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Evaluation of Farmers' Willingness to Pay for Water under Shortages: a case study of Harran Plain, Turkey

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Abstract: The aim of this research is to evaluate farmers' willingness to pay (WTP) for irrigation water under shortages in the Harran Plain, the biggest area of GAP Project, Turkey and explore the potential factors that contribute to it. The data come from a sample of 21,094 farmers in the Harran Plain, 471 of them were chosen via simple random sampling method and interviewed face to face. The contingent valuation, probit and maximum likelihood methods were used for analysis. The result**s** indicate**d** that the average WTP is more than 85.19%, means that 2.23 fold of current price at surveyed time in case of shortages. Explanatory factors, such as secondary school, high school and university graduates from education levels, farmers residing in Harran, modern irrigation systems users, age and household numbers are increasing and pumping irrigation users and proposed increased water prices are decreasing WTP. This research is one of the first studies on this issue in GAP Region-Turkey. The results are important for decision makers and contain useful information about value of water in case of water shortages by farmers' side.

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1. Introduction

There are increasing demands and pressures on natural resources, because of population growth rate, urbanization, industrialization, agricultural irrigations and global warming in many parts of the world. Water use has been growing at more than twice of population increase in the last century. Water scarcity is among the main problems to be faced by many societies. Around 1.2 billion people live in areas of physical water scarcity; 500 million people are approaching this situation and another 1.6 billion people face economic water shortage (UNDP, 2006; FAO, 2007). The agricultural sector has a significant place in the economy of many countries and uses about 70% of global water consumption (UNESCO-WWAP, 2003). Drought and climate change are predicted to make the existing problems worse in many regions (Farmer et al., 2008). Agricultural drought usually occurs after meteorological drought and may cause severe reductions in agricultural yield. It is clear that Turkey will be at a higher risk of droughts in the near future (Kurnaz, 2014; Ocal et al., 2014). The unexpected climatic conditions along with uncontrolled human activities can increase stress on water supplies, especially in Southeastern Anatolia (Türkeş, 1999).

The economically irrigateable land in Turkey is 8.5 million ha due to technical and economic reasons by water resources. Southeastern Anatolian Project (GAP, Turkish acronym) is a multi-sectorial regional sustainable development projects that is mainly based on soil and water resources. The GAP's scope is to eliminate regional disparities among the other regions and increase living standards of people. There are 22 dams, 19 hydroelectric power plants and 1.822 million ha of irrigation land (GAP, 2012). The region has a continental climate, water management and its shortages are an important issue.

Harran Plain, the study field, has 150,000 ha of land at Southeastern part of Turkey and irrigation began in 1995 within the scope of GAP (DSI, 2013). Average precipitation is between 300-365 and annual evaporation is 1,848 mm. (DMİ, 2011). The number of drought years was 26 that are near normal to

exceptionally dry based on 35 years from 1975 to 2009 according to Standardized Precipitation Index (Yapar and Ağraz, 2012). This research is aimed to determine the WTP of farmers under water shortages for agricultural irrigations. This is one of the first studies on this issue in GAP-Turkey.

2. Materials and Methods

The material of this research comes from a sample of 21,094 farmers in the Harran Plain who were chosen via a simple random sampling method. Surveys were conducted by the authors and the pollsters that were trained about such a survey. Study was aimed to determine the farmer's WTP under water shortages for agricultural irrigations, because of expecting shortages due to expanding irrigation areas and climate changes in future. There are 22 Water User Associations (WUAs) in the plain. The farmers were interviewed face to face by given questionnaires in irrigation season of 2011. The validity of data was observed until 2015 by seasonal field visit and interviewed with the farmers. The sample volume was determined by using the formula of Yamane (2006) with a 95% confidence interval and 471 questionnaires were conducted. Within this scope, all the WAUs in the Harran Plain were visited.

The contingent valuation method (CVM), an effective method that treats natural resources as production and consumption goods as demand, was used in this study. Maximum Likelihood Method (MLM) is estimating the parameters that maximize the likelihood function of a sample with the help of the values. One of the Limited Dependent Variable (LDV) models, called as the probit model, is a type of regression where the dependent variable can only take two values, yes is classified as 1 and no is 0 in model. The model is a type of binary classification and a popular specification for ordinal or binary response model. The probit model, which employs a probit link function, is most often estimated using the standard MLM procedure (Maddala, 1983; Gujarati, 1995, 2006; Greene, 2003; Anonymous, 2015). A particular theoretical market is formed based on question was asked regarding safe water availability against shortages and lastly acceptance of payments. The payment amount is randomly selected, starting increasingly with 5% and multiples of 5% to 100% of existing water fee. Thus, the demands of farmers are determined. The unit value is obtained from a face to face interview and then it is multiplied by a population factor. The value function is estimated and the values of WTP are calculated at the end.

The independent variables are selected based on economic and the socio-cultural structure of the region. Each dependent variable has a certain value from initial value of the event if the respondent says yes to the offered amount. If the value exceeds the amount, the respondent will say yes to the offered amount, otherwise the respondent will say no (Maddala, 1983; Gujarati, 1995; Gujarati, 2006; Greene, 2003). The econometric model is established and analyses are performed by using the Limited Dependent package program. The effects and WTP are measured, and statistically significant effects are interpreted.

3. Results and Discussion

Questionnaires were filled by male farmers and 94.5% of them are married with average 7 people in house hold. 35% of farmers were residing in Harran, 25% in Akcakale and 40% in Central District. The education level of farmers were 13% literate, graduation levels were 48% primary school, 17% secondary school, 16% high school and 6% from university. Average farming experience was more than 21 years. The total cultivated land was 7,660 ha and the average land size was 14.8 ha in the surveyed area. 11.5% of lands were located in the pumping irrigation area, and 17% of them using modern irrigation systems. Cotton was the main crop followed by wheat and corn. The farmers' average income was calculated as 37,326 Turkish Lira (TL)/year and 2517.7 TL/ha. The average water fee was 136.7 TL/ha. Farmers have been paying 5.43% of their net income per ha for irrigation as a water charge.

Before proceeding to discussion of the results, a comparison of the probability values resulting from the model and the actual values are given in table 1. The actual and WTP values are almost 2 and 2.23 folds of current price at surveyed time, respectively. The difference between the predicted values and actual values is quite low.

Table 1. The comparison of actual value to the estimated and WTP values of the model (TL)

Model	Actual Value (Probability)	Actual Value	Estimated Value (Probability)	Estimated Value	WTP Value (Probability)	WTP Value
Probit	0.6030 (%)	26.32	0.6229 (%)	26.65	0.8519	30.41
t value	26.44		25.58		22.93	

Table 2. The coefficients and the values of the probit model

Variables	Coefficient	t-value	p-value	95% Confidence Level	
				Lower Limit	Upper Limit
CONSTANT	-0.013	-0.02	0.988	-1.684	1.657
PRIMARY	0.276	1.20	0.229	-0.174	0.727
SECONDARY	0.475[a]	1.71	0.087	-0.068	1.019
HIGHSCHOOL	0.630[b]	2.24	0.025	0.078	1.182
UNIVERSITY	1.146[c]	3.30	0.001	0.465	1.827
HARRAN	0.324[a]	1.91	0.056	-0.009	0.656
AKCAKALE	0.131	0.68	0.497	-0.247	0.509
MDRNIRR	0.637[c]	3.45	0.001	0.275	1.000
GRAVITY	-0.298	-1.26	0.209	-0.763	0.167
PUMPING	-0.520[a]	-1.92	0.055	-1.051	0.012
AGE	0.015[b]	2.03	0.043	0.001	0.029
HOUSEHOLD	0.079[c]	3.07	0.002	0.029	0.130
PRICE	-1.981[c]	-6.76	0.000	-2.556	-1.406

[a,b,c] orderly indicates the degree of statistical significance of 10%, 5% and 1%.

The model is estimated actual value with an error margin of 1.99% and successful in terms of outcome prediction. Another research conducted in Harran Plain and results indicated that farmers have WTP 71.69% more than the existing price under certain conditions for irrigation water (Aydogdu, 2016). The affecting factors of the WTP, the coefficients and the values of the parameters that obtained from the model are given in table 2 where price is dependent variable.

Statistically significant results are given and have been interpreted according to the outcome of the model. There is a positive correlation between education level and WTP. When the education level is increasing, WTP is also increasing. Educated farmers are more sensitive about water shortages. Their expectations and living standards are higher than the uneducated or less educated ones. In case of the welfare loss of based on water shortages will affect them more than the others. These results are statistically significant for secondary school graduated ($p \leq 10\%$), for high school graduated ($p \leq 5\%$) and for university graduated farmers ($p \leq 1\%$).

There is a positive correlation between Harran residing farmers and WTP. Agriculture was done in dry farming conditions in Harran before irrigation. Majority of farmers and their families that was around 72% were seasonally migrated to the other regions for working because of low agricultural incomes. This result is statistically significant ($p \leq 10\%$). On the other hand, it is observed that the agricultural value added was increased by 2.7 fold in crop production, because of irrigation in Harran. Irrigated agriculture has an affect of 3 to 7 fold increase in income as compared to dry farming depending on the season and drought (GAP, 2015).

There is a positive correlation between modern irrigation users and WTP. Modern irrigation systems were generally using by the farmers who have water based problems such as shortages or soil salinity in the plain. There will be shortages in water amount for irrigation in case of drought and climate change. The water table level is high due to furrow irrigations; this causes the salinity in the soil due to high evaporation rates. The Imambakir WUA has an area of 7,464 ha, and is located in the lowest altitude of the plain**.** Intensive salt affected lands are observed due to excessive irrigation and resulted to significant yield losses (Aydogdu et al., 2014a; Cullu et al., 2010). Salt stress affects plant growth and productivity during all developmental stages (Abari et al., 2011). Salinity has led to a 1,841 tons yield loss of cotton; the resulting income lost was $935,711 in 2009 in Akcakale (Aydogdu et al., 2014b). Mismanagement of irrigation network is resulted to drainage problems and irrigation return flows water is used for irrigation in lower part of the plain where there is water shortages at peak irrigation period (Yenigun and Aydogdu, 2010). It is a must to use water more efficiently in terms of environmental and ecological aspects, too. This result is statistically significant ($p \leq 1\%$).

There is a negative correlation between pumping irrigation users and WTP. These farmers will have less negative effect in terms of rainfall distribution or existing of enough water in the irrigation canals as compare to the ones who uses gravity irrigations in short term. These farmers are using underground water and will use more for irrigations in the absence of adequate rainfall or water for irrigations. So their welfare losses will be less as compared to other farmers. This result is statistically significant

(p≤10%). On the other hand, these farmers will also be affected from shortages in long term. There is a positive correlation between age and WTP. When the age is increasing, WTP is increasing too. The shortages and scarcity perceptions of the elderly ones are different than the younger ones. Particularly poverty caused by water shortages were experienced previously by elderly ones before irrigation was started under the GAP. This resulted to increasing WTP of elderly ones. It is statistically significant (p≤5%).

There is a positive correlation between household numbers and WTP. Income losses based on water shortages will be felt more negatively in the crowded families. There is a direct relationship between the number of dependent family members and income. On the other hand, household members are used as a workmanship in agricultural activities, too. So, the problems will be more severe based on income both from agriculture and unemployment. This result is statistically significant (p≤1%). The proposed percentage increase in price will cause to the rise in the price of irrigation water that means more expenditures to farmers. There is a negative correlation between farmers' acceptances of higher prices to WTP. Welfare loss will be experienced due to the water shortages. Thus, increased price will deepen this loss of their welfare and farmers are unwilling to pay more, and there is reluctance in this regard. This result is statistically significant (p≤1%).

The marginal impacts of factors affecting the probability of WTP based on water shortages were given in table 3. The unitary effects of statistically significant variables which are located at table 3 that have been brought changes at probability of maximum WTP have been analyzed. One unit change has an impact effect on secondary school graduates with 14.6% in education levels. This impact is 18.9% on high school graduates and 30.1% on university graduates in a positive way. These results are indicated that there is a direct correlation between education level and water shortages. Educated farmers are aware of water effects on yield, income and prosperity. A unit impact on university graduates, creating more than double effect on secondary school graduates. When education levels are increasing, perceptions about water shortage is increasing too. One unit had brought effects on farmers in Harran by 10.4% of increased WTP. Harran receives almost lowest rainfall in GAP Region and main source of income is agricultural activities (Aydogdu *et al.*, 2015a). A unit had brought effects on modern irrigation user farmers by 19.7% of increased WTP. Modern irrigations are used by more educated farmers and also who have water restrictions for efficient use of water.

A unit had brought effects on pumping irrigation user farmers by 17.4% of decreased WTP. These farmers are located towards to the end of canal at downstream and use underground waters for irrigation because of lack of enough water in canals especially in peak irrigation season. Therefore, there will not be significant changes in irrigation water amount and income losses in short term because of water shortages in canals and results to unwillingness to pay more under such a condition. A unit of change had brought effects on farmer's age by almost 1% of increased WTP. It is normal for age-related increase in the WTP, but the rate has occurred less than expected. This could be explained by a lower education level in the older ages and conservative structure of the region that is people's belief about perception of water scarcity.

Table 3. Measuring marginal impact of factors affecting the probability of WTP.

Variables	Coefficient	t-value	p-value	95% Confidence Level	
				Lower Limit	Upper Limit
PRIMARY	0.089	1.23	0.219	-0.053	0.230
SECONDARY	0.146[a]	1.88	0.061	-0.007	0.298
HIGHSCHOOL	0.189[b]	2.55	0.011	0.044	0.335
UNIVERSITY	0.301[c]	4.84	0.000	0.179	0.423
HARRAN	0.104[a]	1.97	0.049	0.000	0.207
AKCAKALE	0.042	0.69	0.491	-0.078	0.162
MDRNIRR	0.197[c]	3.82	0.000	0.096	0.299
GRAVITY	-0.094	-1.31	0.191	-0.236	0.047
PUMPING	-0.174[a]	-1.93	0.054	-0.351	0.003
AGE	0.005[b]	2.06	0.040	0.000	0.009
HOUSEHOLD	0.026[c]	3.17	0.002	0.010	0.042
PRICE	-0.645[c]	-7.95	0.000	-0.804	-0.486

[a,b,c] orderly indicates the degree of statistical significance of 10%, 5% and 1% .

One unit had brought effects on household numbers by 2.6% of increased WTP. This is an expected result, but the rate was below then expectations. This can be explained by household members could be considered as a manpower to non-agricultural activities for additional income.

A unit of change has impact on the farmers WTP by 64.5% in negative way, because of proposed higher rate water fee due to water shortages. So, it has effect on farmer's unwillingness to pay up to 65%. It is consistent with expectations; because of the water scarcity agricultural income loss will be experienced. Therefore, due to the increase in water prices would affect more of farmers' prosperity. So, the occurrence of unwillingness is normal in this regard.

The index value is created as a combination of variables; impact on the WTP is indicated by the normal and cumulative probability distribution functions. The index is estimated value of the linear model; the probability refers to the changes occurring in the WTP. It has been observed that an occurrence of increase in the index resulted to increase in cumulative WTP and decreased in probability of WTP. So, existence of variables in index such as secondary, high school and university graduates from education level, Harran residing farmers, modern irrigation systems users, and age and household numbers were resulting to increase in WTP. On the other hand pumping irrigation users and proposed increased water fees have a negative effect in WTP and resulted to decrease in WTP, too.

4. Conclusion

This study showed that WTP is increasing by 2 and more folds in case of water shortages. It means economic and ecologic values of water are known by farmers. Farmers are aware that it is not possible to get a significant income from farming without irrigation and also water shortages means poverty. Natural resources are not unlimited resources under increasing demands. Public awareness must be established about sustainable usage and protection of water resources. Water management is an important issue and 61.65% of stakeholders have negative opinion about adequacy and consistency of investment and management decisions in Harran Plain. These results include guidance information about water perceptions among the farmers in case of shortages and willingness to pay for water. And results could be used for pricing policy by decision-makers and policy-makers for Turkey and other countries with similar technical and socio-cultural characteristics.

List of abbreviations:
WUA: Water User Association
DSI: The State Hydraulic Works
GAP: The Southeastern Anatolia Project
CVM: Contingent Valuation Method
MLM: Maximum Likelihood Method
WTP: Willingness to Pay
LDV: Limited Dependent Variables

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