Using Economic Valuation Techniques to Inform Water Resources Management in the Southern European, Mediterranean and Developing Countries: A Survey and Critical Appraisal of Available Techniques

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5.1 Introduction

Water resources include surface water, groundwater, inland water, rivers, lakes, transitional waters, coastal waters and aquifers (Chave, 2001). Together, these water resources are crucial to human health and the natural environment, and are vital to any economy in the world. Water resources are necessary inputs to production in economic sectors such as agriculture (arable and non-arable land, aquaculture, commercial fishing, and forestry), industry (e.g. power generation) and tourism, as well as to household consumption (UNEP, 2005).

Over time however, water resources have been degraded and depleted globally. With respect to water quantity, these trends have grown stronger within the past century during which global freshwater-use increased sixfold, and 50% of global wetlands were lost (IUCN, 2005). In Southern European and Mediterranean countries statistics reveal significant water stress problems regarding water quantity and quality and report deterioration of the state of water resources during recent years. An example of the increased pressure on water resources, is given by the European Commission that reports a 20% increase in the area of irrigated land in Southern Europe since 1985 (EC, 2002). In Chapter 2 of this volume, Barraqué et al. report evidence from fifteen sites in six southern European countries, which face severe water stress in terms of water availability due to climatic conditions and increased demand patterns. Regarding water quality, their findings reveal the deteriorating conditions of groundwater stock, as 7 out of 15 sites exhibit below average groundwater quality. The availability and quality of water resources in the Mediterranean islands is further deteriorated due to their isolated nature and their inability to draw water from more distant resources. In Chapter 3 of this volume, Donta et al summarise the findings of the MEDIS project displaying the strain placed on water resources from increasing demand and natural causes.

These adverse effects on water are a result of increasing water demand from agriculture, industry, tourism, hydroelectric generation, as well as continued pollution.

The effects are further exacerbated by population growth, rapid urbanisation and climate change (UNEP, 2000). From an economic perspective, water resources are over-extracted and are not efficiently allocated. This is due in part to the existence of market and government failures at the local, national and international level. Private costs and benefits diverge from social costs and benefits, leading to social welfare losses (Pearce and Turner, 1990).

In recognition of the deterioration in the quantity and quality of water, several initiatives have been undertaken to ensure the sustainable management and conservation of this valuable resource. The EU’s WFD aims to protect and achieve a “good status” for all water resources by 2015, with a combined approach of emission limit values, quality standards, and the introduction of more efficient water prices. There are also international efforts to conserve water resources, such as the 1971 Ramsar Convention on Wetlands of International Importance, providing a framework for national action and international cooperation for the conservation and wise use of wetlands (Ramsar, 1996).

The aims of this chapter are to highlight the need for economic analysis in the design and implementation of efficient and effective water resources management strategies and policies; to explain and critically assess the suitability of various economic valuation techniques for this purpose; and finally through a comprehensive review of the literature, to demonstrate how these methods can be used in the development of appropriate policies for sustainable water resources management in the Mediterranean and Southern European countries. The chapter is structured as follows: The next section discusses the role of economic analysis in efficient water resources management. In Sections 5.3 and 5.4, the most commonly used economic valuation methods, namely revealed preference methods and stated preference methods, are described. The context in which each of these methods can be used and their respective limitations are explained. The theory is illustrated with examples of existing studies from Mediterranean, Southern European and Developing countries that have employed these methods to estimate the values of water resources. Finally Section 5.5 concludes and discusses implications for water resources policy in Southern European, Mediterranean and Developing countries.

5.2 The Economics of Water Resource Depletion and Degradation: A Conceptual Framework

Even though water resources are vital for the functioning of any economy, they continue to be depleted and degraded at an unsustainable rate. This is true for both developed and developing countries alike, and is due to the nature of the economic development and growth path that has been chosen thus far, which has readily substituted environmental resources (such as water) for other forms of economic resources such as capital and labour for the production of goods and services that are deemed to be more productive and yield higher returns (Swanson and Johnston, 1999). This path has been chosen because the value of environmental resources has often been over-looked in development decisions. Economic efficiency occurs at the point where net social benefits (i.e., benefits minus costs) of an economic activity are maximised, or equivalently, when the marginal benefits are equal to marginal costs. To implement the most efficient social and economic policies that prevent the excessive degradation and depletion of environmental resources, it is necessary to establish their full value, and to incorporate this into private and public decision-making processes.

A widely accepted and often used framework for decision making is Cost Benefit Analysis (CBA). CBA is an analytical tool based in welfare theory, which is conducted by aggregating the total costs and benefits of a project or policy over both space and time (Hanley and Spash, 1995). A project or policy represents a welfare improvement only if the benefits net of costs are positive. Different management options will yield varying net benefits and the option with the highest net benefits is the preferred or optimal one.

A CBA of a policy or project with environmental impacts is complicated because many environmental resources (including most water resources) are public goods. A good is public to the extent that consumption of it is non-rival and non-excludable; It is non-rival if one person's consumption of the good does not reduce the amount available to others and non-excludable if it is possible to supply the good to everyone. Pure public goods cannot be provided by the price mechanism because producers cannot withhold the good for non-payment, and since there is no way of measuring how much a person consumes, there is no basis for establishing a market price. Public goods are therefore not traded in markets as private goods are, and are thus often under-produced or over-exploited by the market. This phenomenon is termed 'market failure' in economic terms. Both surface water and groundwater have public good characteristics in that people who extract them and use them are not paying their scarcity rents (both in terms of quality and quantity); they only pay the private extraction costs. When scarcity rents go unrecognised, the result is inefficiently high extraction or pollution rate over time and space (Koundouri, 2000). Other causes of market failure include insufficient or non-existent property rights, externalities, the lack of perfect competition (e.g., market power) and lack of perfect information. The property rights issue is especially important in the context of water resource management. If there were private property rights, then for example an upstream polluter of water would be legally required to compensate the downstream property rights owner for damages, thus leading to the 'optimal' level of pollution. Externalities refer to costs or benefits borne by individuals who are not directly involved in a market transaction, and who have not been compensated. Where market failures exist, government must intervene to allocate the resources efficiently. Generally, governments do not intervene to correct these failures because environmental conservation is not a high priority. In the case of water supply, a basic human necessity, the government has a stronger incentive to intervene to provide the population with clean water. Though this is true for both developed and developing countries, water quality standards in developing countries tend to be lower than in the developed countries (e.g., EU standards for drinking water quality are stricter than those of the World Health Organisation), and government intervention in the developing world is often slower due to budget constraints and incomplete or non-existent infrastructure and institutions. In addition, certain government policies such as subsidies, distort the prices of environmental resources thereby not accounting for their economic scarcity. These result in the phenomenon of 'government failure'.

To correct for these failures, the value of all the benefits provided by environmental resources need to be captured. Environmental economists have been at the forefront arguing that individuals may derive values from non-market goods, especially environmental resources, through many more sources than just direct consumption (Pearce and Turner, 1990). More specifically, they refer to the importance of considering the Total Economic Value (TEV) of an environmental resource. TEV recognises two basic distinctions between the value that individuals derive from using the environmental resources, i.e., use values, and the value that individuals derive from the environmental resource even if they themselves do not use it, i.e., non-use values. Use values can be further classified into three broad categories: Direct use values, indirect use values, and option values. Direct use values come from the consumptive use of the environmental resource itself. With regard to water resources, these include drinking water, irrigation, or as an industrial input (Table 5.1). For most private (normal) goods, value is almost entirely derived from their direct use. Many environmental resources however, perform an array of functions that benefit individuals indirectly: indirect use values of water resources include benefits such as flood control, nutrient retention, and storm protection. Finally, option value recognises that individuals who do not presently use a resource may still value the option of using it in the future. The option value for water resources therefore represents their potential to provide economic benefits to human society in the future.

A further major expansion of value of an environmental resource is the inclusion of non-use values (Krutilla, 1967). These are values that individuals may derive from environmental resources without ever personally using or intending to use them. These can be further classified into three categories, namely existence value, bequest value, and altruistic value.

Existence value refers to the value individuals may place upon the conservation of an environmental resource, which will never be directly used by themselves or by future generations. Individuals may value the fact that future generations will have the opportunity to enjoy an environmental resource, in which case they might express a bequest value. Finally, altruistic value states that even if the individuals themselves may not use or intend to use the environmental resource themselves, they may still be concerned that the environmental good in question should still be available to others in the current generation.

These concepts are illustrated in Fig. 5 1. The MNPB curve represents the marginal net private benefits of using water resources, where $MNPB_S$ curve represents the marginal net private benefits of using water resources exacerbated by subsidies to their use. The MEC_L is the marginal external costs borne locally from use of water resources and the MEC_{L+G} is the local and global marginal external costs from use of water resources, measured by the TEV of the water resources. These curves

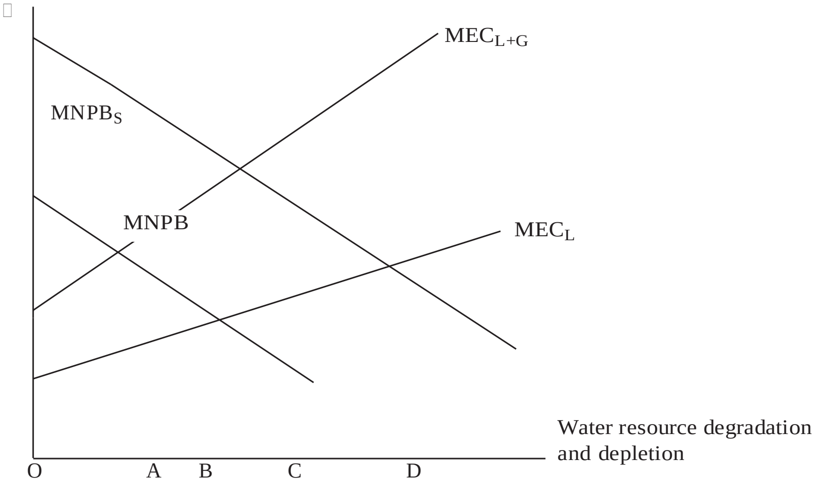

Fig. 5.1 Impacts of market and government failure and population growth on water use Source: Adopted from Pearce (2001); x axis is the decline in quantity and quality of water; y axis is the monetary costs and benefits

result in four equilibria, with four levels of water resource use. Point C is the local private optimum, where all externalities are disregarded and there are no subsidies to water use. Externalities are defined as benefits or costs, generated as by-products of an economic activity that do not accrue to the parties involved in the activity. An externality can be local, in which case it is confined to a specific location, or global, and it can be positive or negative.

Point D is the local private optimum, where, again all externalities are disregarded and water use is subsidised. Point B is the local social optimum, where local externalities are internalised but global externalities are ignored, and point A is the global social optimum, where all externalities are internalised. When an externality is internalised, the market and government failures have been corrected to the point where economic efficiency has been attained. The government failure is measured by distance CD, i.e., the quantity and quality of water resources that is lost due to its conversion for use in economic activities (e.g., irrigation for agriculture or a waste sink for pollution run-off from industry) as a result of government subsidies. Local market failure is measured by BC, and global market failure by AB. The distance AD reflects the inefficiency of water resource use, as shown by the divergence between the private and social optimum. The efficient use of water resources occurs at OA (Pearce, 2001).

To summarise, values of water resources are not straightforward to estimate for CBA purposes. This is not only because many of the water resources are public goods in nature, and hence do not have readily available monetary values attached to them, but also because their value is more complex compared to private goods. This complexity arises from the fact that the value of water resources are composed of both use and non-use values. Capturing the TEV of water resources is crucial to policy and management decisions because they can guide resource allocations among water resource conservation and sustainable management and other socially valuable endeavours, as well as within water resources, thus enabling society to allocate its scarce economic and environmental resources efficiently. Establishing the TEV would also assist in the design of economic incentives and institutional arrangements, and help to identify potential gainers and losers from current depletion and degradation of water resources (Drucker et al., 2001).

Various economic methods have been developed to capture the TEV of environmental resources. Table 5.1 lists the main economic methods that can be used to estimate the values of water resources. The advantages and disadvantages of each method, along with their uses in capturing the value of water resources, is the subject of the subsequent two sections.

Table 5.1 Components of TEV of water resources and appropriate economic valuation methods

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

Source: With modifications adopted from Barbier (1991, 1997), Woodward and Wui (2001), Brouwer et al., (2003), and Brander et al., (2006).

*Acronyms refer to Production Function (PF), Net Factor Income (NFI), Replacement Cost (RC), Market Prices (MP), Cost of Illness (COI), Travel Cost Method (TCM), Hedonic Pricing Method (HP), Contingent Valuation Method (CVM), and Choice Experiment Method (CEM).

5.3 Revealed Preference Methods

Revealed preference methods, also known as indirect valuation methods, look for related or surrogate markets in which the environmental good is implicitly traded, i.e., if it is one of the many components of a good that is purchased by the consumer (Lancaster, 1966). Information derived from observed behaviour in the surrogate markets is used to estimate willingness to pay (WTP), which represents individual's valuation of, or the benefits derived from, the environmental resource. Two such methods prevalent in the environmental economics literature are the hedonic pricing and the travel cost methods. These methods are suitable for valuing those water resources that are marketed indirectly and are thus only able to estimate their use (direct and indirect) values.

5.3.1 Hedonic Pricing Method

The hedonic pricing method (HPM) is based on Lancaster's characteristics theory of value (Lancaster, 1966), which states that any good can be described as a bundle of characteristics and the levels these take, and that the price of the good depends on these characteristics and their respective levels. It is commonly applied to variations in housing prices that reflect the value of local environmental resources. The price of a house will reflect its relevant characteristics, i.e., number of bedrooms, number of bathrooms, size, schools in the neighbourhood, level of crime, etc., in addition to the local environmental resources such as ambient air quality, noise levels, aesthetic views, water quantity or quantity.

It follows that an implicit price exists for each of the characteristics and an implicit marginal WTP, which represents an individual's valuation of the incremental unit of the environmental resource can be identified statistically. A limitation of the HPM is that it only measures direct use values of water resources as perceived by the consumers' of the good in which it is implicitly traded. Services such as flood control, water quality improvement, habitat provision for species, and groundwater recharge may provide values that benefit individuals far away, beyond the consumers of the good, which the HPM is unable to capture (Boyer and Polasky, 2004).

The HPM was developed by Griliches (1971) to estimate the value of quality change in consumer goods. The earliest examples of HPM applied to irrigation water valuation are by Milliman (1959) and Hartman and Anderson (1962). Daniere (1994) employs this method to investigate urban households' valuation of potable water in Cairo, Egypt. Koundouri et al (2003) apply this method in Cyprus to estimate the effect of water salinity on land prices. Latinopolous et al. (2004) utilise the hedonic pricing method to estimate the implicit value of irrigation water in Chalkidiki, a typical rural area in Greece. Noteworthy applications of this method in developing country context include Gundimeda et al (2003), who value improved water availability and quality in Chennai, India by using the HPM, and more recently Yusuf et al

(2005), who use this method to estimate the WTP for water services using data from the Indonesian housing market.

5.3.2 Travel Cost Method

The travel cost method (TCM) is used to estimate use values associated with ecosystems or sites (such as forests, wetlands, parks, and beaches) that are used for recreation to which people travel for hunting, fishing, hiking, or watching wildlife. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represent the “price” of access to the site. Thus, peoples’ WTP to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples’ WTP for a marketed good based on the quantity demanded at different prices. The TCM encompasses a variety of models, ranging from the simple single-site TCM to regional and generalised models that incorporate quality indices and account for substitute sites (CGER, 1997).

The method can be used to estimate the economic benefits or costs resulting from changes in access costs for a recreational site, elimination of an existing recreational site, addition of a new recreational site and changes in environmental quality at a recreational site. There are however several limitations to TCM. Defining and measuring the opportunity cost of time is complicated since there is no strong consensus on appropriate measure. Substitute sites are only taken into account in the random utility approach to TCM, which uses information on all possible sites that a visitor might choose, their quality characteristics, and the travel costs to each site. This approach yields information on the value of characteristics in addition to the value of the site as a whole. TCM however can only be used to value goods consumed in situ and, similar to HPM, it cannot capture the non-use values of environmental resources.

The TCM was first proposed by Hotelling (1931) and subsequently developed by Clawson (1959), and Clawson and Knetsch (1966). Such models have been employed to measure the welfare effects to changes in water quality of recreational sites (e.g. Caulkins et al., 1986; Smith and Desvousges, 1986; Bockstael et al., 1987). Noteworthy applications of the method in developing countries include Choe et al. (1996) who apply the TCM to estimate the local community’s valuation of surface water quality improvements in the rivers and seawater in Davao, Philippines. Yapping (1998) employs the TCM in China to estimate the value of improving the water quality of East Lake in Wuhan. The results reveal that lake users are WTP significant amounts for the use of the lake and its facilities, thus offsetting some of the cost of maintaining water quality for recreation. Maharana et al (2001) use TCM to estimate the demand curve for visits to the sacred Khecheopalri Lake in India, and then derive the annual consumer surplus accrued to the lake using the number of pilgrims in year 1998.

5.3.3 Other Revealed Preference Methods

In addition to the HPM and the TCM, there are also other revealed preference methods that are not as widely used in the context of environmental resources valuation; however they can be useful in certain situations. These are described below.

Replacement Cost Method. This method values the costs of replacing damaged assets, including environmental assets, by assuming these costs are estimates of the benefit flows from avertive behaviour. This method assumes that the damage is measurable and that the value of the environmental asset is no greater than the replacement cost. It also assumes that there are no secondary benefits arising from the expenditures on environmental protection. This method is particularly applicable where there is a standard that must be met, such as a certain level of water quality (Markandya et al., 2002).

Avertive Expenditures Method. This method is based on the household production function theory of consumer behaviour. The household produces consumption goods using various inputs, some of which are subject to degradation by pollution. In the context of water resources, households may respond to increased degradation of these inputs in various ways that are generally referred to as averting or defensive behaviours so as to avoid the adverse impacts of water contaminants. This includes buying non-durables (e.g., bottled water), making expenditures on liming to reduce water acidification, and changing behaviour to avoid exposure to the contaminant (e.g., boiling water for cooking and drinking or reducing the frequency or length of showers if a volatile organic chemicals were present).

There are however important limitations to this method. Individuals may undertake more than one form of averting behaviour in response to an environmental change and the averting behaviour may have other beneficial effects that are not considered explicitly (e.g., the purchase of bottled water to avoid the risk of consuming polluted supplies may also provide added taste benefits). Furthermore, averting behaviour is often not a continuous decision but a discrete one, e.g. a water filter is either purchased or not. Generally, the averting expenditures does not measure all the costs related to pollution that affect household utility and are therefore only able to provide a lower bound estimate of the true cost of increased pollution.

Applications of the method in Mediterranean countries include Haruvy et al (2000) who apply an optimisation model and develop an economic assessment procedure to asses the costs of averting groundwater pollution, by valuing the damage with the cost needed to treat irrigation water in Israel. Rinaudo et al (2005) use an approach similar to the Avertive Expenditures Method, namely the Avoidance Cost method combined with a Contingent Valuation study, to estimate the cost of groundwater pollution in the upper Rhine Valley in France. Examples of applications of this method in developing countries include those by McConnell and Rosado (2000), who have estimate the non-marginal benefits from improvements in drinking water quality using defensive inputs in Guarapari and Grande Vitoria, Espirito State, Brazil, and Um et al., (2002) who have employed the method to estimate improved drinking water quality in Pusan, Korea.

Production Function Approach. This approach can be used to value non-marketed goods and services that serve as an input to the production of marketed goods. The approach relates the output of particular marketed goods or services (e.g. agricultural production, timber, fish catch) to the inputs necessary to produce them. These include marketed inputs such as labour, capital, and land, as well as non-marketed goods and services such as soil stability, air quality, or water quality and quantity. Thus, the implicit value of water can also be calculated by measuring the contribution of water to the profit in cases where water is an important component of a production process and the producer's cost structure is known. If water supply is unrestricted, a producer will continue to use units of water up to the point where the contribution to profit of the last unit is just equal to its cost to the firm. Even if water is "free", there will be costs to the producer associated with water use (including pumping and delivery costs). If water supply is restricted (for example, by quotas or water rights), the producers may cease use of water before the equality is met. The level of water use at varying costs to the producer defines a "derived" demand relationship, since the demand for the water is derived from the demand for the output of the producer (e.g., agricultural commodities). Yaron (1967) employs a water production function for agricultural products to analyze estimate the demand for water in Israel. In an example from southern Europe, Giannias et al (1996) use this approach to estimate the value of water in a bilateral international context, estimating the WTP of Greece to Bulgaria, for increased downstream water quantity from river Nestos.

Net Factor Income. The Net Factor Income approach estimates changes in producer surplus (i.e., the monetary measure of net benefit to a firm of producing a good) by subtracting the costs of other inputs in production from total revenue, and ascribes the remaining surplus as the value of the environmental input (Brander et al., 2004). Thus for example, the economic benefits of improved water quality can be measured by the increased revenues from greater agricultural productivity when water quality is increased. Alternatively, water quality affects the costs of purifying municipal drinking water hence economic benefits can be measured by the decreased costs of providing clean drinking water.

Cost-of-Illness (COI) method. Another approach is the Cost-of-Illness (COI) method in which the benefits of pollution reduction are measured by estimating the possible savings in direct out-of-pocket expenses resulting from illness (e.g., medicine, doctor and hospital bills) and opportunity costs (e.g., lost earnings associated with the sickness). Two important limitations of this approach is that it does not consider the actual disutility of those who are ill, nor does it account for the defensive or averting expenditures that individuals may have taken to protect themselves (CGER, 1997).

Market Prices. Market prices are used to value the costs/benefits associated with changes in quality and quantity of environmental goods that are traded in perfectly functioning markets. They are generally used with other revealed preference methods (e.g. cost-of-illness approach, replacement costs approach), which assume that market price represents the opportunity cost of water resources. Varela-Ortega et al (1998) estimate the effects of alternative water pricing policies on farmers' water consumption in Spain, while Pujol et al (2006) examine the impact of water markets establishment in Italy and Spain. Market prices and the prices of substitute goods in applications on developing countries are used by Bann (1997) to value the benefits of shifting from the traditional use of the mangrove in Koh Kong Province in Cambodia to commercial shrimp farming. She finds support of retaining existing uses both direct including local fishing and charcoal production and indirect such as storm protection Acharya et al (2002) analyze domestic demand for groundwater in Northern Nigeria with the purpose of valuing the groundwater recharge function of wetlands. They find that the populations in the study area would suffer severe welfare loss if wetlands were to cease providing the existing daily level of groundwater recharge.

5.4 Stated Preference Methods

Stated preference methods (SPM), also called direct valuation methods, have been developed to solve the problem of valuing those environmental resources that are not traded in any market, including surrogate ones. In addition to their ability to estimate use values of any environmental good, the most important feature of these survey-based methods is that they can estimate the non-use values, enabling estimation of each component of TEV. Since many of the outputs, functions and services that water resources generate are not traded in the markets, SPM can be used to determine the value of their economic benefits.

5.4.1 Contingent Valuation Method

The purpose of the contingent valuation method (CVM) is to elicit individuals' preferences, in monetary terms, for changes in the quantity or quality of non-market environmental resources. With CVM, valuation is dependent or 'contingent' upon a hypothetical situation or scenario whereby a sample of the population is interviewed and individuals are asked to state their maximum WTP (or minimum willingness to accept (WTA) compensation) for an increase, or decrease, in the level of environmental quantity or quality. To conduct a CVM, special attention needs to be paid to the design and implementation of the survey. Focus groups, consultations with relevant experts, and pre-testing of the survey are important pre-requisites. Decisions need to be taken regarding how to conduct the interviews (in-person, via mail or via telephone surveys); what the most appropriate payment bid vehicle is (e.g., an increase in annual taxes, a single-one-off payment, a contribution to a conservation fund, among others, see Champs et al. (2002) for more on this); as well as the WTP elicitation format (see Hanemann, 1994; Bateman et al., 2003). Ultimately, the mean WTP bids that have been obtained from the sample can then be extrapolated across the population to obtain the aggregate WTP or value of the environmental resource (Mitchell and Carson, 1989).

With regard to water resource applications, CVM is useful for examining direct use values such as recreational fishing and hunting, and indirect use values such as improved water quality. Unlike revealed preference methods, CVM is also able to measure the option use values of water associated with biodiversity, as well as the non-use values. Despite the strengths of CVM regarding its ability to estimate non-use values and evaluate irreversible changes, this method has been criticised on grounds of lack of validity and reliability (Kahneman and Knetsch, 1992; Diamond and Hausman, 1994). This is on account of potential problems including information bias, design bias (starting point bias and vehicle bias), hypothetical bias, yea-saying bias, strategic bias (free-riding), substitute sites and embedding effects. To address these, the Blue Ribbon Panel under the auspices of U.S. National Oceanic and Atmospheric Administration (NOAA) have made recommendations regarding best practice guidelines for the design and implementation of contingent valuation studies that will form the basis of natural resource damage litigation actions (Arrow et al., 1993).

To date more than 5000 CVM studies have been conducted in over 100 countries, most of which make reference to the guidelines of the NOAA panel, and a large proportion of CVM studies have examined water quality and quantity issues specifically. A number of these have been carried out in the Southern European and Mediterranean countries. There are several notable examples, the earliest of which is by MacPhail. (1994) who employs this method in Tunisia, to estimate households' WTP for piped water and sewer services in Tunis. In the first major application of the method in Italy, Press (1995), estimates public's WTP for improvements in groundwater quality in Milan. Bonnieux et al. (1998) apply the CVM to investigate farmers' willingness to accept (WTA) compensation for provision of wetland conservation in France, as a part of the Environmentally Sensitive Area schemes that are being developed and implemented throughout the European Union, under the obligations of the reformed Common Agricultural Policy. Similarly, Franco et al. (2001) employ a CV in order to assist development of agri-environmental schemes in Italy, by estimating the farmers' valuation of agroforestry and the resultant water quality. Kontogianni et al., (2003) estimate public's WTP to ensure the full operation of a wastewater treatment plant, leading to significant improvements in the water quality of Thermaikos Bay in Greece, with this method. This method is also employed in Turkey, by Ozsabuncuoglu (1996) who estimate farmers' WTP for higher quality of irrigation water in Oguzeli, Gaziantep, and by Goksen et al. (2002) who estimate the citizens' WTP for reduced water pollution in the Bosphorus, Istanbul. In Israel Al-Ghuraiz and Enhassi (2005) estimate the WTP for improved water supply in the Gaza strip. Most recently, Birol et al (forthcominga) employ the CVM to investigate farmers' willingness to accept recharging of Akrotiri aquifer in Cyprus with recycled wastewater, and their WTP for different qualities of recycled wastewater. They find that farmers are WTP the highest for highest quality and quantity recycled wastewater.

The Contingent Valuation Method has been also applied widely to value water resources in developing countries. Whittington et al (1992) employ this method to value water supply options, namely public taps and private connections in Anambra, Nigeria. Choe et al. (1996) compare the results from CVM and TCM to evaluate surface water quality improvements in the rivers and sea-water near the community of Davao, Philippines. Their CV results indicate that household WTP for environmental amenities such as improved water quality is low. Barton (2002) employs this methods to estimate the value of improvements in water quality in Costa Rica. The loss of economic benefits from decreasing quality of water resources was estimated in Vietnam by Phuong (2003). Furthermore, a large number of CVM studies focus on the use and non-use values of wetlands. This is because of the substantial local and global indirect and non-use values inherent in this resource (see Crowards and Turner, 1996; Brouwer et al., 2003 for a review). Of the wetland valuation studies reviewed, a considerable number of them are specific to the Southern European and Mediterranean countries, and several of them are carried out in Greece. Oglethorp and Miliadou (2000) employ the CV method to estimate the use and non-use values of Lake Kerkini in Northern Greece. Kontogianni et al. (2001) employ a CV to evaluate different stakeholders' preferences of four development/ conservation scenarios for the wetland surrounding the Kalloni Bay on the island of Lesvos. The CV study by Psychoudakis et al. (2005) estimates the use values of the several ecological functions of the Zazari–Cheimaditida wetland, including flood water retention, food web support, groundwater recharge, nutrient export and sediment retention. More recently, Birol et al. (2006a) use this method to estimate non-use values the Greek public derives from the sustainable management of the Cheimaditida wetland. CV studies on wetlands from other Southern European and Mediterranean countries include those by Birol et al. (forthcoming b) who estimate the non-use values the Cypriot public derives from the sustainable management of the Akrotiri wetland.

5.4.2 Choice Experiment Method

A relatively new addition to the portfolio of SPM, the choice experiment method (CEM), is theoretically grounded in Lancaster's characteristics theory of value (Lancaster, 1966) and based on random utility models (RUMs) (Luce, 1959; McFadden, 1974). RUMs are discrete choice econometric models, which assume that the respondent has a perfect discrimination capability, whereas the analyst has incomplete information and must therefore take account of uncertainty (see Manski, 1997 for more information). A choice experiment is a highly 'structured method of data generation' (Hanley et al., 1998), relying on carefully designed tasks or "experiments" to reveal the factors that influence choice. The environmental resource is defined in terms of its attributes and levels these attributes would take with and without sustainable management of the resource. For example one attribute that can be used to describe the quality of coastal waters is bathing water quality. The levels of this attribute could be high, medium, and low. One of the attributes is a monetary one, which enables estimation of WTP. Profiles of the resource in terms of its attributes and attribute levels is constructed using experimental design theory, a statistical design theory which combines the level of attributes into different scenarios to be presented to respondents. Two or three alternative profiles are then assembled in choice sets and presented to respondents, who are asked to state their preference (Hanley et al., 1998; Bateman et al., 2003).

Similar to CVM, CEM can estimate economic values for any environmental resource, and can be used to estimate non-use as well as use values. The CEM however, enables estimation not only of the value of the environmental resource as a whole, but also of the implicit value of its attributes, their implied ranking and the value of changing more than one attribute at once (Hanley et al., 1998; Bateman et al., 2003). Another advantage of CEM over CVM is that respondents are more familiar with the choice rather than the payment approach. Moreover, CEM can solve for some of the biases that are present in CVM; the strategic bias is minimised in the CEM since the prices of the resources are already defined in the choice sets. Further, yea-saying bias (or warm glow effect) is also eliminated because the choice approach does not allow for the respondent to state a value for the resource even if they do not value it. Finally, the risk of insensitivity to scope (or embedding effect) in CEM is reduced. If the choice sets offered to respondents are complete and carefully designed, the respondent would not mistake the scale of the resource or its attributes for something else that it could be embedded in (Bateman et al., 2003).

Even though CEM has been applied to valuation of environmental resources only in the past decade, there have been some noteworthy applications of this method to water resources valuation in Southern European and Mediterranean countries in the past few years. Abou-Ali and Carlsson (2004) apply this method to estimate the value of improved water quality in Cairo, Egypt. They investigate the welfare effects of improved health status through increased water quality, and find that the estimated WTP is fairly low compared with the costs of a program that would achieve these improvements. Travisi and Nijkamp (2004) include groundwater contamination from fertilisers and pesticides as an attribute in a survey of willingness to pay for agricultural environmental safety among residents of Milan, Italy. They find that that the public derives substantial economic value from the reduction of groundwater contamination. Colombo et al. (2005; 2006) employ a CE to estimate the benefits from soil conservation measures in the Alto Genil and Guadajoz watersheds in southern Spain. They include surface and ground water quality among the important attributes of the soil conservation measures and find that water quality generated the highest economic value among all the soil conservation measures attributes included in the study.

This method has also been applied to estimate the economic values of several vital components of wetlands Southern European and Mediterranean countries. Nunes et al. (2004) apply the CEM to investigate fishermen’s preferences for alternative management practices for clam fishing in a natural wetland, i.e., the Venice lagoon in Italy. Most recently, Birol et al. (2006b) apply the CEM to estimate the Greek public’s valuation of the Cheimaditida wetland. They estimate the use and non-use values of several of the wetland attributes, including biodiversity, open water surface area, research and education activities in the wetland and retraining of farmers to environmentally friendly farming practices. They find that the economic benefits that accrues to the public.

Table 5.2 Advantages and disadvantages of economic valuation methods. (Adapted from CGER 1997.)

Method	Advantages	Disadvantages
Hedonic pricing method (HPM)	Based on observable and readily available data from actual behaviour and choices.	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 (TCM)	Based on observable data from actual behaviour and choices.	Need for easily observable behaviour.
	Relatively inexpensive.	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.
Replacement cost method	Based on observable data from actual behaviour and choices.	Need for easily observable behaviour on averting behaviours or expenditures.
	Relatively inexpensive.	Estimates do not capture full losses from environmental degradation.
	Provides a lower bound WTP if certain assumptions are met.	Several key assumptions must be met to obtain reliable estimates.
		Limited to assessment of current situation.
		Ex post valuation.
		Does not measure non-use values.
Production function method	Based on observable data from firms using water as an input.	Understates WTP.
	Firmly grounded in microeconomic theory.	*Ex post* valuation.
	Relatively inexpensive.	Does not measure non-use values.
Cost-of-illness method	Relatively inexpensive.	Omits the disutility associated with illness.

(continued)

Table 5.2 (continued)

		Understates WTP because it overlooks averting costs. Limited to assessment of the current situation. *Ex post* valuation.
Market prices	Based on observable data from actual choices in markets or other negotiated exchanges.	Does not provide total values (including non-use values) Limited to assessment of current situation. Potential for market distortions to bias values.
Contingent valuation method (CVM)	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 e*x ante* and *ex post* valuation.	Subject to various biases (e.g., 1. interviewing bias, starting point bias, non-response bias, 2. strategic bias, y 3. ea-saying bias, 4. 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 Experiment Method (CEM)	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 e*x ante* and *ex post* valuation.	Technique can be difficult to understand. Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.

The CEM has also been applied successfully in developing country context. Othman et al. (2004) use this method to assist decision makers in determining the optimal management strategy for the Matang Mangrove Wetlands in Perak State in Malaysia. They estimate the values for environmental attributes (e.g., the area of environmental forest protected, the number of bird species protected and the recreation use of the area) as well as the value of a social attribute (i.e., the employment of local people in wetland based extractive industries). Their results reveal that households experience negative utility from reduced employment and hence demand compensation.

The advantages and disadvantages of the valuation methods described in Sections 5.3 and 5.4 are summarised in Table 5.2 below.

5.5 Conclusions

Values of environmental resources such as water are not straightforward to assess due to the public good nature of this resource. This chapter presents a non-technical introduction to the economic valuation techniques that can be used to capture the total economic value (TEV) of changes in the quantity and quality of environmental resources, with a specific focus on water. Capturing the TEV of water resources is an integral part in the design of economic incentives and institutional arrangements that can ensure their sustainable, efficient and equitable allocation. The chapter also reports the studies that apply valuation methods in Southern European, Mediterranean and Developing countries.

References

Abou-Ali, H. and Carlsson, F. (2004). Evaluating the welfare effects of improved water quality using the choice experiment method, Working Papers in Economics 131, Göteborg University, Department of Economics.

Acharya, G. and Barbier, E. (2002). Using domestic water analysis to value groundwater recharge in the Hadejia-Jama'are Floodplain, Northern Nigeria, *American Journal of Agricultural Economics*, 84(2): 415–426.

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., and Radner, R.H. (1993). Report of the NOAA Panel on Contingent Valuations. Natural resource damage assessment under the oil pollution Act of 1990. *Federal Register* 58(10): 4601– 4614.

Bann, C. (1997). An economic analysis of alternative mangrove management strategies in Koh Kong Province, Cambodia, economy and environment program for Southeast Asia, International Development Research Centre 1997.

Bateman, I., Carson, R., Day, B., Hanemann, W.M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R., and Swanson, S. (2003). *Guidelines for the Use of Stated Preference Techniques for the Valuation of Preferences for Non-market Goods*. Edward Elgar, Cheltenham,UK.

Barbier, E. (1991). An approach to economic valuation of tropical wetlands: with examples from Guatemala and Nicaragua. In Girvan & Simons (eds), *Caribbean Ecology and Economics*. St. Michael, Barbados: Caribbean Conservation Association.

Barbier, B., Acreman, M., Knowler, D. (1997). Economic Valuation of Wetlands: A guide for policy makers and planners.IUCN.

Barton, D.N. (2002). The transferability of benefit transfer: Contingent valuation of water quality improvements in Costa Rica. *Ecological Economics* 42:147–164.

Birol, E., Karousakis, K., and Koundouri, P. (2006a). Using economic methods and tools to inform water management policies: A survey and critical appraisal of available methods and an application. *Science of the Total Environment*, 365(1–3): 105–122.

Birol, E., Karousakis, K., and Koundouri, P. (2006b). Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of Cheimaditida wetland in Greece *Ecological Economics* 60: 145–156.

Birol, E., Koundouri, P., and Kountouris, Y. Forthcominga. Farmers' demand for recycled water in Cyprus: A contingent valuation approach. In Zaidi, M.K. (Ed.) *Water Reuse: Risk Assessment, Decision-making and Environmental Security*. NATO Science Series, Springer, The Netherlands.

Birol, E., P. Koundouri and Y. Kountouris. Forthcomingb. Water Resource Management and Wetland Conservation. In Koundouri, P. (Ed.) *Water Resource Policy and Related Issues in Cyprus*. RFF PRESS Series, Issues in Water Resource Policy, Resources For The Future, Washington DC, USA.

Bockstael, N.E., Hanemann, W.M., and Kling, C.L. (1987). Estimating the value of water quality improvement in a recreational demand framework. *Water Resources Research* 23(5): 951–960.

Bonnieux, F., Rainelli, P., and Vermersch, D. (1998). Estimating the supply of environmental benefits by agriculture: A French case study. *Environmental and Resource Economics*, 11(2): 135–153.

Boyer, T. and Polasky, S. (2004). Valuing urban wetlands: A review of non-market valuation studies. Department of Applied Economics, University of Minnesota.

Brander, L.M., Florax, R.J.G.M., and Vermaat, J.E. (2006). The empirics of wetland valuation: a comprehensive summary and a meta-analysis of the literature. *Environmental and Resource Economics*, 33(2): 223–250.

Brouwer, R., Langford, I., Bateman, I., and Turner, R.K. (2003). A meta-analysis of wetland ecosystem valuation studies. In Turner, R. K., Jeroen, C.J.M., van den Bergh and Brouwer, R. (eds.) *Managing Wetlands: An ecological economics approach*. Edward Elgar, Cheltenham, UK.

Caulkins, P., Bishop, R., and Bouwes, N., Sr. (1986). The travel cost model for lake recreation: A comparison of two methods for incorporating site quality and substitution effects. *American Journal of Agricultural Economics*, 68(2): 291–97.

Champ, P., Flores, N., Brown, T., and Chivers J. (2002). Contingent valuation and incentives. *Land Economics* 78(4): 591–604.

Choe, K., Whittington, D., Lauria, D.T. (1996). The economic benefits of surface water quality improvements in developing countries: A case study of Davao, Philippines. *Land Economics* 72(4): 519–537.

Chave, P. (2001). *The EU Water Framework Directive: An Introduction*. IWA Publishing.

Clawson, M. (1959). Methods of measuring the demand for and value of outdoor recreation. REF Reprint No. 10. *Resources for the Future*,.Washington, DC.

Clawson, M. and Knetsch, J. (1966). *Economics of Outdoor Recreation*. Johns Hopkins University Press, Baltimore, MD.

Colombo, S., Calatrava, R. J., and Hanley, N. (2006). Analyzing the social benefits of soil conservation measure using stated preference methods *Ecological Economics* 58: 850–861.

Colombo, S., Hanley, N., and Calatrava, R.J., (2005). Designing policy for reducing the off-farm effects of soil erosion using choice experiments *Journal of Agricultural Economics* 56(1): 81–95.

Commission on geosciences, environment and resources (CGER) Valuing ground water: Economic concepts and approaches. http://www.nap.edu/books/0309056403/html/75.html 1997.

Crowards, T.C., and Turner, R.K. (1996). FAEWE sub project report: Economic valuation of wetlands. Centre for Social and Economic Research on the Global Environment. University of East Anglia, Norwich.

Daniere, A.G. (1994). "Estimating willingness-to-pay for housing attributes an application to Cairo and Manila" Regional Science & Urban Economics 24(5): 577–599

Diamond, P.A. and Hausman, J.A. (1994). Contingent valuation: Is some number better than no number? *Journal of Economic Perspectives* 8: 45–64.

Drucker, A.G., Gomez, V., and Anderson, S. (2001). The economic valuation of farm animal genetic resources: a survey of available methods, Ecological Economics, 36:1–18.

Federal guidelines, economic and environmental principles and guidelines for water and related land resources implementation studies. *U.S. Water Resources Council* February 3 1983.

Franco, D., Franco, D., Mannino, I., and Zanetto, G. (2001). The role of agroforestry networks in landscape socioeconomic processes: The potential and limits of the contingent valuation method. *Landscape and Urban Planning* 55(4):239–256.

Giannias, D.A. and Lekakis, J.N. (1996). Fresh surface water resource allocation between Bulgaria and Greece. *Environmental and Resource Economics*, 8, 4:473–483.

Göksen, F., Adaman, F., and Zenginobuz, E.U. (2002). On environmental concern, willingness to pay, and postmaterialist values evidence from Istanbul. *Environment and Behaviour*, 34(5): 616–633.

Griliches Z., ed. (1971). *Price Indexes and Quality Change*. Harvard University Press,Cambridge, MA.

Gundimeda, H. and Kathuria, V. (2003). Estimation of economic value of water scarcity and quality in Chennai, India: The Hedonic approach, South Asian Network of Economic Initiatives Project.

Hanemann, M. (1994). Valuing the environment through contingent valuation. *Journal of Economic Perspectives*. 8(4): 19–43.

Hanley, N. Wright, R.E., and Adamowicz W.L. (1998). Using choice experiments to value the environmental. *Environmental and Resource Economics*, 11(3–4): 413–428.

Hanley, N. and Spash, C. (1995). *Cost Benefit Analysis and the Environment.* Edward Elgar Publishing, England.

Haruvy, N., Hadas, A., Ravina, I., and Shalhevet, S. (2000). Cost assessment of averting groundwater pollution. *Water Science and Technology*, 42, 1–2:135–140.

Hotelling H. (1931). The economics of exhaustible resources. *Journal of Political Economy*. 39: 1937–75.

IUCN, World Conservation Union, (2005) www.iucn.org.

Kahneman D, and Knetsch J.(1992). Valuing public goods: The purchase of moral satisfaction. *Journal of Environmental Economics and Management*, 22:57–70.

Kontogianni, A., Skourtos, M., Langford, I., Bateman, I., and Georgiou, S., (2001). Integrating stakeholder analysis in non-market valuation of environmental assets. *Ecological Economics*, 37: 123–138.

Kontogianni, A., Langford, I.H., Papandreou, A., and Skourtos, M.S. (2003). Social preferences for improving water quality: An economic analysis of benefits from waste water treatment *Water Resources Management*, 17(5): 317–336

Koundouri, P. Three approaches to measuring natural resource scarcity: Theory and application to groundwater. PhD Thesis, Department of Economics, University of Cambridge, UK

Koundouri, P. and Pashardes, P. (2003). Hedonic price analysis and selectivity bias: Water salinity and demand for land. *Environmental and Resource Economics*, 26:45–56

Krutilla, J.V. (1967). Conservation reconsidered, *American Economic Review*, 57(3): 777–786.

Lancaster, K. (1966). A new approach to consumer theory. *Journal of Political Economy*, 1966; 84: 132–157.

Latinopoulos, P., Tziakas, V., and Mallios, Z. (2004). Valuation of irrigation water by the hedonic price method: A case study in Chalkidiki,Greece,*Water, Air, and Soil Pollution: Focus* 4(4–5): 253–262.

Luce, D. (1959). *Individual Choice Behaviour*, John Wiley, New York, NY.

MacPhail, A. (1994). Why don't households connect to the piped water system? Observations from Tunis, Tunisia, *Land Economics* 70(2): 189–196.

Manski C. (1977). The structure of random utility models. *Theory and Decision 1977*; 8: 229–254.

Maharana, I., Rai, S.C., and Sharma, E. (2001). Valuing ecotoursim in a sacred lake of the Sikkim Himalaya, India. *Environmental Conservation*, 27(3):269–277.

Markandya, A. Harou, P., Bellu, L., and Cistulli, V. (2002). *Environmental Economics for Sustainable Growth: A Handbook for Practitioners*, Edward Elgar, Cheltenham, UK.
McConnell K, and Rosado M. (2000). Valuing discrete improvements in drinking water quality through revealed preferences. *Water Resources Research*, 36(6):1575–1582.
McFadden, D. (1974). Conditional logit analysis of qualitative choice behaviour. In Zarembka P. (Ed.) *Frontiers in Econometrics*, Academic Press, New .York.
Milliman, J.W. (1959). Land values as measures of primary irrigation benefits. *Journal of Farm Economics*, 41(2): 234–243.
Mitchell, R.C. and Carson, R.T. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Baltimore: Johns Hopkins University Press.Nunes, P.A.L.D., Rossetto, L., and de Blaeij, A., (2004). Measuring the economic value of alternative clam fishing management practices in the Venice Lagoon: results from a conjoint valuation application, *Journal of Marine Systems*, 51:309–320.
Oglethorp, D., and Miliadou, D. (2000). Economic valuation of non-use attributes of a wetland: A case study of Lake Kerkini. *Journal of Environmental Planning and Management*, 43(6): 755–767
Othman, J., Bennett J., and Blamey R.(2004). Environmental values and resource management options: A choice modeling experience in Malaysia. *Environment and Development Economics*, 9: 803–824.
Ozsabuncuoglu, I.H. (1996). Evaluation of negative externality by pollutees *Environment and Planning C: Government and Policy* 14(4): 489–500.
Pearce, D.W. and Turner, K.(1990). Economics of natural resources and the environment. Harvester Wheatsheaf.
Pearce, D.W. (2001). Lecture Notes, University College London, London, UK.
Phuong, D.M. and Gopalakrishnan, C. (2003). An application of the contingent valuation method to estimate the loss of value of water resources due to contamination: The case of the Mekong Delta, Vietnam. *Water Resources Development* 19(14): 617–633,
Portney, P.R. (1994). The contingent valuation debate: Why economists should care. *Journal of Economic Perspectives*, 8: 3–17.
Press, J., (1995). Establishing priorities for Groundwater Quality: A Contingent Valuation Study in Milan, *FEEM (Fonidazione Eni Enrico Mattei)* Newsletter (1): 7–10.
Pujol, J., Raggi, M., and Viaggi, D. (2006). The potential impact of markets for irrigation water in Italy and Spain: A comparison of two study areas. *Australian Journal of Agricultural and Resource Economics*, 50(3):361–380.
Psychoudakis, A., Ragkos, A., and Seferlis, M., (2005). An assessment of wetland management scenarios: The case of Zazari-Cheimaditida (Greece). Water science and technology. *Water Supply Journal*, 5(6): 115–123.
Ramsar Convention. Strategic Plan 1997–2002. Ramsar Convention Bureau, Gland, Switzerland. 1996.
Rinaudo, J.-D., Arnal, C., Blanchin, R., Elsass, P., Meilhac, A., and Loubier, S. (2005). Assessing the cost of groundwater pollution: The case of diffuse agricultural pollution in the Upper Rhine valley aquifer. *Water Science and Technology*, 52, (9):153–162.
Smith, K, and Desvousges, W.H. (1986). *Measuring Water Quality Benefits*. Boston, MA: Kluwer-Nijhoff.
Swanson, T. and Johnston, S. (1999). *Global Environmental Problems and International Environmental Agreements: The Economics of International Institution Building*, Edward Elgar, Cheltenham, UK.
Travisi, C., and Nijkamp, P., (2004). Willingness to pay for agricultural environmental safety: Evidence from a survey of Milan, Italy, Residents Tinbergen Institute Discussion paper TI, 04-070/3.
Um, M., Kwak, S., and Kim, T. (2002). Estimating willingness to pay for improved water quality using averting behavior method with perception measure, *Environmental & Resource Economics* 21: 287–302.
United Nations Environment Program (UNEP) (2000). *Global Environmental Outlook*. Earthscan Publications.

Varela-Ortega, C., Sumpsi, J.M., Garrido, A., Blanco, M., and Iglesias, E. (1998). Water pricing policies, public decision making and farmers' response: Implications for water policy. *Agricultural Economics*, 19(1–2):193–202.

United Nations Environment Program (UNEP) (2005). Vital water statistics. http://www.unep.org/vitalwater/

Woodward, R.T., and Wui, Y.S. (2001). The economic value of wetland services: A meta-analysis. *Ecological Economics*, 37: 257–70.

Whittington, D., Smith, V.K., Okorafor, A., Okore, A., Liu, J.L., and McPhail, A. (1992). Giving Respondents Time to Think in Contingent Valuation Studies: A Developing Country Application, *Journal of Environmental Economics and Management*, 22: 205–225.

Yaron, D., (1967). Empirical analysis of the demand for water by Israeli agriculture. *Journal of Farm Economics*, 49 (2): 461–473.

Yapping, D. (1998). The value of improved water quality: An application of contingent valuation and travel cost methods to East Lake in Wuhan, China, EEPSEA Research Report.

Yusuf, A. and Koundouri, P. (2005). Willingness to pay for water and location bias in hedonic price analysis: Evidence from the Indonesian housing market, *Environment and Development Economics*, 10:821–836.