Economic Valuation Methods for Efficient Water Resources Management: Theory and Applications

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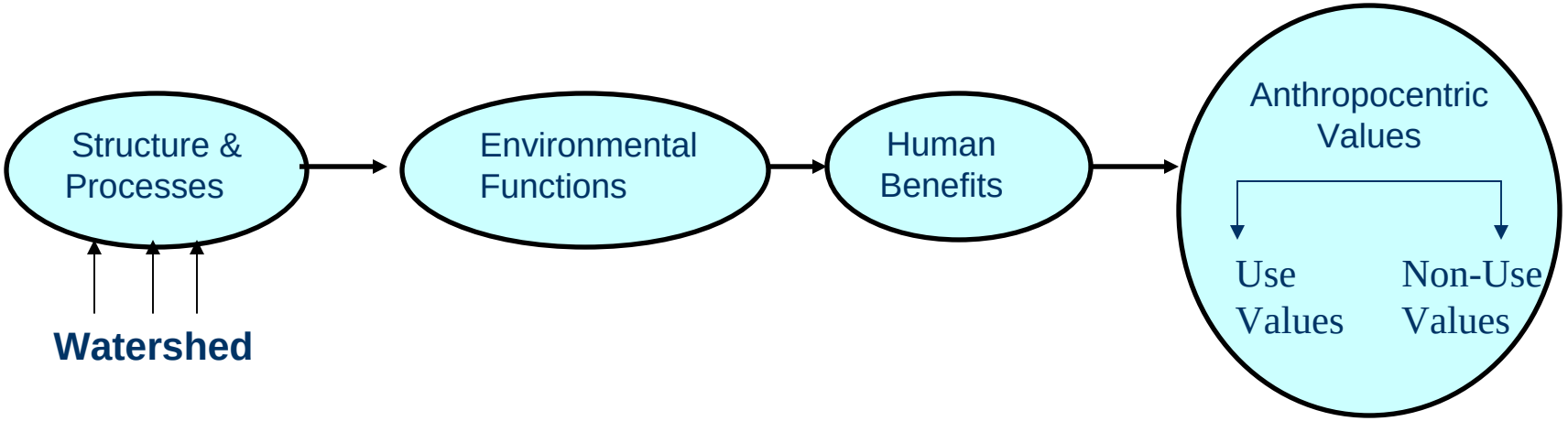
Outline

- Introduction: Economic Framework for Sustainable Water Resources Management
- Valuation Methods:
  - Revealed Preference Techniques
  - Stated Preference Techniques
- Applications to Water Resources:
  - Cyprus EU Water Management Project
  - Choice Experiment to Estimate Non-Use Values of Wetlands

An Economic Framework to Measure Value of Environmental Functions

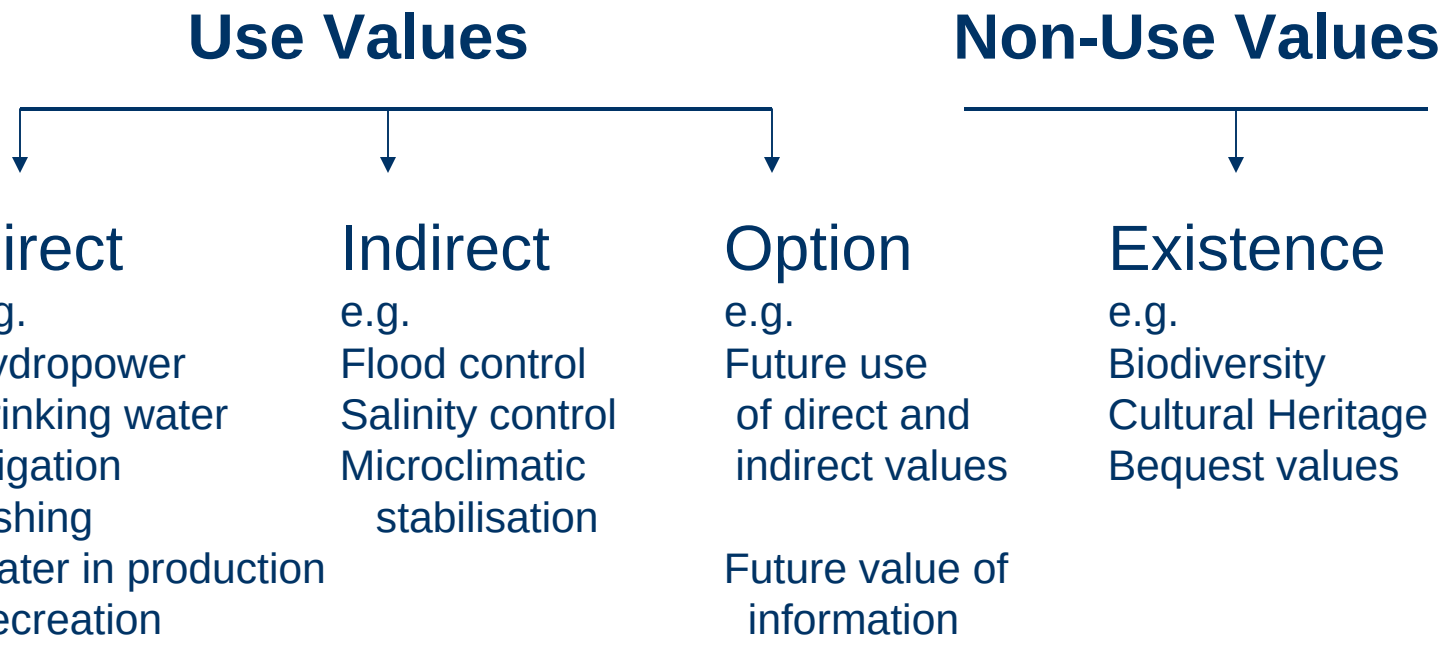
Need for economic efficiency and social equity in WRM over the long-term. Thus, need to incorporate full cost recovery of water services.



...A crucial component of Cost-Benefit Analysis

The Total Economic Value of Water

To estimate benefits, need to obtain the TEV of water resources. This is composed of:



Total Economic Value in the WFD

1- Characterisation of the groundwater basin

- Economic significance of water uses
- Trends in key indicators and drivers
- Dynamic path of demand and supply of water
- Gaps in water status by the agreed date of meeting ‘water balance’?

2- Assess current cost-recovery

- How much water services cost and who pays this cost?
- How much of this cost is recovered?
- Potential cost-recovery mechanisms

3- Identification of measures and economic impact

- Construction of a cost-effective programme of measures
- Cost-effectiveness of potential measures
- Financial & socio-economic implications of the programme of measures
- are costs disproportionate? → Derogations

Steps towards Estimating TEV

1. Identify Uses and Functions

2. Identify Stakeholders (Focus Groups)

3. Choose Appropriate Valuation Methodologies

4. Estimate Monetary Values of Uses

Valuation Methods and the TEV Components they can estimate

Revealed preference methods (indirect methods):

- Hedonic Pricing Method
- Travel Cost Method
- Averting Behaviour Method
- Residual Analysis (Production Cost Method)

Use Values

Stated preference methods (direct methods):

- Contingent Valuation Method
- Choice Experiment Method

Use & Non-Use Values (value of conservation)

Meta-Analysis Method

Methods not strictly based on economic welfare:

- Replacement Cost Methods
- Restoration Cost Methods

Hedonic Valuation Method (HVM)

If environmental resource is not traded in any market, because it is a public good, then no market price exists to reveal WTP. A resource can be defined in terms of services it yields or an `attribute' it embodies. This attribute may be embodied in other goods or assets which are marketed, and which do have observable prices. Using these prices you can derive economic value.

E.g: Farm prices in an area with good groundwater are most likely higher than in an area without either ground- or surface water. Comparing differences in farm prices across a region and controlling for other influences, then the difference in prices of these farms would lie in groundwater access.

Problems:

-Only capable of measuring the subset of use values that people are WTP for through the related market.

- If consumers are not fully informed about the qualities of the attributes being valued, hedonic price estimates are of little relevance.

Travel Cost Method (TCM)

Infers the value of a set of attributes from expenditure (time and money spent on the trip) on outdoor recreational facilities or visits to nature reserves.

E.g: Valuing the effects on the demand for recreation of a change in water quality in a river.

Problems:

- Capable of measuring the subset of values that people are WTP for.
- Very few applications outside resource-based recreational amenities.
- Data-intensive.
- What value should be assigned to time costs of travel?
- Statistical problems.

Averting Behavior Method (ABM)

Use of expenditures undertaken by households that are designated to offset an environmental risk, in order to infer WTP for avoiding environmental degradation.

E.g: Use of water filters.

Problems:

- Limited to cases where households spend money to offset environmental hazards.
- Insufficient studies to comment on convergent validity.

Residual Analysis Method (RAM)

Values all inputs for the good produced at their market price – except for the water itself. The remaining value of the good, after all other inputs are accounted for, is then attributed to the water input.

E.g: Valuing water as an input in production of different crops.

Problems:

- Only part of use-value of water can be captured.
- Market imperfections can bias valuation estimates.

Contingent Valuation Method (CVM)

CVM relies on a constructed, hypothetical market to produce monetary estimates of value. The value of an environmental resource to an individual is expressed as:

- Maximum Willingness-to-Pay (WTP)
- Minimum Willingness-to-Accept (WTA, Compensation)

E.g: Conduct survey to obtains peoples' bids (either WTP or WTAC) for a specified change in the quality of water in a river, contingent upon the description of a hypothetical market where water quality is traded.

Problems:

- Interviewing bias
- Strategic bias
- Hypothetical bias
- Non-response bias
- Yea-saying bias
- Information bias

Choice Experiment Method (CEM)

CEM is a survey-based technique which can estimate the total economic value of an environmental stock/flow or service and the value of its attributes, as well as the value of more complex changes in several attributes.

E.g: Each respondent is presented with a series of alternatives of the environmental stock/flow or service with varying levels of its price and non-price attributes and asked to choose their most preferred option in each set of alternatives.

Problems:

- Simplified version of reality … but CEM eliminates or minimises several of the CVM problems (e.g. strategic bias, yea-saying bias, embedding effects).

Operational at the policy level?

Question: How can these methods be made operational in the context of the development of groundwater management strategies at the **policy level**?

Answer: Recent years have seen a growing interest in the potential for producing generally applicable models for the valuation of non-market environmental goods and services, which do not rely upon expensive and time-consuming original survey work, but rather extrapolate results from previous studies of similar assets.

This approach is called **meta-analysis** for the use and non-use values generated by environmental resources.

Meta-Analysis Method (MAM)

Meta-analysis is the statistical analysis of the summary of findings of empirical studies: i.e. the statistical analysis of a large collection of results from individual studies for the purpose of integrating the findings.

E.g: Freshwater fishing meta-analysis of TC valuation studies (Sturtevant, 1995).

Meta-analytical research seems to have been principally triggered by:

- Increases in the available number of environmental valuation studies.
- Seemingly large differences in valuation outcomes as a result of use of different research designs.

Environmental Benefits-Transfer

- Transposing monetary environmental values estimated at one site (study site) to another (policy site).
- Values must be adjusted to reflect site specific features.
- When time or resources are limited, this provides an alternative to conducting a valuation study. Using meta-analysis for benefits transfer has advantages.

E.g: Environmental Valuation Reference Inventory (www.evri.ca)

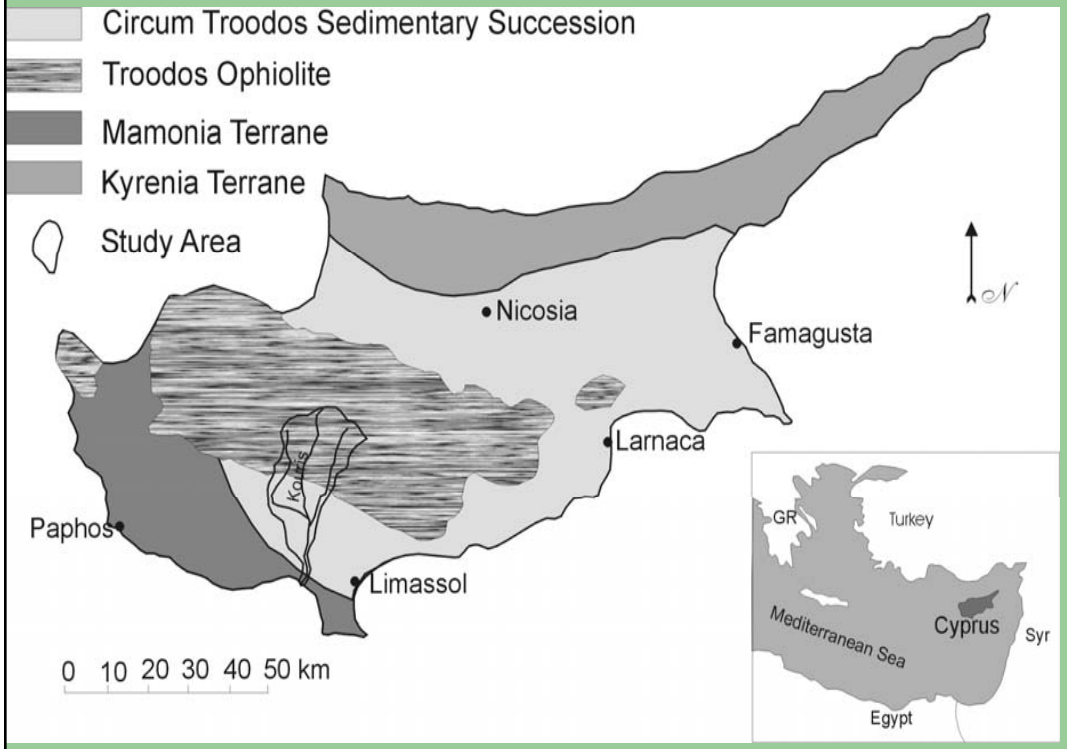
Problems

- May involve bias
- Validity and reliability issues

Applications to Water Resources

- Case Studies
  - Cyprus EU water management project
  - A Choice Experiment to Estimate the Non-Use Values of the Cheimaditida Wetland in Greece

The 'Cyprus' EU Project



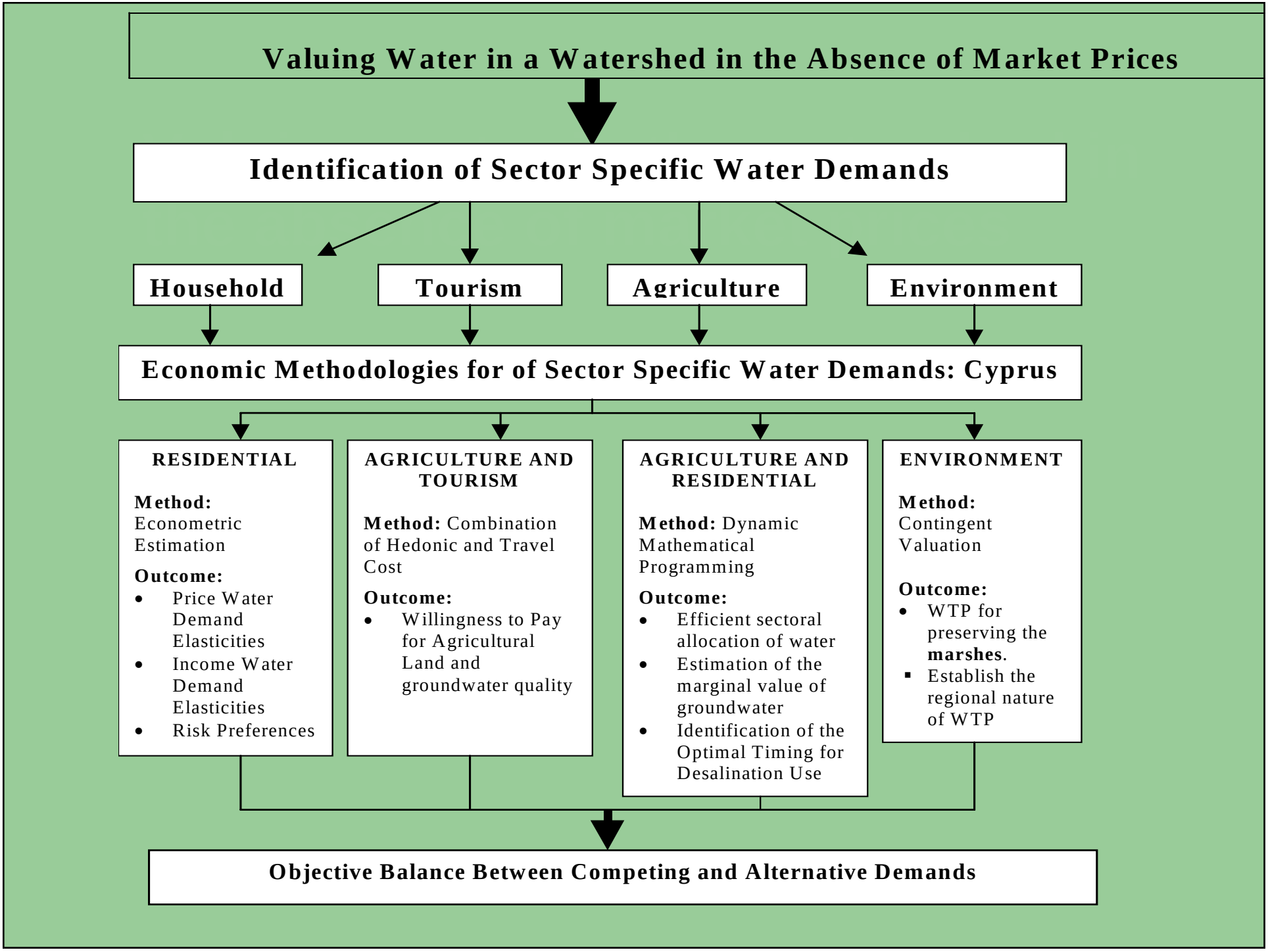
Water Supply	Water Demand
Surface Water	Household
Groundwater	Agriculture
Diversions	Tourism
Desalination	Environment
Reuse	

→ Water Deficit

Predicted Sectoral Growth (GDP: 6%)

- Tourism: 5-10% economic growth.
- Agriculture: 2.2% economic growth and expansion of government schemes
- Residential: 1% population growth

- The approach has been applied in Crete. (http://www.arid-research.net)
- It is now applied in France and Finland.


Valuing Water in a Watershed in the Absence of Market Prices
Identification of Sector Specific Water Demands
Household
Tourism
Agriculture
Environment
Economic Methodologies for of Sector Specific Water Demands: Cyprus
RESIDENTIAL
Method: Econometric Estimation
Outcome:
Price Water Demand Elasticities
Income Water Demand Elasticities
Risk Preferences
AGRICULTURE AND TOURISM
Method: Combination of Hedonic and Travel Cost
Outcome:
Willingness to Pay for Agricultural Land and groundwater quality
AGRICULTURE AND RESIDENTIAL
Method: Dynamic Mathematical Programming
Outcome:
Efficient sectoral allocation of water
Estimation of the marginal value of groundwater
Identification of the Optimal Timing for Desalination Use
ENVIRONMENT
Method: Contingent Valuation
Outcome:
WTP for preserving the marshes.
Establish the regional nature of WTP
Objective Balance Between Competing and Alternative Demands

Sector	PED (-)	IED	Marginal Value/ WTP	Risk Premium
Households	0.4-0.8 increasing in income	0.25-0.48 decreasing in income	£Cy0.45/m^3	-
Agricultural/ Quality	-	-	£Cy1.07/ ha	-
Agricultural/ Quantity	0.48	-	£Cy0.30/m^3	18%
Environmental	-		£15 per household per year for wetland preservation	-

Policy Recommendations:

- **Inter-sectoral allocation of groundwater should be based on the marginal value of the resource for each sector:**

Marginal value higher in residential sector than agricultural sector at current use levels.

Policy should be directed towards reducing the appropriation of water by agriculture.

- **Balance demands through efficient pricing:**

Groundwater: Include resource cost

Surface water: Long-run marginal cost (LRMC)

- **With limited supply, PED can guide pricing policy**

PED of water is higher for residential than for agriculture sector.

This means that larger increases in price required for a unit of agricultural demand reduction.

A Choice Experiment to estimate non-use values of the Cheimaditida wetland, Greece.

- Estimated non-use values of 4 wetland attributes:
  - Biodiversity (€15)
  - Open water surface area (€9)
  - Education and research extraction (€8)
  - Local Employment (€0.12 per person)

Can combine these non-use values with direct and indirect use values of the wetland to obtain TEV…

In general, sustainable management of water resources implies net benefits exceed net costs. Valuation methods are integral in determining whether this criterion is met.

For more information please visit www.arid-research.net

Thank you.