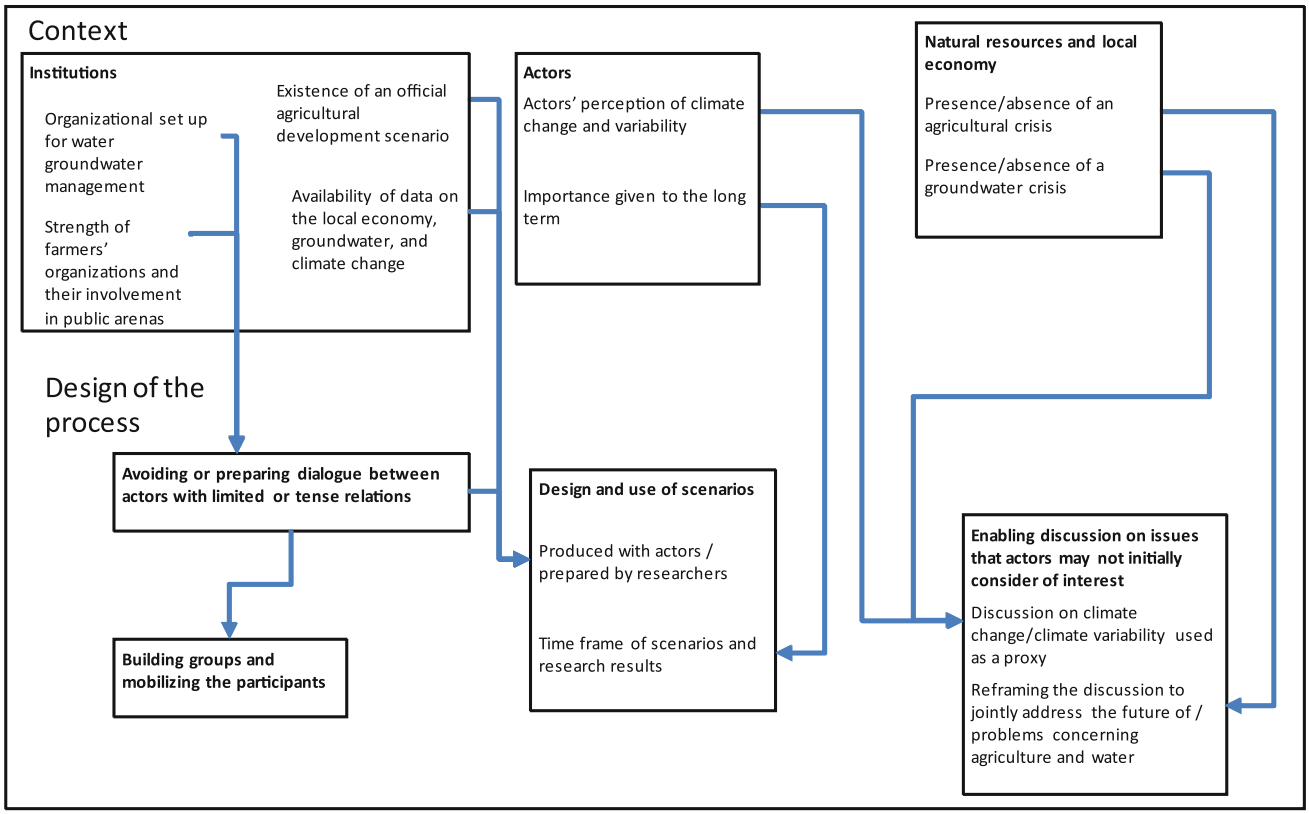

Fig. 2 Main links between context and choices in the design of the participatory processes

preparation of a multi-actor final workshop in Portugal and Morocco revealed that interesting exchanges are possible, the limited means of both public organizations and farmers' organizations meant that after the end of the research-led discussion processes, the interactions were not maintained.

Conclusion

The present study showed that it is possible to undertake participatory analyses for adaptation to climate change in situations that are not initially thought to be favourable for such work. In all three regions, the farmers demonstrated their interest and ability to engage in foresight analyses, despite the economic fragility of their sector and their lack of experience in discussing such issues. In the face of the severe agricultural crisis, the method helped actors progress from a passive attitude towards expected changes to a more proactive one.

Three keys to success were identified a posteriori. First, the preliminary analysis of the study areas and of local actors by the research teams enabled them to tailor their process design to the local context. This involved assessing a set of criteria including the institutions, actors, the status of natural resources and of the economy, and the skills and position of the researchers. Second, the process lasted long enough to enable trust to be built between researchers and participants, along with the development of a common frame of understanding. Finally, the teams succeeded in working in an interdisciplinary way.

The wide range of choices made by the three teams also underlined the absence of "one best way" to assess adaptation to climate change using a participatory process. In the last 10 years, many authors have put forward an ever increasing number of approaches to implement participatory discussion on adaptation to climate change at local level. This wealth of approaches highlights the need for teams who intend to implement participatory process to clearly explain how they designed their methodology.

The present study provides the answers to several methodological questions, especially regarding perceived stumbling blocks and risks. However, these answers may not provide much guidance in the design of other processes of participatory analysis that aim to include possible adaptation to future climate change, since case-specific answers can rarely be extrapolated to other situations. This is all the more true because the teams were not only unsure whether some of the choices they made during the process design stage would succeed, they were also unsure whether

the options they decided to leave aside would necessarily hinder process implementation. For these reasons, comparative analysis of the experience reported here may be more useful in the way it rendered explicit the choices that had to be made during process design, and the factors that were taken into account when making such choices, since both choices and factors are likely to be present in similar processes.

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