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Socio-Economics and Water Management: Revisiting the Contribution of Economics in the Implementation of the Water Framework Directive in Greece and Cyprus

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Abstract

This chapter sets out the socio-economic principles that should govern water resources management for the achievement of a sustainable allocation of the resource over time and across space, in accordance with the EU Water Framework Directive. The resulting allocation should be economically efficient, social equitable and acceptable, and environmentally sustainable. The main background concept guiding the identification of such an allocation is that of the 'Total Economic Value (TEV)' of water resources, which derives from the ecosystem goods and services that water resources provide the economy and society. In this chapter we present the state-of-the-art with regards to estimating TEV of water resources and explain how these estimations can facilitate the design and implementation of the different European policies in relation to mitigation of different forms of water stress.

Keywords: Water Framework Directive, Total Economic Value, Water Valuation, Non-market Valuation

Abbreviations

CBA	**Cost Benefit Analysis**
CEM	**Choice Experiment Method**
CV	**Contingent Valuation**
RBD	**River Basin District**
TEV	**Total Economic Value**
WFD	**Water Framework Directive**
WTP	**Willingness to Pay**

1. Introduction

In this chapter, we provide a state-of-the-art review of the basic economic valuation methods that can be used for the monetization of the economic and societal benefits provided by water resources, and we discuss on how the valuation outcomes can inform policy for a better and more efficient water management plan, in accordance with European Union's Water Framework Directive (WFD) (CEC 2000). Contrary to previous pieces of legislation which focused on specific water-related environmental issues, WFD aimed at creating an integrated policy framework for the sustainable management and protection of aquatic resources (inland surface waters, transitional waters, coastal waters and groundwater) both in terms of quantity and quality across European Union country members (Koundouri et al. 2013b). So, as stated in Waternote 9[1], the Directive has developed a "*combined approach for point and diffuse sources and refers to several related directives*" (p.1). The necessity for the development of such a policy framework became imperative by taking into account the increased demand for high quality water quantities. The Directive characterizes water as heritage, and highlights the need to treat it as such, not only from an anthropocentric perspective, i.e. the elimination of health risks, but also from a biocentric perspective, i.e. the protection and improvement of water-related value and its eco-system functions.

For the implementation of the Directive, all member states are obliged within specific deadlines to identify all individual river basins within their national territories and assign them into specific river basin districts (RBD). The latter are defined as the basic management units according to article 3 of the Directive. Coastal waters shall be assigned to the nearest or most appropriate river basin districts. When a water resource is shared by two or more countries, international river basins should be created. It is countries' responsibility to develop appropriate basin management plans in order to achieve the main goals of the Directive, concerning proper monitoring of the water status and development of appropriate programs of measures for pollution control and progressive improvements on the quality of surface waters, groundwater and protected areas within each RBD.

The Directive has set specific standards and guidelines for the assessment of the chemical status of all water resources, the ecological status of surface water (such rivers and lakes, and coastal waters), and the quantitative status of groundwater. For the assessment of the ecological status, the main focus is on biological elements (e.g. composition and abundance of aquatic flora), hydro-morphological elements supporting the biological elements (e.g. quantity and dynamics of water flow), and chemical and physico-chemical elements supporting the biological elements (e.g. thermal conditions). The determination of groundwater chemical status is based on conductivity and concentrations of pollutants, whereas the determination of surface water chemistry status is based on appropriate "safety factors" for annual average substance concentration. Finally, groundwater quantity is defined by its level regime. A good quantity status is achieved if the long-run annual average rate of abstraction does not exceed the available groundwater resource.

2. Economic Aspects of Water Framework Directive

Given the increased water scarcity, the WFD has recognized the need of incorporating economic analysis in water-related policy agenda, and using appropriate economic instruments for assessing water value and meeting certain environmental objectives, in accordance with the various articles of the Directive. Economic issues are mainly discussed in articles 5 and 9, and in annex III. According to article 5, all Member States need to undertake an analysis of each river basin district characteristics, review the impact of human behavior on the status of surface water and groundwater, and proceed

[1] Waternote 9 can be accessed here: http://ec.europa.eu/environment/water/participation/pdf/waternotes/water_note9_other_water_legislation.pdf

with an economic analysis of water use. Although each country shall proceed and implement its own techniques, European Union's guidelines (European Communities 2003) suggest the following implementation steps: (i) characterizing the river basin in terms of the economics of water uses, trends in water supply and demand levels, and current recovery levels of water services' costs, (ii) identifying all water bodies or groups of water bodies that fail to meet the environmental objectives of the Directive, and (iii) developing appropriate programs of measures to be included in river basin management plans through cost-effectiveness analysis and justifying potential derogation from an economic perspective. A very important aspect raised by the Directive is the need to proceed with a cost-effective analysis.

As highlighted in article 9 and Annex III, countries shall take into account the principle of cost recovery of water services, including environmental and resource costs, and also consider the social, environmental and economic effects of the recovery, and regional geographical and climatic conditions as well. Table 1 includes a summary of the total cost of water services. The goal is to develop appropriate water policies that provide strong incentives for users to use water resources efficiently and also ensure an adequate contribution of the various water users (industry, households and agriculture) to the cost recovery of water services. It is also crucial to evaluate the cost of the application of various programs of measures and choose the most cost-effective combination with regards to water uses.

Table 1 – Total economic cost of water services

Financial Cost	Cost of providing and administering water services. Includes: Capital cost, operation cost, maintenance cost, and administrative cost.
Environmental Cost	Environmental cost represents the costs of damage that water uses impose on the environment and ecosystems and those who use the environment (e.g. a reduction in the ecological quality of aquatic ecosystems or the salinisation and degradation of productive soils.
Resources Cost	Resource cost represents the costs of foregone opportunities which other uses suffer due to the depletion rate of recharge or recovery (e.g. linked to the over-abstraction of groundwater).

Source: Koundouri et al. (2013b), p.10

Overall, according to the relevant EU guidelines (European Communities 2003), the Directive views the contribution and importance of economic analysis into the following topics: (i) understanding the importance of economic issues and tradeoffs at each river basin and promoting water quality restoration, which in turn can have a positive impact on local, regional and national economy, (ii) identifying and assessing the most cost-effective way for achieving certain environmental objectives for water resources, given the limited availability of financial resources for water-related agenda, (iii) evaluating the role of various programs of measures for the improvement of water status (identifying losers and gainers), and consider possible additional measures for the compensation of losers, (iv) relaxing the environmental objectives on several water bodies in order to account for economic and social impact, if this can help the promotion of overall sustainability, and (v) developing appropriate economic and financial instruments, such as water prices, pollution charges or environmental taxes, in order to achieve environmental objective more effectively.

As we will discuss in subsequent sections, economic science has developed a variety of appropriate tools for meeting the demands of WFD. These tools allow us to quantify the total economic value of aquatic resources, taking into account both use and non-use benefits, informing policymakers about the effectiveness and sustainability of a proposed management plan.

3. Methodology for Implementing WFD

Given that there is no market for water-related resources, quantifying the benefits for society and economy arising from aquatic ecosystems can be a challenging task. When a fully functioning market exists, as in cases of private goods, the value of the good is normally reflected on the market price. With reference to the water resources, this may be the case for fish products for example, which are priced in a market. However, market value does not exist for services such as recreation activities or biodiversity wealth of a coastal area. In this section, we provide an overview of the most important economic techniques that can be employed for identifying and estimating water's total economic value (or at least some aspects of total value), i.e. the value of all benefits that individuals may derive from a non-market good.

3.1. Total Economic Value

Total economic value (TEV) comprises of two main types of values that can be derived from an environmental resource, i.e. use values and non-use values. The former refer to the benefits that people receive from the usage of the specific commodity, whereas the latter refer to the benefits that people attach to the commodity even if they do not make use of it. Use values can be further divided into three main categories: direct use values, arising from the consumptive use of a certain environmental good, indirect use values, and option values, representing the potential benefits that can be derived from a certain environmental asset by future generations. Non-use values can be further classified into existence values, i.e. the value that individuals place on the existence of an environmental good as it stands, bequest values, i.e. values that individuals place on the importance of preserving an environmental good in favour of future generations, and altruistic values, i.e. the value an individual places on the need to maintain an environmental good in order to be used by other individuals. Table 2 provides examples of various components of water resources' TEV, whereas Table 3 provides groundwater taxonomy of values in particular.

3.2. Non-Market Valuation Techniques

The development of non-market valuation techniques allows quantifying various components of the total economic value (TEV) of an environmental commodity such as water. Revealed preference techniques help estimate use values, whereas stated preferences techniques are appropriate for estimating non-use values.

Table 2 - TEV components for water resources

Use values

Direct use values	***Indirect use values***
Irrigation for agriculture	Nutrient retention
Domestic and industrial water supply	Pollution abatement
Energy resources (hydro-electric, fuel wood, peat)	Flood control and protection
Transport and navigation	Storm protection
Recreation/amenity	External eco-system support
	Micro-climatic stabilisation
Option values	Reduced global warming
Potential future uses of direct and indirect uses	Shoreline stabilisation
Future value of information of biodiversity	Soil erosion control
Non-use values	
Biodiversity	
Cultural heritage	
Bequest, existence and altruistic values	

Source: Birol et al. (2006b), p.107

Table 3 - Taxonomy of groundwater valuation terminology

Physical State Terminology	Economic Terminology	Accounting Terminology: Stocks	Accounting Terminology: Flows
A. Extractive values	Use Values		
1. Municipal use values			*
2. Industrial use values			*
3. Agricultural use values			*
4. Other extractive use values			*
B. *In situ* values			
1. Ecological values		*	*
2. Buffer values		*	*
3. Subsidence avoidance values		*	*
4. Recreational values			*
5. Sea water intrusion values		*	*
6. Existence values	Nonuse Values		*
7. Bequest values			*

Source: Committee on Valuing Ground Water, National Research Council (1997), cited in Koundouri et al. (2013d), p. 12

3.2.1. Revealed Preference Techniques

In the current review, we will introduce the basic revealed preference techniques that are widely used in environmental economics science for revealing the value that individuals assign to an environmental good, i.e. hedonic pricing method and travel cost method.

Hedonic Pricing Method

Hedonic pricing method uses the price variations of real estate market in order to estimate the value of a local environmental good or service. The main assumption behind this method is that the quality of the surrounding environment, such as air, water and noise pollution levels or the existence of green spaces, will be reflected on the house prices of the selected areas. People usually take into account local environmental characteristics when deciding to buy a property. So for example, Mahan et al. (2000), based on a dataset of 14.000 home sales in Portland, found that proximity to wetlands has an effect on property values. Specifically, a decrease in the distance to the nearest wetland by 304.8 meters from an initial distance of 1652 meters (1 mile) caused an increase to in property value equal to € 371.6. In case of groundwater, land rent or property prices can be used as shadow prices, i.e. implicit values, for estimating the value of water's quantity and quality. To mention an example, Torell et al. (1990) compared sales of irrigated and non-irrigated pieces of land in an attempt to measure groundwater's value in the southern High Plains (an area within various central USA states such as Texas, Oklahoma and Kansas) in the United States. Their findings revealed the value of groundwater as an important part of irrigated farmland transaction prices, comprising from 30% up to 60% of the farm sale price across the various states.

Travel Cost Method

Travel cost method is commonly used for estimating people's willingness to pay for visiting various ecosystem areas or natural landscapes for recreational activities. The value of the environmental amenity is reflected on the time and travel cost that a person is willing to incur in order to accessing a certain site. The results of this method can be used in order to determine changes in the access costs of a recreational site, eliminating or adding a new recreational site, or determining interventions in order to improve the environmental conditions on the site. To mention an example, Bowker et al. (1996) employed the TCM to estimate the value of guided white-water rafting on Chatoga and Nantahala rivers in the USA. They derived a value between € 75.9 and € 243.7 per visitor per trip, subject to various model assumptions and the river quality.

3.2.2. Stated Preference Techniques

In contrast with the revealed preference methods that were described before and are used to capture use values, stated preference techniques are appropriate for capturing non-use values as well. In this section, we will review the two most popular methods of this type, i.e. contingent valuation and choice experiment. In terms of policymaking, stated preferences methods can be particularly useful for the calculation of the various benefit components, use and non-use, arising from ecosystem services; benefits that have a positive impact on the promotion of human well-being. Capturing and monetizing the net value of ecosystem services may increase the efficiency of policy interventions, leading to an increase in environmental sustainability and net benefits for the society (Defra 2007).

Contingent Valuation

This approach aims at eliciting people's willingness to pay for positive changes in the quantity or quality of an environmental resource (or willingness to accept a negative change in the status of an environmental resource). CV is a survey-based approach where participants are asked to state their preference (and willingness to pay) on a hypothetical scenario proposed by the study. In this case, the construction and implementation of the survey process is a major challenge. Special care needs to be taken for the wording of the questionnaire and the administration of the survey in order to minimize bias. Table 4 contains a brief presentation on the basic criteria for a good scenario. To mention a water-related example, Pate and Loomis (1997) found a WTP equal to € 183.3 per household for the employment of an improvement program for a wetland in California. They found that this amount decreases as long as the distance from the wetland increases.

Table 4 – Scenario design criteria and contingent valuation measurement outcome

Is the scenario…	If not, respondent will…	Measurement consequence
Theoretically accurate?	Value wrong things (theoretical mis-specification).	Measure wrong thing.
Policy relevant?	Value wrong things (policy misspecification).	Measure wrong thing.
Understandable by respondent as intended?	Value wrong things (conceptual mis-specification).	Measure wrong thing.
Plausible to the respondent?	Substitute another condition, or not take seriously.	Measure wrong thing. Unreliable, bias-susceptible don't know, or protest zero.
Meaningful to the respondent?	Not take seriously.	Unreliable, bias-susceptible don't know, or protest zero.

Source: Mitchell and Carson (1988), p.190

Choice Experiment Method

Choice experiment method (CEM) is a relatively new addition to the pool of stated preference techniques, having its theoretical foundation on Lancaster's (1966) theory of value suggesting that satisfaction is derived not by the consumption of a certain good itself, but from the various attributes it provides. According to this method, a bundle of environmental goods is presented to the respondents, who are asked to elicit their preference for each good, with regards to its attributes or characteristics. In order for the monetary comparison across the various goods to be feasible, price is usually one of the main attributes for each good. Due to its experimental nature, CEM enables researchers to evaluate attributes at various levels (e.g. high, medium and low status of bathing water quality, as an attribute of coastal water quality) and identify tradeoffs that respondents make among the various attributes. In CEM, it is assumed that each set of choices is associated with a certain level of utility, which is modelled as a function of individual socio-economic characteristics and the attributes of the management scenario under investigation. To mention a water-related example, Willis et al (2002) adopted CEM to study the preference tradeoff of water company consumers between increasing water supply security and the potential effect of this situation on local wetland sites biodiversity and on river flows in Sussex, UK. Their findings suggest that consumers assign an insignificant value on increasing water supply, but assign a value equal to WTP € 2.1 and WTP € 6.3 for a unit increase in the conservation of wetland habitats and river flows respectively. Table 5 provides a quick description of each method's advantages and disadvantages.

Table 5 – Advantages and disadvantages of economic valuation methods[2]

Hedonic pricing method	**Advantages**
	Based on observable and readily available data from actual behaviour and choices.
	Disadvantages
	Difficulty in detecting small effects of environmental quality factors on property prices. Connection between implicit prices and value measures is technically complex and sometimes empirically unobtainable. Ex post valuation. (i.e. conducted after the change in environmental quality or quantity has occurred). Does not measure non-use values.
Travel cost method	**Advantages**
	Based on observable data from actual behaviour and choices. Relatively inexpensive.
	Disadvantages
	Need for easily observable behaviour. Limited to in situ resource use situations including travel. Limited to assessment of the current situation. Possible sample selection problems. Ex post valuation. Does not measure non-use values.
Production function approach	**Advantages**
	Based on observable data from firms using water as an input. Firmly grounded in microeconomic theory. Relatively inexpensive.
	Disadvantages
	Understates WTP. Ex post valuation. Does not measure non-use values. Omits the disutility associated with illness.
Contingent valuation	**Advantages**
	It can be used to measure the value of anything without need for observable behaviour (data). It can measure non-use values. Technique is not generally difficult to understand. Enables ex ante and ex post valuation.
	Disadvantages
	Subject to various biases (e.g., interviewing bias, starting point bias, non-response bias, strategic bias, yea-saying bias, insensitivity to scope or embedding bias, payment vehicle bias, information bias, hypothetical bias). Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.
Choice	**Advantages**

[2] It should be noted that when time and budget constraints do not allow the employment of an original valuation study, the benefit transfers method can be applied, transferring the economic value estimations from one study site to another study site with similar location characteristics. More details about this benefit transfer method can be found in Koundouri et al (2013c).

experiment method	It can be used to measure the value of any environmental resource without need for observable behaviour (data), as well as the values of their multiple attributes. It can measure non-use values. Eliminates several biases of CVM. Enables ex ante and ex post valuation.	
	Disadvantages	
	Technique can be difficult to understand. Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.	

Source: CGER (1997), cited in Birol et al. (2006b), p. 114

3.2.3 Laboratory Experiments

In contrast with the stated preference methods, where individuals' elicitation of preferences is based on a hypothetical scenario, laboratory experiments can be used as an alternative method investigating preferences under a "real setting" situation fully controlled in the laboratory (Murphy and Stevens 2004). Given that hypothetical values exceed actual values, laboratory experiments may be used for the mitigation of hypothetical bias (Murphy and Stevens 2004). In these experiments, real economic incentives are provided to the participants in order to reveal their preferences and willingness to pay for a certain public or private good. So, for example, in a typical second-price sealed-bid Vickrey auction (Vickrey 1961), the experiment participants submit sealed and a unit of the good is acquired by participant who provided the highest bid in a price equal to the value of the second-highest bid. Table 6 contains a brief description of some basic incentive compatible mechanisms. Several conditions may affect the quality of the performed experiments in terms of internal and external validity. The former may be violated by factors such as participants' unfamiliarity with the elicitation mechanisms and participants' tendency to use numbers that are presented to them during the experiment as anchor values for their willingness to pay, whereas the former may be violated by factors such as an unfamiliar laboratory environment, unrepresentative sample and the presence of researchers scrutinizing the behaviour of the participants (Alfnes and Rickertsen 2011).

Table 6 – Incentive compatible mechanisms

Elicitation Mechanism	Participant Procedure	Market Price	Rule	# of Winners
English auction	Sequentially offer ascending bids	Last offered bid	Highest bidder pays market price	1
2^{nd} price auction	Simultaneously submit sealed bids	Second highest bid	Highest bidder pays market price	1
Nth- price auction	Simultaneously submit sealed bids	Nth highest bid	n-1 highest bidders pay market price	n-1

Random Nth-price auction	Simultaneously submit sealed bids	Randomly drawn Nth highest bid	n-1 highest bidders pay market price	n-1
Becker-DeGroot-Marschak	Simultaneously submit sealed bids	Randomly drawn price	Participant pays market price if bid exceeds market price	Individually determined
Real Choice	Choose alternatives in multiple scenarios	Randomly drawn binding scenario	Everybody pay market price	All participants
Incentive compatible conjoint ranking mechanism	Rank alternatives in multiple scenarios	Randomly drawn binding scenario	Everybody pay market price	All participants
Open-ended choice experiment	Simultaneously submit quantities	Randomly drawn price	Everybody pay market price for submitted quantities	All participants
Multiple price list	Accept/reject stated prices	Randomly drawn price	Participants pay market price if it is accepted	Individually determined
Real dichotomus choice experiment	Accept/reject	Given price	Participants pay market price if it is accepted	Individually determined
Quantity trade-off experiment	Accept/reject	No price	Participants complete trade if it is accepted	Individually determined

Source: Alfnes and Rickertsen (2011, p.219)

3.3 Integrated Hydro-economic Models for Optimal Water Management

In the previous section, we provided an overview of some common valuation techniques that can inform water policymaking with regards to calculation of various components of water's total economic value. Here, we will discuss on the importance of hydro-economic models as a tool for estimating water economic value and suggest strategies for optimal water allocation[3].

Integrated hydro-economic models are mathematical models that combine hydrologic, engineering, environmental and economic aspects of water resources systems at a regional level (Harou et al. 2009). They are used in order to suggest ways for more

[3] Expect for non-market valuation techniques and hydrological models, linear programming and various other econometric modelling approaches can be used for estimating the economic value of water, but they are not covered in this review chapter. For example, programming models can be used for estimating the water quantity that maximizes farmers' private profits through computer simulations, in cases where there is data absence on a wide range of prices.

efficient and transparent use of water, given the existence of scarcity. The main assumption behind hydro-economic models is that demand for water is derived by its generated economic value. Its value may change subject to dynamic changes in water quantity and the type of use. Water demand curves represent consumer's willingness to pay for varying quantities of water. Due to the various conditions that may affect water availability (such as location and hydrologic conditions), more than one demand curves may be used (Harou et al. 2009).

Commonly, although hydro-economic models are driven by various institutional and socio-economic factors, the key focus is on the water system and the corresponding effect on one or more economic sectors (Brouwer and Hofkes 2008). For this purpose, water node networks and substance balances across the examined river basin are linked with a demand function representing economic activity. Table 7 provides a brief description of various types of hydro-economic models with their associated advantages and disadvantages, whereas the disciplinary dimensions behind integrated hydro-economic models are depicted in Figure 1.

Table 7 - Some design choices, options, and implications for building a hydro-economic model

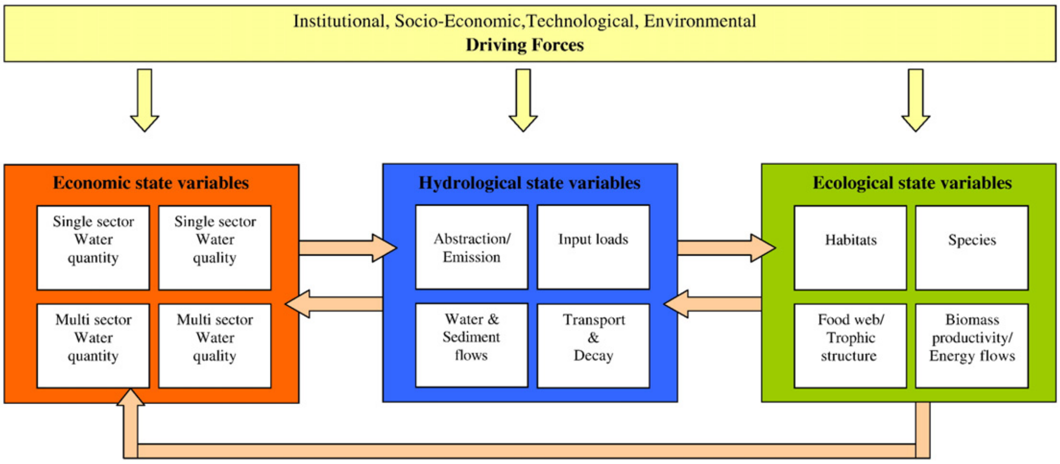
Simulation/optimization	
Simulation	
Summary	Time-marching, rule-based algorithms; Answers question: ''what if?"
Advantages	Conceptually simple; existing simulation models can be used, reproduces complexity and rules of real systems.
Disadvantages	Model only investigates simulated scenarios, requires trial and error to search for the best solution over wide feasibility region.
Optimization	
Summary	Maximizes/minimizes an objective subject to constraints*; answers question: ''what is best?"
Advantages	Optimal solutions can recommend system improvements; reveals what areas of decision space promising for detailed simulation.
Disadvantages	Economic objectives require economic valuation of water uses; ideal solutions often assume perfect knowledge, central planning or complete institutional flexibility.
Representing time	
Deterministic time series	Model inputs and decision variables are time series, historical or synthetically generated.
Summary	Conceptually simple: easy to compare with time series of historical data or simulated results.
Advantages	Inputs may not represent future conditions; limited representation of hydrologic uncertainty (system performance obtained just for a single sequence of events).
Disadvantages	
Stochastic and multi-stage stochastic	
Summary	Probability distributions of model parameters or inputs; use of multiple input sequences ('Monte-Carlo' when equiprobable

	sequences, or 'ensemble approach' if weighted.
Advantages	Accounts for stochasticity inherent in real systems.
Disadvantages	Probability distributions must be estimated, synthetic time series generated; presentation of results more difficult; difficulties reproducing persistence (Hurst phenomenon) and non-stationarity of time series.
Dynamic optimization	
Summary	Inter-temporal substitution represented.
Advantages	Considers the time varying aspect of value; helps address sustainability issues.
Disadvantages	Requires optimal control or dynamic programming.
Submodel integration	
Modular	
Summary	Components of final model developed and run separately.
Advantages	Easier to develop, calibrate and solve individual models.
Disadvantages	Each model must be updated and run separately; difficult to connect models with different scales.
Holistic	
Summary	All components housed in a single model.
Advantages	Easier to represent causal relationships and interdependencies and perform scenario analyses.
Disadvantages	Must solve all models at once; increased complexity of holistic model requires simpler model components

Source: Harou et al. (2009), p.632

**** If optimized time-horizon is a single time period, the model can be considered a simulation model that uses an optimization computational engine.***

Figure 1 – Disciplinary dimensions underlying integrated hydro-economic modelling



Source: Brouwer and Hofkes (2008), p.17

Note: As explained in the main text (Brouwer and Hofkes 2008), the estimation of hydro-economic models is based on an optimization algorithm with reference to various surface and groundwater flow processes and their corresponding impact on one or more economic sectors, as depicted by the arrow direction from the blue box to the orange box. Only a few models exist that start from opposite directions.

4. Rapid Assessment of River Basin Districts: Cyprus and Greece

In this section, we provide a brief description of the socio-economic and the water status of the river basins in the two countries. In Cyprus, the whole country constitutes a single river basin area, whereas Greece is divided into fourteen river basin areas.

Cyprus

Cyprus has a population of 703.529 inhabitants, with 485.304 people living in urban areas and 218.225 people living in rural areas (INECO 2009). The total area of the island is 9.251 square kilometers. For 2012, according to World Bank statistics, the total GDP reached 23 billion dollars. The single river basin territory consists of 261 surface water bodies (rivers, lakes, and coastal areas) of 47 square kilometers and 20 groundwater bodies of 313 square kilometers (European Commission 2012). Regarding surface water ecological status, a total number of 105 water bodies, natural and artificial or heavily modified, have been characterized as having above average ecological status (high or good), 82 water bodies have been characterized as having moderate ecological status, whereas 20 surface water bodies are of poor or bad ecological status. However, the status of 54 surface water bodies, mainly small ones with episodic surface flows occurring less than once per year on average, have not been determined yet. With reference to chemical status, surface water bodies are classified into those ones with a good status and those ones with a poor status. Specifically, 193 water bodies appear to be of good chemical status, whereas 12 water bodies are of low status. The chemical status of 56 water bodies is still undetermined, for the reason that was mentioned in case of the ecological status. Focusing on the chemical status of groundwater, 11 water bodies are of good quality, eight water bodies are of poor quality and the quality of one body is undetermined. Finally, with reference to quantitative status of groundwater, four water bodies are of good status, 15 bodies are of poor status (since Cyprus is characterized by a semi-arid climate and water scarcity) and the status of one body is unknown[4].

Greece

Greece occupies a total area of 131.957 square kilometers. According to the most recent Census in 2011, the total population has been found to be 10.815.197 inhabitants. Base on World Bank statistics for 2012, its total GDP is 249 billion dollars approximately. As mentioned before, Greece consists of 14 river basin districts. Table 8 includes information about the population and area of each basin, and data on water use, i.e. demand for supply, demand for irrigation and demand for industry, whereas Table 9 contains a classification of each river basin with regards to its water quality status (good, moderate, bad) as defined by the National Management Program of water inventory (2008). As it can be seen, most of the river basin districts appear to have low concentration of water pollutants. Overall, eight districts have been characterized as having good quality conditions, whereas only one district (Thrace) has been characterized as having bad quality conditions.

Table 8 - Economic analysis of the most important water uses and pressures in each RBD

RBD	Population (2001)	Area (km^2)	Demand for supply (hm^3/year)	Demand for irrigation (hm^3/year)	Demand for industry (hm^3/year)
West Peloponnesus	331 180	7 301	23	201	3
North Peloponnesus	615 288	7 310	36.7	395.3	3
East Peloponnesus	288 285	8 477	22.1	324.9	0.03
West Sterea	312 516	10 199	22.4	366.5	0.35
Epirus	464 093	10 026	33.9	127.4	1
Attica	3 737 959	3 207	400	99	1.5
East Sterea	577 955	12 341	41.6	773.7	12.6
Thessaly	750 445	13 377	69	1550	0.054
West Macedonia	596 891	13 440	43.7	609.4	30
Central Macedonia	1 362 190	10 389	99.8	527.6	80
East Macedonia	412 732	7 280	32	627	0.321
Thrace	404 182	11 177	27.9	825.2	11
Crete	601 131	8 335	42.33	320	4.1
Aegean Islands	508 807	9 103	37.19	80.20	1.24

Source: Report on the implementation of Article 5 of the WFD (2008), cited in Koundouri et al. (2014b), p.13

Table 9 – Overall condition of river quality

[4] As cited in Cyprus Management Plan, the main source of data for water status comes from EU's WISE (Water Information System for Europe) database.

	Concentration									
RBD	**NO_2**			**P**			**NH_4**			**Total Condition**
	L	M	H	L	M	H	L	M	H	
West Peloponnesus	2	0	1	2	0	0	0	0	0	Good
North Peloponnesus	1	0	0	1	0	0	0	1	0	Good
East Peloponnesus	1	1	0	2	0	0	1	0	0	Good
West Sterea	11	0	0	10	2	1	0	9	0	Good
Epirus	7	0	0	8	0	1	3	4	0	Good
Attica	1	0	0	2	0	0	1	0	0	Good
East Sterea	3	0	2	1	2	0	0	3	0	Moderate
Thessaly	3	1	0	2	2	0	0	4	0	Moderate
West Macedonia	12	1	1	10	3	10	0	11	5	Bad
Central Macedonia	7	0	0	2	1	7	0	7	0	Moderate
East Macedonia	7	0	0	3	3	3	0	7	0	Moderate
Thrace	8	9	1	0	5	12	0	13	4	Bad
Crete	4	0	0	4	0	0	4	0	0	Good
Aegean Islands	-	-	-	-	-	-	-	-	-	Good

Source: Adopted with modifications from Koundouri et al. (2014b), p.14

5. Review of Valuation Case Studies from Cyprus and Greece

In the current section, we provide a review of the most important water-related valuation studies that have been employed by RESEES[5] team during the last decade in Cyprus and Greece. These studies cover a wide range of valuation approaches that can be used in order to efficiently assess the total economic value, i.e. use and non-use values, of the provided wetland services.

Crete, Greece

Genius et al. (2013) developed a theoretical model in order to investigate the potential effect of information transmission on the adoption and diffusion of modern irrigation technology in agriculture through two main sources of information (as commonly identified in the literature), i.e. extension agents and social learning (interaction with peer farmers and learning by doing). To test their model empirically, a dataset of 265 olive-grower located in the four major district of the island of Crete in 2005 was used. The dataset included information about the year when the farmers adopted a new irrigation technology (such as drip or sprinklers) and about some key farming operation variables, such as production patterns, gross revenues, input use, water use and cost, and socio-demographic characteristics at the year of adoption. According to the available data, none of the farmers had adopted a new technology before 1994,

[5] Research Team on Socio-economic and Environmental Sustainability. More details about team's research can be found here: http://www.aueb.gr/users/koundouri/resees/

whereas a 64.9% (172) of farmers had adopted a drip technology between 1994 and 2004. The mean adoption time for the sample was 4.68 years.

Using duration analysis, assuming that irrigation adoption and diffusion is based on the conditional probability of adoption at a certain moment (given that adoption did not occur earlier) and subject to individual farmers' characteristics and the local environmental conditions, they found that both extension services and social interaction with peer farmers are essential channels for the adoption and diffusion of new technology. Not unexpectedly, the two aforementioned channels have been found to be complementary. Moreover, the findings reveal the important role of water and crop prices in the adoption and diffusion of new technology, with water prices being positively associated with the adoption time and the crop prices being negatively associated with adoption time. Another factor that affects decision for adoption is risk attitude, with risk avert farmers being more likely to adopt a new irrigation technology. Adoption decision is also positively associated with adverse weather conditions (as in the case of Crete, which is characterized by a semi-arid climate). With reference to socio-demographic characteristics, the findings suggest that the time before adopting a new technology decreases with age up to the age of 60 years, whereas it increases with age afterwards, highlighting the combined effect of planning horizon and farming experience. Finally, adoption time increases with education levels up to nine years (primary school education), but it decreases with higher education levels.

Asopos, Greece

Asopos river runs in the Eastern RBD of Greece, approximately 60 kilometers away from north of Athens. The catchment of Asopos river occupies a total area of 724 square kilometers, consisting one of the three catchments that exist in Eastern RBD. The area is of significant ecological importance, hosting rare habitats and working as a migratory passage for bird populations. Moreover, the nearby coastal zone is a popular place for tourists and various recreational activities. In particular, 37.6% of Asopos RBD population is vacation or second residences. However, Asopos has witnessed a serious degradation in environmental quality, particularly affecting the quality of the water. The serious environmental degradation together with the different sub-population groups with regards to socio-economic characteristics (rural local residents vs. vacation urban residents from Athens) makes this case study particularly interesting.

For this purpose, Koundouri et al. (2013a) conducted interviews with Asopos residents in 2011 and employed a choice experiment in order to calculate their willingness to pay for improvements in the environmental conditions. Following common practice of conducting a CE survey for non-market valuation, the implementation stage included the following steps: (i) selection of attributes, (ii) definition of attribute levels, (iii) choice of experimental design in order to allocate alternative scenarios to choice tasks and present them to the participants, (iv) elicitation of preferences, based on respondents ranking of the available scenarios in each choice task. Table 10 presents the main attribute and the corresponding levels. Various choice cards with different combinations of suggested policy action plans were presented to the respondents.

Table 10 – Attributes and levels

Attribute	Status Quo (Option A)	Some Policy Action
Environmental conditions	Bad	Moderate or Good
Impact on local economy	Negative today	Improved by 2015 or positive by 2027
Human health	Water not suitable for drinking, cooking and irrigation	Water suitable for all uses (drinking, cooking and irrigation) or water suitable for some uses (drinking and cooking)
Cost in Euro (Tri-monthly water bill per household for the next 15 years)	0	2, 4, 6, 8 or 12

Source: Koundouri et al. (2013a), p.105

Table 11 – Marginal WTP for the two sub-populations (all respondents)

Attribute Level	Marginal WTP (Athens)	Marginal WTP (Asopos)
Status Quo Policy Option	7.28***	8.31***
Environmental conditions Moderate	10.07***	9.59***
Environmental conditions Good	2.41***	0.47
Local economy improved by 2015	4.03***	1.70***
Local economy positive by 2027	-1.78***	-1.13***
Water for some uses	5.68***	7.29***
Water for all uses	6.27***	5.16***

Source: Koundouri et al. (2013a)

Marginal WTP for status quo becomes insignificant when serial non-participants are excluded, i.e. those ones that are not satisfied by none of the alternative policy scenarios.

The results show that status quo policy scenario is always insignificant when serial non-participants are excluded from the analysis, but respondents from both sub-population groups, Asopos and Athens residents, elicited significant marginal willingness to pay for alternative policy scenarios that improve local environmental conditions. The marginal willingness to pay for the different attribute levels for the two sub-populations is presented in Table 11, showing that WTP levels may differ between the two sub-populations.

In order to examine the impact of environmental degradation on health and the social cost from the consumption of products that are produced in an areas with poor water conditions, a lab experiment has been conducted by Drichoutis et al. (2013) focusing again on Asopos RBD. For these purpose, a sample of 61 consumers were recruited in Athens in order to participate in 4th price Vickrey performed in lab. After a brief training on the lab experiment process, participants were asked to bid in order to exchange a kilo of potatoes produced in Asopos areas with a kilo of potatoes produced in a region with good ecological status. Bids were modeled as a function of socio-economic characteristics of the respondents, the initial monetary endowment, their risk perceptions and potatoes consumption habits, and estimates were obtained with the employment of a random effects regression model. The results suggested that participants were willing to pay a price premium in order to exchange Asopos potatoes with the potatoes from the other region in order to reduce potential health risk. The mean upgrade bid from lower to upper quality potatoes was found to be € 0.60 euro per kilo. This outcome holds even if participants were informed that there is no available data for assessing the risks of consumption for human health.

Cheimaditida Wetland, Greece

Another CE study has been performed by Birol et al. (2006a) in Greece in order to estimate the value of the benefits derived by Cheimaditida wetland, located 40 kilometers southeast of Florina in the northwest part of Greece, and assist policymaking into developing more efficient wetland management plans in accordance with the Ramsar Convention and the WFD. The wetland of Cheimaditida covers an area of 168 square kilometers and contains one of the last remaining freshwater lakes in Greece. Rich fauna, flora and habitat diversity can be met in the wetland. However, the economic activity in the area of the wetland (mainly agriculture, forestry and fishing), has caused some negative effects on the water quantity and quality, and in turn on local biodiversity.

For the purposes of the choice experiment, two ecological (biodiversity and open water surface area), two socio-economic (inherent research and educational values, and re-training of farmers), and one monetary attribute (for calculating welfare changes) were selected. The ecological and socio-economic attributes have been selected in such a way that reflects the variety of the economic benefits generated by Cheimaditida wetland. So, for example, open water surface areas and the associated natural vistas may cause feelings of serenity and tranquility, whereas the quantity of the water that is included in the surface areas are necessary for ensuring the sustainability of local biodiversity. Table 12 summarizes the main attributes and the various levels that were presented to the study participants. The payment vehicle was a one-off tax payment for the year 2006-2007 deposited to "Cheimaditida Wetland Management Fund", controlled by a credible and independent body. For the collection of the data, face-to-face interviews with adult populations were employed in eight town and two cities (Athens and Thessaloniki) representing a continuum of distances from the wetland, as well as urban and rural populations. The collected dataset, besides responses on the various management plan scenarios, included socio-economic characteristics and participants' attitudes towards the environment. A total number of 407 adults accepted to participate in the survey.

A total number of 3256 choices elicited by the 407 survey participants were analyzed with the use of four basic conditional logit models. The findings of the analysis revealed respondents' preferences for management scenarios that promote all attributes of the choice experiment, i.e. biodiversity, open water surface area, research and education activities, and farmer's re-training. With reference to the monetary attribute, higher payment levels have been found to be negatively associated with respondents' utility. Taking into account the existence of potential heterogeneity among respondents' preferences, people with higher levels of education, income and environmental consciousness appear to prefer management scenarios with higher levels of ecological and socio-economic attributes. Depending on the various employed models, average willingness to pay for the various management attributes varies between € 15.10 and € 17.8 for improvements in biodiversity, € 7.25 and € 11.02 for improvements in open water surface area, € 8.69 and € 10.79 for education and research opportunities, and € 0.075 and € 0.195 for farmers' re-training.

In order to estimate the compensating surplus for the alternative management scenarios, the difference between the welfare measures under the "status quo" scenario and three basic management scenarios have been calculated: (i) current scenario ("status quo"), i.e. low biodiversity, low water surface area, low research and educational opportunities, and no farmers' re-training, (ii) scenario 1 (low impact), i.e. low biodiversity, higher levels of open water surface area, low research and educational opportunities and retraining of 30 farmers, (iii) scenario 2 (medium impact), i.e. high level of biodiversity, low open water surface area, high research and educational opportunities and retraining of 75 farmers, and (iv) scenario 3 (high impact), high level of biodiversity, high open water surface area, high research and educational opportunities and retraining of 150 local farmers. Expectedly, the compensating surplus increases when moving from the status quo to one of the alternative scenarios for the management of the wetland. Subject to the various model specifications, the mean WTP ranges between € 58.2 and € 107.59 for the low impact scenario, € 80.11 and € 116.49 for the medium impact scenario, and between € 102.69 and € 134.46 for the high impact scenario. Finally, a cost-benefit analysis was employed to find the net benefits generated by each of the three aforementioned scenarios. The estimated aggregate net benefits[6] have been found to be € 335.351.463, € 357.421.769 and € 412.825.286 for low impact, medium impact and high impact management scenarios respectively, indicating that social welfare maximizes with the high impact scenario.

[6] The estimation of costs for each of the scenarios has been based on communication with Greek Biotope/Wetland Centre in Athens, whereas the estimation of benefits has been derived by aggregating compensating surplus over the entire sampling frame for one of the specified econometric models.

Table 12 – Wetland management attributes and levels used in the CE

Attribute	Definition	Management Level
Biodiversity	The number of different species of plants, animals, their population levels, the number of different habitats and their size.	Low: Deterioration from current levels. High: A 10% increase in population and size of habitats.
Open water surface area	The surface area of the lake that remains uncovered by reed beds.	Low: Decrease from the current open water surface area of 20%. High: Increase open water surface area to 60%.
Research and education	The educational, research and cultural information that may be derived from the existence of the wetland, including visits by scientists, students, and school children to learn about ecology and nature.	Low: Deterioration from the current levels of opportunities. High: Improve the level of educational and research opportunities by providing better facilities.
Re-training of farmers	Re-training of local farmers in environmentally friendly employment such as eco-tourism and arid-crop production.	Number of farmers re-trained in environmentally friendly employment 30,50,75,150
Payment	A one-off payment to go to the "Cheimaditida Wetland Management Fund"	4 payment levels from the pilot CV: 3, 10, 40, 80.

Source: Birol et al. (2006a) p.147

Akrotiri Wetland, Cyprus

Birol et al. (2008b) conducted a contingent valuation study in order to monetize the economic benefits associated with Akrotiri wetland in Cyprus. The wetland of this study is located in Akrotiri peninsula, in the southernmost part of Cyprus, covering a total area of 25 square kilometers. It mainly consists of a seasonal brackish lake and the surrounding saltwater and freshwater marshes, called Phassouri marshes. Akrotiri is the largest wetland in the country and its importance has been recognized by Ramsar Treaty (site no: 1375), Birdlife International and Barcelona Convention (Kailis 2005). The wetland works as a main migratory route for birds moving between northern Europe, Asia and Africa, offering a wealth of important biodiversity. Moreover, Akrotiri wetland offers important opportunities for recreation and education. For example, birdwatchers can enjoy a large number of greater flamingos during the autumn and spring migrations, whereas educational trips are organized by schools from nearby villages and the city of Limassol.

Water is deposited to the salt lake of the wetland mainly from two main sources: (i) runoff from Akrotiri aquifer located on the north side of the wetland (30% of the water supply) and (ii) rainfall (70% of the water supply), regulating the salinity regime of the lake. The wetland is especially susceptible to various environmental problems mainly due to its proximity to a major urban center and military installations, and reliance on the outflows from the Akrotiri aquifer system.

To monetize people's valuation of Akrotiri wetland sustainable management, 188 adult Greek-Cypriots were interviewed in the summer of 2005. A quota sample strategy was administered in order to ensure that the collected sample would be representative of the total population in terms of gender, age and geographical distribution. Following Kontoleon and Swanson (2003), survey participants were asked to value three different management scenarios, in terms of simultaneous changes in quantity (water level, directly affecting wetland area and level of biodiversity) and quality (educational and recreational activities, as well as the construction of British radars at the wetland).

The questionnaire consisted of three main parts. In the first part, in order to identify user and non-users, participants were asked whether they are aware of the existence of the wetland and, if yes, whether they have visited it in the past. In the second part, a brief description of the wetland and its functions was provided and, subsequently, participants were asked to reveal their maximum willingness to pay in order to move from current status-quo (scenario A) to three different management scenarios (scenarios B, C and D). In scenario B, 300.000 m^3 of water would be used to flood the wetland, resulting in a 10% increase in the biodiversity. The scenario also assumes investments for the improvements of infrastructure for educational and recreational activities, whereas the British radars will still be constructed in the nearby military base. Scenario C assumes a capacity of 900.000 m^3 of water for wetland's flooding, increasing biodiversity levels by 20%. Again, investments will be made for improving infrastructure for education and recreation, whereas the British radar will still be constructed. In Scenario D, 900.000 m^3 of water will be used again for the flooding of the wetland, but the construction of the British radar will be cancelled, leading to an overall increase of 25% on biodiversity level. As in the previous scenarios, investments will be made for the improvement of education and recreation infrastructure. An 'advanced disclosure' approach was adopted, with all scenarios being presented to the respondents in advance. In the third part, basic socio-economic information about participants has been collected.

Table 13 presents participants willingness to pay for moving from status quo (scenario A) to each of the different management scenarios. In order to assess the specific importance of use and non-use values, the sample has been divided into users and non-users, i.e. people who have visited the wetland versus people who have never visited the wetland. As the findings suggest, both users and non-users are willing to pay in order to move from status quo to one of the suggested management scenarios, highlighting the significance of wetland's use and non-use values.

Moreover, a random effects interval regression model was specified in order to assess how WTP varies with regards to the different management attributes (water capacity for flooding, provisions of infrastructure for recreation and education, construction of British radars), as well as social, economic and attitudinal characteristics (such as environmental consciousness index) of the respondents. As before, two different regressions were employed with users and non-users respectively. The results revealed, among others, the importance of use values, based on the positive association between WTP and number of visits to the wetland. In terms of socio-demographics, having a child appeared to be negatively associated, contrary to the expected "bequest" values, with non-users' WTP, whereas employment appeared to be a significantly positive determinant only among users. Income variable was excluded from the regression, because of its high correlation with employment and environmental consciousness index, the latter being a strong determinant of WTP for both users and non-users.

Table 13 – Respondents WTP for different management scenarios

WTP from scenario A to…	Pool (188)	Users (142)	Non – users (142)
Scenario B, lower bound	10.51 (12.77)	12.54 (14.49)	9.86 (11.99)
Scenario B, lower bound	12.77 (14.57)	16.21 (17.16)	12.60 (13.37)
Scenario C, lower bound	12.95 (13.69)	14.61 (14.89)	12.30 (13.20)
Scenario C, upper bound	16.55 (15.72)	18.66 (17.61)	15.58 (14.90)
Scenario D, lower bound	14.40 (16.31)	14.97 (14.90)	14.18 (14.89)
Scenario D, upper bound	18.25 (18.18)	19.30 (17.58)	17.83 (18.60)

Source: Birol et al. (2008b)
Standard errors in parenthesis. Lower and upper bound represent different "intensities" of management implementation for each scenario.

Extending the abovementioned study, Birol et al. (2008a) employed a contingent valuation study with 97 farmers in the area of Akrotiri aquifer, characterized by rapid deterioration of water quality and quantity, to investigate farmers' preference toward a new water resource (called treated wastewater) appropriate for replenishing an aquifer used for irrigation, and estimate their willingness to pay for adopting this new technology. After a detailed explanation of how the new technology works and the associated benefits, farmers were presented with four different wastewater use scenarios varying in terms of quantity and quality: (i) program A, i.e. aquifer is replenished with low quality wastewater, whereas the quantity of the water will remain at the current medium levels and the pumping costs will remain the same for the next ten years, (ii) program B, i.e. aquifer is replenished with medium quality wastewater, whereas the quantity of the water will remain at the current medium levels and the pumping costs will remain the same for the next ten years, (iii) program C, i.e. aquifer is replenished with medium quality wastewater, whereas the quantity of the water will increase to a high level and, in turn, the pumping costs will decrease to half or even more within the next ten years, and (iv) program D, i.e. aquifer is replenished with high quality wastewater, whereas the quantity of the water will increase to a high level and, in turn, the pumping costs will decrease to half or even more within the next ten years. A "status quo" scenario, i.e. no wastewater use program is implemented, was also presented to the farmers.

During the valuation process, farmers were first asked whether they were willing to pay some money for moving from status quo to program A. If they answered positively, they were asked to reveal the maximum WTP per m^3 of water, based on choice cards with amounts ranging from CYP 0.01 to CYP 2. A similar procedure was followed for eliciting preferences and willingness to pay for moving from status quo to one of the other wastewater use scenarios. The findings suggest that WTP increases with programs offering higher quality and quantity of wastewater. Specifically, farmers are willing to pay CYP 0.3-0.37 per m^3 of water to move from status quo to program A, while they are WTP another CYP 0.025-0.028 to move from status quo to program B, a further CYP 0.028 – 0.0312 to move from status quo to program C, and a further CYP 0.065-0.071 for the implementation of program D. A random effects interval regression model was adopted to verify the positive association between WTP and wastewater use programs. Indeed, the finding showed that WTP increases significantly with the use of high quality treated wastewater, as well as with medium and high levels of wastewater quantity. Not surprisingly, farmers with larger areas of irrigated land and those ones using wells for obtaining water for their land were willing to pay more for wastewater use programs offering higher quality and quantity.

Kiti, Cyprus

Koundouri and Pashardes (2003) employed an empirical analysis using data from 282 owners of land parcels in the coastal region of Kiti in order to investigate the impact of selectivity bias on the hedonic valuation of groundwater quality. Sample selection bias may arise when failing to account for the fact that a specific input, i.e. use of land in this particular case, can be used for alternative purposes subject to its qualitative characteristics. In this case study, fresh groundwater quality is examined as the main qualitative characteristic affecting the use of land. Proximity to sea may reduce the probability of using a parcel of land as an input in agricultural activities due to higher levels of water salinity on the one hand, but may increase the probability of using the land for tourism activities.

The econometric analysis, using Heckman's two step estimation procedures, showed that land owners are willing to pay a marginal value of CYP 10.7 per hectare to avoid water salinity (i.e. increasing coast proximity) when sample selection bias is not corrected, whereas they are willing to pay a marginal value of CYP 11.5 to "gain" groundwater salinization, a counter-intuitive effect, when sample selection bias is corrected. The estimated WTP is statistically insignificant in the former case (without sample selection bias correction), whereas it is statistically significant in the latter case. The main implication of this result is that the cost of lower quality of groundwater when the parcel of land is closer to the coast may be offset by an increased probability of using the land for tourism purposes. This outcome highlights the need to account for selectivity bias when employing hedonic valuation for the estimation of the shadow price of an environmental resource.

In 2006, Koundouri and Christou used empirical data from Kiti region to test the performance of their theoretical model characterizing the optimal control solution for groundwater, a renewable resource with stock-dependent extraction cost and a backstop substitute (i.e. water desalination offered as an alternative option in coastal aquifers), facing two-sector linear demands (agricultural and residential sectors). Solving the optimal control problems requires the estimation of the scarcity value of in situ groundwater, i.e. the economic value of groundwater. The findings suggest that the gains in social welfare are not significant in the presence of a backstop substitute, due to the existence of GSE[7] effect, whereas GSE disappears in the absence of a backstop substitute and after controlling from extraction when myopic behaviour leads to irreversible loss of the recharge capacity of the aquifer. The critical issue is not the initial presence of the backstop technology, but the optimal point of its adaptation, i.e. finding the unit costs at which the adoption of the technology may become an effective substitute for the exhaustible resource. The theoretical model proposed by the authors of the paper solves for the optimal time of backstop adaptation and identifies an endogenously defined trajectory to the steady state (i.e. at the point where technology is adapted and water desalination begins) allowing dynamic adaptation to resource, i.e. fresh groundwater, scarcity changes.

Cyprus

In a study with household data from various regions in Cyprus in the period 1996-1997, Hajispyrou et al. (2002) applied a model of household demand for water consistently with fundamental principles of consumer behaviour in order to estimate the price and income elasticity of residential demand for water and assess the effects of moving from the current heterogeneous increasing block water pricing system employed in Cyprus regions to a regionally homogeneous uniform pricing system. To account for household heterogeneity, they modelled demand of water as a function of various socio-demographic characteristics. With regards to welfare effects, the findings suggest that the current system is progressive but inefficient, since it introduces gross price distortions leading in deadweight loss. The regional differences appear to cause a significant price heterogeneity that cannot be justified on efficiency and equity criteria. In particular, efficiency cannot be justified, since it is difficult to imagine that supply costs are reflected on price differences in a small island like Cyprus, whereas equity cannot be justified given that, according to the empirical findings of the paper, consumers of large quantities of water pay much less per cubic meter of water than consumers of smaller amounts of water. Moreover, the findings suggest that water is a necessity good, especially for households with lower incomes, with budget elasticity ranging between 0.25 and 0.48 for the lowest income group and the highest income group respectively. The price elasticity of demand for water decreases with income level, starting from -0.79 for the worse off and reaching -0.39 for the better off households.

[7] The Gisser- Sánchez effect (GSE), as first described by Gisser and Sánchez (1980), refers to the paradoxical empirical result of insignificant benefits from managing groundwater extraction even in areas with water scarcity issues.

6. Conclusion and Policy Implications

The main purpose of this chapter was to discuss on how economic tools can assist in the achievement of the targets set by EU Water Framework Directive (2000) and in the design of efficient, socially equitable and environmentally sustainable water management policies. As we have described in the previous sections, a variety of valuation methods are available in order to identify and quantify the economic values, use and non-use, arising from the various aquatic resources and ecosystems. Estimating the value of these benefits is an important prerequisite for the design of appropriate policies.

A brief description of water-related empirical studies conducted in Cyprus and Greece during the last decade revealed various insights that the economic analysis can offer to the policymaking. To mention some highlights, it is important to take into account preference heterogeneity of the population when designing provision of public goods. This is particularly important for the design of socially equitable policies. Various socio-demographic characteristics and different interests may affect perceptions and willingness to pay for a certain environmental good or policy intervention. Second, hedonic valuation approach may yield misleading outcomes about the effect of a certain environmental attribute on producers or consumers' welfare if the potential existence of sampling bias is ignored. In the particular case study described in this chapter, it has been shown that the sample selection problem has resulted in misleading parameter estimates reflecting the shadow (or implicit) prices of the fresh groundwater quality attribute. Third, knowledge accumulation through both extension services and social learning, farmers' risk preferences and water and crop prices are significant determinants for the adoption and diffusion of modern irrigation technologies in the agricultural sector. The aforementioned determinants should be taken into account for any potential reforms in agricultural policy.

Finally, to discuss on another substantial aspect of the economic toolkit, the estimated economic value of the benefits yielded by the implementation of various water-related management scenarios can be compared with the associated costs in order to identify the management scenario, among the scenarios where benefits exceed costs, that achieves social welfare maximization and, thus, design socially efficient wetland management policies. CBA may also be helpful in the identification and avoidance of policy interventions with disproportionate costs that may prevent Member States from the practical implementation of WFD objectives. Disproportionality occurs in cases where the achievement of good water status has significant adverse consequences for the wider environment and human activities, but alternative means are not available for the certain achievement, or in cases were specific measures for the improvement of water status are quite expensive (Koundouri and Dávila 2013). To mitigate disproportionate costs, less stringent objectives or derogations from the initial timeline may be considered.

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