

# Drivers of Change in Southern European Agriculture: Online Participatory Approaches for the Analysis of Planned and Autonomous Adaptation Strategies

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## **Abstract:**

Together with socio-economic and policy changes, climate change deeply affects sustainable patterns of water management. The presented work explores how online participatory tools can be linked to a decision support system (DSS), in order to set up a web based DSS for assessment and evaluation of autonomous and planned water-saving adaptation strategies in irrigated production systems. Innovative online participatory tools are developed and tested. The paper presents online participation (eParticipation) as a means to establish communication with the main "agents" (farmers) of the socio-ecosystem of interest. This is composed of two phases: (i) assessment of farmers' perceptions of ongoing changes through a preliminary online questionnaire; (ii) development of ad hoc adaptation strategies and their evaluation through a second questionnaire linked to a DSS tool. The article demonstrates that eParticipation is effective in involving stakeholders in decision-support when utilising existing communication channels. Nevertheless, like in other participatory approaches, the problem of self-selection emerges, and the results should be treated carefully when it comes to statistical conclusions and political decisions.

**Keywords:** *Climate change adaptation; agriculture; eParticipation; decision-support system tools*

## 1 INTRODUCTION

Climate, socio-economic, and policy changes affect water availability and call for sustainable approaches to water management. Access to water is particularly important for the agricultural sector. Due to land and climate configurations, Southern Europe is especially dependent upon irrigation. Expected temperature and precipitation variations, as well as an increased frequency of the extreme weather events as a consequence of climate change, could require some well-established farming techniques and irrigation practices to be modified.

The European project ICARUS (IWRM for Climate Change Adaptation in Rural Social-Ecosystems in Southern Europe) aims at improving water resources management in rural areas of Southern Europe, through the introduction of the climate change adaptation perspective in water saving practices in agriculture. This paper illustrates innovative participatory methods implemented in one of the ICARUS project's case studies - the Veneto Region, Italy - as an exploratory exercise for the setting up of a web-based Decision Support System (DSS) tool.

Uncertainties and complexity related to climate change science pose challenges for decision-making. A meaningful participation may help to integrate perspectives and experiences of all actors involved, rendering the policy processes more inclusive and transparent. The participatory webDSS tool developed in this research addresses specifically the broadening of public participation in the decision-making process regarding climate change adaptation.

The exploration of autonomous adaptation is the starting point for a bottom-up approach to climate policy because it allows the explanation of processes of change at the individual level (even if not directly labeled as adaptation to climate change), as compared to planned adaptations, which are policy-driven. Together, planned and autonomous adaptations should cover: short term coping actions; longer term transitions; purposeful and accidental adaptations; anticipatory and reactive activities; and activities motivated by non-climate drivers [Tompkins et al., 2010]. The level of acceptance of planned adaptation strategies mainly depends on the people involved. Thus, comprehending their motivation, knowledge, and perceptions is crucial for the effectiveness of the strategies [ibid].

This paper explores the potentials of eParticipation, that is based on the use of Information and Communication Technologies (ICT), for setting technology-facilitated participatory processes that enable interaction between the civil society and the formal politics and the administration sphere [Sabo et al., 2008].

The aim of this paper is to propose an innovative online participatory approach for the analysis and evaluation of planned and autonomous adaptation strategies. In order to incorporate different components of the social dimension of adaptation, such as farmers' perceptions and attitudes, and facilitate its integration in decision-making, this research links eParticipation techniques to a pre-existing DSS tool. The output is a web-based DSS prototype - a new tool for eParticipation.

## **2 CASE STUDY**

The Veneto Region is situated in the northern part of Italy, with a population of about 5,000,000 people. The Utilised Agricultural Area (UAA) in Veneto is 835,000 ha, nearly half of its territory. The number of registered farms is 120,735, with an average size of 6.7ha [ISTAT, 2011]. The major crops are maize (33%), forage (24%), wheat (11%), vine (9%), soya (8%), and horticulture (7%) [Veneto Region, 2011]. With 70,000 ha of vineyards, Veneto is one of the leading Italian regions for wine production [ibid]. 53% of the whole Veneto territory has some form of irrigation system [Zucaro and Povellato, 2009].

The results of some European projects<sup>a</sup> show that the annual temperature may change by 1 to 2°C, and availability of the water resources may decrease by 5 to 15% in the Veneto Region by 2025.

## **3 METHODS**

In the current digital age of the "network society", eParticipation has rapidly been gaining recognition as an important tool for broadening participation. It is described as a tool that promotes the inclusion of the public in participative and deliberative decision-making processes, which contributes to the transformation of the relationship between politics and citizens [UN, 2007]. Ideally, this approach should enable the public to become an actor in discussions and decision-making over public policies.

This paper examines an innovative approach to eParticipation that links online questionnaires to the development of a webDSS tool. The former allows the identification of autonomous adaptations and stakeholders' planning priorities, which leads to the initial development of alternative adaptation strategies, whilst the latter concerns the involvement of participants in their evaluation.

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<sup>a</sup> See in particular CESR - SCENES WebService (Last accessed on February 27, 2012).  
[www.1stcellmedia.de/customer/uni/cms/index.php?option=com\\_content&task=view&id=68&Itemid=239](http://www.1stcellmedia.de/customer/uni/cms/index.php?option=com_content&task=view&id=68&Itemid=239).

### **3.1 From mDSS to webDSS**

The main objective of the research is to consolidate and test the newly developed webDSS. This tool is an updated version of an existing DSS software, mDSS [Giupponi, 2007], capable of managing the data required for providing informed and robust decisions by enabling integration of socio-economic and environmental modelling techniques and multiple-criteria decision methods. It is beyond the scope of this paper to explain in detail all of the mDSS functionalities, however on a general note, the existing mDSS tool comprises four main phases:

1. **Conceptual Phase** identifies the issues and explores the problem.
2. **Design Phase** includes the identification of the alternative options (strategies) and selection of the decisional criteria. The variables are organised in the form of a matrix - the Analysis Matrix (AM). AM is a table containing the indicator values expressing the performances of the alternative options for each decision criterion. After this, different criteria are ordered based on their importance, and their weights are calculated. One of the methods for providing criteria's values is the revised SIMOS procedure [Figueira and Roy, 2002], used in this case study. In this procedure, participants order criteria in a table, based on their relative importance, allowing for their hierarchic arrangement in a visual way.
3. **Choice Phase** uses Multi-Criteria Analysis (MCA) evaluation techniques to judge all options against their contributions to solve the problem, through the elaboration of the criterion values stored in the matrix. Four different decision rules are available in the mDSS software: Simple Additive Weighting (SAW); Ordered Weighting Average (OWA); the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS); and ELECTRE. The ELECTRE method, utilised in this case study, is based on a pair-wise comparison of the alternatives [Rogers & Bruen, 1998; Shanian et al 2008].
4. **Group decision-making (GDM)** is a final phase that facilitates the identification of a compromise solution. The Borda rule is one of the offered GDM options (others are Condorcet and Extended Borda). The Borda rule attaches a number of points to each strategy equal to the number of strategies ranked lower than it, so that a strategy receives  $n - 1$  points for a first preference,  $n - 2$  for a second, and so on, with zero points for being ranked last; where  $n$  is the number of strategies [Young, 1974].

The webDSS will simplify mDSS, which has been used in the workshops where mediators have guided stakeholders through the procedure. This will be done by assembling only the methods needed for each given decision-making context. Whilst in mDSS participants (experts) can choose among different methods offered in each phase (e.g. SAW or ELECTRE, Condorcet or Borda), the interface of the new software will have visible only those methods that we predefine as suitable for a specific case study. For instance, as we will show later, the combination Likert scale-SIMOS-ELECTRE - Borda was built in webDSS for the ICARUS project. The possibility of tailoring the tool to different uses/users (for instance, a more complex version for a more scientific audience, or a more qualitative version for non-experts), whilst maintaining a straightforward methodological setting, broadens its possibility of application to the wider public.

### **3.2 Linking online questionnaires to the webDSS**

The online questionnaire is one particular eParticipation tool. It resembles its offline counterpart, but it has lower administration costs and a faster turnaround time. eParticipation conducted through an online questionnaire is suitable for collecting basic information on less explored issues, such as autonomous adaptations, and proves useful in understanding participants' relationships with the topic at hand [Phang and Kankanhalli, 2008]. The strength of this questionnaire lies in its online nature, which is expected to allow an outreach to a large number of participants in a short time.

The first online questionnaire aimed at providing a set of most suitable adaptation strategies and criteria for their evaluation, identified by the local farmers (*Conceptual phase* of the DSS). The questionnaire examined farmers' perceptions over present and expected changes in the environment, economy, policy, and society. It also analysed whether cropping practices and water management have already undergone some changes in recent years and whether farmers saw a need for adaptation due to variability in climatic conditions and other changes.

Farmers were recruited via the existing social network of Agro-Meteorological eBulletin users. The eBulletin is published by the Environmental Protection Agency of the Veneto Region (ARPAV). It is both hosted on their website and distributed through an e-mailing list. A specific Bulletin is issued for each of the 35 agricultural zones in the Region, up to twice a week in the irrigation period and less frequently during the rest of the year. The eBulletin was utilised as a means to distribute the online questionnaire to its 6,000 users, a much broader group of participants than we would have been able to reach with traditional face-to-face interviews.

The questionnaire was distributed between mid-July and mid-September 2011, as a link in each issue of the eBulletin. It was composed of 16, mostly close-ended questions, divided into two sections. The first section included socio-demographic information and farms' characterisation (size, income, crop production, and irrigation practice). The second section investigated irrigation techniques; perceived environmental, economic, social, institutional, individual changes, and any environmental pressure that has been influencing farmers' agricultural practice in the past 10 years. These were followed by questions on existing and needed adaptation measures in terms of crop and water management. Final questions explored the role of the eBulletin in improving agricultural practice, and what additional information should improve it. The last question offered farmers the option to leave their contact details.

The second online questionnaire aimed at testing the combination of methods that we found most suitable for the ICARUS case study, to be used in the new webDSS platform (*Design phase*). It was sent to a sample of those farmers who had left their full contact details in the first participation phase, assuming that by doing so they had expressed their readiness for further collaboration. The second questionnaire was composed of two sections. The first section presented a set of adaptation strategies that were drafted according to the outputs of the first online questionnaire, documentation review, and interviews with experts and policy makers of the regional administration. The adaptation strategies were proposed to the farmers for their evaluation in terms of seven criteria. Again, the criteria were based on interests expressed in the first questionnaire and allocated in terms of the sustainability pillars (social, economic, environmental). For each criterion (question), the strategies were evaluated via a likert scale, offering five options, from *very good* (5) to *very poor* (1). The results of the questionnaire enabled the compilation of the AM. In the second section of this questionnaire, participants were involved in a criteria weight evaluation exercise, which was derived from the revised SIMOS procedure.

Due to the development stage of the webDSS tool, the outcomes of the second questionnaire (AM and SIMOS) were inserted manually in mDSS, in order to run ELECTRE and identify the preferred strategy (*Choice phase*). The use of Simos and ELECTRE was selected as the sequence of methods most suitable for evaluation and ranking of alternative adaptation strategies conducted by the wider public (non-experts) [Shanian et al 2008]. Finally, the analysis of the possible conflicts between differing preferences and identification of a compromise solution among results obtained from participants was performed in a group decision-making context, using the Borda rule (*Group decision-making phase*).

The individual results were sent to each farmer, together with the final outputs of the group decision-making procedure. Farmers were then contacted by phone to collect their feedback, compare their expectations with the results obtained, and for additional inputs for refining the design of the webDSS prototype.

## 4 RESULTS

### 4.1 eParticipation - first phase

The results of the first round of participation allowed the mapping of farmers' perceptions on changes in economy, environment, and society, and their positions concerning needed and existing adaptation measures. These results clarified the state of affairs of water saving measures in agriculture, and obstacles for their implementation. This was an important input for consolidating adaptation strategies. Besides, analysing major farmers' concerns and needs enabled proposing criteria for the strategies evaluation.

With 590 individuals that completed the questionnaire, the sample presented almost 10% of the Bulletin users and 0.5% of all the farmers (farms) in the region. Most of the responses were collected within a 10 day period starting from the questionnaire's first publication in the eBulletin (Figure 1), hence this surveying process proved to be time efficient. Conducting traditional interviews, and with limited resources, it would have been highly unlikely to achieve a similar number of responses in the same time.

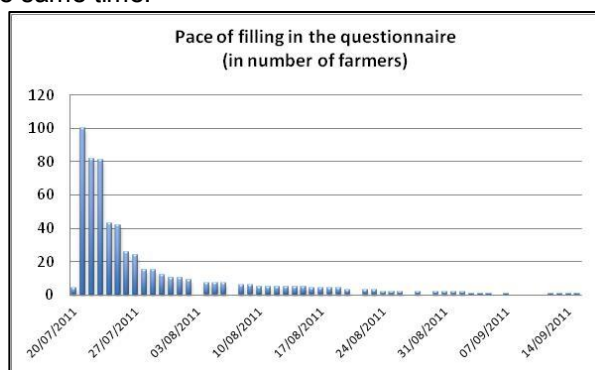


Figure 1. Reponses collection process.

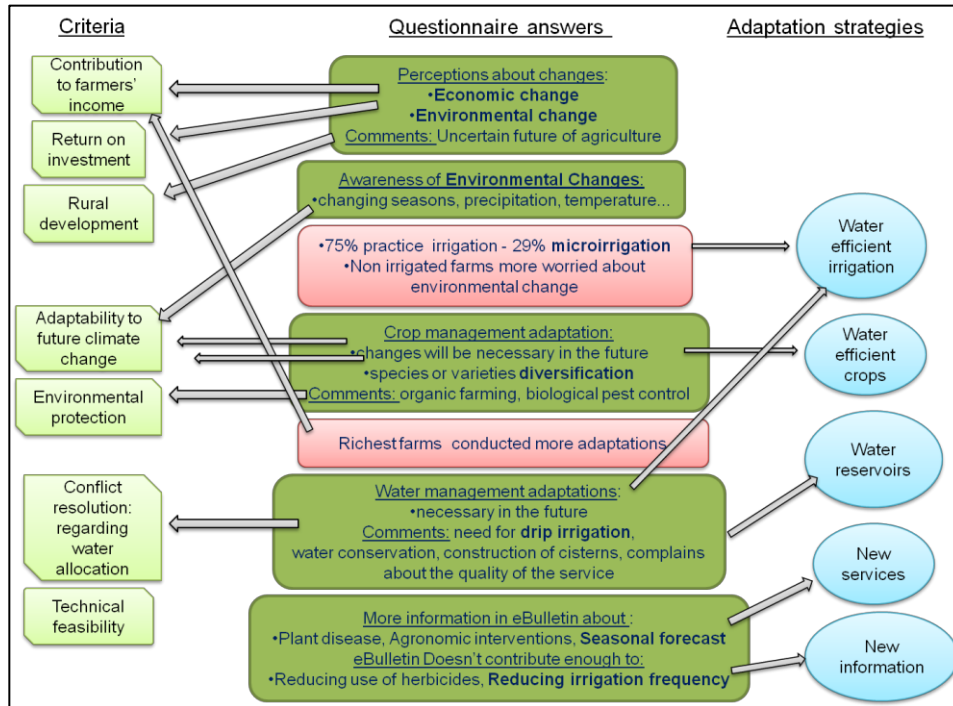
The results of the questionnaire showed that farmers were predominantly worried about economic change, followed by a concern over environmental changes. It appeared that farmers were worried about the future of agriculture, due to both farming continuity disruption and farms being abandoned by the youth. This is connected to the reported missing support for the local production, and a lack of support for small farms.

The results showed that the participants were aware that environmental changes have been influencing agriculture in the past 10 years, with 23% of farmers reporting tangible perception of shifting seasons, 22% changes in precipitation and 19% changes in temperature. Regarding crop and water management adaptations, the most frequent answer was that measures would be necessary in the future. The most common agronomic interventions already in place were species or varieties diversification and introduction of integrated pest control. Commenting on this question, farmers suggested organic farming and biodynamic agriculture, together with the introduction of the biological pest control. This answer suggests a rather high presence of the organic farmers in the sample. Besides, the results show a high percentage of specialized farmers, mainly wine producers, among the participants.

The comments regarding water management change were numerous, and the most frequent one was about the need for drip irrigation and water conservation measures, whilst some suggested the construction of either farm water tanks or dams in the hilly region. Some farmers complained about the quality of the service provided by the Irrigation Boards in charge of water supply. In October 2011, a brief report with the main results from the first questionnaire was published on the ARPAV's website.

The results of the first questionnaire were further discussed with experts, and the five strategies (directions for investments) were identified (Figure 2): use of reservoirs for flood retention and water storage; prioritisation of low-water-requiring

crops; investments in high efficiency irrigation technologies (sprinkle and drip irrigation); improvement of existing agricultural information systems (weather forecast, pests and diseases, irrigation requirement, etc.); and new climate services for longer-term adaptation (seasonal forecast). Moreover, from farmers' answers, and experts' inputs the following seven criteria were identified for ranking the strategies (Figure 2): contribution to farmers' income; return on investment; adaptability to potential future climate change; contribution to resolution of conflicts regarding water allocation; rural development; environmental protection; and feasibility.



**Figure 2.** First questionnaire results. The answers from the questionnaire (green), and questionnaire analysis (red) suggested adaptation strategies (blue) and evaluation criteria (light green). Notice that the last criterion (technical feasibility) was not recognised by the farmers, but suggested by the experts from the region.

Finally, the first online questionnaire enabled recruiting the farmers for the second phase, where they were more directly involved in the decision-making process.

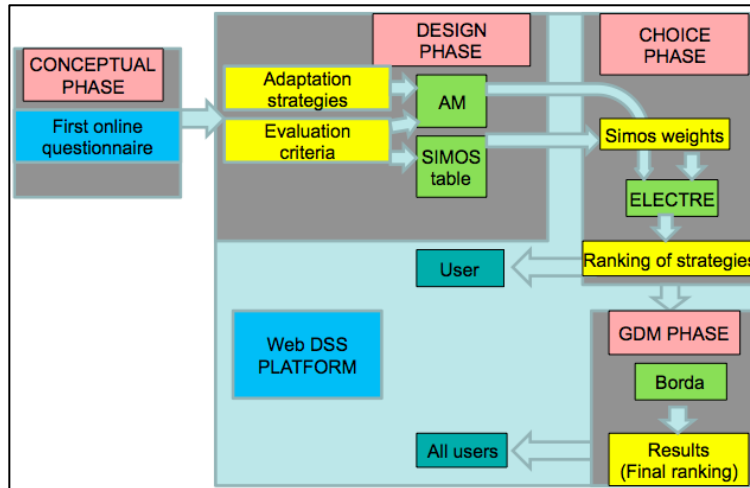
#### 4.2 Second eParticipation phase

The main output of the second phase is the webDSS prototype. The second online questionnaire had the primary aim to test the procedure to be implemented in the webDSS and the acceptability of the measures and criteria proposed specifically for the Veneto Region case study.

In the interviews that followed the second online questionnaire, participants praised the strategies chosen as particularly apt to the Veneto Region's needs and options for future investments. They also added comments on the approach – i.e. to simplify the first section of the questionnaire, which has now been turned into a matrix rather than the original series of questions, or to keep the SIMOS procedure, which in their opinion was intuitive enough. The comments were very useful for consolidating the webDSS. Overall, interviewees recognized the tool as powerful in identifying the agricultural sector's needs.

In the prototype under development, the steps from the Design phase to the GDM phase are carried out online by the webDSS platform (Figure 3). In this platform, the Conceptual phase of the original mDSS is predefined through the first questionnaire. An AM interface allows stakeholders to assign values (1-5) to the

strategies according to the given set of criteria, which is followed by another interface for criteria weighting through the SIMOS method (Design phase). After normalising the weights, the platform integrates the values from AM and criteria weighting into a ranking of strategies, through the ELECTRE method (Choice phase). In the last interface, the user will be able to visualise his/her own ranking (outcome of ELECTRE), and the ranking resulting from the aggregation of all individual responses, through the Borda rule (GDM phase) (Figure 3).



**Figure 3.** webDSS diagram. Red squares present DSS phases, blue squares present different tools, yellow squares present results, and light green squares present different methods (interfaces) in webDSS

The final output of this process will supply policy-makers with the necessary information to define how to direct investment priorities, with consideration of the preferences and expectations highlighted by this participatory process. This is expected to improve the effectiveness and acceptance of the final policy choice. The target group of the three specifically tailored versions of the webDSS developed until now – in Italian, Spanish and Portuguese - are farmers from the ICARUS case studies, namely the Veneto region, Valencia (Spain) and Central Algarve (Portugal). In Veneto, the consolidated version of the webDSS will be sent to those 370 participants who left their contact in the first online questionnaire.

## 5 DISCUSSION AND CONCLUSIONS

The preliminary results of this research show that eParticipation techniques can effectively facilitate the involvement of large numbers of farmers in the processes aimed at supporting the design of climate change adaptation strategies.

The first questionnaire's high absolute number of responses suggests readiness of the targeted agents to take part in the process, when contacted through an existing online social network. Although relative numbers (i.e. the rate of response) are similar to many other experiments and set at around 10%, the absolute numbers are much higher than what could have been achieved through more traditional approaches, such as local meetings and face-to-face interviews, with the same time and money invested. The collection of numerous responses disclosed farmers' perspectives on current and expected environmental, economic or institutional changes, as well as present situation regarding autonomous adaptations.

However, the proposed approach, as is the case with any other participatory practice, is subject to self-selection of participants. This should not be overlooked when analysing and communicating the results to policy-makers. For instance, the obtained sample diverges from the Veneto Region statistics regarding farms with vineyards (that are overrepresented). Nonetheless, not influencing the selection of participants helps to overcome other potential biases that could hinder objectivity in

a conventional participatory practice. Moreover, it provides useful insight into the engagement and communication potential of online approaches and expected responses from different categories of farmers. Our sample suggests that professional farmers, such as wine producers, show higher interest and stronger motivation for the use of online services, which easily made them accessible for participation in the survey. Similarly, a high percentage of organic farmers in the sample suggests that this is a rather proactive group, ready to pioneer in innovative approaches.

The use of eParticipation has also helped testing and improving the webDSS prototype, through the interaction with a selected group of respondents. The new software is now ready to be operationally adopted by the ICARUS project with the interfaces in three different languages. webDSS is expected to contribute significantly to the quality and transparency of communication and participation in the project with very limited budget requirements.

We expect that the combination of online questionnaires and webDSS, within an eParticipation framework, could provide robust decision support in the adaptation policy development, while achieving more inclusive engagement of local actors, and creating cross-cutting networks that link the general public, in this case presented by farmers, with mediators (scientists), planners, and policy makers.

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