The Use of Economic Valuation in Environmental Policy: Providing Research Support for the Implementation of Eu Water Policy Under Aquastress

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1 Introduction

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Water stress is a global problem with far-reaching economic and social implications. The mitigation of water stress at regional scale depends not just on technological innovations but also on the development of new integrated water management tools and decision-making practices. Through the nineteenth and twentieth centuries, water resources management was primarily addressed as an engineering challenge. However, the realisation that effective management for the benefit of multiple stakeholders is crucially dependent on an understanding of a wide variety of natural, economic, political and social processes occurring at different spatial and temporal scales has shifted the emphasis towards a softer framing of both the challenge and appropriate interventions. Those individuals and institutions that have a remit to manage water resources for both human and environmental benefit are able to select from an increasing range of policy mechanisms (including economic, sociological, educational and technological as well as human-centred measures) and are increasingly concerned with developing understanding amongst stakeholder groups and cultivating the legitimacy of both problem characterisation and solution selection.

This book aims to show that economics in general, and non-market valuation methods in particular, together with participatory and engineering tools, can facilitate the design and implementation of the different European policies in relation to mitigation of water stress. The results presented in this book derive from AquaStress, which is an EU-funded integrated project (IP) contract n°511231-2—6th EU Framework Programme for RTD (http://www.cordis.lu)—delivering interdisciplinary methodologies enabling actors at different levels of involvement and at different stages of the planning process to mitigate water stress problems. The project draws on both academic and practitioner skills to generate knowledge in technological, operational management, policy, socioeconomic, and environmental domains. Contributions come from 35 renowned organizations, including SMEs, from 17 countries.

The AquaStress project generates scientific innovations to improve the understanding of water stress from an integrated multisectoral perspective to support: (a) diagnosis and characterization of sources and causes of water stress; (b) assessment of the effectiveness of water stress management measures and development of new tailored options; (c) development of supporting methods and tools to evaluate different mitigation options and their potential interactions; (d) development and dissemination of guidelines, protocols and policies; (e) development of a participatory process to implement solutions tailored to environmental, cultural, economic and institutional settings; (f) identification of barriers to policy mechanism implementation; and (g) continuous involvement of citizens and institutions within a social learning process that promotes new forms of water culture and nurtures long-term change and social adaptability.

Moreover, the AquaStress project adopts a case study—stakeholder-driven approach—and is organized in three phases: (i) characterization of selected reference sites and relative water stress problems, (ii) collaborative identification of preferred solution options and (iii) testing of solutions according to stakeholder interests and expectations. It makes a major contribution to the European Communities' objectives stated in the 6th EU Framework Programme and supporting the Community Directive 2000/60/EC and the EU Water Initiative. Eight test sites have been selected in which well-defined case studies are under consideration for developing adequate new mitigation and option strategies in accordance with the needs and concerns of local stakeholders. The selection has been based on a detailed analysis and characterisation of the test sites on the basis of the following criteria: (a) an existing and accessible wealth of existing data on the physical characteristics of the water regions and water management systems; (b) stakeholders amenable to participatory processes; (c) the types of water stress issues represented include insufficient or failing infrastructure, inappropriate agricultural and land use practices, industrial pollution, inefficient water use in domestic, agricultural and industrial sectors, pressures from seasonal population changes (tourism), energy demands, etc; and (d) comprehensive representation of the major water stress issues across Europe and North Africa. The test sites selected are located in Bulgaria, Cyprus, Italy, Morocco, the Netherlands, Poland, Portugal and Tunisia.

The results from case studies based on the above test sites are the main thrust of this book. In particular, this book is divided into three parts. After this introductory chapter, Remoundou and Koundouri review the up-to-date use of non-market valuation economic methods in the design and implementation of EU water policies. This survey chapter aims to smooth the introduction of the reader to the research and results presented in Part I of the book. Part I includes the prementioned review and four additional chapters, each on the implementation of a policy-design focused choice experiment (CE) in the following test sites: Poland, Portugal, Cyprus and Tunisia. The choice experiment methodology, which is commonly used for economic evaluation of environment goods, is also a very useful instrument in terms of understanding stakeholders' preferences over policy factors and their willingness to accept the new policy. Respondents are asked to express their maximum willingness to pay (WTP) or minimum willingness to accept (WTA) for a hypothetical change in the level of provision of the good. According to welfare economics, the stated WTP amounts are assumed to be related to respondents' underlying preferences in a consistent manner. For each of the four case studies, the design and the implementation of the choice experiment is processed after intensive consultation with the local water agency and trial on the pilot group of farmers, whose suggestions on the policy attributes in interest have been fully taken into account.

These chapters are therefore going to explore the extent to which choice experiment can help in the policy design process and the implementation of the EU Water Framework Directive (WFD). The WFD clearly integrates economics in water management and water policy decision-making. To achieve its environmental objectives, good water status for all EU waters, in a more efficient manner the directive calls for an economic analysis of water uses in each river basin district and assessment of the current level of cost–recovery in order to identify cost-efficient economic instruments to achieve sustainable water management and full cost recovery under the polluter pays principle. Consideration of costs and benefits associated with improvements of ecological status of EU surface and groundwater is therefore crucial and choice experiments are promising in this regard. Further, valuation applications presented in the current volume directly contribute to other water-related EU directives that form part of the EU water legislation such as the Drinking Water Directive, the Flood Risks Directive, the Urban Waste Water Treatment Directive and the Integrated Pollution Prevention and Control Directive.

Chapter 3 focuses on a case study from the Polish AquaStress test site. Following the flooding episodes of 1997 and 2004, the Polish authorities embarked on an attempt to reduce flood risk in the Upper Silesia region (see Chapter 3 for a map of the region). The application of the choice experiment method of this chapter focuses on the estimation of local residents' preferences for reduction in flood risk, access to the river for recreational activities and conservation biodiversity in the river catchment. The findings reveal that the residents of the catchment area derive the highest benefits from reduction of flood risk to a low level, followed by recreational activities and biodiversity conservation in the area, respectively. Birol, Handley, Koundouri and Kountouris translate these results as the locals' preferences for use values derived from flood reduction relative to use and non-use values from recreation or biodiversity conservation.

Chapter 4 provides a case study of the use of choice modelling method in irrigation water supply policy and management in Portugal. Katayama, Liu, Musharrafiyeh, Sarr and Swanson argue that provision of local public goods requires fully understanding of local people's preferences over supply policy design, and their willingness to switch from status quo to the new public goods or institutions. This understanding not only helps policy design but also spurs the local cooperation and directly determines economic performance. Irrigation infrastructure, as well as water resource, is an important common property shared within the same catchment. Farmers' participation, as well as their preference understanding, is therefore critical to the policy designer in order to realise social welfare maximization. A recent irrigation development project by Alqueva dam on Guadiana River (Portugal) is planning to extend a public irrigation system to farming land in the Serpa-Mértola region where most areas are currently mainly rain-fed, with only a few areas irrigated by groundwater or pump water from excavated reservoirs or rivers. Understanding local farmers' preferences on new irrigation systems and water supply policy, as well as the acceptability of the new policy is the main purpose of this study. The CE analysis shows that current irrigators are only willing to accept public water if it is provided with pressure, which is the most important attribute in the policy design valued by farmers, followed by reliability and nitrate concentration. Farmers who are currently undertaking dry-land farming are more willing to accept a public water irrigation scheme even without pressure. In addition, farmers prefer water with a lower nitrate concentration, but at a tiny scale of willingness to pay. Finally, the policy simulation reveals that, when provided with public water supply under the proposed price, some farmers show the preference to change the crop structure, mainly from non-irrigated crops to olive yards, or by planting more olive trees. As proposed water price increases, fewer farmers would accept the policy and change crop structure.

Chapter 5 reports the results of a CE study conducted in Cyprus to value farmers' benefits from recharging with tertiary treated wastewater an aquifer threatened by seawater intrusion. Birol, Koundouri and Kountouris design and apply a choice experiment, that allows estimation of the willingness to pay for the recharge for various farmer profiles. The results indicate that farmers have significant WTP for maintaining current water quality and quantity through aquifer recharge. On the other hand, once accounting for preference heterogeneity through observed socioeconomic variables, the WTP for higher levels of agricultural employment becomes negative, hinting to the farmers' understanding of the common pool problem. The overall conclusion is that current water scarcity in Cyprus, combined with the increased need for agricultural produce, enhances the acceptability of recharge schemes.

Chapter 6 focuses on a CE applied on the Tunisian test site. A major priority for Tunisian water managers in the Merguellil Valley (see Chapter 6 for the relevant location coordinates) is to find ways to stop the continuous decline of the water table. This issue is important because of the economic and environmental consequences of such decline. The main cause of this depletion of the groundwater, the over-exploitation of the aquifer due to the multiplication of unlicensed wells and boreholes, is well known. Despite the existence of a legislation regulating drilling of boreholes and wells, the authorities are reluctant to enforce the law for both economic and social reasons. Nonetheless, managing the groundwater has become imperative if irreversible damages are to be prevented. To provide a better understanding of the farmers likely attitudes towards policy changes designed to stabilize the water table level, Liu, Musharrafiyeh, Noden, Sarr and Swanson used a policy choice experiment. This choice experiment seeks to elicit farmers' willingness to pay to shift from the current status quo regime where the groundwater is being over-exploited to a regime that ensures a sustainable management of the groundwater. This new regime will be costly to the farmers because under the new policy: (1) groundwater will no be longer free; (2) meters will be installed in each farm and institutions monitoring closely water use as well as potential defrauding behaviour will be implemented; (3) installation fees will be required from farmers; and (4) restriction to irrigated areas might be imposed in cases of serious water scarcity. The main benefit to the farmers is that a stabilisation of the water table, in addition to ensuring a good quality of water, guarantees the reliability of the water supply and a relatively low extraction cost. This analysis shows that farmers, assuming that the respondents are representative of the farming community of the Merguellil Valley, seem ready for a policy change to manage the groundwater, even if this means they have to pay substantial short-term costs (pricing of groundwater, metering and quantity restriction) to reap long-term benefits. The condition for such acceptance, however, is that farmers require transparency and independent monitoring. These requirements, they believe, should guarantee them equal and fair treatment. However, the wealthier farmers seem to be reluctant to a policy change that could threaten their current position. For any policy design to be successful, it will have to deal carefully with the possible resistance of the wealthier farmers to change.

Part II of the book moves away from the use of choice experiments in the implementation of the EU water policies, and proceeds to discuss participatory and engineering tools that can facilitate the determination of efficient water resources policies and the consequent implementation of the EU WFD. Recent research has demonstrated that a variety of participatory mechanisms can be employed at different stages of the Adaptive management AM)[1] cycle, creating the conditions for social learning and favourable outcomes for diverse stakeholders (Stringer *et al.*, 2006). However, the design of an appropriate process, the structuring of data, information and knowledge, and the posing of meaningful, empowering questions to stakeholders remain poorly researched. In Chapter 7, Schroeder, Manez and Jeffrey explore these issues through the use of agent- based modelling to support resource allocation in a water stress context. Agent-based modelling (ABM) involves the representation of a problem context as a dynamical system of interacting agents. Although not limited to computer-based applications, the ABM discussed in this chapter is of that class and comprises multiple interacting agents situated within a model or simulation environment. The aspiration of the authors is to explore the theoretical consequences of different economic behaviours that are exhibited during periods of water stress and to test and evaluate different adaptive environmental assessment and management approaches for the case study region—Tadla in Morocco. The model results and stakeholders' feedback help to identify promising options and combinations of options for alleviating water stress. Workshops with groups of farmers serve to facilitate discussion on future sustainable management and use of surface water and groundwater resources and to validate the model for further research. Public participation, which can generally be defined as allowing stakeholders and the broad public to influence the outcome

1 Adaptive management (AM) is a clear and systematic process for adjusting management and research decisions to better achieve management objectives, recognising that knowledge about natural resource systems is uncertain. Therefore, some management actions are best conducted as experiments in a continuing attempt to reduce the risk arising from that uncertainty.

of plans and working processes, plays a key role in the implementation of the EU WFD. The article 14 of the Directive contains explicit provisions for the consideration of participation by stating that member states shall encourage active involvement of all interested parties in the implementation of the Directive, not only regarding the development of a river basin management plan but also from the very beginning of the implementation of the WFD (transformation into national laws, characterization and analysis of water bodies, establishment of monitoring programmes, development of the programmes of measures). The WFD, therefore, brings new and innovative concepts to sustainable water management in Europe to allow better-informed and more creative decision making and increased public acceptance, less litigation, fewer delays and more effective implementation.

Chapters 8 and 9 are based on contributions from engineers, whose contribution is crucial and vital in the implementation of water management policies in general, and the EU WFD in particular. The WFD stresses the need for integrated water resources management strategies to achieve truly protection of the aquatic environment. Economic ideas and processes should therefore be integrated with traditional engineering and hydrologic models of water management problems. Combining economic management concepts with an engineering level of understanding of a hydrologic system can provide results and insights and suggest promising innovative solutions for policymakers to consider. Integrated economic–engineering–hydrologic modelling can become a basis for shared understanding of water problems as a foundation for negotiated management and policy solutions.

In particular, Chapter 8 attempts the integration of two test-site-related investigations, under the umbrella of an overall assessment of water stress mitigation options, tailored to situations with dominant industrial water use. The chapter is introduced with a presentation of the general aspects related to industrial water use and the legal framework conditions for industrial water management. Behind this background the two target regions—Przemsza in Poland and Iskar in Bulgaria—are described to illustrate how industrial water use impacts on the regional water utilisation. The major objective of the chapter is to identify a set of potential water stress mitigation options on the basis of a set of integrated methods that include a strong stakeholder participation component. Special attention is paid also to system dynamics modelling (SDM) as a tool for assessment and identification of the industrial water-saving options. Wintgens, Dimova, Ribarova, Druzynska, Caruk, Vamvakeridou-Lyroudia, Tarnacki, Melin, and Savic underline the importance of industrial water use in the context of integrated water resources management and for the implementation of the EU Water Framework Directive as well as the Integrated Pollution Prevention and Control Directive.

The methodology used for the investigation includes a set of integrated actions covering stakeholder participation as well as detailed technological studies and system simulation to characterise and improve the regional water management, with a specific focus on industrial water use. While in the Polish test site the situation was investigated more on a ‘river basin scale level’, the Bulgarian site has focused more on a large individual industrial water user. Among the tools employed, modelling techniques stand out, and are used (1) to get a better understanding of water resources situation in the Polish test site and (2) to describe the complex water system utilised by the dominant water user in the Sofia region, as well as to assess the impact of improvements by water-saving approaches and policies on regional water stress. The SDM approach was used to identify options the water user can take to adapt to different water availability scenarios. Intensive interactions with local stakeholders is the most crucial element in all activities, establishing the basis for a sound understanding of the situation, for learning about different points of view and perceptions, and for obtaining vital data to carry out the analysis. The results of the chapter come at a time where the development of river basin management plans is on the top of the agenda for many water resources managers in Europe. The methods and results presented could be useful as inputs to the management plans of the basins concerned in the studies and to blueprints for water stress mitigation processes in different contexts.

Chapter 9 aims to provide a new instrument that can serve as a water stress mitigation tool. In particular, Bauer, Botti, Zaccolo and Olsson quantify the vital minimum flow (VMF) for the middle and low Flumendosa Basin in Italy, and incorporate it in the reservoir release pattern for the main three dams in the system of the selected case study. The modelling tools used—Desktop Reserve Model, Aquapak programme and flow duration curve—are firstly applied in combination, leading to a newly developed methodology for estimating minimum river flow. Then, this minimum flow requirement is integrated in the operation schedule of a multi-reservoir system. This integration provides an important step for future elaborations and investigations aiming towards the establishment of a commonly used method with potential transferability to other regions. The authors also compare the simulated results of the implementation of this engineering tool, with the current river flow, which is the result of the amount of water released from the reservoir, which in turn is defined by the current law. The current law is the result of the current policymaking processes and water management practice in Flumendosa. This comparison between real-world practices and 'optimal' water management provides interesting insights for policymaking.

Part III of the book, brings us back to the use of economic tools and focuses on policy appraisal through social cost–benefit analyses and the choice/estimation of the socially efficient discount rate to be used in such analyses. Policy appraisal is an important element of applied economic welfare analysis that combines economic theory and practice to inform policy decision making. Typically, a policy will be applied if the socioeconomic benefits from its implementation outweigh the total costs from designing and applying the policy. Furthermore, when several policies are evaluated, ideally the one that maximizes the benefits on aggregate welfare should be identified and implemented. Policies, especially those relating to environmental decisions, are not to be assessed for the effects they have in a single period. These policies entail streams of costs and benefits for decades or even centuries, as they affect the stock of non-renewable natural resources. In Chapter 10 Kountouris and Koundouri illustrated the significance of the discount rate choice on policy appraisal and implementation based on the AquaStress case studies, presented in Chapters 3–9.

Overall, declining discounting appears to be the discounting measure that can better account for long-term projects. Based primarily on uncertainty and the notion of intergenerational equity, declining discounting is appropriate for water management projects. This is because such projects inherently involve significant uncertainty and their relevance extends beyond the short-term horizon. Conducting the social cost–benefit analysis using a declining discount rate will better take into account the welfare of future generations and give them more substantial weighting compared to the constant discounting case. This constitutes an important message for the EU water policymakers! We hope they are listening!

References

Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment. *Official Journal* L 135, 30/05/1991 pp. 0040–0052.

Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption *Official Journal* L 330, 5.12.1998, pp. 32–54.

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. *Official Journal* L 288, 6.11.2007, pp. 27–34.

European Commission, 2000. Directive 2000/60/EC of the European Parliament and of the Council of 23rd October 2000 establishing a framework for Community action in the field of water policy, *Official Journal* L 327/1, 22 December 2000. Brussels: European Commission.

European Commission, 2008. Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control. *Official Journal* L 24, 29 January 2008.

Stringer, L.C., Dougill, A.J., Fraser, E., *et al.* 2006. Unpacking ‘participation’ in the adaptive management of social–ecological systems: a critical review. *Ecology and Society* 11(2): 39.