https://doi.org/ 10.33472/AFJBS.6.Si2.2024.1325-1335

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

ANALYSIS OF FACTORS INFLUENCING HOUSEHOLDS' WILLINGNESS TO PAY FOR WATER USE: A CASE STUDY IN NAM DINH

Bui Anh Tu - Thuyloi University, Vietnam

Email: buianhtu@tlu.edu.vn

Article History

Volume 6,Issue Si2, 2024

Received:27 Mar 2024

Accepted : 30 Apr 2024

doi: 10.33472/AFJBS.6.Si2.2024.1325-1335

Abstract: The provision of irrigation water and agricultural production services has shifted from supplying water resources to a "service" model, where there is an agreement between the buyer and the seller, and the traded commodity is water resources. Examining this product exchange from a "commodity" perspective emphasizes the willingness to pay of water users. This willingness to pay is influenced by various influencing factors, which alter the pricing decisions of water users for irrigation services. This study investigates the impact of these factors on the willingness to pay of water users through contingent valuation method and multivariate regression methods to establish a relationship between the domestic irrigation fee and the additional amount people are willing to pay based on influencing factors. The results of the study will analyze the extent of the influence of these factors on the willingness to pay of water users, thereby implying implications for policy.

Keywords: willingness to pay, irrigation, water pricing

1. General Introduction

The products and services derived from irrigation projects are quite diverse, serving production in various forms directly related to 'water.' Determining the prices of irrigation products and services must adhere to the principle that 'Water is an economic commodity,' a principle applied and implemented by many countries worldwide in establishing water prices for agricultural irrigation. Accordingly, the pricing should reflect all costs related to resources as well as the investment, operation, and maintenance costs of irrigation projects. The basis for establishing

prices for irrigation products and services still relies on the production costs (costs) of the service provider.

The objective of this study is to apply a method to determine the willingness to pay for irrigation products and services, quantifying the factors influencing the willingness to pay for irrigation services. The research results in Nam Dinh province will assist researchers and managers in approaching and proposing reasonable water pricing policies.

There are numerous studies worldwide on the willingness to pay of users for irrigation products and services, such as Aydogdu (2016), Biswas (2015), Altobelli (2018), Latinopoulos (2001), etc. These studies consistently show that when the quality of irrigation water services is ensured, water users are willing to pay a higher price than the current price they are paying. Furthermore, analyzing the factors influencing the willingness to pay is an effective way for governments and water users to agree on water prices, operational methods, and ensure the irrigation needs of the population.

2. Research Methodology

2.1.Contingent Valuation Method

The study employs the Contingent Valuation Method (CVM) in its research. The CVM method is one of the valuation techniques conducted under assumptions, determining the value of non-market goods and services without direct exchange and therefore lacking a market price (Mitchell & Carson, 1989). The basis of this method is to construct a hypothetical market and investigate the willingness of users to pay for changes in service quality and the environment. This method utilizes interview and survey questionnaires for households using irrigation services at the research site to determine the Willingness To Pay (WTP) of individuals for the domestic irrigation fee.

2.2.Multivariate Regression Method

The study employs the multivariate regression method to establish the relationship between the domestic irrigation fee that people are willing to pay additionally and the influencing factors. The dependent variable is the domestic irrigation fee that individuals are willing to pay extra for irrigation water, and the independent variables include factors influencing the willingness to pay, such as education level, production area, demographic characteristics, etc. The choice of the linear model for analyzing WTP in the study is based on previous research by Song N. V. (2011) and Huan N. B. (2017).

The general model defining the willingness to pay is as follows:

$$WTP = \beta_i \times X_i + \varepsilon \quad (1)$$

In which:

WTP represents the level of willingness to pay for irrigation water by service users

X_i is the i^{th} independent variable, a factor influencing the willingness to pay

β_i is the parameter reflecting the degree of impact of variable X_i on the dependent variable WTP

ε is the error term.

The independent variables Xi include::

- *Demographic factors group:* education level, the number of family members, agricultural production experience. The education level is assumed to have a positive effect on WTP: higher education enables farmers to enhance their ability to receive, use, and analyze information, thereby positively influencing WTP for irrigation water (Akter, 2007; Va'squez, 2009). It is also assumed that farming experience will positively impact farmers' WTP for irrigation water prices (Akter, 2007).
- *Agricultural production characteristics group:* cultivated area, access to irrigation water sources (distance from the fields to the channel). Both the cultivated area and access to irrigation water sources are assumed to have a positive impact on WTP. A larger cultivated area will require more water, or the income from farming will be higher, making them willing to pay more for irrigation water. Easy access to irrigation water sources makes farming more convenient, increases income, and leads to higher WTP (Mezgebo, 2013; Rohith, 2011).
- *Market characteristics group:* market accessibility (marketplace), participation in non-agricultural activities. It is expected that households close to the market will have a higher WTP for irrigation water due to increased trading opportunities and reduced transaction and transportation costs for agricultural products (Sentayi, 1997). Participation in non-agricultural activities will have a negative impact on WTP for irrigation water because farmers will allocate labor from agriculture to non-agricultural activities, reducing the demand for cultivation (Sanyal, 2011).
- *Institutional and policy factors group:* access to agricultural extension services, access to credit, participation in training. Access to agricultural extension services and participation in training will help farmers enhance their knowledge and adopt new agricultural production technologies. This improves awareness of the necessity to pay for maintaining irrigation water sources. Access to credit enables farmers to invest more in agricultural production, increasing income. Therefore, it will have a positive impact on WTP for irrigation water (Addis, 2010).
- *Perception and attitude factors group:* Farmers with a positive attitude will be more willing to pay higher amounts to maintain and improve the quality of the irrigation system.

Table 1. Description of Variables Used in the Model

ID	Variables	Description	Expectation
1	WTP	Willingess to pay	
2	KN	Agricutural experience	+
3	SLTVGD	Number of family members	-/+
4	GD	Educational level of the host	+
5	Thunhap	Average montly income	+
6	DTRuong	Area of agricutural land	+
7	PhiNN	Income from non-agricuture activities	-

ID	Variables	Description	Expectation
8	KCKenh	Distance from field to canal	+/-
9	KCCho	Distance from household to nearest market.	+/-
10	Thaido	Willingness of farmers to pay more money to maintain infield irrigation system	+
11	TCTC	Accessibility to credit	+/-
12	Daotao	Participation in training	+

When the dependent variable is a continuous variable, the economic model that determines the willingness to pay is used as the ordinary least squares (OLS):

$$WTP = \beta_0 + \beta_1 KN + \beta_2 GD + \beta_3 SLTVGD + \beta_4 DTRuong + \beta_5 Thunhap + \beta_6 KCCho + \beta_7 KCKenh + \beta_8 PhiNN + \beta_9 Thaido + \beta_{10} TCTC + \beta_{11} DaoTao \quad (2)$$

2.3.Survey Sampling

The sample size of the thesis is determined by the following formula (Thu T. T. K., 2013):

$$n = \frac{NZ^2 p(1-p)}{Ne^2 + Z^2 p(1-p)} \quad (3)$$

In which:

n is the number of survey questionnaires;

N: Represents the total population size;

p(1-p): Represents the maximum variance [0.5 x (1 – 0.5)] = 0.25 (assuming a proportion p, q of 50% - 50%);

Z = 1.96: Corresponds to a confidence level of 95%;

e= 0.05: Represents the sampling error;

Within the scope of the thesis research, N is the number of households using irrigation water, determined by the following formula:

$$N = \frac{DSNT}{NKBQ} \quad (4)$$

Where: DSNT is the rural population of Nam Dinh province, obtained from the Statistical Yearbook of Nam Dinh province in 2018, and NKBQ is the average population of one household in rural areas nationwide, taken from the 2016 Survey on the Population's Living Standards in Vietnam conducted by the General Statistics Office.

After calculating the number of agricultural households using the formula (3) as 382 households, the author chooses the research sample size to be 420 households. The selected sample size is larger than the calculated sample size to account for potential issues such as survey forms being damaged, lost, or deemed invalid.

The study randomly selects households using irrigation services. The list of households utilizing irrigation services is provided by the commune:

Table 2. Sample Distribution by Regions

ID	District	Number of farmer households	%	Number of observations	The commune chose to survey
1	Nghia Hung	41820	20,45	86	Nghia Trung Nghia Thinh
2	Y Yen	57671	28,20	118	Yen Ninh Yen Binh
3	Giao Thuy	46026	22,51	95	Giao Tien Giao Thinh
4	My Loc	17131	8,38	35	My Thanh My Trung
5	Xuan Truong	41856	20,47	86	Xuan Ngoc Xuan Chau

3. Research Results

Through a survey of 402 households using irrigation water in Nam Dinh province, the average number of family members is 4.13 people, and 60% of households have an average income of over 7 million VND per month. The average agricultural production experience of the households is 20.8 years, reflecting that agriculture still plays a crucial role in the economic and social life of Nam Dinh.

After collecting the 402 observations, the study conducted statistical analysis of the collected data. The results show that the Adjusted R Square (R2) coefficient calculated based on 402 observations is 0.538, indicating that this linear regression model is suitable for the dataset of the sample at a level of 53.8%. The F-value is 43.419 with a sig. value of 0.000 <5%, indicating that the R square of the population is not equal to 0. This implies that the constructed linear regression model is appropriate for the entire research population.

Table 3. The research results on the willingness to pay of households for irrigation water fees

ID	Variables	Standardized Beta Coefficient	t	Sig.	VIF
1	(Constant)		-5,627	0,000	
2	KN	0,353	7,457	0,000	1,943
3	SLTVGD	0,083	2,296	0,022	1,142
4	GD	0,184	4,921	0,000	1,213
5	Thunhap	0,052	1,360	0,175	1,251
6	DTRuong	0,128	2,916	0,004	1,670
7	PhiNN	-0,098	-2,719	0,007	1,121
8	KCKenh	-0,222	6,273	0,000	1,083

9	KCCho	0,231	5,766	0,000	1,389
10	Thaido	0,211	5,332	0,000	1,359
11	TCTC	0,057	1,548	0,122	1,176
12	Daotao	0,093	2,155	0,032	1,616
Adjusted R Square		0,538			
DW-Test		1,987			
F-Test		43,42			
Prob. F		0,000			

Based on the results presented in the table above, it is observed that the variables "TCTC" and "Thunhap" do not have a significant impact on the dependent variable "WTP" (as the Sig. value of the test is greater than 0.05). All other variables have statistically significant effects on the dependent variable, among which "GD," "KN," "DTRuong," "KCKenh," "KCCho," and "Thaido" have a higher influence than other factors in the research model.

The VIF values for all factors are less than 2, indicating no issues of multicollinearity. Income from non-agricultural sectors will negatively impact farmers' willingness to pay. The development of tourism and industry will lead people to shift from agricultural to non-agricultural areas, limiting their willingness to contribute to the internal irrigation fee and leading to abandonment of land, fields, and a deterioration of irrigation systems.

Regression results indicate that the willingness to pay the additional internal irrigation fee for households using irrigation water is influenced by the number of years of agricultural production experience, the number of family members, education level, cultivated area, non-agricultural production activities of the family, distance between the channel and the family's agricultural production area, distance from home to the market, the attitude of the household, and the number of training sessions on internal irrigation.

The regression coefficients of the "PhiNN" and "KCKenh" variables are negative, implying that households with their main income source from non-agricultural activities and a longer distance from the channel to the fields will have a negative impact on the willingness to pay the internal irrigation fee.

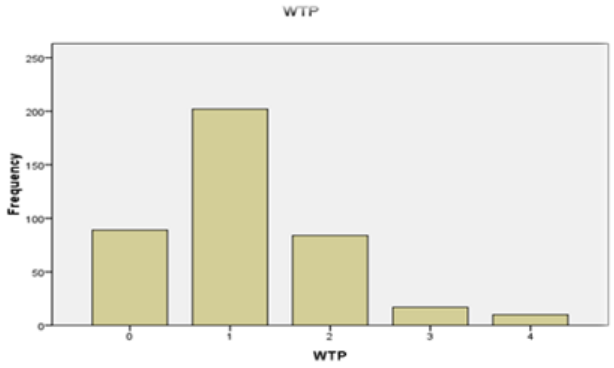

Figure 1. Description of the price range that farmers are willing to pay for irrigation services.

The price range (Willingness to Pay - WTP) most chosen by 402 households of farmers is level 1 (below 5,000 VND) with a selection rate of 50.2%. There are 89 households unwilling to pay additional fees, 202 households willing to pay an additional amount less than 5,000 VND per field per crop season, and 84 households willing to pay an additional amount ranging from 5,000 to less than 10,000 VND per field per crop season, accounting for the corresponding percentages of 22.1%, 50.2%, and 20.9%, respectively.

3.1. Analysis of willingness to pay among the population based on educational attainment

Educational attainment is one of the demographic characteristics that plays a crucial role in reflecting human capital. In this study, educational attainment refers to the level of education achieved by the individuals interviewed, primarily the head of the household. The higher the level of educational attainment, the more opportunities individuals have to engage with specialized knowledge, lifestyle, culture, and society. Additionally, a higher educational attainment is positively correlated with the ability to acquire and analyze knowledge from various sources. Consequently, an improved level of educational attainment contributes significantly to raising awareness of the role of irrigation systems, promoting water conservation, and enhancing agricultural productivity.

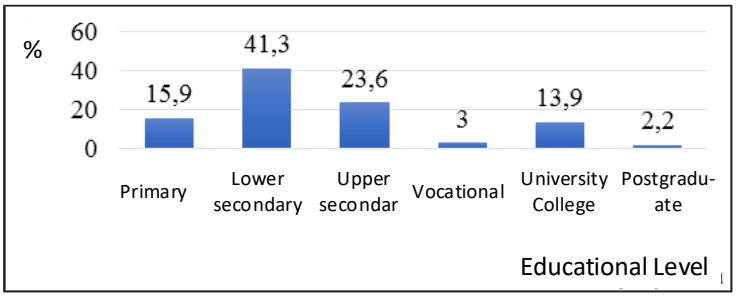

Figure 2. Educational Attainment of Household Heads

The educational attainment of household heads is relatively high, providing favorable conditions for increasing awareness of water-saving irrigation and protecting irrigation structures, thereby positively influencing the Willingness to Pay (WTP) for irrigation water.

The results of the study on household willingness to pay, classified by educational attainment, clearly support the hypothesis presented above. Households with higher educational attainment tend to have a higher willingness to pay compared to those with lower educational attainment. At the level of unwillingness to pay additional fees, the percentage of household heads with educational attainment below primary and lower secondary education is quite similar. In contrast, households where the head has at least vocational education show a very small percentage of unwillingness to pay additional fees (ranging from 4.2% to 10.6%).

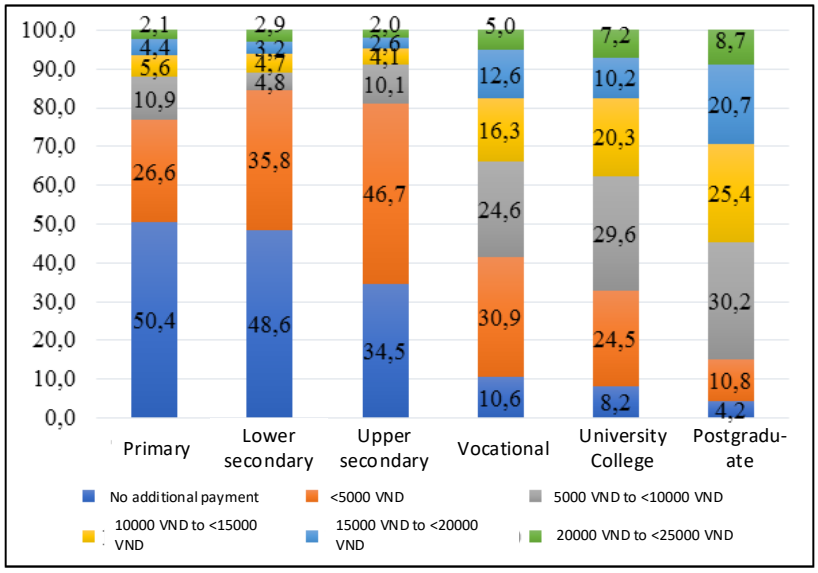

Figure 3. Willingness to Pay of Households Classified by Educational Attainment

For willingness to pay levels of 5,000 VND and above, households with heads who have a postgraduate degree have the highest readiness to pay at a rate of 30.2%. Meanwhile, for commonly surveyed educational levels such as primary, lower secondary, and upper secondary education, an average of 44.5% of households are unwilling to pay additional irrigation fees. This implies that over 50% of the remaining households agree to increase the internal irrigation fee to better support the maintenance and operation of the irrigation system. This result suggests an important conclusion that the influence of educational attainment on enhancing the quality of the irrigation system in the long term and increasing short-term internal irrigation fees. This outcome highlights the crucial role of improving education and civic awareness as an indirect measure to enhance the efficiency of irrigation system operations.

3.2.Analysis of willingness to pay among the population based on the primary source of income

The primary sources of income for households are highly diverse, with nearly one-third of the surveyed households deriving their main income from farming. The remaining over two-thirds of households rely on other occupations while still engaging in small-scale agricultural production and benefiting from the irrigation system (having cultivated fields near canals or ditches).

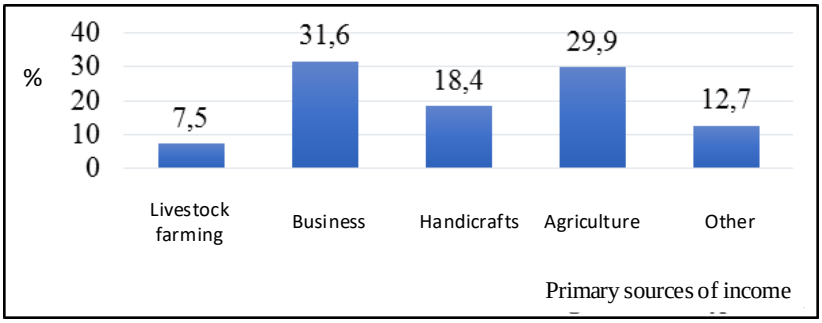

Figure 4. Primary Sources of Income for Households

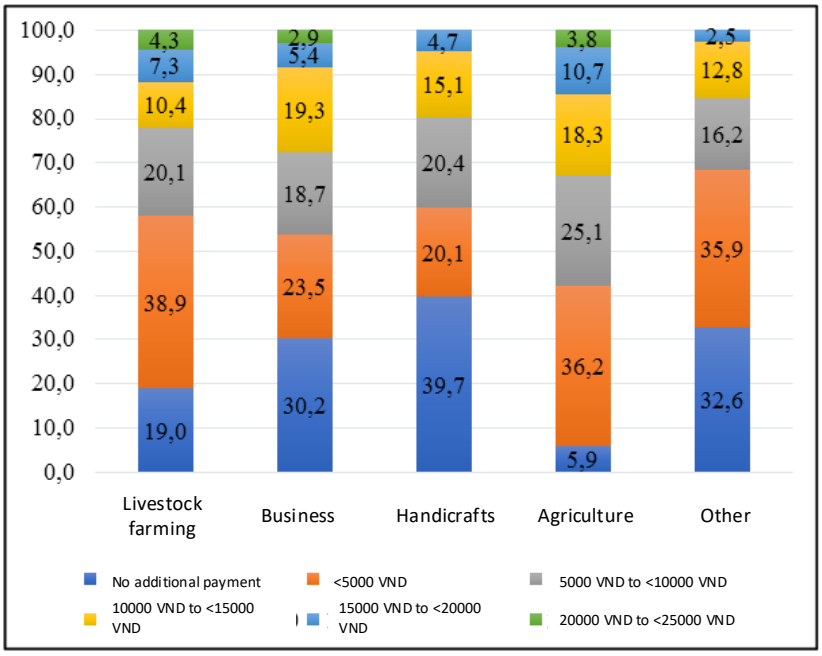

Figure 5. Willingness to Pay of Households Classified by Primary Source of Income

The primary source of income for households is a crucial factor influencing the willingness to pay additional fees for internal irrigation. Households are more willing to pay when the benefits of the irrigation system directly impact their daily lives. Through a survey of 402 households with irrigation services, it was observed that pure farming households are the most willing to pay, with only 6% of pure farming households unwilling to pay additional internal irrigation fees. At the same price level, pure farming households consistently have a higher willingness to pay than other household groups.

For households with the primary source of income from livestock farming, nearly 40% of these households are willing to pay less than 5,000 VND/field/crop season, the highest percentage among the five household groups. Most of these households benefit from the internal irrigation system as they can drain water from livestock farming and release poultry on the channel. Therefore, their willingness to pay is relatively high.

Business households have a relatively high average income compared to other occupational groups. Even though they are less directly dependent on the internal irrigation system, they are still willing to pay additional fees because the contribution is relatively small compared to the family income (only 30.2% of business households do not pay extra, while 19.3% of business households are willing to pay an additional fee ranging from 10,000 to 15,000 VND/field/crop season).

Households with the primary income from industry and handicrafts seem to benefit less from the internal irrigation system, leading to a lower willingness to pay additional fees. About 40% of these households are unwilling to pay extra, but more than 40% are willing to pay up to 10,000 VND/field/crop season. There is a differentiation here depending on the income of each household.

4. Conclusion

The research has identified the price point at which farmers are willing to pay extra for the use of irrigation water from the irrigation system. Nearly 80% of those interviewed in Nam Dinh province agreed to pay an additional amount, with the most accepted price being below 5000 VND. Additionally, constructing a regression function between the Willingness To Pay (WTP) variable and other relevant variables helps determine the influence of factors on the farmers' willingness to pay for irrigation water. This information can guide the formulation of reasonable policies, such as increasing internal irrigation fees and distributing them according to household income, the main source of income from agricultural production. Furthermore, enhancing training to raise awareness of the value of irrigation services, protecting irrigation works for the beneficiaries is crucial.

Factors related to water usage in households, such as education level, income, and age, have a significant impact on the willingness to pay. Therefore, irrigation service providers should strengthen communication, guide water usage through training sessions to promote efficient and mindful water use. Additionally, active participation in monitoring, using, and protecting the irrigation system is essential for sustainable water management.

References

Aydogdu (2016). Evaluation of willingness to pay for irrigation water: harran plain sampling in gap region – Turkey. Applied ecology and environmental research 14(1): 349-365. Budapest, Hungary.

Durba Biswas and Ven Katachalam (2015). Farmers' Willingness to Pay for improved irrigation water – a case study of Malaprabha irrigation project in Karnataka, India. Water Economics and Policy, Vol. 1, No. 1 (2015).

Altobelli, Lall, Dalla Marta, Caraccilo, Cicia, D'Urso, Del Giudice (2018). Willingness of farmers to pay for satellite-based irrigation advisory services: A southern Italy experience. The Journal of Agricultural Science.

Mallios và Latinopoulos (2001). Willingness to Pay for irrigation water: A case study in Chalkidiki, Greece. 7th International Conference on Environmental Science and Technology Ermoupolis, Syros island, Greece.

Mitchell, R.C. and Carson, R.T. (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, Washington DC.

Nguyen Ba Huan (2017). Estimating the Willingness to Pay for the Use of Clean Water among Residents in Chương Mỹ District, Hanoi City. Journal of Forestry Science and Technology. 1/2017: 129 – 139.

Nguyen Van Song (2011). Determining the Willingness to Pay of Farmers for the Collection, Management, and Treatment Services of Household Solid Waste in the Gia Lam District, Hanoi. Journal of Science and Development. 9(5): 853 – 860.

Alemayehu, T. (2014). Farmers' Small holder Farmers' Willingness to Pay for lmproved lrrigation Water: A Contigent Valuation Study in Koga lrrigation Project Ethiopia. Journal of Economic and Sustainable Development, 5(19) 5-15.

Akter, S. (2007). Farmers'Willingness to Pay for lrrigation Water under Government Managed Small Scale lrrigation Projects in Bangladesh. Journal of Bangladesh studies 9:21-31.

Adepoju, A. A. and Omonona, B. T. (2009). Determinants of willingness to pay for improved water supply in Osogbo Metropolis, Osun Siate, Nigeria. Department of Agricultural Economics, Ladoke Akintola University of Technology.

Nam Dinh branch of water resources. Summarizing the report on production and business results of private limited companies exploiting irrigation structures in Nam Dinh province in the period of 2015 - 2018.

Latinopoulos, P.Z. M. (2001). Willingness to pay for irrigation water: A case study in Chalkidiki, Greece. Aristotle University of Thessaloniki, Greece.

Mezgebo, A., Tessema, W., and Asfaw, 2.2013. Economic Values of lrrigation Water in Wondo Genet District, Ethiopia: An Application of Contingent Valuation method. Journal of Economics and Sustainable Development,4(2)'.23-36.

Moffat. B., Motlaleng. G. R. and Thukuza (2012). Households' willingness to pay for improved water quality and reliability of supply in Chobe Ward, Maun. Botswana Journal of Economics 8(12): 45-61 .

Ogunniyi, L. T., Sanusi, W.A., & Ezekiel,A.A(2011). Determinants of rural house hold willingness to pay for safe water in Kwara State, Nigeria. Aquaculture, Aquarium, Conservation and Legislation International Journal of the Bioflux,4(5): 660-669.

The 15th NationalAssembly (2017). The law of irrigation no.08/2017/QH14.

Rodriguez, F., and Southgate, D (2003). Water resources management and willingness to pay: The case of Cotacachi, Ecuador. Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program Research Brief, 15.

Rohith, B. K. and Chandrakanth, M. G. (2011). Institutional and economic dynamics of water users cooperative societies in Cauvery basin of Karnataka. Agricultural Economics Research Review. 24(2):235-242.

Va'squez, W. F., Mozumder, P., Herna'ndez-Arce, J. and Berrens, R. P (2009). Willingness to pay for safe drinking water: Evidence from Parral, Mexico. Journal of Environmental Management 90 (11): 3391-3400.

Robert Cameron Mitchell, Richard T. Carson (1989). Using surveys to value public good the contingent valuation method. Washington D.C, USA. ISBN 0-915707-32-2.

Washington D.C, USA. lSThe theory of statistics. The Publisher of National Economics Eniversity, 2013.

Nam Dinh statistics office (2017). Nam Dinh yearbook 2017.

The generalstatisiics office (2016). Survey results of Vietnam living standards 2016