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Research-supported participatory planning for water stress mitigation

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With multi-stakeholder issues such as climate change or population growth providing significant challenges for water managers, participatory approaches to planning and management are becoming increasingly popular. To aid water stress mitigation in Bulgaria's Iskar region, a participatory process with a broad range of stakeholders was designed and tested. Options adapted for the region such as risk management and industrial and domestic water conservation were studied. The results suggest that strong research support is needed to adapt participatory management theories into operational planning processes. Definition of appropriate working groups with clear roles and responsibilities are also needed to ensure effective implementation.

Keywords: drought; flood; participation; stakeholders; water stress

1. Introduction

Water stress occurs when the water demand exceeds the available water supply for a certain period or when the quality restricts its use (EEA 1999). The trends for the year 2030 show that as a result of increasing tourism, irrigation and climate change, water stress is predicted to increase for many regions, including Southern Europe (EEA 2005). Appropriate responses to water stress need to be based on understanding multi-purpose water use and consider both water demand and supply measures for management adapted to the local context. In view of these needs, we propose that the mitigation of the water stress may benefit from being: (1) participatory, to build on the contributions and perspectives of users, specialists and policy makers; and (2) supported by research, to promote innovative, holistic and reflective water management practice.

During the last 30 years, the need for public participation and stakeholder involvement in water policy making and management has increasingly been

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highlighted in international policy documents (i.e. United Nations 1972, 1992, 2000, 2002, ICWE 1992, UNECE 1998, EU 2000, 2002, UNESCO-WWAP 2003, UNDP 2006). This is primarily based on the argument that complex socio-technological-environmental systems, such as those in the water sector, cannot be effectively managed by only traditional technocratic, engineering approaches, since such approaches are commonly unable to provide management strategies that meet the underlying needs and values of the locally affected populations. Instead, adaptive and holistic forms of management are required (ADVISOR 2004, Delli Priscoli 2004, Ison *et al.* 2004, Pahl-Wostl *et al.* 2008, Benn *et al.* 2009).

According to Werick and Whipple (1994), the transformation of this theoretical understanding of the need for participation into practical application is seen to have passed through four main eras. It began with the 'era of closed participation', where participation of the public served the political purpose of rationalising projects, followed by 'the era of maximum feasible participation', the 'era of environmentalism' and finally, the 'era of collaborative decision building' (Werick and Whipple 1994). Societal transition to the final era has been supported by much research and practical work. Examples include methodological approaches such as ADVISOR (2004), Alternative Dispute Resolution (Ayres *et al.* 1996), the Logical Framework Approach (AusAID 2005) and Shared Vision Planning (Imwiko *et al.* 2007); large projects such as the US Drought Preparedness Studies (Werick and Whipple 1994), SLIM (Ison *et al.* 2004) and HarmoniCOP (Tippett *et al.* 2005); and summary or review publications such as Grimble and Wellard (1997), Creighton *et al.* (1998), Weber and Tuler (2006) and Imwiko *et al.* (2007).

However, despite mounting experience in public participation, the statements made by Werick and Whipple (1994) that meeting the standards of public participation 'is an elusive goal' and that 'challenges for the future will remain' are still valid. One of these challenges is identifying the most appropriate form of participation for different contexts, as the participatory management theories are not typically differentiated relative to the types of the planning subjects encountered or focal content treated (Buchy and Race 2001. Godschalk *et al.* 2003). In particular, the complexity of engineering, scientific or technological problems requires careful design of participation programmes to match the needs of the problem context (Chess 2000, Weber and Tuler 2006).

In this paper we suggest research-supported participatory planning approaches as a possible means for coping with this challenge. Research, such as Maguire (2003), provides reviews on standards for good practice in scientist-stakeholder interactions in the environmental modelling field. However, another part of the existing challenge is to implement and evaluate practical experiences of setting up participatory process steering groups, which ensure effective collaborations between various parties such as researchers, participatory method practitioners and local stakeholders. Our work will demonstrate how a strongly interactive co-operation between three working groups can be organised for structuring problems and studying options for regional water stress mitigation, with specific emphasis on its application in a political and social context largely unfamiliar with participatory approaches.

The study presented here has been carried out within the scope of an integrated FP6-EC project, AquaStress (www.aquastress.net), which aims to develop integrated, comprehensive and multi-sectoral approaches for the diagnosis and mitigation of water stress. The project's research structure has been set up around eight case studies in Europe and Africa (Italy, Portugal, Netherlands, Poland, Tunisia, Morocco, Cyprus and Bulgaria) for managing regional water stress, which are carried out in a participatory manner with local stakeholders. This paper will present and discuss just one aspect of the project's findings; namely the development of a methodology for research-supported participatory water management processes, as well as one example of its practical implementation in the Upper Iskar catchment in Bulgaria.

2. Methodology

2.1. Concept

The research-supported participatory process, developed in the EU project Aquastress has seven logical steps, outlined in Figure 1. The process is based on the principles of effective public involvement as follows: (1) two-way communication; (2) involvement of stakeholders as early as possible and throughout the process; (3) deliberation involving informal and personal processes; and (4) representation of all interests (Blahna and Yonts-Shepard 1989). Furthermore, it is research-supported to conform to the specificity of the problem to be solved, namely mitigation of regional water stress. Three working groups are suggested (dashed lines in Figure 1): (1) the Process Organization Group (POG); (2) the Local Public Stakeholder Forum (LPSF); and (3) the Joint Work Team of researchers (JWT).

The Process Organization Group sets the initial project goals and process design. In the AquaStress project, this group was composed of researchers. This is a core group, which is involved in all other steps of the water stress mitigation process, providing methodological support, process management and facilitation of the meetings. The role of this group is well defined by Berkes (2009) who uses the term 'bridging organisations'. The second group, the LPSF, encompasses regional stakeholders who have a broad range of interests linked to the regional water

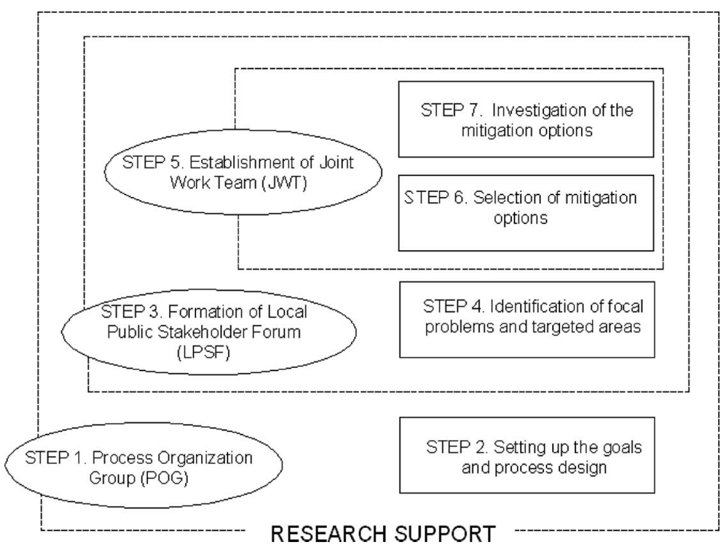

Figure 1. The process: providing research support to local stakeholders for problem identification and mitigation.

system's management and have in-depth knowledge and understanding of the system related to their own experience and perspectives. Collaboration of the stakeholders in the forum then allows a comprehensive analysis of the situation and elucidation of focal problems, thus providing an opportunity to identify strategic areas to be targeted for managing or solving these problems (Figure 1, Step 4). The third group of researchers, the JWT, involves experts on water stress mitigation options. The tasks, in which these three groups are involved, are separated with dashed lines in Figure 1.

2.2. Procedures and methods

The scientific procedures and methods, which were used to support the participatory process and to enhance the quality of the outcomes of the project, are outlined in Table 1 and further explained below. Steps 1 and 2 are not included in Table 1 as they precede the participatory part of the process and have the purpose of preparing Steps 3 to 7.

2.2.1. Stakeholder analysis

A stakeholder analysis aims to aid the identification and selection of relevant members of the stakeholder community to participate in the LPSF. The analysis should assure that the public is representative and that no important stakeholders are left outside the process without excellent reason. A broad range of methods have been developed or adapted for stakeholder analysis in the natural resource management (Grimble and Wellard 1997, MacArthur 1997, Ramírez 1999, Brugha and Varvasovsky 2000, Rinaudo and Garin 2005, Blackstock and Richards 2007, Reed *et al.* 2009). The POG selects the most appropriate method and carries out the analysis.

2.2.2. DPSIR approach for problem and objective analysis

DPSIR is a planning approach that may be applied to elucidate focal problems for further detailed investigation. The DPSIR framework was initially proposed by the National Institute of Public Health and Environment, Bilthoven, in the Netherlands (EEA 1998). The DPSIR framework, as explained by Kristensen (2004), identifies a

> chain of causal links starting with **D** – "Driving forces" (economic sectors, human activities) through **P** – "Pressures" (emissions, waste) to **S** – "States" (physical, chemical and biological) and **I** – "Impacts" on ecosystems, human health and functions, eventually leading to political **R** – "Responses" (prioritisation, target setting, indicators).

2.2.3. Case study definition

Due to resource constraints, it is usually not feasible to attempt to solve all regional water stress problems simultaneously. Therefore, a selection of the most critical areas and corresponding potential management measures is of crucial importance. The 'case study' can be defined by a combination of mitigation options (such as saving water, reducing water pollution, etc.) to be further investigated and implemented in a particular region. The definition of the objectives to be worked towards in the case study is interactive and involves all groups. Once the areas of interest are defined by the LPSF considering their local knowledge of the system, the researchers (JWT) can then suggest technical, economic and/or social options to be applied, based on their knowledge of available and potentially applicable options or tools.

2.2.4. *Feasibility study and literature review*

Once determined, the mitigation options should be examined in terms of application feasibility in the region, after which an action plan for the option's implementation can be determined. All groups take part in this process. The researchers (JWT, POG) carry out the theoretical study of the specific methodology to be applied and adapt it to the local needs and constraints. The stakeholders (LPSF) are responsible for ensuring that the researchers understand local conditions and that a feasible action plan is produced. It should be noted that the process should be strongly interactive, characterised by several intermediate meetings, workshops or consultations, as is shown in Table 1, in order to mutually assess the progress of the feasibility study and redress potentially unsuitable or controversial issues before the final evaluation at the end of the project

2.2.5. *Evaluation*

The evaluation methodology is to be primarily developed by the POG as the first steps take place before the LPSF formation. The evaluation of the participatory process and its characteristics is of use for determining the effectiveness of the stakeholder participation process in helping to manage the water stress problems at a regional level. The evaluation can be developed with three major purposes. First, to portray the initial circumstances (context) at the start of the participation process; second, to describe the most important developments that occur *en route* through the participatory initiative (process); and finally, to assess the extent to which the defined objectives and goals (result/outcomes) have been achieved.

Table 1. Research support to enhance the participatory process.

Steps (Fig. 1)	Procedure	Purpose	Participatory tool
Step 3	Stakeholder analysis	Identifying relevant stakeholders to form the LPSF	Interviews, questionnaires
Step 4	DPSIR approach	Determining regional focal problems and areas	Round table discussion
Steps 5 and 6	Case study definition	Selecting mitigation options and establishment of the Joint Work Team of researchers	Workshops and consultation with stakeholders
Step 7	Feasibility study and literature review	Designing the specific research plan for each mitigation option	Workshops, technical meetings, consultation with stakeholders
All steps	Evaluation	Obtaining feedback from the stakeholders	Interviews and questionnaires

3. Application of the methodology in the Upper Iskar catchment

3.1. Process initiation

The process for mitigation of a regional water stress was initiated by an international consortium of research centres, which designed the AquaStress project. The Iskar region was selected as one of eight test sites, where severe water stress is predicted for the year 2030 (EEA 2005). The River Iskar is the longest interior river in the Bulgarian territory. The Iskar springs from south-western Bulgaria and flows into the Danube at the northern border of the country. The river is 368 km long and the watershed area, including the tributaries, is 8647 km^2. The region of Upper Iskar, forming the focus of this study, comprises the catchment area of the main stream and its tributaries (3668 km^2) from the springs in Rila Mountains to the town of Novi Iskar where the river leaves the Sofia area. There are four major municipalities: Sofia, the capital of Bulgaria (38 settlements, approximately 1.2 million citizens), Samokov (28 settlements, 38,000 citizens), Gorna Malina (14 settlements, 4300 citizens) and Elin Pelin (19 settlements, 28,000 citizens). The main industrial water consumer is the metallurgical plant Kremikovzi, which is situated in the Sofia region. The water resources in the basin have a variety of principal uses including: drinking and municipal water supply (being the predominant sources for the Sofia water supply system); industrial water supply; electro-power production; irrigation; and recreation.

3.2. Establishment of the Local Public Stakeholder Forum (LPSF)

The process of Iskar LPSF establishment took approximately five months. It started with a stakeholder analysis, which comprised three activities: (1) Identification (mapping) of the stakeholders; (2) Assessment of stakeholder interests and agendas; and (3) Investigation of patterns of interaction and dependence (Grimble 1998). Considering the importance of the LPSF, the process was interactive and participatory after its instalment. After the initial selection by the POG, the stakeholders in the LPSF performed a new analysis in order to choose other members who they thought should also be included. Table 2 lists the institutions, whose representatives are involved in Iskar LPSF.

3.3. Identification of the focal problems and the targeted areas

The DPSIR approach (outlined in the previous section) was selected by the POG and applied by the members of the LPSF in a workshop, using roundtable discussion techniques in order to identify the regional focal problems (Figure 2). The role of the researchers was to explain the approach to the stakeholders and to facilitate the discussions, while the stakeholders had the leading role in identifying the system attributes.

Four main driving forces of the water stress situation in the region were outlined. The most important natural factor was defined as climate variability (alternate periods of dry and wet conditions). For example, due to the series of dry years (and some would argue poor dam management), there were very dramatic water crises in Sofia in 1962, 1963, 1986, 1990, 1991, 1994 and 1995. By contrast, in the summer of 2005, Bulgaria suffered a number of floods of severe intensity throughout the country, including in the Upper Iskar catchment.

Table 2. Members of the LPSF.

Participant	Type	Role
Ministry of Environment and Waters	*Government Institution*	Determines the water policy in Bulgaria
Danube Basin Directorate	*Government Institution*	Controls execution of the water law in the Iskar catchment
Municipality of Samokov	*Local Institution*	Administrates the first large town upstream of Sofia
Sofiyska Voda Ltd	*Water Utility*	Responsible for the provision of the water, sewerage and wastewater treatment services to the city of Sofia
Raikomers	*Private Service Provider*	The biggest company in Sofia building new pipelines and repairing old ones
Institute of Irrigation and Mechanization, Sofia	*Main water consumer*	Determines the irrigation policy in the Sofia region
Heating installations	*Main water consumer*	Supplies Sofia with heating services, operates the installations
Kremikovtzi, Ltd	*Main water consumer*	The biggest metallurgy plant in Bulgaria, significant polluter of the Iskar river
Bulgarian Water Association	*NGO*	Open to all individuals who are interested in water problems
Association of Lawyers	*NGO*	Provides knowledge on the legislative aspects
Forum of Bulgarian Women	*NGO*	Examines gender issues
Global Water Partnership, Bulgaria	*NGO*	Participates with experts to examine the interrelations between water and vegetation
Local expert	*Individual*	Provides expertise for Iskar reservoir management, developer of the software SOPER
Chairmen of a building council	*Individual*	Provides an urban water customer opinion

The Iskar reservoir had been constructed to help to overcome the problem caused by irregular seasonal surface run-off. At present, the reservoir is the main water supply source of Sofia, delivering approximately 80% of its drinking water. The existence of only one large source of water was considered as another driver of the water stress (Figure 2). The next two drivers have an anthropogenic character and were defined as 'former state water policies' and 'socio-economic development of the capital in the transition period' (Figure 2). Although both cause similar pressures on the water management framework, they were notable because of their different features.

The first driver combines all negative administrative or political heritage from the time before the transition period of the country (starting in 1989), which still has an impact on water issues today. The second driver combines the following: the boom in the construction of buildings in the capital and the general city expansion; the extraordinary growth in the Sofia population as a result of intensive migration

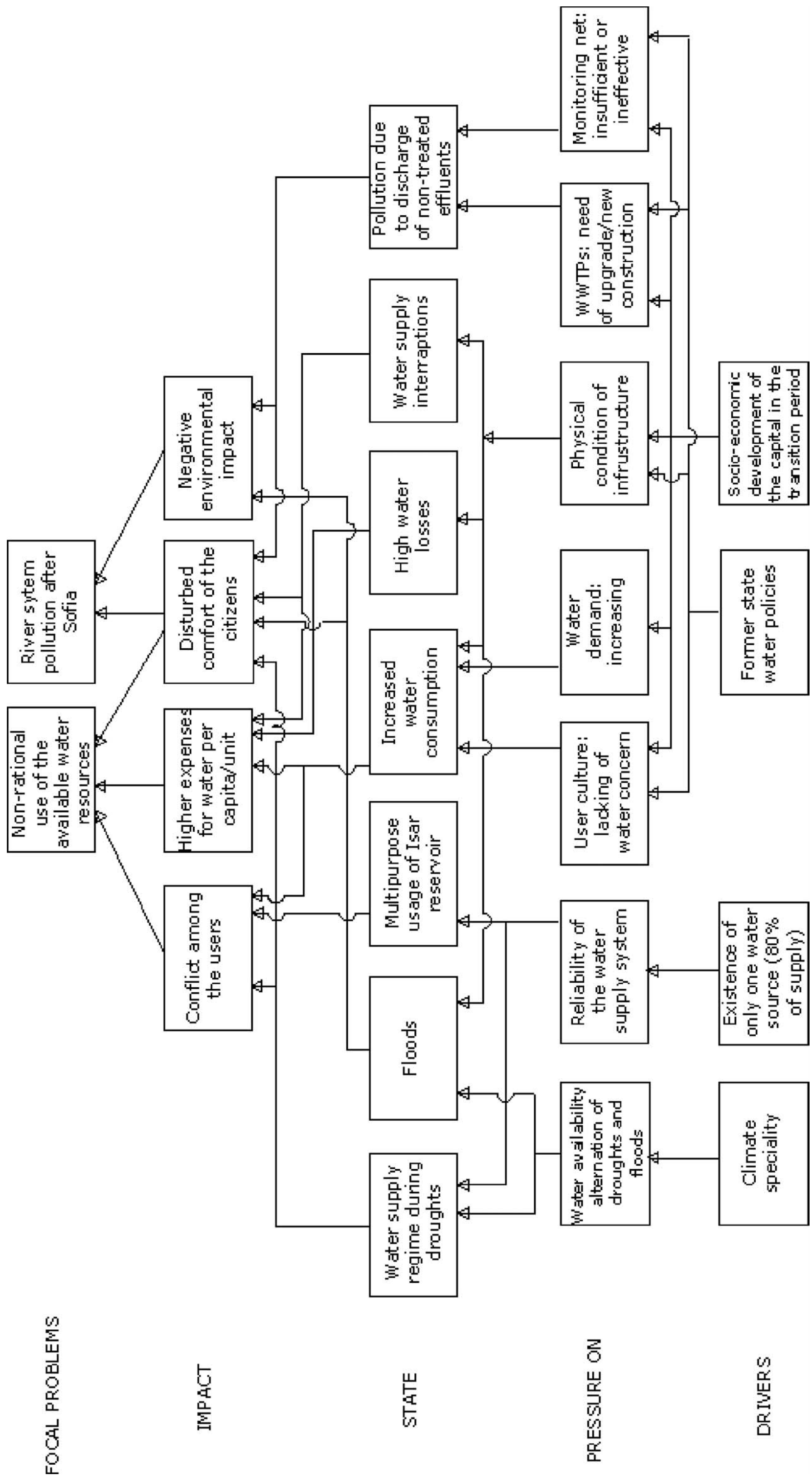

Figure 2. DPSIR outcomes for the Upper Iskar catchment.

during recent years; and the industrial changes due to the transition in the political structure of the country. A common pressure of these two drivers is reflected through the user or consumer culture in the Upper Iskar catchment – several generations grew up with little concern for how water was used. The user behaviour together with the current physical conditions of the water infrastructure leads to higher regional water consumption and higher overall water-related expenses per capita. This outlines the first focal problem of the region, which is the non-rational use of the available water resources (Figure 2).

The second focal problem concerns the water quality and was determined as the river pollution downstream Sofia (Figure 2). Kremikovtzi is not only the largest metallurgical plant in Bulgaria and the main industrial water user in the region, but is also considered to be the biggest water polluter in the Upper Iskar catchment.

3.4. Selection of mitigation options and formation of the Joint Work Team

The selection of the mitigation options to be examined was carried out interactively, together with the establishment of the third important group of participants in the project: the Joint Work Team (JWT). To benefit from the international expertise available in the AquaStress project, all project partners were invited. The establishment of the JWT took five months.

After analysing the current state of the Iskar's water resources (Figure 2), the stakeholders (LPSF) identified seven areas, where detailed studies are needed to improve the situation: (1) A technological solution for reducing the pollution from the metallurgical plant Kremikovtzi; (2) Supporting short-term decision making for the operation and water allocation of the Iskar reservoir; (3) Economic evaluation on the feasibility for reducing water leakages in the urban distribution systems; (4) Optimising inter-institutional co-ordination between those involved in management and operation of the Iskar waters; (5) Demand-Side Management (DSM) of the Sofia water supply system; (6) Flood and drought management in the Iskar system; and (7) Development of 'play and learn' modules for enhancing the water culture of the users. As a result of a series of discussions among all working groups, the final list of five mitigation options was selected during a workshop by LPSF voting (Table 3).

Options 1 and 3 (Table 3) were selected to respond to the first focal problem identified by the LPSF – the non-rational use of the available resources (Figure 2). The data from the National Statistical Institute for the period of 5 years (2000 to 2004) show that the biggest users are the domestic sector (Sofia water supply system, 54.6%) and the industrial sector (44.9%). Only 0.5% of the abstracted water remains for the other users. The main industrial consumer (85% share of the total industrial water use) is Kremikovzi Ltd, which is the largest metallurgical company in the Balkan Peninsula, contributing almost 2% of Bulgaria's Gross Domestic Product and producing over 10% of Bulgaria's exports to the EU. Therefore, these two principal users were identified as targets for the application of mitigation options within the case study. It was assumed that if the two largest water consumers used water more efficiently, competition would diminish and the available resources would be enough to cover the current demands, leading to greater social consensus and agreement over water sharing rules.

To consider the second focal problem identified by the LPSF, the river pollution, treatment techniques for pollution reduction also require examination (Figure 2).

Table 3. Selected mitigation options to be studied and implemented.

Number	Mitigation option	Target
Option 1	Saving water in industry	A1. Industrial sector
Option 2	Reducing pollution from industrial waters	
Option 3	Saving water in the domestic sector	A2. Domestic sector
Option 4	Participatory modelling for water management and planning	A3. Risk (flood and drought) management
Option 5	Integration of technical and non-technical options	

The analyses undertaken by the LPSF showed that the river system downstream of Sofia is polluted due to Kremikovtzi and municipal sewerage system inputs. The municipal wastewater treatment was not chosen as a target, as a management strategy for this issue has already been developed and the reconstruction of Sofia's waste water treatment plant is underway. Therefore, Option 2 was selected for further study (Table 3).

Option 5 was chosen because the latest flood and drought events in the country showed, perhaps because of their infrequent occurrence, that both citizens and institutions were not prepared to cope with them and that further research is needed in order to manage these extreme events.

The following research entities (partners in the project) with expertise in the selected targeted areas were included in Iskar JWT:

- University of Architecture, Civil Engineering and Geodezy, Bulgaria;
- Rheinisch-Westfaelische Technische Hochschule Aachen (RWTH), Germany;
- University of Exeter, UK;
- Cranfield University, UK; and
- Cemagref, France.

3.5. Outlines of the feasibility studies on the mitigation options

The investigation of each of the mitigation options, listed in Table 3 has been thoroughly described in other papers and is beyond the scope of the current paper (Dimova *et al*. 2007, Inman *et al*. 2007, Vamvakeridou-Lyroudia *et al*. 2007, Daniell *et al*. 2008, Daniell 2008, Inman *et al*. 2008, Ribarova *et al*. 2008, Vamvakeridou-Lyroudia *et al*. 2009, Wintgens *et al*. 2009). Only some of the aspects of their participatory content will be underlined in what follows.

3.5.1. Saving water and reducing pollution in the industrial sector

After a series of meetings between researchers and stakeholders from the Kremikovtzi plant, the following research needs were defined and studied further: determining water flows in the industrial site; System Dynamics Modelling (a methodology for studying and managing complex feedback systems, typically used when formal analytical models do not exist) for simulating the complex water system as a whole, (Vamvakeridou-Lyroudia and Savic 2008); investigation of different system components (comparison with European standards and BREF documents); and sampling and analysis of relevant priority substances in the plant and evaluation of potential reduction measures for those occurring substances.

3.5.2. Saving water in the domestic sector

The regional feasibility of the demand management in Bulgaria's capital, Sofia was selected to be studied. The other possible study for saving water in the domestic sector was identified by the stakeholders as 'Economic evaluation on the feasibility for reducing water leakages' (see above). This proposed study was not kept for further investigation in Aquastress projects because there is similar on-going study being undertaken by the Sofia Water Supply company. Implementation of demand management to reduce domestic water demand requires co-ordination across organisations (water companies, local and national government agencies) to create the right economic conditions, as well as understanding of citizens' perceptions of water conservation to understand how public participation can be encouraged. Considering demand management's links to people's behaviours, a participatory approach was chosen. Ten local experts were involved from the beginning of the study as advisers. In addition, 600 citizens were interviewed about their perceptions on household water saving techniques and the results were analysed using Bayesian network modelling software to identify data dependencies.

3.5.3. Risk management

The LPSF and JWT team considered that a collaborative approach to education and collective action in the region on how to work together to manage the extreme flood and drought events was required. That is why the risk management process was designed and organised to be as participatory in nature as possible. Sixty people were involved in this process and grouped as follows: national level stakeholders (called policy makers); local level stakeholders (one group from upstream and one group from downstream of the main Iskar dam); citizens (two groups from downstream of the main Iskar dam) and the LPSF. A year-long series of 'participatory modelling' workshops (Table 3) were run with the six participating groups (Daniell *et al*. 2008). Various types of interviewing techniques and participatory workshop exercises such as cognitive mapping, preference distribution games, group discussion, robustness analysis, spatial mapping and action planning were used. The participatory modelling process resulted in 24 specific projects that were to be submitted for funding by a variety of sources. Over half were for preparedness activities and the others for recovery and reconstruction efforts.

3.6. Evaluation by the LPSF

Based on an evaluation protocol developed by researchers (Marsh *et al*. 2001), evaluation tasks were performed by all members of the LPSF (100% of its 14 members filled in the questionnaires and were subsequently interviewed). In addition to closed question responses, open question responses from the questionnaires also highlighted a number of participants' perceptions of the process. For example, one participant noted:

> All the options in our investigation are up-to-date. My expectations are fully met. The interactions with the organisers are excellent, so are the relationships established in the LPSF. Since all the participants have a common goal – to give the best of their knowledge and experience in the project, the communication between us was excellent and professional. We all try our best to find the best communication. When other people were involved, the meetings were constructive. We all worked as a team.

Further discussion on the evaluations is provided in the next section.

4. Discussion

4.1. Lessons learnt for 'good practice' in stakeholder participation processes

The research-supported participatory process was developed and tested over a period of four years for the Upper Iskar catchment as part of the Integrated FP6 project, AquaStress. In total, more than 50 different types of meetings – co-ordination, workshops and public events, including media presentations – were organised and held. In total 600 interviews with citizens from Sofia were carried out in the A2 study (Table 3). In addition, 100 interviews with citizens from the other regions in the test site were carried out at the beginning of the A3 study (Table 3). Ten external experts were involved in the A2 study and over 60 people participated in the workshops of the A3 study.

The Iskar study adds one more example to the body of literature available on the practical implementation of the stakeholder participation processes. However, it has also been able to offer further empirical evidence about best practice stakeholder participation process organisation in a number of areas.

It is considered that public participation should take place while the options are still being considered and, preferably, when the problem is still being defined (Creighton 2005, Tippett *et al*. 2005). Taking this suggestion into account, the establishment of the LPSF was placed at the very beginning of the process, as shown in Step 3 of Figure 1. The evaluation results support this choice as the evaluations showed that 92% of the stakeholders agreed that ''This process has taken place at a sufficiently early stage in the policy formulation process to allow participants to have some genuine influence''.

Creighton (2005) stated that one of the most frequent problems in participatory processes is a failure to include a broad enough range of stakeholder opinions. To avoid this, the establishment of the LPSF was aided by a conceptual design and stakeholder analysis initially implemented by researchers. The stakeholder analysis was carried out by external (European) and internal (Bulgarian) researchers from the AquaStress Project, then later with a first range of stakeholders in an interactive manner, in order to ensure a representative and competent group of stakeholders for driving the rest of the research project process. In the evaluation questionnaire there was also a question on this issue, formulated as: ''In my opinion, the participants in this process fairly represent the members of the public who will be affected by the issues raised in it''. This was the only question that received 100% agreement, thus confirming that the efforts taken to carry out the stakeholder analysis and implement the suggestions for representation had been a valuable exercise.

Conflict management is another critical issue in public participation processes. In the project, great attention was paid to carrying out the stakeholder analysis, because all next steps depend on the capacity of the people selected to work effectively together. However, as the stakeholders were selected from a diverse range of groups, it was also normal that some conflicts and differences in opinion were apparent. For example, not all LPSF participants agreed with the selected options. Out of 14 participants, four stated in an anonymous questionnaire that there were competing interests in the process. Some of them (two) did not support mitigation options 1 and 2, arguing that the Kremikovtzi enterprise is a private metallurgical company and that EU money should not be used to solve their problems, even if it is a heavy water user and polluter. Another two did not agree with possible flood mitigation strategies under options 4 and 5 and one thought that there would be a contradiction between use of water saving devices in the domestic sector and the financial interest of the private company, which operates the urban water supply system (mitigation option 3). When conflicts appeared that were not mitigated by the participatory methods chosen, after discussing the issues, the decisions were taken based on a majority vote, as agreed *a priori* when the LPSF members signed the protocol of co-operation with the AquaStress project. This protocol also aided the smooth running of the participatory process as it outlined mutual responsibilities.

4.2. Working group interactions

Three core permanent working groups were established – the POG, the LPSF and the JWT. The international experience about the interactions between the stakeholders and the scientists shows several alternatives, including establishment of one steering group of stakeholders and scientists in the beginning of the process or starting the process with researchers and later involving stakeholders (Cohen 1997, Buchy and Race 2001, Maguire 2003, Janse and Konijnendijk 2007, Berkes 2009). The alternative dispute resolution approach differentiates participatory processes where third party assistance is needed and suggests it to be in a form of process consultation, facilitation, mediation and fact finding (Ayres *et al*. 1996). The result of the study showed that depending on the nature of the investigated system, an appropriate structure of the involved parties should be established and it is the role of the researchers to suggest a preliminary design for it. In the process, a core group of researchers (POG) both internal and external to the Iskar system designed the water stress mitigation process to be undertaken. The LPSF stakeholder group then appeared to identify the system and focal problems to be examined. Only after this stage, when the local situation was clarified and the needs were determined, a JWT of researchers entered to study the local feasibility of different mitigation options. The Iskar case study was carried out in the frame of an International research project, so

Table 4. Roles of the researchers and the stakeholders.

Researchers: *Process Organisation Group (POG); Joint Work Team (JWT)*	Stakeholders: *Local Public Stakeholder Forum (LPSF)*
To design the whole process, considering the specificity of the targeted subject (POG)	To bring insights related to the system
To suggest the methods and the techniques (POG and JWT)	To exchange knowledge with scientists
To study the feasibility of the options (POG and JWT)	To provide information and opinions
To facilitate the process (POG)	To evaluate the feasibility of the application of the tools suggested by the scientists

the necessary research support was provided by the existing expertise in the project consortium. The experience on the roles of the scientists and the stakeholders is summarised in Table 4.

The collaboration between researchers and stakeholders throughout the project's lifetime proved to be possible and useful for both parties. Information and knowledge exchange between them appeared to occur in a natural and effective manner throughout the process, enhancing the collective learning of all involved. The results produced at the end of the project's life were satisfying, not only from personal perspectives of those who were involved, but also from a regional perspective, as considerable progress had been made towards solving crucial regional water stress problems. The major local achievements of the participatory Upper Iskar catchment water stress mitigation process and its five mitigation options include:

- Initiation of multi-level (ministers to citizens) participatory decision-making processes in the region;
- Understanding driving forces and internal processes of the region's water stress;
- Identification of the water flows and water quality in Kremikovtzi metallurgical plant;
- Development of a programme of measures for the reduction of aqueous emissions and water use in Kremikovtzi;
- Developing and applying Systems Dynamics Modelling for water saving scenarios in industry;
- Demand management scenarios assisting water savings in the domestic sector;
- Development and implementation of an operational protocol for a participatory modelling process used to aid decision making related to combined flood and drought risk management; and
- Development of an action plan to cope with water stress in one part of the Upper Iskar Basin area.

4.3. The research support

The most important outcome of the work presented here is not simply the repetition or refutation of previous research findings or common pre-conceptions, but the innovative idea that commonly constructed understanding between experts, local stakeholders and affected populations can be achieved, if the participatory process is well supported by an appropriate research methodology. It is not by accident that the EU Commission provides funds for improving the links between research entities, regional authorities and local business communities (EU Commission, Work programme, 2007–2008, (European Commission 2007)). It has become evident that researchers have much useful knowledge that could be provided to support regional development and management initiatives in Europe (and elsewhere), yet they often have difficulties in transferring it (European Commission 2007). It was underlined in the introduction that public participation is considered to be necessary for solving the regional water problems holistically, but it was also stated that the participatory approaches need to be adapted to the content of the studied subject. Researchers can take on this role and support the convening of broad-scale multi-level participatory processes when finance is available, rather than leaving it to government agencies or

NGOs, as has been common in other participatory environmental policy processes (Holmes and Scoones 2000).

4.4. The process drawbacks

The general weakness of the suggested approach is that being participatory, its success is very much dependant on the personalities of the people involved and the availability of financing. There are three core groups, so the total number of permanently involved persons is quite high (in our case approximately 30). To reduce the possibility of failure due to human error, there are benefits of having an approach that is research-based in nature. The available research mechanisms, such as careful planning, in-depth stakeholder analysis, interviews with JWT members, prior to their assignments and participant evaluation, are valuable tools to ensure that the process is effectively meeting its objectives and should be considered for future applications. Another specific characteristic of the process is that it was initiated within the AquaStress project with a clear research scope but without an institutional mandate. The lack of an institutional mandate could weaken the stakeholder motivation to actively participate in the process. To avoid this, preliminary meetings were held with the high level managers of the institutions involved in the LPSF, and a protocol of co-operation between AquaStress project and them was signed.

5. Conclusions

The theoretical background of an integrated, participatory and multi-sectoral approach to the diagnosis and mitigation of regional water stress has been developed. It was applied to eight case studies in Europe and Africa, and demonstrated in this paper for the specific case study of the Upper Iskar catchment in Bulgaria. The approach was shown to be replicable and adaptable, considering the results of its application to countries and regions with different socio-economic situations. It supports the 'good-practice' suggestions of how to organise public participation processes and was considered beneficial by all stakeholders involved. Moreover, considering the current lack of well-reported case studies in the literature of how and by whom public participation programmes may be designed and supported, the Upper Iskar example provides a number of interesting insights for scientists and practitioners alike. The innovative element of the approach – the establishment of three core groups, one of local stakeholders (LPSF) and other two of researchers (POG and JWT) – proved to be effective because they complemented each other to guarantee a comprehensive understanding of problems and appropriate and innovative water stress mitigation options. The central role played by the stakeholder group was to provide locally grounded knowledge from a broad range of viewpoints and pre-assessment of researchers' decision-aiding tools and methods for application in their own regional context. This role for stakeholders resulted in significant local benefits: identification of the focal water stress-related problems; selection of targeted areas for water stress mitigation efforts; and the choice of appropriate management options for water stress mitigation.

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