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Estimation of Economic Value of Social Participation in Water Pollution Control in the South of Tehran

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ABSTRACT

Throughout the year, a huge volume of the surface running water as well as sewage flow down into the plantations of the south of Tehran which can have detrimental hygienic and environmental impacts. In this study, people's views and their willingness to pay for participation in reduction of water pollution in the south of Tehran are investigated by use of Contingent Valuation Method (CVM). The results show that the residents of Tehran incline to pay 860 milliard Rials annually for the sewage filtration, the management of its use, and consequently the decrease in hygienic and environmental damages. According to these results, the most important characteristic of the products irrigated with treated sewage is their hygiene and healthiness. The results showed that, based on the priorities of the citizens, treated sewage in the first stage should be used in irrigating the green spaces then in indirect edible products such as forage and wheat and at a later stages it can also be used as a source of drinking water for animals and irrigating crops such as tomatoes and leafy vegetables.

1. Introduction

In the new trends, water is not a disposable commodity and its reusing is necessary. Although the use of sewage in agriculture is considered as a new and secure source of supplying water, its application without planning can result in economic and environmental consequences that, compensating many of which, at least in the short term, is not possible. Pollution of the surface and ground water and disease outbreaks are clear examples of these consequences. Among the positive effects of the use of sewage in agriculture, reducing the pressure on water resources and reducing the cost of water supply can be mentioned (Heidarzadeh and Shirzad, 2009). In many cases, the supply of water for agriculture requires exorbitant costs for water transfer, construction of dams and perverted waterworks or pumping water from deep underground, while for the sewage, the sewage refineries are in the surface of the ground and due to the approximate stability of its flow, there is no need to restrain it by dams.

Looking at the state of progress of the construction of networks and sewage refineries in the capital of Iran in comparison with other countries' capitals reflects the fact that Tehran has the lowest status of implementation and exploit of the networks and sewage refineries in the region (Majidi and Yamini, 2009). According to the latest data provided by Tehran province Water and Sewage Company, only 1.28 percent of the urban population of Tehran province is covered by sewage collection systems. This suggests that large volumes of sewage in Tehran are entering in an unplanned way to the natural resources and the environment (Water Infrastructure of Tehran, 2012).

In Tehran, the numbers of factories equipped with proper sewage refinery are very limited and industries mainly drain their sewage without refinement or with inadequate refinement. Since each cubic meter of unrefined sewage can infect about 50 cubic meters of water, if no basic action would be done about control (collection, refinement and reuse) of the industrial sewage, the water potential of the country will be seriously threatened.

South of Tehran province has 78 thousands hectares of agricultural land that a part of the land is irrigated with raw sewage (Ostandari Tehran, 2012). 70% of Tehran sewage part of which sent to the south of the city is domestic and non-industrial which with clean river waters of the heights of capital, they enter into the south area. However, the industrial sewage has a great role in polluting the waters of the south of Tehran. The amount of lead in surface water and sewage entering into Tehran's south are up to 400 times more than the normal standards (Water Infrastructure of Tehran, 2012) . The results of the studies on organizing surface waters of the south of Tehran show that in a 30-years period, the total amount of water of northern branches of Tehran watercourses equals to 141 million cubic meters per year as it increases up to increases up to 372 million cubic

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meters per year at the end of the city and the beginning of the farmlands of the south of Tehran, and after using it in agricultural land, a stream about 190 million cubic meters exits from the Sharif Abad station. In other words, nearly three-quarters of the surface waters leading to the south of Tehran are the results of water consumption in the city of Tehran (equivalent to 231/4 million cubic meters per year) and a volume equivalent to 182/3 million cubic meters per year of surface water is exploited by farmlands of the south of Tehran (MYEC, 2011). In 2005, the Environmental Protection Agency took samples and tested the three main watercourses of Tehran: Sorkhehesar, Madavard and kan. The results indicated that the most concentration of pollutants is in the south-east of Tehran (Varamin city) and the south-east of Rey. The region between Rey and Varamin is exposed to a variety of pollutants due to the convergence of watercourses in this area. This issue causes transporting all the pollutants of Tehran into this area.

Due to proximity to Tehran, Plain of Varamin has a special place in the agricultural sector. Surface water resources provide 40% of the water used in the agricultural sector of this plain. Farmers' reliance on groundwater in this area has led to a decline in groundwater levels (Heidarian, 2009). Studies show that the groundwater level in Varamin aquifer during 1385-1375, has dropped between 13/7 m to15/6 m, and the annual drop of water reservoir of Varamin plain is 141/72 million m^3. Based on the FAO examinations, Varamin plain has about 70 thousands hectares of lands suitable for agriculture that only 50 thousands hectares of it have been canalized, but based on the amount of water for irrigation only 35 thousands hectares are arable and usable. However, with the implementation of the project of utilizing Tehran's refined sewage for irrigating of the fields, the whole 50 thousands hectares of canalized land will be cultivated (FAO, 1999). In Rey city, 3,000 hectares of agricultural lands are without irrigation network and they are provided with resources such as raw sewage for irrigation of agricultural products (Ostandari Tehran, 2012). Also, about 380 hectares of agricultural lands and vegetable plantations of Rey are irrigated by sewage of Firozabad creek which is the most important sewage canal of Tehran (Water Infrastructure of Tehran, 2012). The reason why water shortage is always the main concern of the farmers of this region is the geographical condition of the region. In recent years due to the policies and civil projects, the agricultural water resources of the region have severely been affected, and a large number of wells and aqueducts were dried, so this issue has contributed to the usage of sewage in agriculture of this region.

Poor quality of irrigation water can have negative side effects on soil quality, agricultural products, public health, merchantability reduction and public acceptance of the crops. Therefore, this study attempted to identify the extent of public participation in control of environmental and health effects of the use of raw sewage, sewage refinement and management of refined or treated sewage usage in the south of Tehran and factors affecting it. Social participation includes a variety of individual team actions in order to interfere in determination of destiny of their own and community and influence processes of the making decision about public affairs. Participation can be done at two levels: mental participation dimension which is the tendency to social participation, and social and behavioral dimension of social participation which occurs as the membership, monitoring implementation and decision-making (Azkia and Gafari, 2002). Social participation can be defined at different levels including: the share of community in health projects, water supply, forestry, natural resources, and infrastructure that have preset goals (Mousavi, 2005; Bishop and Heberlein ,1979).

2. Research Methodology

In order to achieve the objectives of the research, the Contingent Valuation Method (CVM) was used. CVM is a measurement method which measures the peoples' preference for public goods (such as recreation areas or environmental services, police services, etc.) or studies the feasibility of non-produced goods (Mitchell and Carson, 1989; Weldesilassie, Frör, Boelee, and Dabbert, 2009). Public goods are not exchanged in the market and this means that people's preferences for these goods cannot be expressed by the price data and the market value. A hypothetical scenario is defined in CVM. This scenario is a hypothetical market created through a public survey of people who are affected by that public good. This hypothetical scenario (hypothetical market) provides a basis for establishing exchange in a situation such as real market. Through using this method, Alebel et al (2009), Abu Ali and Carlsson (2004), Barton (2002), Birol (2009), Birol et al. (2008) and (2010), Jones et al. (2007), Tsagarakis (2005), Tziakis et al. (2009) and Weldesilassie (2008) estimated the value of willingness to pay for sewage refinement (Abou-Ali and Carlsson, 2004; Carson and Haneman, 2005).

CVM valuates the Willingness to Pay (WTP) or Willingness to Accept (WTA) for the created changes in goods and public services directly from questioning people. In fact, the purpose of this method is extraction of preferences and individual tastes as the monetary components for making changes in the quality and quantity of the public goods and services. Assuming that q is a non-market good and x is a vector of a market good, then the function of the direct utility of consumer is: $u(x,q)$. Proportional to this direct utility function, the indirect utility function can also be defined: $v(p,q,y)$ in which p is the vector of market goods price and y shows the consumer income. Since there is no determined price for non-market goods, the amount of their monetary cost is replaced by the quantity amount of this good (Boyle et al., 1996).

The basis of contingent valuation is on valuating the created changes in the quality or quantity of q good. Assuming that the amount of non-market good changes from q *to* q and this change results in improving the condition, then: $u^1 > u^0$, If the change leads to worsening the situation then: $u^1 < u^0$, but if this change does not make any difference in situation, it is: $u^1 = u^0$,. In theory, according to Hicksian criteria, such changes in utility can be expressed as the monetary components. These criteria

include: Compensating Variation (CV) and Equivalent Variation (EV), as they can be expressed as follows (Boyle et al., 1996).

$$v(p,q^1,y-C)=v(p,q^0,y)$$
$$v(p,q^1,y)=v(p,q^0,y+E) \quad (1)$$
$$sign(C)=sign(E)=sign(u^1-u^0)$$

If the change in the quantity or quality of non-market goods leads to an improvement, then we will have: $E > O$ and $C > O$. In this case, C shows the consumers maximum willingness to pay in order to achieve this change, and E shows the consumers least willingness to accept for not making this change, and vice versa. Assuming that $y = m(p,q,u)$ is the cost function, through using this cost function CV and EV can also be written as follows:

$$C=m(p,q^0,u^0)-m(p,q^1,u^1)=y-m(p,q^1,u^1) \quad (2)$$
$$E=m(p,q^0,u^1)-m(p,q^1,u^1)=m(p,q^0,u^1)-Y$$

This relationship can also be shown as the integral of shadow price function of non-market goods for individual, as following: (3)

$$C=\int_{q^0}^{q^1}\pi_h(p,q,u_h^0)dq \quad (3)$$

However, since the shadow price function ($\pi(p,q,u) = -\partial m(p,q,u)/\partial q$) is not visible, utility changes caused by changes in the level of public goods, can be achieved with asking questions about a person's willingness to pay for this change (Carson and Haneman, 2005). One way to question about a person's willingness to pay for this change is discrete Dichotomous Choice- Double Bounded (DC-DB) (Hanemann, 1984). In CVM, the responder faces two offers that the level of second offer is conditional on the person's response to the first offer. If the person answers "No" to the first offer (which is shown with$B$), the second offer value is less ($B_l < B$), but if she/he responds positively to the first offer, the second offer values greater than the first offer ($B_u > B$). So there will be four possible consequences. Suppose that the respondent's willingness to pay isY_i^*. This value is not visible because the consumer answers only "yes or no" to the offer. Thus on this basis, the probability of replies can be expressed as follows (Carson and Haneman, 2005):

$$\Pr\{Yes/Yes\}\equiv\pi^{yy}(B_i,B_{iu})=1-G(B_{iu};\theta)$$
$$\Pr\{Yes/No\}\equiv\pi^{yn}(B_i,B_{iu})=G(B_{iu};\theta)-G(B_i;\theta) \quad (4)$$
$$\Pr\{No/Yes\}\equiv\pi^{ny}(B_i,B_{il})=G(B_i;\theta)-G(B_{il};\theta)$$
$$\Pr\{No/No\}\equiv\pi^{nn}(B_i,B_{il})=G(B_{il};\theta)$$

Where $G(B_i;\theta)$ is the cumulative probability distribution (eg, normal or logistic) of the offer with θ parameter's vector. Supposing a sample of responsive N, the likelihood log function for the respondents in dichotomous CVM is written as follows:

$$LnL(\theta)=\sum_{i=1}^{N}\begin{Bmatrix}d_i^{yy}\ln[1-G(B_{iu};\theta)]+d_i^{yy}\ln\\ [G(B_{iu};\theta)-G(B_i;\theta)]+d_i^{ny}\ln\\ [G(B_i;\theta)-G(B_{il};\theta)]+d_i^{nn}\ln G(B_{il};\theta)\end{Bmatrix} \quad (5)$$

Likelihood maximum estimates for the dichotomous model ($\hat{\theta}$) can be achieved by solving the first condition ($\frac{\partial \ln L(\hat{\theta})}{\partial \theta}=0$) (Mitchell and Carson, 1989). The function of willingness to pay according to the econometric model data is based on the following formula:

$$WTP=WTP(Bid,Z,\varepsilon) \quad (6)$$

In this equation, ε is random sentence with zero mean, *Bid* is the suggested value for willingness to pay and Z shows other explanatory variables. With assuming a linear functional form for the WTP, WTP mean is defined as following:

$$\hat{\mu}=-\left(\hat{\alpha}+\bar{X}\hat{\beta}'\right)/\hat{\beta}_0 \quad (7)$$

Where β_0 is the coefficient of the proposed amount. Because the dependent variable in equation (6) is as one and zero and the dual dichotomous questionnaire normal distribution was used, the Logit model was used to estimate the willingness to pay. The population of the study doesn't belong to the people with a special class, age, education, income and job; it belongs to the people at all levels and classes. Therefore, the study population includes all the residents of Tehran, Rey and Varamin whose population size is unlimited. So to determine the sample size the unlimited sampling formula was used as it is shown:

$$n=\frac{\left(Z_{\frac{\alpha}{2}}\right)^2\times pq}{\varepsilon^2} \quad (8)$$

Where Z is the standardized variable value in the unit corresponding to the confidence level, p is the estimate of evident variable attribute in population, q is the estimate of non-evident variable attribute population, and ε is the value of permissive error in measuring variable observations in population. Since participating or not participating of other members of population cannot be determined, 50 percent was considered for p and q parameters. The Z value was considered 1/96 and ε was 5%. Therefore, the sample size was obtained 384 that according to the proportion of the population in different regions, the sample required in Varamin was 25, Rey 13 and Tehran 346. In order to increase the accuracy of the study, 450 questionnaires were completed and out of which 414 questionnaires were finally analyzed. All the results were obtained through using STATA and SPSS software.

3. Results of the Study

In the beginning of the questionnaire some information about the water crisis and situation of the studied area were presented. Then, in order to solve the problem of farmers' unprincipled use of raw sewage and its environmental

consequences in the south of Tehran, need for refinement center, management and research about the huge amount of sewage in Tehran was presented and the respondents were asked about their willingness to financial contribution which reflects how much people value solving the problems and helping to preserve the environment and health of south of Tehran. To study the psychological effects of the word type used for water source, two types of questionnaires including 316 sewage questionnaires and 98 recycled water inventory questionnaires were used. Demographic and economic characteristics of the studied sample are shown in Table 1. For ethics variable a question was asked with this content that if protection of water resources is the moral duty of every person. In this regard, if the person wishes to pay by a sense of duty towards water resources, she/he has moral or deontological tendencies, and if this payment is intended to benefit from water resources, the individual has consequentialist tendencies. Variable of water shortage crisis indicates the views of people about the seriousness of water and water shortage issue. Variable of strategy of wastewater usage demonstrates the people's view about using the treated sewage in order to protect water resources of the country. Trust in government programs' variable is provided in this way that the trustee of recruitment and use of the money paid by the members is a government organ, so this variable is indicates the members' attitudes toward efficient and targeted use of the collected money. In Table (2) the features of the irrigated crops by the refined sewage from perspective of the consumers were ranked through Friedman test which accordingly the feature of health and wellness of the product has the highest priority and the smell characteristic of the product has the lowest priority. Also, in this table, the priorities of the use of treated sewage are presented from the perspective of consumers. The results indicate that the consumers gave the highest rank to the irrigation of landscape irrigated by treated sewage and they placed the lowest rank for irrigation of the direct feedstuffs such as tomatoes and leafy vegetables.

Table 1. Characteristics and fluctuation of demographic and economic variables of the sample

Variable	Variable type	Mean	Standard deviation
Age (years)	Discrete	37.64	8.07
The number of family members	Discrete	3.51	1.02
Education (years)	Discrete	13.30	3.80
Income (Rial)	Discrete	14720290	8549275
Information update	Ranking	2.78	1.24
Ethics	Ranking	3.33	1.39
Water shortage crisis	Ranking	3.34	1.27
Sewage using strategy	Ranking	3.28	1.34
Confidence in government programs	Ranking	3.02	1.34

Source: research findings

Table 2. Ranking the features of the products under irrigation and the priority of using the refined sewage

Product's features	Ranking	Type of using treated sewage	Ranking
Product's health	1	Landscape irrigation	1
Product's quality	2	Used for animal drinking	2
Product's taste	3	Indirect edible products irrigation	3
Product's price	4	direct edible products irrigation	4
Product's smell	5		

Source: research findings

To determine the amount of willingness to pay, preliminary sampling was used. In this sampling the people were asked that according to their financial constraints and the other socio-economic limitations, when they pay the water bill, if they have any tendency to pay a tax amount every two months for participation in construction and operation of a sewage refinement center in Tehran. In accordance with the statistical and scientific methods10,000, 20,000 and 40,000 Rials were obtained among the expressed amounts, and these amounts in the original questionnaires were entered as the offer variable to ask about people's willingness to pay. The results of Logit model estimates for willingness to pay (3) with z-statistic and significance level of each variable are shown in Table (3). The proposed amount has a negative effect on willingness to pay and indicates that when the amount of tax increases, the willingness to pay will be reduced. Income and education are the positive variables in people's willingness to pay. The results showed that the increase of confidence in the government's programs, solution of the use of sewage to reduce the pressure on water resources, the importance of the water crisis and the word type used (recycled water instead of sewage) have a positive effect on the individuals' willingness to pay. Based on the test's maximum likelihood and significance level of its statistics, it can be stated that the variables presented in the model have been able to significantly explain the dependent variable. The prediction accuracy rate of the model is 73/31, in other words it can be said that in three quarters of cases, the explanatory variables could correctly predict the dependent variable.

In order to derive better results of the estimated model, the final effects and stretch of each of the independent variables

should be calculated. Based on the results of Table (4) when income and family size increase 1%, the probability of willingness to pay will be increased 0/12 percent and reduced 0/18 percent, respectively. Such an interpretation can also be provided for the other variables.

Using equation (9), by substituting the means of other variables and calculating the value of adjusted intercept, the expected willingness to pay monthly per household was calculated. The expected value of the willingness to pay of the studied sample is 38450 Rials. According to the number of households living in Tehran including 3732190 households, the total financial contribution of the residents of Tehran can be obtained as 143 516 593 410 Rials.

Table 3. The results of Logit model of willingness to pay

Variable's name	The estimated value	Z statistics	The significance level
The proposed amount	–0.0009477	-9.03	0.000
Income	0.000000253	2.29	0.022
Family	-0.138	-1.60	0.110
Education	0.056	2.43	0.015
Gender	0.115	0.66	0.507
Age	-0.030	-2.85	0.004
Information update	0.231	3.16	0.002
Water shortage crisis	0.240	3.15	0.002
Ethics	0.489	6.54	0.000
Solution of sewage use	0.276	3.75	0.000
Confidence in government programs	0.257	3.76	0.000
Word	0.861	3.61	0.000
Tehran residents	0.114	0.49	0.628
Intercept	-1.684	-2.24	0.025
McFadden's R2	% 20.7	Log likelihood	-429.55
McKelvey and Zavoina's R2	% 36.3	χ^2	224.02
Count R2	%73.3	level of significance	0.000
McFadden's Adj R2	%18.1	Percentage of accuracy of forecasting	%73.31

Source: research findings

Table 4. The estimate of final effect of Logit model of willingness to pay

Variable's name	Stretch in mean	Final effect
The proposed amount	-0.7818	–0.000165
Income	0.1207	0.0000000442
Family	-0.1865	-0.0240
Education	0.2573	0.0098
Gender	0.0170	0.0201
Age	-0.5273	-0.0053
Information update	0.2143	0.0402
Water shortage crisis	0.2566	0.0428
Ethics	0.5069	0.0851
Solution of sewage use	0.2830	0.0480
Confidence in government programs	0.2498	0.0447
Word	0.0385	0.1498
Tehran residents	0.0349	0.0197

Source: research findings

4. Conclusion

To study the social participation of Tehran residents in pollution control of waters in south of Tehran, the contingent valuation method was used. The most important variables in attraction of social participation are the amount of payment and moralistic view of the individual towards reducing pollution and protecting the environment and health of south of Tehran. Providing information about the existing problems, the water crisis and reduction strategies such as using treated sewage based on the existing standards were among the important variables affecting this study. Also, confidence in the transparency of behavior of the center for public participation absorption was other important variable affecting willingness to pay. With the increase in each of the above variables, the participation amount based on its final stretch will increase. Therefore, planning to improve these factors can be an effective step in reducing water pollution in south of Tehran and healthy agricultural development and improving marketability of products presented in Tehran market. The average amount of individuals' willingness to pay is obtained 38,450 Rials bimonthly as it is added to their cost price of water. Therefore the amount of 861,016 million Rials public participation will be ensured annually for commissioning, research and management of sewage refineries. The results indicate that people are concerned about the characteristics of the health of agricultural crops irrigated with treated sewage and there is need to revise the standards for sewage refinement and using World Health Organization criteria in treating such water resources. The results also showed that, the treated sewage should be used in this order of priority: first, for the irrigation of green spaces, irrigation of indirect edible products (such as forage and animals' drink), then for the irrigation of direct edible products (such as tomatoes and leafy vegetables).

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