

**PEOPLE'S WILLINGNESS TO PAY TO IMPROVE  
AGRICULTURAL IRRIGATION WATER SUPPLY SYSTEM: A  
CASE OF AP BAC IRRIGATION SYSTEM, HANOI**

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**Abstact:**

*The study uses the random iterative assessment method to investigate, the regression analysis method to analyze, the research results show that the average percentage of people who agree to pay to use agricultural water 60% of the total population of the district. Investment in improving agricultural water supply services to people is facing many difficulties because of the limited state budget, inadequate policies, and many damaged works. To implement the "socialization" of agricultural water services, the study estimated people's willingness to pay for the use and improvement of agricultural water services in Dong Anh, Hanoi. The research results are the basis for the development of recommendations for effective agricultural water management and are suitable to local conditions.*

**Keywords:** *Willingness to pay, service improvement, agricultural water.*

**1. Introduction**

Water pollution occurs when some components or properties of water exceed a certain threshold, making the water unusable for a certain purpose. Olaniran (1995) defines water pollution as the presence of too many hazards (contaminants) in water so that it is not suitable for drinking, bathing, cooking, or other purposes other use. The willingness to pay to improve the environment depends entirely on the ownership of resources and the environment. When the environment is polluted, the owner has no right to stay in the waste area or in the case of land and water resources as common ownership, public goods.

Therefore, everyone who suffers damage from pollution wants to improve the quality of the environment in order to have a better production and living process.

In fact, environmental pollution is the cause of many diseases in the world. Investing in improved sanitation has proven to be effective and brings many benefits to human health and the community. A study was conducted in Kim Bang district, Ha Nam province on people's willingness to pay for the construction of a wastewater treatment system. The research results show that the median average of households willing to spend to build a wastewater treatment system is 1,813,800 VND, accounting for 4% of the annual income of households. The study also shows that the total willingness to spend to build the wastewater treatment system of the people is over 3.18 billion VND. In addition, factors such as a high level of education, dissatisfaction with the current wastewater treatment system, good household economy, increasing age, number of people in the household are factors that increase willingness to pay for the construction of wastewater treatment system. Men have a higher willingness to pay than women and those with occupations other than agriculture also have a higher willingness to pay (Nguyen Hoang Thanh et al., 2012).

To research the willingness to pay of the people to improve the agricultural irrigation water supply system in Ap Bac irrigation system is of great significance in helping the agricultural water supply service activities to have appropriate development orientations. Thereby satisfying the needs of most of the population, contributing to promoting the city's socio-economic development quickly and sustainably.

## **2. Method**

### ***2.1. Data collection methods***

To have an overview and overall data about the research area as well as the research problem, the author has collected secondary data in 3 aspects. The first, On the economy - society - environment through the Socio-economic General Report of Dong Anh District, Hanoi City. The second, synthesized from sources legally published in scientific works, books, and newspapers: Report on survey results of the Institute of Environmental Science and Technology of Hanoi University of Science and Technology in 2016. Teaching materials on principles of economic statistics” by Nguyen Vu An. The third, Summary report on wastewater treatment at the research agency "AQUA Vietnam Environmental Technology Joint Stock Company". Besides, Primary data is collected through actual observations, direct interviews with individuals through questionnaires, and a randomly selected sample of interviewees.

To assess the willingness of people to pay for the improvement of the agricultural irrigation water supply system, the author conducts surveys and interviews to collect the necessary information sources for the research. Specific topics include some of the following steps:

+ *Step 1*: Determine the research objective: Find out the influencing factors and evaluate the willingness to pay for the agricultural irrigation water supply system.

+ *Step 2*: Determine the survey location: Dong Anh district, Hanoi city.

+ *Step 4*: Identify the subjects that need to be investigated and interviewed: Farmers in Dong Anh district, Hanoi city.

+ *Step 5*: Design the questionnaire, interview, and conduct the survey. The questionnaire is designed to be simple, concise, easy to understand, specific, and purposeful. The questionnaire includes the following main contents:

- Information about the subjects: full name, age, gender, occupation, income, education level.

- The situation of the agricultural water supply of Hanoi Irrigation Company, difficulties in the process of supplying agricultural water to the district. The investment cost for agricultural water supply of Hanoi irrigation company. The necessary materials to improve the system for the people.

- People's willingness to pay for the use of improved agricultural irrigation water to improve the water supply system.

+ *Step 6*: Conduct interviews with each household with the contents of the designed questionnaire.

## **2.2. Data Analysis Methods**

*Descriptive statistics method*: This method is used to describe the criteria in the research such as the average values, the interviewee's assessment of the research problem, the willingness to pay off the interviewee. Hereby making statistics into tables for easy analysis.

*Contingent Valuation Method (CVM)* is a direct method to estimate willingness to pay. CVM is based on the simple idea that if you want to know a person's willingness to pay for certain properties of the environment, just ask the person directly.

Unlike traditional methods, CVM does not pass through an actual market but through a hypothetical market, in which the factors in the survey sample are considered as actors participating in that market. The thesis builds a hypothetical scenario related to participating in the installation of wastewater treatment systems in Phung Xa textile and dyeing village. Through the results of the individual survey, the household will determine the average WTP level of participating in the installation of wastewater treatment systems. The average WTP level is determined through the following weighted-average calculation:

$$WTP = \frac{\sum_{k=1}^n wtp_k \times n_k}{\sum_{k=1}^n n_k}$$

In which:

k: index of WTP levels;  $k = 1 \div n$

$wtp_k$ : wtp level k

$n_k$ : number of households corresponding to the level of  $wtp_k$

Through the results obtained during the investigation, the author has built a multivariable linear regression model to analyze the factors affecting the spending level for WTP as follows:

$$WTP_i = \beta_0 + \beta_1 X_i + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + e_i$$

In which:

- WTP: willingness to pay (in thousands of VND)
- $\beta_0$ : intercept factor
- $\beta_1, \beta_2, \beta_3, \beta_4$  : coefficients corresponding to the variables to be estimated
- $X_i$ : age
- $X_{2i}$ : gender
- $X_{3i}$ : level
- $X_{4i}$ : income
- $e_i$ : random error
- Compliance with standards and independent distributors, with the average value of zero

### **3. Results**

#### ***3.1. Introduction to Ap Bac irrigation system***



*Ap Bac pumping station* was invested, built, and put into operation in 1963, located at K53+950 on the left bank of the Red River. The pumping station is responsible for designing and irrigating 14,000 hectares of cultivated area in 3 districts of Dong Anh, Soc Son, and Me Linh. Since 2015, Hanoi City has assigned more tasks in addition to serving agricultural production, the Ap Bac irrigation system also supplies raw water to the North Thang Long Water Plant. The station consists of 06 units, type of pump DU 750, with a designed flow rate of each machine is 8,100 m<sup>3</sup>/h; the flow rate of the whole station is 12.4 m<sup>3</sup>/s; the minimum design water level at the suction tank is +2.60 m.

*Ap Bac field pumping station* was invested and built-in 2010 and renovated and upgraded in 2018, located at K53+700 on the left bank of the Red River. When the water level of the Red River is low and the design water level is not guaranteed, Ap Bac field pumping station is responsible for replacing Ap Bac pumping station. . The station consists of 25 pump units of type HL 1100-12, the flow rate of each unit is 1,100 m<sup>3</sup>/h; flow rate of the whole station is 7.6 m<sup>3</sup>/s; the bottom of the suction tank is at a height of -1.50 m to ensure normal operation of 25 units in the condition that the water level of the Red River drops to a height of +0.10 m at the suction tank.

*Vong La pepper pumping station* is designed with 3 units. In which, pump 1 is used to pump domestic wastewater so as not to flow into the raw water canal: in the dry season, the symbol is DN200, Q=90m<sup>3</sup>/h, H=10m; pump 2 is used to pump rainwater for Vong La reservoir, symbol DN400, including 01 operating unit and 01 backup unit with Q=600m<sup>3</sup>/h, H=18m; pump installation height +7.8m. The pumping station is operated by 01 single-phase control cabinet. The pressure pipeline has a length of L=982m.

#### *System of managers, control houses, security houses*

- Ap Bac pumping station manager has an area of 130.2m<sup>2</sup>; is a 2-storey house; 14m long; 9.3m wide; 11m high. The structure is a reinforced concrete frame house with 200# mark, the wall is made of solid bricks of only VXM grade 75#, 22cm thick.

- Fixed pump station control house: Rebuilt in 2018; has an area of 84.7m<sup>2</sup>; 01-storey house; 10.3m long; 8.22m wide; 3.6m high. The structure is reinforced concrete bearing frame house with 200# mark, VXM brick wall with mark 75#, 22cm thick. The house is roofed with 1.76m high heat-resistant corrugated iron.

- The guardhouse at K2+300 on the Mid canal was built in 2018 with an area of 46m<sup>2</sup> and is a 1-storey house with 02 rooms and 01 permanent room. The structure of the guardhouse is a frame house with 1x2 stone reinforced concrete, grade 200#. the foundation is driven by 1x2 stone concrete piles of 200# mark 2m deep; VXM unburnt brick wall 75#; 1x2 stone concrete roof deck, mark 200#. The whole house is painted with waterproof paint.

#### *Substations and medium voltage lines*

- Substation with machine capacity 2000KVA-22/0.4KV;

- The medium voltage line is an underground cable system Cu/XLPE/PVC/DSTA/PVC/W 24kV-(3x120mm<sup>2</sup>) with a total length of 335m.

*The channel within the sanitary protection zone of the domestic water intake area* has a length of 1000m from the upstream of the field pumping station and 200m from the downstream of the fixed pumping station. The channel has an average width of 100m and an average bottom elevation of -0.5m.

#### *Canal system and works on the canal.*

- Ap Bac pumping station channel has a length of 160m, solidified with concrete slab roof with roof coefficient m = 1.5; channel bottom width 22.0 m; channel bottom elevation at the beginning of the route +0.20 m.

- Ap Bac pumping station discharge canal has a length of 190m, solidified with concrete woven sheet roof with roof coefficient m = 1.5; channel bottom width 10.0 m; channel bottom elevation at the beginning of the route +7.20 m.

- Ap Bac field pumping station discharge channel has a length of 285m, solidified roof with concrete woven sheets with roof coefficient of 1.5; channel bottom width 8.0 m; channel bottom elevation at the beginning of the route +7.45m.

- The central irrigation canal has a length of 2,468m, the roof is solidified with concrete slabs with a roof coefficient of 1.5; channel bottom width 9.0 m; elevation of the canal bottom at the beginning of the route +6.74m; elevation of canal bank at the beginning of the route +9.00 m.

- Drains and regulators

+ Self-flowing sluice: At K0+215, the left bank of the discharge canal at Ap Bac pumping station; culvert has 2 doors; length L= 11m; 1.6m wide; 2.5m high; V5 opening and closing machine, electric motor with a corrugated iron roof.

+ Sluice across Vong La dike: At K53+920 on the left bank of the Red River; built-in 1962; culvert has 2 doors; 35.7m long; 2.9m wide; 2.5m high; flow rate 12.5m<sup>3</sup>/s; culvert operated by V10 collapsible machine; electric motor covered with corrugated iron. The culvert bottom is +6.6m high; the top of the culvert is +9.4m; the bottom of the upper terrace has a height of +6.72m and the downstream of the culvert has a height of +6.6m.

+ The sluice to the Viet Thang - Thanh Cong canal: At K1+474 on the right bank of the middle channel, there is a reinforced concrete one-door round sluice with length L=10m; diameter D=60cm; drains use open-closer V1.

+ Regulating at the weir: At K2+500 on the Mid channel; culvert has 2 doors; 4.2m long; 3.5m wide; 3.2m high; culvert operated by opener V10; electric motor with the corrugated iron roof; culvert bottom has a height of +6.3m; the top of the culvert has a height of +9.5m.

### ***3.2. Demographic***

Before considering the willingness of people to pay for water quality improvement, the current payment scenario is based on: "With the current urgent water situation, the supply of clean water is guaranteed for people to use". Water in Ap Bac Irrigation System, Dong Anh District, Hanoi City is necessary. To assess the role of agricultural water and propose the most reasonable water supply solution most accurately. It is assumed that in the future the water quality will be improved to ensure the current agricultural irrigation water quality standards and at the same time overcome environmental problems. Please choose the price of water/ha that you think is most suitable for the benefits that the water source brings to the family.

We need to consider some characteristics of the household group interviewed. These characteristics have a direct influence on the willingness to pay of the next people of the people in the future. The first is gender, out of a total of 172 interviewed households, a total

of men accounted for 55.56% of the total sample, accounting for 44.44% of the total sample. The mean age of the survey samples was 41.93. In general, at this age, the sample has a middle age. Regarding the average income of the surveyed household group is 5.61 million/month, this income is quite high, but this is the income of individuals, not households. So if calculated on average per household, it fluctuates in the range of 2-3 million/person. Moreover, Dong Anh district is a town mainly developing trade and transportation services, the industry is also quite developed while agriculture is almost very little, mainly cum so, this income level also reflects the economic life of the people of Dong Anh district.

**3.3. Evaluation of willingness to pay to participate in improving agricultural irrigation water supply system in Ap Bac irrigation system.**

Regarding the assessment of willingness to pay to participate in the improvement of the agricultural irrigation water supply system in the Ap Bac irrigation system. Through the survey of 60 people representing 60 people, 56 people (93.3%) interviewed answered that they are willing to pay for the connection and installation of wastewater treatment systems, only 4 people (6.7%) interviewed said that they are not willing to participate in system installation because their income is low.

**Table 1. Price people are willing to pay for participation in improving water supply systems in irrigation systems Ap Bac**

<i>k</i>	<i>WTP<sub>k</sub> (thousand dong)</i>	<i>(%)</i>
1	100000	14.29
2	150000	35.71
3	200000	12.5
4	250000	10.71
5	300000	7.14
6	350000	7.14
7	400000	5.36
8	450000	3.57
9	500000	3.57



So from the table and applying the formula, we can calculate the average WTP = 221,428 thousand VND/1ha. Thus, the average price that people in Dong Anh district are willing to pay for participating in the improvement of the agricultural irrigation water supply system in the Ap Bac irrigation system is on average 221,428 thousand VND/ha.

### **3.4. Linear regression model**

Through the results obtained during the investigation, the author has built a multivariable linear regression model to analyze the factors affecting the spending level for WTP as follows:

$$\text{WTP} = 5127.2 + 1231.8 * \text{AGE} + 15384 * \text{GENDER} + 32476 * \text{LEVEL} + 0.0063 * \text{INCOME}$$

Observing the model, we see that, the dependent variables that are age, gender, education level, income are all proportional to WTP. With the significance level of 0.05, we evaluate the relationship between the WTP variable, and the independent variables as follows:

P-Value (age) = 0.04 < 0.05, showing that the age variable has a close relationship with WTP. This can be explained, the older the people, the more their need for improving the irrigation water supply system at the Ap Bac irrigation system to protect the health of the people higher. Therefore, they are willing to pay for the improvement of the irrigation water supply system at Ap Bac irrigation system to protect the living environment as well as their own health. The age variable has a great influence on WTP.

P-Value (gender) = 0.286 > 0.05, showing that the gender variable is not closely related to WTP. Whether male or female, everyone realizes the importance of improving the irrigation water supply system in the Ap Bac irrigation system for the main study area. The respondents whether male or female may participate in the response, and the WTP results are not strongly related to gender.

P-Value (level) = 1E-04 < 0.05, which proves that the educational level variable has a close relationship with the WTP variable. The reason for this is that the more educated people, the more knowledgeable they have access to information sources, which helps them to have a correct awareness of the need willing to pay for the improvement of the irrigation water supply system at Ap Bac irrigation system.

P-Value (income) = 7E-06 < 0.05, which proves that the income variable has a close relationship with the WTP variable. People with higher incomes are usually more willing to pay for the improvement of the irrigation water supply system in the Ap Bac irrigation system than those with low incomes.

#### 4. Discussion and Conclusion

Through the research model and the analysis results of the factors affecting the willingness to pay for agricultural water supply services, we find the influencing factors affecting the willingness to pay including local factors, education level, household size, number of workers in the household, total income, daily water use of the household and environmental awareness of the household head. These results are also consistent with previous studies. Besides, the study also discovered 4 new factors that were found to be statistically significant variables: living area of the household, number of people working in the household, water source used and environmental awareness.

The government when developing programs/projects on improving the water environment in localities should pay attention and consider factors such as contribution to the fund, household income, education level, and household's attitude towards the environment. In particular, the expected contribution of funds should revolve around the value of WTP estimated from this study.

The results of this study can be used as a basic source of information to estimate the total amount of funds that can be obtained. This will serve as a basis for estimating the financial ability of the people to develop programs to improve the quality of polluted agricultural water environment in the locality.

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