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Water scarcity conflicts in a community managed irrigation system in Northern Tunisia: Supporting dialogue and negotiation

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Abstract. Conflict over water resources emerges from complex interactions among biophysical, social, and economic processes operating at multiple scales. The concomitant use of surface and groundwater managed for multiple uses is a classic coping strategy to manage the water scarcity yet a relevant example of such conflict. Managing these resources is thus a dynamic decision-making process involving actors with different perceptions of the situation, who adapt different strategies to satisfy their objectives and interests. This paper presents the results of an effort to address these conflicts through reinforcing the adaptive capacity of different actors to cope with water scarcity in a multi-scale irrigation system. The study site focuses on the irrigated area of Zaouiet Jedidi in Northeast Tunisia. This region is characterized by an intensive irrigated agriculture, mostly through an excessive pumping of groundwater resources. Individual strategies to face the water scarcity are dominating leading to a rapid deterioration of the groundwater resources. Irrigation through individual and informal wells is an example of such strategies. As the demand for agricultural and urban water has concurrently continued to develop, the groundwater has continued to drop. Despite the State's efforts to increase the water supply to the region through the transfer of surface water from the dams of northwestern Tunisia, the overexploitation of groundwater resources exceeded 200 %. A participatory process was implemented to initiate a process of interaction and coordination between the different stakeholders involved in the management of the irrigated area. We analyzed to what extent and by what mechanisms, a participatory problem-solving process can facilitate the emergence of collection action to face the water scarcity.

Keywords. Water scarcity; UPH 22; participatory modelling; capacity development; SDG16

1 Introduction

There is a grown concern about the lack of effective options to manage water scarcity. These options are usually beyond the social or institutional capacity or carry too high an economic cost to be affordable in developing countries (Frederick, 1997). Ohlsson and Turton (1999) argued that we need to view the water scarcity in relation to present water practices and management rules. This shifted the focus on the need to find the appropriate societal tools for dealing with the consequences of natural water scarcity. Much emphasis is placed today on the necessity to understand stakeholders' perception as a pre-request to identify the social bottlenecks which stand in the way of new kinds of adaptive measures to water scarcity. The complexity of water resource management issues stems from the irreducible plurality of standpoints. It involves stakeholders who frame issues in various and sometimes conflicting ways, they employ different strategies to satisfy their goals and interests. Differences in perceptions reflect differences in the underlying value system and may often lead to communication barriers and policies controversies (Elsawah et al., 2015).

Many studies emphasized the need to establish participatory learning environments where individuals can meet, interact, learn, and take collective decisions (Keen et al., 2005). According to Van den Hove (2006), problem solving processes, needed to tackle the sustainable development issues, are in fact dynamic processes of capacity building. These processes should allow the integration of different sources of information, values, and logics of various actors. It is deemed that participatory approaches have the potential to meet these problem-solving requirements. Several studies have demonstrated the effectiveness of simulation tools and role-playing games (RPG) to facilitate dialogue, negotiation and collective decision making among multiple stakeholders (Etienne, 2009). This study presents the results of an effort to reinforce the adaptive capacity of different actors to cope with water scarcity in the irrigated area of Zaouiet Jdidi located at north Tunisia. A participatory process was implemented to initiate a process of interaction and coordination between local stakeholders.

2 Materials and methods

2.1 Context and case study

The Zaouiet Jdidi irrigation scheme is located in Cap Bon region (Nabeul governorate), northern Tunisia, and covers 1042 ha (Fig. 1). The whole area is actually cropped by citrus orchards. This system is irrigated from a collective irrigation network since 1969 to save citrus orchards because of previous overexploitation of the Grombalia aquifer from individual wells. Since 1985, irrigation has been supplied from the Medjerda River by the Canal of Medjerda-Cap Bon (CMCB). The irrigation water was pumped by the Belly pumping station into the buffer reservoir of Sidi Toumi, then distributed through pipelines in the command area. The irrigation scheme is divided into 30 hydraulic sectors. Until 1998, allocation and distribution of irrigation water were managed by the Commissariat Reìgional au Deìveloppement Agricole (CRDA). In 1998, irrigation management was transferred to the water users' association (WUA). The CRDA retained a control function on the implementation of the management contract but was not involved in the routine operation of the system that was under the responsibility of the WUA. Currently, This system operated under a situation of water scarcity that resulted from (i) priority given to drinking water supplies which continued to increase and (ii) development of irrigated areas due to the continuous deterioration of the groundwater's quality (Ferchichi et al., 2017).

2.2 Participatory intervention process

The purpose of this participatory process is to support the negotiation and discussion between different actors and to facilitate the emergence of collective actions to face the problem of water scarcity. The approach is based on five stages (Fig. 2). A role-playing game was designed based on (i) description of the system (infrastructure, farms' typology, regulations, and governing rules) and (ii) participatory modelling of farmers' representation of the water scarcity in the irrigated area of Zaouiet Jedidi. The role-playing game was used in eight participatory workshops organized with different actors (farmers, WUA, CRDA), from January to March 2015. The first workshop was organized first with the WUA, followed by six workshops organized with the WUA and farmers from different sectors. The final workshop was organized with water managers from the CRDA. A restitution workshop was organized in May 2015 with WUA technical stuff, representatives of farmers from each sector and managers from the CRDA. Proposed solutions during previous workshops by each actor were discussed. Participants proposed to test innovative planning of the water distribution between users of the collective irrigation network. Two workshops with farmers and WUA were organized for this planning. During the implementation of this process, observations, structured and semi-structured interviews were conducted to assess impacts of such intervention of actors' perception and strategies

3 Results

3.1 Initial actors' perception of the origins of the water scarcity

During interviews farmers referred to the problem of water scarcity as a situation where: (i) water is rarely available when it is most needed; (ii) interruptions of the water supply are frequent and unpredicted; (iii) low pressure and (iv) insufficient quantities and extended irrigation intervals. While the managers, represented by the WUA and the administration, defined the water scarcity as a situation where they can no longer satisfy the farmers water demand.

The role-playing game represented a sector covered with citrus orchards and irrigated both from collective network of the WUA and individual wells. The role session comprised a total of six game turns which represent the three-peak period of water consumption (June, July, and August), each game turn represents 15 d.

3.2 Participatory workshops with local stakeholders using role playing games

Participants proposed solutions to improve the irrigation water management in their system. These proposals focus on three components:

1. Improvement of the management of the collective network mainly through testing the reorganization of water turn between farmers, keeping the irrigation network in charge during peak period hours and making sure that water turn schedules are respected by farmers.

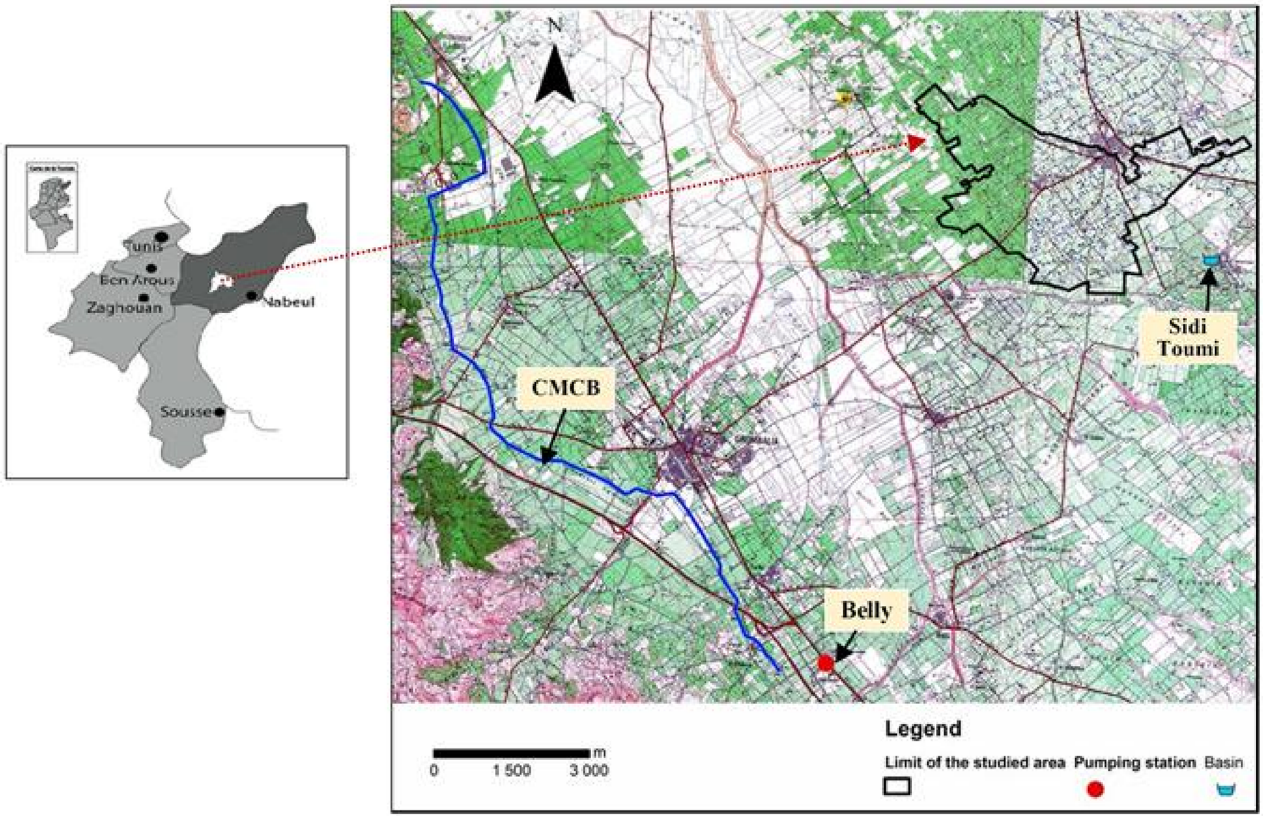

Figure 1. The irrigated area of Zaouiet Jdidi, Cap Bon (Ferchichi et al., 2017).

Figure 2. Presentation of the participatory process implemented in the irrigated area of Zaouiet Jedidi.

2. Improvement of groundwater management through reinforcing the conjunctive use of surface and groundwater.

3. Reinforcing communication between managers and farmers through regular meetings between farmers and the WUA.

During the multi-actors' workshop, the relevance and feasibility of the proposed actions were classified by participants. Reorganizing irrigation turns between farmers and improving the communication between farmers and managers were identified as the most feasible and relevant actions. Participants propose testing new rules to schedule irrigation turns between farmers in a pilot sector. Farmers from sector 15 volunteered to test this reform.

3.3 Testing new collective rules for irrigation schedules

A technical support for the reform of the irrigation schedule in the pilot sector was provided through two workshops organized with farmers and the WUA. The water needs of each farm were estimated and the total needs were compared to the current capacity of the network. It turns out that only 42 % of the needs of this sector can be met from the network.

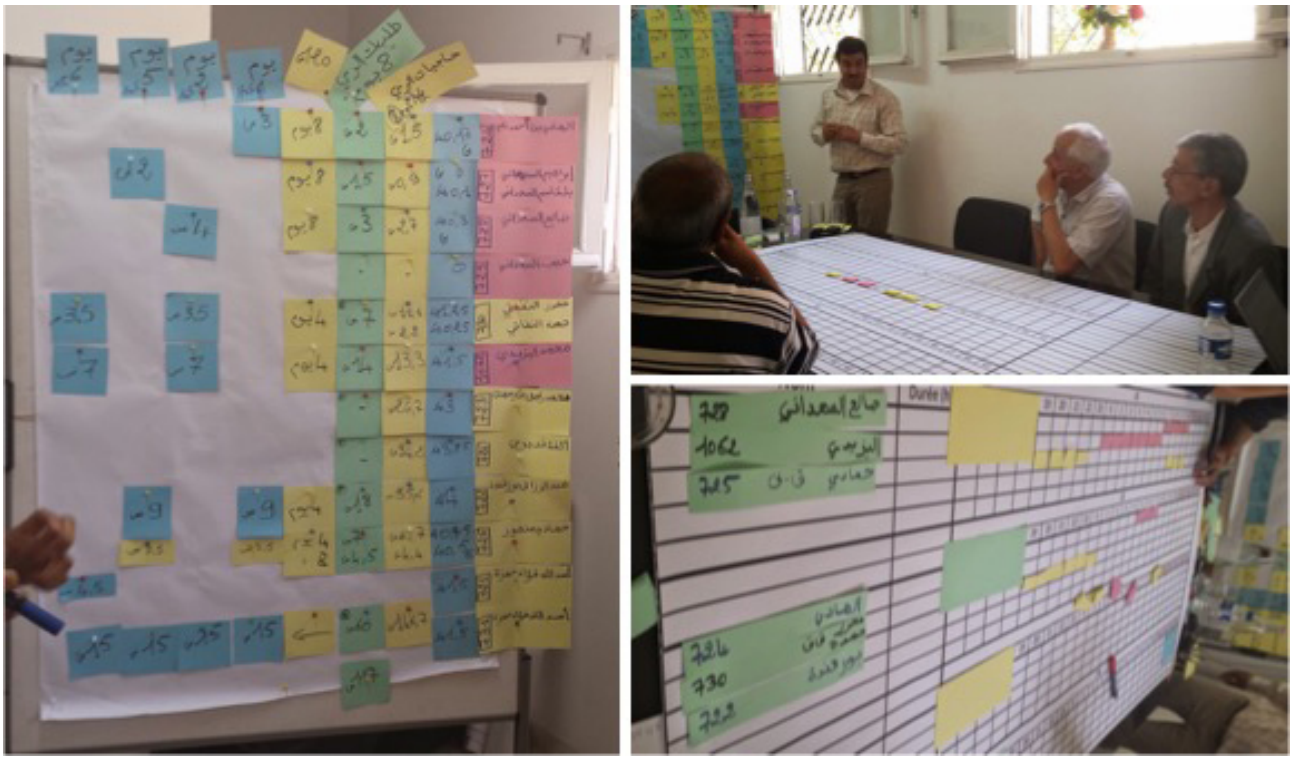

Figure 3. Photos of farmers and WUA discussing new irrigation management rules.

The access to groundwater resources and the irrigation technique were considered in this process. Each farmer indicated his desired duration and frequency of irrigation (Fig. 3).

The main decisions made by the participants are to:

1. Organize irrigation schedules according to the water needs of each farmer rather than the application of the WUA's "first come first served" rule.
2. Revise the modalities of access to the collective network: only two farmers can irrigate at the same time in the same sector and only one farmer can irrigate during peak periods of electricity consumption.
3. Farmers must sign a commitment to ensure that they will respect these rules otherwise sanctions can be applied by the WUA.

4 Discussion

The results of the role-playing game with farmers showed that the construction of a model based on the stakeholders' perception of the water scarcity can be a strong support to trigger group discussion and negotiation and to explore possible solutions to cope with the problem of water scarcity. Despite the existence of a large set of sophisticated model-based tools developed for tackling water management problems, many studies argued that they did not consider the requirement of the user group and failed to support decision making processes (Bekius et al., 2022). By combining a simple simulation model and a role-playing game, tensions on the water resources and difficulties in such context allowed participants to shift from the virtual world to the real word and to propose solutions that can be applied in their system. Prell et al. (2007) argued that decisions outputs of models that have been developed through collaboration with stakeholders are less likely to be contested than those based on the outputs of "black box" models. Legitimacy building of this process with farmers was achieved through the participative modelling because it fulfilled an important condition defined by Suchman (1995): "to provide legitimacy an account must mesh both with larger belief systems and with the experienced reality of the audience's daily life".

The participative process not only succeeded in changing the social representation of farmers and eliciting individual learning, but interactions between participants also facilitated the collective learning. As a result, participants become aware of the interdependences between different actors. They shifted from the upstream management level controlled by the administration, considered initially as the only level to define solutions, to the downstream level managed by the WUA and farmers, to propose achievable solutions. In this study, we considered that group discussion and interactions reinforced the collective action through two processes: (1) consensus- oriented process and (2) compromise-oriented process. For the first process participants were able to share a

common vision of the problem, they reached a consensus and proposed collective actions to face the water scarcity. For the second process, conflicts of interests exist due to the plurality of participants' standpoints. Compromises were established while defining some rules. As an example, farmers without access to the groundwater pressured the others to use this alternative resource and decreasing their water demand from the collective irrigation network. Van den Hove (2003) criticized the expanding discourse associated with participatory approaches, based on reaching consensus, and where the unavoidable conflicts tend to be occulted. The author recommended to consider participatory approaches as a combination of consensus-oriented processes in the pursuit of a common interest and compromise-oriented processes aiming at the adjustment of particular interests.

5 Conclusion

The main contribution of this study is the development of a learning approach in order to change the perception of local actors of the current situation of water scarcity and to reflect on the construction of collective actions for the improvement of the quality of irrigation service. Through this participatory process, it is estimated that the participants have acquired negotiation techniques allowing them to face the problems of water management in their system. The assessment of learning evidence and its effects on participants' perceptions leads us to conclude the necessity to understand the social context, in which the problem-solving process is anchored, and to analyze the underlying interests and values beyond apparent perceptions and discourses.

Code availability. The source code used for the participatory modelling can be obtained by writing to the corresponding authors.

Data availability. The literature data base can be obtained by writing to the corresponding authors. The spatial data used to map the irrigated area are obtained from data collected from the public administration (Ministry of Agriculture, CRDA Nabeul). The description of the roleplaying game (design method, rules, tests, etc.) is available in Ferchichi (2017).

Author contributions. The three authors developed the methodology and organised the different workshops. IF prepared the datasets, performed the analysis of the workshops results and wrote the manuscript. AZ and SM reviewed the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

Competing interests. The contact author has declared that none of the authors has any competing interests.

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