Valuation of the External Cost Caused by the Environmental Pollution of Three Lakes in Northern Greece

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Abstract: The preservation/restoration of natural environment is usually entailing high cost mostly paid by citizens through taxes. The effect of these taxes is double. The direct effect is the obvious additional income for the State, and the indirect effect is an additional income for the citizen, due to increasing tourism. Since the evaluation of this good cannot be in market terms, authors apply a modified CVM (Contingent Valuation Method), which is part of Experimental Economics, in order to find out the order of concern that people have about natural environment. Authors also, try to investigate their WTP (Willingness To Pay) for supporting activities for preservation/restoration of three lakes in Northern Greece, in particular, lake of Ioannina, lake of Florina and lake of Kastoria. For the purpose of this research, authors use parametric and non-parametric approaches, as well as Linear Regression and Logic Models.

Keywords: Valuation method, CVM, natural environment, WTP, Logit Model, linear regression, parametric and non-parametric approaches.

1. Introduction

Wetlands—and especially lakes—are the most productive ecosystems in the world. They support plenty of ecological activities and important natural habitats. These ecological activities translate strictly into economic functions and services such as flood protection, water supply, improved water quality, commercial and recreational fishing and hunting [1]. Although, it is a common knowledge that the multiple role of wetlands is usually biased towards the economics benefit from commercial use and exploitation. Usually, the natural benefits of wetlands are underestimated and the order of exploitation is so high that leads to the extensive degradation [2]. Despite the uncertainty in total area of wetlands around the world, there are some figures indicating the importance of the problem. In Europe, 50% to 60% of wetlands have been lost in past century due to the

human intervention, while the United States has lost 54% of its original wetlands [3]. The accelerated rate of wetlands loss was a great alarm for many countries and scientists around the world to take care of the situation. In 1971, more than 100 countries created the Ramsar Convention of Wetlands of International Importance, providing the first step for a greater international cooperation about the protection and the "wise use" of wetlands and their resources [4]. A increasing number of valuation studies on environmental sector contribute evidence about the importance of wetlands. Literatures provide a variety of studies which include many valuation methods, such as CVM (Contingent Valuation Method), replacement value method etc. [3], use 39 wetlands valuation studies to create a meta-analysis using CV method [4], also created a meta-analysis of 30 Contingent Valuation applications. A few years later [5], made a meta-analysis using 190 wetlands valuation studies [6].

Despite the fact that there is a great international scientific concern about the restoration and protection

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of wetlands, in Greece, there are only a few studies. In literature, it is used CVM to evaluate stakeholders' preferences among four possible hypothetical scenarios for a wetland in Lesvos Island [7, 8]. Another CV research estimates the use values of ecological functions of Zazari-Cheimadidita wetland. In present study, authors are using CVM to valuate three wetlands in Greece. In particular, authors are investigating the WTP (Willingness To Pay) of local citizens to preservation/restoration of three lakes in Northern Greece, lake of Ioannina (lake Pamvotida), lake of Kastoria (lake Orestiada) and lake of Florina (lake Cheimaditida). This research is organized in five sections. The first section is the introduction and previous relative works. In Section 2, authos present some information about each lake, which leads us to this research. In Section 3, authors present the data and the empirical analysis of the research. Last but not least, in Section 4 there are the conclusions, while the bibliography takes place in Section 5.

2. Knowing the Lakes

2.1 Lake of Florina (Lake Cheimaditida)

Cheimaditida is a lake of northern Greece, located 40 km south of the prefecture of Florina. It is one of the lakes formed among the mountains of Verno, Voras, Askio and Vermio. Among these mountains there are some more wetlands, like Lake Vegoritida, Lake Zazari etc.. Cheimaditida's surface is around 10.8 square km, its maximum length is 6.3 km and it is located in an altitude of 593 m. Its average depth is 1 meter and the maximum is 2.5 m. The water quality of Lake Cheimaditida is affected by household waste of the adjacent nine communities. Apart from this pollution, the quality of lake water is affected by livestock waste animals which are breeding around. However, the critical pollution factor is the excessive use of fertilizers and pesticides in crops, which end up in lake through ground dismantling. The level of Lake Cheimaditida has been dramatically reduced in recent

decades, mainly due to irrigation, with adverse effects on the flora and fauna of the area. The Greek Biotope-Wetlands Center investigated the concern of local citizens (farmers, fishermen and local authorities) about the problem. The results declared the willingness of the citizens to pay for the restoration of the lake.

2.2 Lake of Kastoria (Lake Orestiada)

Lake of Kastoria, Orestiada, is located in Western Macedonia in western part of Kastoria Prefecture, northeast, east and southeast of the town of Kastoria and between the mountains of Verno, Aschi, Korissos and Vigla. Orestiada's surface is around 28 square km and located in an altitude of 630 m. Orestiada's average depth is around 3.5 meters and the maximum depth is 9.5 meters. The coast length is about 31 km. The water of the lake comes mainly from streams. In the area, there are nine streams leading to the lake. The largest of these is the stream of Xiropotamos. In addition to streams, rain water and snowfall, Lake Orestiada is also fed by many lush springs. Orestiada is an urban lake with intense human activity over the last decades, due to the threat of ecological balance of the area which is polluted by urban waste water, sewage effluents, fertilizers and solid waste. In Orestiada, the eutrophication phenomenon is intense, with all its negative effects on the quality of its water. The water of the lake, as the ultimate recipient of all natural processes, as well as the human activities, is constantly receiving loads of nutrients and other components and, in particular, phosphorus charges. According to results of a study which took place in lake of Kastoria [5], when the lake freezes almost every year, there is a decrease in oxygen and in the summer an increase in pollution due to agricultural activities.

2.3 Lake of Ioannina (Lake Pamvotida)

Lake of Ioannina (Lake Pamvotida) is located in the north-western part of Greece at an altitude of 470 meters above the sea level and is perhaps one of the

rare cases, where a lake has been connected so much to the history and like of a city, Ioannina. The lake is 7.5 km long, 1.5-5 km wide, has average depth 4-5 meters, maximum depth 11 meters and surface around 22.8 square km. It is surrounded by the Mitsikeli and Tomaros mountains and it is formed by water of three main springs. The drainage of the water takes place through the Lapista ditch and flows from the river Kalamas. The pollution of the natural environment of Lake Pamvotida and mainly of the lake's water derives from human activities related to the city of Ioannina, small and large communities and residential areas located around, as well as the industrial output. The main source of pollution of the lake is urban and industrial waste water, as well as the waste of a large number of poultry farms, pig farms and cheese dairies in the area, many of which are illegal. Around 75% of the output of these farms is transferred indirectly to the lake resulting a crucial pollution to the water.

3. Data and Empirical Results

3.1 Data

In order to investigate the WTP of the citizens around each lake, authors took three random samples from each town (Ioannina, Florina and Kastoria) and authors asked them to complete some questionnaires. Authors took 60 questionnaires from citizens of Florina, 90 questionnaires from citizens of Ioannina and 80 questionnaires from citizens of Kastoria. The main question authors asked on each interviewee is the amount of money that he/she is willing to pay per month in order to restore the lake of his/her town. Authors also asked their opinion about the lake and their living distance from the lake. A list of variables which were tested is the following.

3.2 Empirical Results

In the first part of the analysis authors present some descriptive statistics about citizens' willing to pay in each town. In Table 1, it is the list of variables. In Table 2, it is presented the descriptive statistics for WTP.

On the one hand, descriptive statistics provide evidence that citizens of Kastoria are willing to pay more for the restoration of the lake. On the other hand, citizens of Ioannina are willing to pay far less for the restoration of their lake.

Table 1   List of variables.

X_1 :	Visiting the lake
X_2 :	Way of information about the lake condition
X_3 :	Ecological condition of the lake
X_4 :	Main problem of the lake
X_5 :	Reason of the ecological problem
X_6 :	Authorities' concern about the lake
X_7 :	Membership of an ecological organization
X_8 :	Local authorities participation every 100 euro
X_9 :	People participation every 100 euro
X_{10} :	What do you wish to be done?
X_{11} :	WTP for the restoration
X_{12} :	Willingness to pay for the restoration if you were living next to the lake (WTP1)
X_{13} :	What do you want to restore first?
X_{14} :	Amount of money that you would accept in order not to restore the lake Willingness to Pay (WTA)
X_{15} :	Industries
X_{16} :	Gender
X_{17} :	Age
X_{18} :	Living
X_{19} :	Heritage close to the lake
X_{20} :	Working around the lake

Table 1 to be continued

X_{21}:	Distance from the lake
X_{22}:	Working condition
X_{23}:	Work relative to the lake
X_{24}:	Marital status
X_{25}:	Members of the family
X_{26}:	Education level
X_{27}:	Income according to citizen in Northern Greece
X_{28}:	Income according to citizen of the town

Table 2 Descriptive statistic for WTP of the citizens of each town.

	Mean	Standard deviation	Range	Min	Max
Ioannina	1.99	0.772			
Kastoria	13.16	11.221	50		
Florina	8.22	12.356	50		

Table 3 Linear regression model for each lake.

Town	Linear Regression Model
Ioannina	$X_{11} = 0.195 * X_4 + 0.349 * X_6 - 0.174 * X_{10} - 0.595 * X_{12}$
Kastoria	$X_{11} = 1.164 - 0.279 * X_9 + 0.82 * X_{12} - 0.147 * X_{14} - 0.173 * X_{19} + 0.113 * X_{28}$
Florina	$X_{11} = 0.743 + 0.222 * X_7 - 0.322 * X_9 + 0.581 * X_{12} - 0.174 * X_{19}$

Table 4 ANOVA for every model of each town.

Town	Model	Sum of squares	Df	Mean square	F statistic	Sig
	Regression	36.408	19	1.916	19.851	
Kastoria	Residual	5.792	60	0.097		
	Total	42.200	79			
	Regression	39.670	25	1.587	7.625	
Ioannina	Residual	13.319	64	0.208		
	Total	52.989	89			
	Regression	39.421	19	2.075	4.762	
Florina	Residual	17.429	40	0.436		
	Total	56.850	59			

In the next part of the analysis, authors estimate a linear regression model with dependent variable $X1_1$ (WTP). One of the main supposes of linear regression is the absence of multi-collinearity between the independent variables. In order to examine the existence or absence of multi-collinearity authors estimate a VIF (Variance Inflation Factor) test in SPSS. From this test, authors observe that $X1_7$ and $X2_2$ have VIF-value higher than the other values. In order to solve this problem, authors choose to exclude $X1_7$ from the model. Then authors estimate the linear model with remain variables for each lake and the results can be observed in Table 3.

The coefficients which were not statistically significant are excluded from the models.

Coefficients were examined in 5% level of significance.

Table 3 provides evidence that only few variables can affect the WTP of the local citizens. Some variables were found statistical significant in every model and some variables only in one model. This happens because every area in Greece has its own particularities.

In the next step of the analysis, authors made a variance analysis (ANOVA) of each model, in order to examine if there is a good adaptation of the

Table 5 Logit model fitting information.

Town	Model	-2 Log Likelihood	Chi-square	Df	Sig
Kastoria	Intercept Only	175.04			
	Final	0.000	175.049	19	
Ioannina	Intercept Only	199.351			
	Final	76.177	123.174	24	
Florina	Intercept Only	152.153			
	Final	78.925	73.228	19	

Table 6 Logit estimation result.

Town	Variable affect WTP (sign)
Kastoria	$X_{12}(+), X_{13}(+), X_{14}(-), X_{19}(+)$
Ioannina	$X_1(-), X_4(+), X_6(+), X_{10}(-), X_{12}(+), X_{15}(+)$
Florina	$X_{10}(-), X_{13}(+), X_{24}(-)$

theoretical model. The results of each model are presented in Table 4.

As it is observed in the last column of Table 4, the *p*-value of *F*-statistic in each model is lower than 0.05, which means that all models have good adaptation to the theoretical model. This is powerful evidence that our research is steady and our results are valid.

In the last step of analysis is the estimation of a logit model for every model (one for each lake). First authors estimate the fitting of each model by the logit fitting information test, the results of which are presented in Table 5.

As it is observed in the last column of the Table 5, the fit of the models is statistically significant while the *p*-value of all three tests is lower than 0.05, which means that the results of the logit estimation will be valid.

In Table 6, authors can see the results of the logit model (authors show only the statistically significant variables).

According to Table 6, authors can say for example for Kastoria, that if the citizens live next to the lake $(X)_{12}$, the possibility to pay is higher, while the same possibility is also higher if the citizens have heritage next to the lake $(X)_{19}$. On the other hand, the possibility to pay is lower if a good amount of money is offered to them in order to ignore the degradation of the lake $(X)_{14}$. Similar results are excluded for every town.

4. Conclusions

According to the results of the empirical analysis, author can separate the conclusion in three different sections, each for every lake. About the lake of Kastoria (Orestiada), author found that the citizens are able to play higher amount of money for the restoration of the lake, while they believe that the protection of the lake is a crucial subject. The same WTP is increased if the citizen lives close to the lake, if the amount of money that would get as compensation is decreased, if he/she has heritage next to the lake and if his/her income is higher than the average of the local community.

About the lake of Ioannina (Pamvotida), author found that a citizen's WTP is increased if he/she visits the lake very often, if he/she believes that the appearance of the lake is awful, if he/she thinks that the local authorities are not able to take care of the problem and if he/she lives close to the lake.

Finally, about the lake of Florina (Cheimaditida), authors also found that a citizen's volition to pay for the preservation/restoration of the lake is increased, while the ecological condition of the lake is really bad. The same WTP is also increased if the citizen lives close to the lake and if the citizen is married.

According to the results above, authors cannot ignore the fact that those three important wetlands of Greece are degraded. Citizens who live next to those lakes declare to pay higher in order to restore the lake. This is evidence about the condition around these lakes. It is important to mention that there are different parameters that affect the citizens' WTP in every town. This is a normal fact because of the very different situation and living conditions in every town resulting in different requirements of local people. Last but not least, is the social dimension which appears in Florina, because if the citizen who declares "married", is willing to pay higher in order to restore the lake. It is probably a future concern because he/she wants his/her children to grow up in more healthy and beautiful environment. This study is about three big wetlands of Greece. It should be a part of a greater project about environmental protection which has to be supported by every single citizen and all authorities because the environmental pollution may lead to the human extinction.

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