Estimating farmers’ valuation of aquifer recharge with treated wastewater The Cypriot case study

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1. Introduction and motivation

The aim of this chapter is to examine farmers’ attitudes towards recharging a depleting aquifer with treated municipal wastewater in a water-scarce region. The case study reported here is conducted in Cyprus, a semi-arid Mediterranean country that faces chronic water resource scarcity and hence is in constant search of alternative water resources (Koundouri 2009).

Treated municipal wastewater has been proposed as an alternative water source that should be accounted for in the water balance of water-scarce areas (see, for example, Fetter and Holzmacher 1974; Paling 1987; Bouwer 1992; Barnett *et al.* 2000). Aquifer recharge with treated wastewater is expected to have significant effects on farming practices, especially in areas with widespread irrigated agriculture. It is expected to increase the quantity of water available for irrigation during the summer months. At the same time the recharge will serve to maintain water quality at acceptable levels for agricultural use by preventing saline water intrusion and maintaining the hydrological balance. Therefore, this plan has been proposed as a solution to the replenishment of several depleting aquifers in Cyprus.

Nevertheless, current European Union (EU) level regulations on treated wastewater use limit the types of crops reclaimed wastewater can be used to irrigate. In particular, treated wastewater should not come into direct contact with the parts of the crops that humans will later consume. From this respect, an aquifer recharge is likely to lead to changes in crop patterns, moving farmers away from vegetable and grain farming towards cultivation of orchards, such as citrus and olive trees. Furthermore, it is likely that the irrigation technology will also change with the use of the retreated wastewater, as farmers will need to substitute sprinkler irrigation with drip irrigation.

As a result, the effects of aquifer recharge with treated wastewater could potentially generate both economic costs and benefits, which should be accounted for when conducting the cost–benefit analysis to inform wastewater treatment, irrigation water and aquifer management policy.

In this chapter we employ a stated preference, choice experiment method to capture the values appropriated by local farmers from the replenishment of the aquifer they use for irrigation with treated wastewater. To this end, 142 farmers in the Akrotiri aquifer area were interviewed. The choice experiment data were analysed with individual conditional logit models for various farmers clusters, identified according to the size of the farm and the intensity of reliance on the aquifer for irrigation. The results reveal that farmers are not opposed to the aquifer management plan which proposes to replenish the aquifer with treated wastewater: i.e. their willingness to pay (WTP) significant amounts, in terms of higher per cubic meter water prices, to ensure this plan is implemented, and current levels of water quality and quantity are maintained in the aquifer. Whereas size of the farm does not affect farmer choices of aquifer management plan attributes, those farmers that rely on the aquifer for irrigation are WTP the highest amounts to ensure the current levels of water quality and quantity are maintained. These farmers, however, do not exhibit significant WTP values for preservation of agricultural employment in the area, implying that they would prefer less competition for this scarce water resource.

The next section presents the background to the agricultural water scarcity problem in Cyprus. Section 3 explains the underlying theory and principles of the choice experiment method. Section 4 describes the case study, and the survey instrument and sample are presented in Section 5. Section 6 reports the results of the econometric analysis, Section 7 WTP estimates and Section 8 concludes the paper and outlines policy implications.

2. Background

The agricultural sector is the major consumer of groundwater in Cyprus, accounting for approximately 60% of groundwater consumption. While all groundwater resources belong to the state, over the past decades, a large number of wells and boreholes were created without any regulations. This has placed a further burden on the already-limited water quantity. It is estimated that most coastal aquifers have been mined down to 15% of their capacity (Koundouri 2009). This has led to further degradation of groundwater resources through seawater intrusion.

Furthermore, there is large discrepancy between the quantity of water consumed and the contribution to national income: 70% of all water resources in Cyprus is used by agriculture, a sector which accounts for 2.7% of national income (Cyprus National Statistics 2007). Despite the government's promotion of water-saving irrigation schemes, water resources continue to be used inefficiently by the agricultural sector. This phenomenon is mainly attributed to the large number of small-scale farmers, which constitute a large proportion of total farms in Cyprus.

In addition to the shortage in quantity of water, the agricultural sector has a detrimental impact on the overall quality of water in Cyprus. Although water quality is still considered to be satisfactory for irrigation purposes, increasing levels of pollution from chemicals (e.g. pesticide, nitrate and fertiliser) run offs have been detected both in groundwater and surface water. This has led to the gradual phasing out of groundwater from the domestic water supply. In addition, if current climatic conditions and water demand patterns persist, combined with decreased precipitation rates, it is expected that salinity levels will increase, thereby rendering groundwater from major aquifers unusable (Koundouri 2009).

Efficient, effective and sustainable management of water resources has therefore become a central policy goal for Cyprus, since water resources are of the utmost importance for sustaining the current economic growth. In particular, the large tourism industry, one of the pillars of the Cypriot economy, requires significant water quantities during summer months when the shortage is most pronounced. Long dry periods may also affect water supply for households and agriculture alike: during the drought of the 1990s, for example, the water supply was limited to a few hours per day in major cities.

Currently all major cities in Cyprus apply secondary or tertiary wastewater treatment, and treated wastewater is used directly for irrigation. In the Limassol prefecture, where the study presented in this chapter is undertaken, large-scale wastewater treatment was initiated with the construction of a treatment plant in 1995. The objective of this initiative was to provide a safe and reliable system for wastewater disposal and to improve environmental and water resource management (Papaiacovou 2001). Most recently, the Water Development Department has been considering the use of the rapidly depleting Akrotiri aquifer as a storage tank, i.e. to recharge the aquifer with treated wastewater, in order to reduce the effects of seawater intrusion.

The study presented in this chapter aims to help the policymakers by providing information on the farmers' WTP for the replenishment of the aquifer with treated wastewater, as well as their preferences for the quality and quantity of water used to replenish the Akrotiri aquifer.

3. Method

The choice experiment (CE) method has its theoretical grounding in Lancaster's model of consumer choice (Lancaster 1996), and its econometric basis in random utility theory (McFadden 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. To illustrate the basic model behind the CE presented here, consider a farmer's choice of aquifer management plan. Assume that utility depends on choices made from a choice set C, which includes all possible aquifer management plans. The farmer has a utility function of the form:

$$U_{ij} = V(Z_{ij}) + e(Z_{ij}) \tag{1}$$

For any farmer i, a given level of utility will be associated with any aquifer management plan j. Utility derived from any of the aquifer management plans depends on the attributes of the aquifer management plan (expressed in vector $\boldsymbol{Z}$), such as the quantity and quality of treated wastewater used to replenish the aquifer.

Random utility theory (RUT) is the basis for integrating behaviour with economic valuation in the CE method. According to RUT, the utility of a choice is composed of a deterministic component (V) and an error component (e), which is independent of the deterministic part and follows a predetermined distribution. The error component implies that predictions cannot be made with certainty. Choices made between alternatives will be a function of the probability that the utility associated with a particular aquifer management plan j is higher than with other alternatives. Assuming that the relationship between utility and attributes is linear in the parameters and variables function, and that the error terms are identically and independently distributed with a Weibull distribution, the probability of any particular aquifer management plan alternative j being chosen can be expressed in terms of a logistic distribution. Equation (1) can be estimated with a conditional logit model (CLM) (McFadden 1974; Greene 1997, pp. 913–914), which takes the general form:

$$P_{ij} = \frac{\exp(V(Z_{ij}))}{\sum_{h=1}^{C} \exp(V(Z_{ih}))} \qquad (2)$$

The conditional indirect utility function generally estimated is:

$$V_{ij} = \beta_1 Z_1 + \beta_2 Z_2 + \ldots + \beta_n Z_n \qquad (3)$$

where n is the number of aquifer management plan attributes considered, and the vectors of coefficients β_1–β_n are attached to the vector of attributes (Z).

The assumptions about the distribution of error terms that are implicit in the use of the CLM impose a particular condition known as the independence of irrelevant alternatives (IIA) property. IIA states that the relative probabilities of two options being chosen are unaffected by introduction or removal of other alternatives. If the IIA property is violated, then CLM results will be biased. A second limitation of the CLM is that it assumes homogeneous preferences across farmers. As is well known in consumer theory, preferences are generally heterogeneous. Accounting for this heterogeneity enhances the accuracy and reliability of estimates of demand, participation, marginal and total welfare (Greene 1997). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account.

An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary (Boxall and Adamowicz 2002). One solution to detecting the sources of heterogeneity could be through cluster analysis, which can be applied by stratifying farmers into various clusters and then estimating the aquifer management plan demand function, i.e. CLM, for each cluster separately. Variables that are hypothesised to affect farmer demand for different aquifer management plans (e.g. size (area) of the farm and the degree of reliance on aquifer for irrigation) can be used to assign farmers into different clusters.

4. The case study

The case study in this chapter is the Akrotiri aquifer, one of the many aquifers in Cyprus to be facing serious threats to its water quality and quantity, mainly due to the open access nature of these water resources. The Akrotiri aquifer is located in the southernmost part of the island, extending over 42 km^2. This groundwater resource is of substantial importance to the local economy since it provides irrigation water for farmers in the surrounding communities, as well as residential water for households in some of these communities.

The aquifer is replenished with runoffs from the Kouris River, releases from the Kouris River Dam, rainfall and agricultural return flows (Mazi *et al.* 2004). However, overextraction by local farmers for irrigation purposes, combined with decreased precipitation rates and dam construction on the upstream of the Kouris River, have led to a severe strain on the aquifer, limiting its water inflow. The limited water inflow has in turn led to seawater intrusion and the consequent salinisation, i.e. deterioration of water quality in the aquifer.

To mitigate the combined threat of aquifer depletion and seawater intrusion, the water management authorities plan to use the aquifer as a storage tank for tertiary-treated wastewater from the nearby city of Limassol. At present, this wastewater is being discarded to the sea after treatment. This plan, if implemented, is expected to replenish the scarce water resource and contribute to the relaxation of the stringent water conditions in the area. However, farmers will have to change their current farming practices and irrigation technologies in order to align with the legal restrictions of using treated wastewater.

5. The choice experiment design and implementation

The first step in design of a CE study is the definition of the good to be valued in terms of its attributes and the levels of these attributes. In this case, the good to be valued was defined to be an 'aquifer management plan'. The attributes and their levels were selected after consultations with local policymakers and scientists, and focus groups with local farmers.

The aquifer management plan is based on the replenishment of the aquifer with treated wastewater. This plan is expected to have impacts on water quantity and quality in the aquifer, and on the number of farmers employed in the agricultural sector in the area. The water quality and quantity attributes were selected to have two levels: the current medium level and low level. The present water quantity available for irrigation was defined to be medium. Given the current precipitation rates and aquifer utilization, water quantity is expected to decrease to low level within the next decade. Nevertheless, under the aquifer replenishment plan, water quantity can be maintained at its current medium level. Water quality at the present is in the medium state, but is expected to decrease to a low level due to seawater intrusion and increased concentrations of chemicals from agricultural activities. Under the aquifer recharge scheme, the quality may be maintained at the current medium level.

Employment in agriculture was selected to have four levels (1500, 1455, 1380 and 1275 farmers). Currently, there are approximately 1500 registered farmers in the area, but this figure is expected to decrease by 15% to 1275 if no action is taken to replenish the aquifer. Alternatively, agricultural employment can be maintained at 1500 farmers, decrease by 3% to 1455 or by 8% to 1380 farmers, depending on the quantity and quality of wastewater used to replenish the aquifer.

The payment vehicle chosen was the price of water per cubic meter. The price increase had four levels: 5%, 10%, 15% and 25%. Given that each community/source of water may charge a different price per cubic meter of water, this allows for a continuous monetary measure in the analysis. Furthermore, information on the current prices the farmers pay per cubic meter of water were gathered so as to be able to convert these percentage values into monetary values.

Using these attributes and their levels, a number of unique aquifer management plans can be derived. By an orthogonalisation procedure, we produced 32 profiles that were randomly paired in 16 choice sets. Each choice set was augmented with a status quo alternative that described the situation expected to prevail under no replenishment: i.e. for the status quo alternative, water quality and quantity were defined to be low, employment in agriculture would decrease to 1275 farmers and price would increase by 50% due to decreased water quantity and quality. To reduce the cognitive burden imposed on farmers from coping with 16 choice sets, the choice sets were randomly blocked to two versions, each containing eight choice sets. Each of the versions was administered to half of the sample. Table 5.1 presents an example of a choice set.

The survey instrument consisted of two components. In the first component, the CE study, the aim and the scope of the aquifer replenishment plan was explained to the respondents. The respondents were then read a statement describing the

Table 5.1 Example of a choice set: assuming that the following aquifer management plans are the only ones available, which one would you choose?

Aquifer management plan characteristics	*Management plan A*	*Management plan B*	*Business as usual*
Water quality	Low level	Current (medium) level	Low level
Water quantity	Current (medium) level	Low level	Low level
Employment in agriculture	1455	1380	1275 farmers
Increase in the price of water per m^3	5%	15 %	0%
I prefer	Management plan A	Management plan B	Business as usual

current water conditions in the area. In this statement, they were also acquainted with the definition of treated wastewater, its potential uses and disadvantages. Then they were read a description of the attributes valued in the CE and their levels. Subsequently, respondents were sequentially presented with the choice sets and were asked to state their preference. Debriefing questions were also asked to discriminate between protestors and those with a true zero value among those selecting the status quo alternative in all choice sets. The second component of the survey consisted of questions on farmers' current agricultural and irrigation practices, as well as social, economic and demographic characteristics.

The survey instrument was implemented in February and March 2008 in the five villages located around the Akrotiri aquifer. A sample of 150 farmers (i.e. 10% of the approximately 1500 farmers in the Akrotiri aquifer area) was envisaged. In each village approximately 35 randomly selected farmer households were contacted and informed of the survey. Those that agreed to participate in the survey were subsequently interviewed after an appointment at a later day. The respondents were by and large those household members who were responsible for making farming decisions. As a result of face-to-face household visits, the response rate was high, at 100%. Among the 150 farmers, eight protestors were identified and removed from the sample. The final sample contained 142 individuals for a total of 1136 choice observations. Table 5.2 reports the descriptive statistics of the sample.

Table 5.2 Descriptive statistics

Characteristic	*Definition*	*Sample average (S.D.) or percent*
Farmer characteristics		
Age	Age in years	49 (7.4)
Experience	Years of experience in farming	24.4 (8.3)
Education	Per cent less than mandatory	15.1%
	Per cent mandatory	19.1%
	Per cent high school	45.2%
	Per cent more than high school	24.4%
Full-time farmer	Per cent whose main occupation is agriculture	29.4%
Farm characteristics		
Total area owned	Total area of agricultural land owned by the farmer in m^2	17854.5 (25912.8)
Total area cultivated	Total area of agricultural land cultivated by the farmer in m^2	28633.8 (66126)
Total area irrigated and cultivated	Total area of agricultural land cultivated by the farmer that is irrigated in m^2	22514.8 (41342.2)
Tree cultivation	Per cent of farms whose main produce are trees	63.3%
Main source of irrigation water	Per cent from well on farm	15.7%
	Per cent from dam	57.4%
	Per cent other (e.g. rain)	19.1%
Drip irrigation	Per cent using drip irrigation	54.4%

Source: Akrotiri Aquifer Wastewater Replenishment Farmer Acceptance Survey, 2008.

Table 5.3 Results of the CLM for each cluster

Variable	*Coefficient (S.E.)*				
	CLM	*CLM model for large farms*	*CLM for small farms*	*CLM for farms relying primarily on aquifer*	*CLM for farms relying primarily on other water sources*
Water quality	0.233*** (0.064)	0.234*** (0.072)	0.237* (0.140)	0.423*** (0.151)	0.206*** (0.072)
Water quantity	0.465*** (0.063)	0.465*** (0.071)	0.470*** (0.137)	0.803*** (0.147)	0.407*** (0.071)
Agricultural employment	0.003*** (0.0004)	0.004*** (0.0004)	0.003*** (0.009)	0.001 (0.001)	0.004*** (0.0004)
Price of water per m^3	–16.732*** (1.584)	–18.247*** (1.844)	–12.298*** (3.109)	–13.735*** (3.621)	–18.081*** (1.802)
Log-likelihood	–1,039.904	–814.4048	–223.0853	–190.8841	–819.8348
ρ^2	0.14	0.115	0.248	0.174	0.136
No of observers	1,136	904	232	208	912

Source: Akrotiri Aquifer Wastewater Replenishment Farmer Acceptance Survey, 2008.
*** 1% significance; ** 5% significance and * 10% significance level with two-tailed tests.

6. Results

To examine the significance of the design attributes in determining farmer choice of aquifer management plan, we estimate a CLM on the pooled dataset. The CLM estimates are reported on the second column of Table 5.3.

The overall fit of the models, as measured by McFadden's ρ^2, is very satisfactory by conventional standards used to describe probabilistic discrete choice models.[1] The results of the CLM demonstrate that all of the aquifer management plan attributes are significant determinants of farmer choice. The positive coefficients on the quality, quantity and agricultural employment attributes indicate that farmers are more likely to choose alternatives with higher levels of these attributes. As expected, maintaining the current water quality and quantity levels are desirable for farmers in the region. The coefficient on water price is negative, as predicted by economic theory, implying that farmers are more likely to choose alternatives with lower prices for cubic meters of water. The magnitudes of the coefficients with two levels indicate that the most important determinant of farmer's stated choice is the maintenance of water quantity followed by water quality. The large

1 The ρ^2 value in multinomial logit models is similar to the R^2 in conventional analysis except that significance occurs at lower levels. Hensher *et al.* (2005, p. 338) comment that values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits.

coefficient on water price indicates the size of the negative impact of price in individual alternative choice.

Overall, the CLM estimates reveal that there exist significant economic values to be gained from the maintenance of current water quantity and quality, which can be achieved through the implementation of the aquifer replenishment plan. At the same time, the low number of protestors suggests that the recharge policy is widely accepted by the farmers and substantially improves welfare. Nevertheless, it is worth noting that the data for the CE exercise reported here were collected close to one of the worst droughts in Cypriot history. This could have biased respondents towards the benefits of the replenishment plan, regarding reclaimed wastewater as a last resort solution to the water scarcity.

To illustrate possible heterogeneity in the preferences of different clusters of farmers, we estimate CLMs for various split clusters of farmers: large- vs small-scale farmers and farmers that get the majority of their irrigation water from the aquifer vs those who obtain the majority of their water from other sources (e.g. dam, rain, other farmers, etc.).

We define small-scale farmers as those that cultivate an irrigated area of $<$8,000 m^2, whereas large-scale farmers are those that cultivate an irrigated area $\geq$8,000 m^2. The CLM estimates for different-sized farmers are reported in the third and fourth columns of Table 5.3. The estimated coefficients for the CLM for large-scale farmers closely resemble those of the pooled CLM model, both in terms of magnitude and sign. In fact the Swait–Louviere log-likelihood ratio test cannot reject the null hypothesis that the regression parameters for the CLM for the poor and the CLM for the clusters are equal at the 1% significance level at four degrees of freedom. Therefore, the two clusters of farmers have similar preferences for the aquifer management plan. In other words, size of the area farmed is not a significant determinant of farmer choice of aquifer management plan.

We define farmers that primarily use aquifer water for irrigation as those farmers that pump from wells on their farms over 50% of their irrigation water, whereas those farmers pumping less than 50% are categorized as using water primarily from other sources. The Swait–Louviere log-likelihood ratio tests reject the null hypothesis that the regression parameters for CLM for the poor and the CLM for the clusters are equal at the 1% significance level at four degrees of freedom. Therefore, the two clusters have significantly different preferences for the aquifer management attributes. In fact, for the cluster that relies on aquifer water for irrigation, the number of farmers employed in the area attribute is an insignificant determinant of choice, revealing their desire for less competition for the limited water resources available in the aquifer. Water quality and quantity attributes are ranked similarly for both of the clusters.

7. Willingness to pay estimates

The CE method is consistent with utility maximisation and demand theory (Bateman *et al.* 2003). Welfare measures can be calculated from the parameter estimates by using the following formula:

$$\text{CS} = \frac{\ln \sum_i \exp(V_{i1}) - \ln \sum_i \exp(V_{i0})}{\alpha} \tag{4}$$

where CS is the compensating surplus welfare measure, α is the marginal utility of income (represented by the coefficient of the monetary attribute in the CE, which is the price of water) and V_{i0} and V_{i1} represent indirect utility functions before and after the change under consideration.

For the linear utility index, the marginal value of change in a single aquifer management plan attribute can be represented as a ratio of coefficients, which represents the marginal rate of substitution between price and the aquifer management plan attribute in question, or the marginal welfare measure (WTP) for a change in any of the attributes. For the aquifer management plan attribute with four levels, i.e. employment, equation (4) reduces to part-worth (or implicit price) formula

$$W = -1 \frac{\beta_{\text{attribute}}}{\beta_{\text{monetary variable}}} \tag{5}$$

For the effects coded binary aquifer management plan attribute (water quality and quantity), the formula becomes

$$W = -2 \frac{\beta_{\text{attribute}}}{\beta_{\text{monetary variable}}} \tag{6}$$

Using the Wald procedure (Delta method) in LIMDEP, farmers' WTP for marginal changes in each one of the attributes are calculated for each one of the estimated models presented above. The results are reported in Table 5.4.

According to the CLM estimates, reported in the first row of Table 5.4, on average farmers are willing to pay higher prices for water to ensure the current levels of water quality and quantity are maintained as a result of the implementation of the aquifer replenishment plan. They are WTP an additional CYP0.014 per cubic meter of water to ensure medium water quality, and CYP0.028 per cubic meter of water to ensure medium water quantity. Furthermore, farmers are WTP CYP0.0002 per cubic meter of water to save one job in the agricultural sector.

WTP for some of the aquifer management plan attributes differs significantly across clusters (Table 5.5): Large-scale farmers are WTP CYP0.013 and CYP0.026 to maintain current water quality and quantity, respectively, while the WTP for maintaining an extra farmer in agriculture is CYP0.0002. For small-scale farmers, WTP for water quality is insignificant, whereas their WTP for water quantity is significantly higher than large-scale farmers at CYP0.038, although their WTP for agricultural employment is the same as the large-scale farmers. When the WTP values for farmers that use different sources for irrigation are

Table 5.4 WTP values for high water quality, water quantity and agricultural employment for the CLM and the CLM for each cluster

Model	*WTP in CYP for medium water quality*	*WTP in CYP for medium water quantity*	*WTP in CYP for agricultural employment*
CLM	0.014*** (0.010–0.018)	0.028*** (0.024–0.032)	0.207×10^{-3}*** ($0.17*10^{-3}$–$0.23*10^{-3}$)
CLM for large farms	0.013*** (0.009–0.017)	0.026*** (0.022–0.030)	0.0002*** ($0.1*10^{-3}$ $0.2*10^{-3}$)
CLM for small farms	–[a]	0.038*** (0.024–0.042)	0.0002** ($0.1*10^{-3}$–$0.2*10^{-3}$)
CLM for farms relying primarily on aquifer	0.031** (0.018–0.044)	0.058*** (0.040–0.072)	–[a]
CLM for farms relying primarily on other water sources	0.011*** (0.007–0.015)	0.022*** (0.018–0.026)	0.0002*** ($0.1*10^{-4}$–$0.2*10^{-4}$)

Source: Akrotiri Aquifer Wastewater Replenishment Farmer Acceptance Survey, 2008.
*** 1% significance; ** 5% significance and * 10% significance level with two-tailed tests.
[a] – Indicates insignificant WTP.

Table 5.5 *P*-values for the significant differences between WTP values

Model	*WTP in CYP for medium water quality*	*WTP in CYP for medium water quantity*	*WTP in CYP for agricultural employment*
CLM for large farms vs CLM for small farms	–	0.0001	1
CLM for farms relying primarily on aquifer vs CLM for farms relying primarily on other water sources	0	0	–

compared, we see that farmers who rely on the aquifer for irrigation are WTP as high as CYP0.031 for water quality, and CYP0.058 for water quantity. Both of these figures are significantly higher than the WTP of those farmers who rely on sources other than the aquifer for irrigation of their farms.

8. Policy implications and conclusions

This chapter reported the results of a CE study undertaken in a water-scarce region of the world, namely Cyprus, to (1) examine farmers' acceptance of a plan which proposes to replenish their local aquifer with treated wastewater from the nearby municipalities and (2) capture the economic benefits that might be generated by the replenishment of this aquifer, whose water quantity is depleting and water quality is deteriorating at a fast rate due to the common pool nature of this water resource. To this end, we collected stated choices from 142 farmers on their preferred aquifer management plans, using water quantity, water quantity and agricultural employment in the area as the main attributes that define a hypothetical aquifer management plan. Data on irrigation and farming practices as well as attitudes and preferences towards wastewater use for irrigation were also collected from the same farmers.

The results of the study reported in this chapter reveal that farmers derive significant economic benefits from the replenishment of the Akrotiri aquifer with treated wastewater. On average, farmers prefer those aquifer management plans which sustain the water quality and quantity at its current levels, and thereby prevent salinisation. Small-scale farmers derive higher values from sustaining the quantity of water in the aquifer compared with their large-scale counterparts. This result can be explained by small-scale farmers' lack of infrastructure to acquire water from other sources. Moreover, those farmers that rely on the aquifer for irrigation derive the highest economic benefits from those aquifer management plans that ensure the current levels of water quality and quantity are maintained, and seawater intrusion is avoided. These benefits should be aggregated over the entire population and weighted against the costs of such plans in order to decide on the implementation of such a plan.

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