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The water framework directive in Greece. Estimating the environmental and resource cost in the water districts of Western and Central Macedonia: methods, results and proposals for water pricing

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Abstract

The EU, understanding the need for sustainable management of water resources, established a framework for community action in the field of water policy under the Water Framework Directive (2000/60/EC). Results reveal that an essential condition for sustainable water management is the understanding of its true value. Correct pricing of water helps to improve services for water distribution and also contributes to its preservation. Therefore, the aim of this paper is the presentation of the methods of calculating the environmental and resource cost, their application in a particular study area (Water Districts of Central and Western Macedonia, Greece) and the conclusions following from the estimations. After extensive literature review it was found that there is not a perfectly acceptable method of calculating the environmental and resource cost of water. What is more, the pricing of water use is necessary because water use requires actions having a direct economic cost, as well as 'external' costs to society such as the environmental and resource cost. Prices in a "justified" pricing model should reflect the recovery of full cost aiming at maximizing social welfare, preventing the exploitation of resources and securing access to water to the socially vulnerable members of society.

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1. Introduction

The Water Framework Directive (2000/60 EC) constitutes a legal document that sets a challenging task to the EU members. Its primary aim is to deliver good water status in EU Member States by 2015. Under the Water Framework Directive (WFD), every country member is obliged to prepare a River Basin Management Plan (RBMP) for each river basin lying in the state's territory. In addition, Article 5 requires an economic analysis of the water use in each Member State. The economic analysis should point out which pressures on water quality, originating from economic drivers, can impede the fulfillment of the target posed by the WFD. In addition, Article 9 demands the implementation of water pricing policies that enhance the sustainability of water resources and are based on the economic analysis of Article 5.Under the Integrated River Basin Management Plans of the Water Districts of Central Macedonia and Western Macedonia, the deliverables "Economic Analysis of Water Use and definition of the Cost Recovery Ratio of water services" and "Preliminary Proposals for Water Pricing in the Water Districts of Western and Central Macedonia" were published by the Special Secretariat for Water of the Ministry of Environment, Energy and Climate Change (MEEC) in Greece. Both deliverables were prepared with the contribution of the University Institute of Urban Environment and Human Resources, Panteion University, Athens, Greece. The main focus of the present paper is on presenting the methods, with which the environmental and resource cost in both Water Districts were estimated. It must be underlined that a realistic estimation of costs and more specifically of environmental and resource cost, contributes to the amelioration of water services and consequently to its conservation and sustainable use through the design of a suitable water pricing policy.

2. The Water Districts of Central and Western Macedonia

The Water District of Central Macedonia (WD10) has an area of 10.165 km^2, and includes the River Basins of Axios (GR03), Gallikos (GR04), Chalkidiki (GR05) and Athos (GR43).The Water District borders north with FYROM , while river run offs flow southeast of Thermaikos gulf and to the bays between the capes of the Chalkidiki peninsula . All River Basins are under the jurisdiction of the Regional Administration of Central Macedonia. Within the limits of the WD 10 the Regional Administration Units of Chalkidiki and Mount Athos, of Thessaloniki and Kilkis are situated, as well as parts of the Regional Administration Unit of Pella (33%) and Imathia (26%). Under national law, the Decentralized Administration of Macedonia - Thraki, Central Macedonia Water Directorate is responsible for the entire watershed of the WD10(Secretariat for Water- Ministry of Environment, Energy and Climate Change, 2012).

Extensive plains are situated mainly in the western part of the WD10 (Thessaloniki. Lagadas and Giannitsa) and the area is not considered as mountainous. The average altitude of WD10 is 245m, where 36% of its area has an altitude below 100 m and only 3 % of its area has an altitude of over 800 m. Only Mount Athos (2.033m) and Mount Kerkini (2.031m) have an altitude above 2.000 m. Its population, based on census data of the Hellenic Statistical Authority in 2001 was 1.356.509 inhabitants, while according to the provisional results of the 2011 census there is an increase of 1% (1.373.830 inhabitants) (Secretariat for Water- Ministry of Environment, Energy and Climate Change, 2012). The average annual rainfall ranges from 400 to 800 mm, while in the mountainous parts exceed 1.000 mm. Snowfall is quite common during the period September-April. The mean annual temperature ranges between 14.5 ° C and 17 ° C with the coldest month in January and warmest in July. The average annual total water supply to WD10, according to a study by the Ministry of Development (Ministry of Development, 2008), amounts to 5,3 x 10^9 m^3. 28% (1.5 x109 m^3) comes from own resources, while the rest 72% (3,8x10^9 m^3) comes from:

- the water inflow from the neighboring FYROM (3.3x109m^3 i.e. 87 %);
- the karst aquifer discharge of the Paiko Mountain that is extended beyond the boundaries of Central Macedonia (57x10^6m^{3}i.e.1,5%) and;
- the waters of the river Aliakmonas and more specifically the Aghia Barbara reservoir (about 446x10^6 m^3 i.e.12%).

The Water District of Western Macedonia (WD09) is located in the northwestern part of Greece and includes the River Basins of Prespes(GR01)and Aliakmonas (GR02). Its area is 13.624 km^2 and it is under the jurisdiction of the Administrative Region of Western Macedonia (65,2 %) and Central Macedonia (33,1%). The former belongs to the Decentralized Administration of Epirus - Western Macedonia and the latter to the Decentralized Administration of Macedonia - Thrace. Parts of the WD09 belong to the Administrative Regions of Epirus (0,4 %) and Thessaly (1,4 %). In addition, WD09 covers all twelve (12) municipalities of the Administrative Region of Western Macedonia, significant portion of nine (9) municipalities of the Administrative Region of Central Macedonia, part of one municipality of the Administrative Regions of Epirus and parts two municipalities of the Administrative Region of Thessaly) (Secretariat for Water- Ministry of Environment, Energy and Climate Change, 2012).

The area of WD09 is mostly mountainous as only 30% of the area of it is below 600m. Main feature is the existence of nine mountain peaks with an altitude of over 2,000 meters with the highest peak in Greece (Olympus Mitikas 2.917m). Apart from that, WD09 is characterized by the existence of two major mountain complexes. The first consists of the mountains Verno (2.128 m) , Askio (2.111 m) and Vourino (1.688 m) , while the second from the mountains north (2.524 m) , Vermio (2.052 m) and Pieria (2.180 m) . Between them the relatively plain areas of Kastoria , Florina , Ptolemais and Grevena are situated. In contrast, the eastern part of WD09 is dominated by the plains of Edessa, Naoussa, Veria and Pieria (Secretariat for Water- Ministry of Environment, Energy and Climate Change, 2012).

WD09's population, based on 2001 census data of the Hellenic Statistical Authority was 601.726 inhabitants, while according to the 2011 census, there is a decrease of 3,5% (581.410 inhabitants). The average annual rainfall ranges from 600 to 1.000 mm, while in the mountainous areas exceeds 1.200 mm. Snowfall is quite common during the period September - April. The mean annual temperature ranges between 14,5 and 17 ° C, with the coldest month in January and warmest in July. According to a study by the Ministry of Development (Ministry of Development, 2008), the average annual total water supply to the water district was estimated at 3.769 x 10^6 m^3, of which approximately 56,8 x 10^6 m^3 are transported underground from the WD09 to the WD10 through the karst system of Mountain Paiko.

3. Estimation methods of the Environmental and Resource Cost for the Water Districts of Central Macedonia and Western Macedonia

3.1. Estimation of the Environmental Cost

Environmental cost is defined as the valuation in monetary units of the environmental impacts for water resources and related ecosystems, caused by various socio-economic activities. The issue of economic valuation of environmental impacts does not have a direct and clear approach and this is why different estimation methodologies accompanied by corresponding restrictions have been proposed (Bithas, 2011). It is also important to note that the very relevance of the economic valuation of environmental pressures under certain conditions is often disputed (Bithas, 2011) and (Bromley, 1998). Nevertheless, monetization is still useful for internalizing the external costs of socioeconomic processes. This framework was followed to assess the pressures on aquatic ecosystems and resources of the Water Districts Central and Western Macedonia and its respective River Basins. Specific methodological frameworks have been proposed by the European authorities as well as by the National Monitoring Authority, the Special Secretariat for Water (WATECO – Working Group 2.6, 2003), (Working Group 2B- Drafting Group ECO2, 2004) or (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012]. The report of both Water Districts followed these standards and adapted them to the characteristics of the study area. More specifically, the selected method for the estimation of the environmental cost was that of the "avoidance cost" of the environmental impact/ pressure i.e. the "recovery cost" of the environmental impact that has already taken place. This method is clear on objective and can be directly applied. In addition, during the estimation of the environmental cost for both Water Districts a number of environmental pressures were observed, which could not be avoided or overcome. This is why it was attempted to estimate the environmental cost in those cases where avoidance or restoration was not feasible. Based on certain assumptions, those cases were correlated with other pressures that shared a number of common characteristics and avoidance and/or restoration was realizable. Such kind of approximation was carried out so as to avoid underestimation of such cases that would certainly lead to an inefficient policy proposal. However, there were cases where the definition of cost was almost impossible, as "cause – effect" relationships between anthropogenic pressures and impacts on ecosystems and their ecological status could not be established. Additionally, it was not clear which were those socio-economic activities that could affect the ecological status of a water resource. In that case, the costs caused by such activities are usually ignored and not calculated. Nevertheless, this inevitably leads to biased estimates and to an erroneous allocation of environmental costs. In the respective Water Districts the environmental cost caused by any economic activity in the River Basins was estimated, even if "cause and effect" relationships could be identified. The basic assumption was that any activity that affects water resources and ecosystems creates impact-pressure, the cost of which is approximately equal to the "avoidance cost. For those cases where the cost of avoiding or treating that pressure could not be efficiently estimated, the respective cost of the more closely related activity was adopted.

3.2. Estimation of the Environmental Cost: Methodological Approach

The assessment of the significant pressures on the water bodies of both Water Districts was based on the detailed recording of all anthropogenic pressures (pressures of pollution, effects of extract quantities of water from the aquatic system, changes in the morphology of the water system, etc.). The aim was to understand on the one hand, the major management problems for each River Basin and on the other hand the mechanism by which each water body is affected.

More specifically environmental cost was estimated for the following cases:

- Lack or inefficient operation of wastewater treatment plants;
- industrial water use;
- (point or non-point source) pollution from agricultural use and;
- pollution by stabled livestock.

More details are provided in Appendix A.

3.3. Estimation of the Resource Cost

Resource cost refers to the foregone benefits that are due either to the inefficient allocation of water resources or the excessive use of water resources, i.e. water withdrawals greater than the renewable water reserves. Consequently, the resource cost equals to the foregone benefits of the service that is deprived of the use of the particular natural resource, while under conditions of effective allocation this would have not have happened . It is true that in a number of cases this is the service that provides the highest socio-economic benefits (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012.) This is why the framework proposed by relevant European documents could be used so as to accurately estimate the context of resource cost in the respective Water Districts(WATECO – Working Group 2.6, 2003), (Working Group 2B- Drafting Group ECO2, 2004. Common Implementation Strategy, Assessment of Environmental and Resource Costs in the Water Framework Directive). In the case of the Water Districts of Central and Western Macedonia, resource cost is associated with the use of water at a greater level than the rate of their natural renewal. This means that water use deprives water stocks from the future and this is why it can be characterized as an intertemporal foregone benefit. In that way, the resource cost refers to the cost caused by the "excessive" use beyond the socioeconomic optimal level which is by convention identical to the level of the resource's renewal (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012.).

In accordance with the above mentioned assumptions, resource cost is "caused" by an institutional framework that dictates the hierarchy of uses as well as the basic allocation of the resource. The institutional framework is an administrative framework which sets clear priority to the use of water and intervenes, where necessary, to allocate resources. Also, this framework has no substantial relationship to the existence of a market for the natural resource, as the existing pricing mechanisms are determined administratively(Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

All in all, resource cost equals to the foregone benefits caused by a hypothetical restriction of water use to the water renewal rates. Those foregone benefits will be estimated by restricting the use that yields the smaller benefits. It is therefore assumed that water demand for all other uses that yield proportionally greater benefits is satisfied in priority(Bithas, 2008), (Briscoe, 1997), (Pearce, 1999).

3.4. Estimation of the Resource Cost: Methodological Approach

According to the study, existing resource cost is operationally assessed as an opportunity cost of the water resources deficit. Apart from that, the amount of water deficit is determined both spatially and temporally. Distinctive opportunity costs caused by the excessive use of water resources are associated with the gradual reduction of groundwater stocks in some areas, which creates a timeless rarity. Therefore, future withdrawals will be impossible to be satisfied as they have a drastically reduced underground water reserve at their disposal. Consequently, there is an opportunity cost equal to the benefits of future uses that could be met , given that such future uses could exploit water resources to a rate a least equal to the renewal rate of the aquifer, thus without reducing the corresponding stocks . The same goes for the current period, i.e. when water stocks are not reduced, no opportunity cost and therefore no cost resource exists(Special Secretariat for Water- Ministry of Environment and Climate Change, 2012) .

Firstly, so as to estimate the opportunity costs brought about by the reduction of groundwater stocks, it was assumed that future economic conditions are proportional to the current ones. Therefore, opportunity cost is considered as the cost of avoiding the creation of intertemporal rarity caused by the current socio-economic activities. In other words, the cost is equal to the current foregone benefits from the restriction of less economically efficient use. At that point, it should be noted that this restriction is imposed so as not to prevent the aquifer's apparent depletion (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

The operational assessment for both Water Districts was based on the hypothesis that the restriction of water use will be implemented in the agricultural water use in irrigated areas. Therefore, the cost equals to the foregone benefits of converting the respective areas of irrigated crops in rainfed ones (dry land farming). The size of the areas as well as the crops converted to rainfed is determined by the area that is hypothetically irrigated by the annual groundwater reserve deficit (exceeding the rate of water renewal)(Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

The water use that was responsible for the deficit of the groundwater reserves of the respective water body in both Water Districts was mainly the agricultural use (organized and private), household use, industrial and mining use and livestock use(s. Appendix B for more details). This fact confirms the primary assumption and estimation method presented above. Nevertheless, it should be noted that the main user of groundwater reserves is agriculture but not organized farming (under the local and regional Land Declaration Associations) but individual farmers that take water from drilling. For that reason and according to the "polluter –pays- principle", the estimated resource cost should be distributed accordingly to each user.More details are provided in Appendix B.

4. Water Pricing based on the Principle of Total Cost Recovery, including Environmental and Resource Cost.

Water prices should in any case reflect the total cost recovery so as three main objectives can be served:

- Use efficiency;
- Resource sustainability;
- Social equity/ justice.

However, since the calculation of the marginal cost is not feasible, the pricing approach is based on the average total cost. Any deviation from the values that reflect the full cost should be sufficiently and adequately explained. As modern scientific research demonstrates (Bithas, 2006) and (Bithas. 2008), inefficient water pricing leads to the deterioration of water scarcity, which causes a drastic increase in prices in the long term. Meanwhile, an inefficient water pricing that underestimates future demand jeopardizes the goal of sustainable management, mainly for securing the amounts of water needed for the smooth functioning of ecosystems(Special Secretariat for Water-

Ministry of Environment and Climate Change, 2012) and (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

Prices of each water use should reflect the total cost and this presupposes the inclusion of both environmental and resource cost. It is however important to note that in practice both environmental and resource cost cannot be reliably estimated despite the great number of proposed methodological frameworks (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012 and (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

Nevertheless, the inclusion of external costs such as environmental and resource cost does not ensure the effective protection (sustainable management) of the environmental goods and the resource per se. In other words, the inclusion of external cost is a necessary but not sufficient condition (Bithas, 2011). This is why the goal of sustainability should be realized through direct interventions such as control and the avoidance of environmental pressures. Even when anthropogenic pressures cannot be avoided, proposed management interventions based on the latest available technologies should be designed. Thus the pricing of externalities must be for the part of the environmental pressure that cannot be avoided (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

Similar interventions are applied to resource cost. More specifically, water scarcity should primarily be addressed through rational use and application of technologies and other water saving technologies. Only after those interventions are implemented, then the remaining excess demand must be submitted to internalize the resource cost (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012) and (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

The operational pricing schemes proposed by the study for the Special Secretariat for Water (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012) demand the internalization of external costs to the users that are responsible for that inflicted cost. The pricing of environmental and resource cost should relate to that entities that created them. In that way, users are urged to confront the pressures they are responsible for, so as to minimize the respective environmental and/or resource cost (Special Secretariat for Water- Ministry of Environment and Climate Change, 2012).

Conclusions

The purpose of this article was a detailed presentation of the estimation methods for the environmental and resource cost, their application in a particular study area (Central and Western Macedonia), through the implementation of the River Basin Management Plan on two Water Districts and the presentation of conclusions based on the calculations.

Water is a good of paramount biological importance for humans, not only for their subsistence, but because it constitutes one of the essential raw materials for primary production, such as agriculture and livestock and secondary production, such as industry. One of the major problems of modern water resources management is the scarcity and/or quality of resources. The European Union understanding the criticality of the issue of scarcity of water resources, and having a basic guideline to sustainable management , proceeded in establishing a framework for Community action in the field of water policy or the WFD. Through an extensive literature research and analysis of estimations methods for the environmental and resource cost of water, it became clear that there is not only one acceptable way of calculation. It was found, however, that the efficient water pricing helps to improve water distribution services as well as to contribute to its preservation/ sustainable management.

The cost of water results from the distribution of the resource to different uses, i.e. exploiting scarce resources available to the society. In addition, the disposal of water resources to different uses means that:

- the water ceases to be a “free natural commodity”;
- it is a “normally produced good» and;
- is of paramount biological and economic importance.

This results in line with the above mentioned conclusions that water pricing is necessary because the use of water is demanded in activities that have:

- direct cost i.e. cost savings , such as energy costs , labor costs , management costs , transport costs , etc. , and;

- emerging “external " costs to society such as environmental costs and resource costs.

However, a "just" water pricing scheme should be designed and should primarily aim at maximizing the benefits enjoyed by society (Maximizing Social Welfare) by using water, taking into consideration the income distribution in society. For this reason the prices, i.e. part of the "right" water pricing should reflect the full cost so as to:

- To limit excess water use and avoid wasting resources that aggravates the future scarcity
- To ensure a “just” allocation among users
- To ensure access to water for the "economically weak" members of society.

By estimating both environmental and resource cost for Water Districts of Central and Western Macedonia, it was blatant that a redesigning water pricing scheme is necessary. The water pricing scheme should be based on the following three pillars:

- Total cost recovery;
- Sustainable use of the water resources and;
- Social equity.

A basic precondition for achieving the above mentioned pillars is the complete and clear documentation of all cost categories. Both environmental and resource cost should be estimated with an economically realistic approach before these can be charged to the user.

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Appendix A. Methodology for the estimation of the Environmental Cost in Water Districts of Central and Western Macedonia

A.1. Lack/ inefficient operation of wastewater treatment plants

For the estimation of the environmental cost, emanating from the lack or inefficient operation of wastewater treatment plants, it was firstly identified which specific municipalities were affected by it. After locating the municipalities, two sub- categories were identified

- Municipalities, where a the installation of a wastewater treatment plant, along with the construction of a sewage system, was necessary and;
- Municipalities, where there exists a wastewater treatment plant, but lack the necessary infrastructure (sewage system).

For both cases, the methodology derived from a 2009 study of the MEEC, based on actual data relating to the construction of wastewater treatment facilities in Greece, that were financed under the Hellenic National Strategic Reference Framework.

As far as the **capital costs** are concerned, these were calculated as follows:

Construction of the sewage system (for areas with a population density less than 70 inhabitants/ hectare)

$$L = 2.75D + 60.58$$

where,

L, the necessary length of the sewage system in mm/hectare and;

D, population density in inhabitants/hectare.

For areas with a population density greater than 70 inhabitants/ hectare, L equals to 250mm/ hectare. Finally, the capital cost (in €) for the construction of the sewage system equals to:

$$CC_{sewage} = 250L$$

Construction of a wastewater treatment facility
The capital cost (in €) was based on the following equation:

$$CC_{wastewater} = 5000P^{0.7}$$

where P, the population served by the wastewater treatment plant in inhabitants.
In relation to the operational and maintenance cost (OEM) it was assumed that:

- for sewage system, it equals to 1.5% of the capital cost, with an estimated useful life of 50 years and a depreciation rate of 2% and;
- for the wastewater treatment facility, the OEM equals to 2% of the capital cost, with an estimated useful life of 50 years and a depreciation rate of 2%.

A.2. Industrial water use

It was assumed that the environmental cost caused by the use of water in industries equals to the cost of building facilities treating industrial wastewater. More specifically, the annual cost of treating wastewater from industrial use was based on the equation:

$$\lambda = 1.03Q^{-0.3}$$

where
λ, the cost per m^3 in €/ m^3
Q, the daily water inflow in m^3

A.3. (point and non-point) pollution from agricultural use

A challenging task was the estimation of the pollution from agricultural use. It was assumed that the environmental cost of point pollution equals to the creation of a constructed wetland and amounts to €1.3 /acre/year or €0,003/m^3. Concerning the environmental cost of non-point pollution in areas that there is no drainage system, this amounts to €0.65 /acre/year (half of the environmental cost of point source pollution).

A.4. Pollution from stabled livestock

For that specific category, an identical approach with that of the industrial water use was followed. For WD10 the results can be summarized in table 1.

Table 1: Environmental cost categories in the respective River Basins of the Water District of Central Macedonia (WD 10)

Environmental Cost Categories	AXIOS	GALLIKOS	CHALKIDIKI	ATHOS	WD 10
Lack/ Inefficient Operation of Wastewater Treatment Plants	3.971.524 €	1.297.069 €	13.427.716 €	0 €	18.696.309 €
Point Source Pollution from Agricultural Use	1.177.248 €	17.732 €	14.443 €	0 €	1.209.423 €
Non- Point Source Pollution from Agricultural Use	374.768 €	32.397 €	187.255 €	0 €	594.420 €
Industrial Water Use	776.725 €	532.959 €	476.513 €	0 €	1.786.197 €
Pollution by stabled Livestock	269.122 €	65.302 €	340.100 €	0 €	674.524 €
Total Environmental Cost	6.569.387 €	1.945.459 €	14.446.027 €	0 €	22.960.873 €

And for WD09 the results are presented in Table 2.

Table 2: Environmental cost categories in the respective River Basins of the Water District of Western Macedonia (WD 09)

Environmental Cost Categories	ALIAKMONAS	PRESPES	WD 09
Lack/ Inefficient Operation of Wastewater Treatment Plants	12.902.829 €	886.238 €	13.789.066 €
Point Source Pollution from Agricultural Use	441.844 €	82.159 €	524.003 €
Non- Point Source Pollution from Agricultural Use	231.634 €	113.395 €	345.029 €
Industrial Water Use	709.054 €	112.906 €	821.960 €
Pollution by Stabled Livestock	1.109.013 €	6.845 €	1.115.858 €
Total Environmental Cost	15.394.374 €	1.201.543 €	16.595.916 €

Appendix B. Methodology for the estimation of the Resource Cost in Water Districts of Central and Western Macedonia

Table 3: Estimation of the Resource Cost in the Water District of Central Macedonia (WD 10)

	Crops	Area (in acres)	Mean production (in Kg/acres)	Total production in tn	Unit cost (€/Kg)	Total value in €	Cultivation conversion cost in €
Irrigated	Grapevine	146.338	2.000	292.675	0,34	99.509.797 €	
Rainfed	Grapevine	146.338	800	117070	0,34	39.803.919 €	59.705.878 €
Irrigated	Nuts	146.338	500	73.169	1,7	124.387.246 €	
Rainfed	Nuts	146.338	450	65852	1,7	111.948.522 €	12.438.725 €
Irrigated	Beans	146.338	250	36.584	1,50	54.876.726 €	
Rainfed	Beans	146.338	150	21.950	1,5	32.926.036 €	21.950.691 €

Table 4: Estimation of the Resource Cost in the Water District of Western Macedonia (WD 09)

	Crops	Area (in acres).	Mean production (in Kg/acres)	Total production in tn	Unit cost (€/Kg)	Total value in €	Cultivation conversion cost in €
Irrigated	Grapevine	61.294	2.000	122.588	0,34	41.679.920 €	
Rainfed	Grapevine	61.294	800	49035	0,34	16.671.968 €	25.007.952 €
Irrigated	Nuts	61.294	500	30.647	1,7	52.099.900 €	
Rainfed	Nuts	61.294	450	27582	1,7	46.889.910 €	5.209.990 €
Irrigated	Beans	61.294	250	15.323	1,50	22.985.250 €	
Rainfed	Beans	61.294	150	9.194	1,5	13.791.150 €	9.194.100 €

Table 5: Unit Cost (Resource Cost) of water uses and contribution (in %) of each water use to the Resource Cost in the Water District of Central Macedonia (WD10)

	Irrigation (Land Declaration Associations)	Irrigation (Private)	Household	Industrial	Mining	Livestock	Water Drilling	Total
Unit Cost (resource cost) per use	0,001 €	0,05 €	0,01 €	0,002 €	0,001 €	0,001 €	0,001 €	0,06 €
Resource Cost percentage per use	1%	80%	12%	4%	1%	1%	1%	100%

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