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Research Paper

Economic Analysis of Fisherfolks' Willingness to Pay for Improved Management of Water Hyacinth in Lake Victoria, Kenya

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ABSTRACT: *The study aimed at estimating the fisherfolks' Willingness-to-pay (WTP) for improved management of water hyacinth in Lake Victoria, Kenya. The study also examined the socio-economic determinants influencing fisherfolks' WTP decisions for improved management of water hyacinth in Lake Victoria Kenya. Total of 268 fisherfolks were sampled. The Tobit regression model was used to analyze the socio-economic determinants of individuals' WTP decisions for the improved water hyacinth management in Lake Victoria. The results showed that fisherfolks were on average willing to pay amount of Kshs. 175.11 (US$1.75) with a total contribution of Kshs. 42,500 (US$ 42.5) monthly to improve water hyacinth management in Lake Victoria. The variables age, experience, income, perception of fisherfolks about water hyacinth infestation, fishing groups and gender of fisherfolks had a significant influence on the fisherfolks' WTP decisions for improved management of water hyacinth in Lake Victoria. The Lake Victoria management authorities should take the opportunity to raise funds for improved management of water hyacinth in Lake Victoria.*

Key Words*: CVM, Fisherfolks, Tobit, Water hyacinth, WTP*

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I. INTRODUCTION

Globally, water hyacinth infestation is reported in five continents and in more than 50 countries. The most affected regions include; United states of America, South East Asia, Central and East Africa (Bicudo et al., 2007). In Central America countries, water hyacinth was reported in México, Costa Rica, Salvador, Puerto, Panama and the Dominican Republic between 1965 and 197 (Alberini, 2013). In these regions, water hyacinth formed series of mats on water bodies resulting in obstruction of navigating vessels and ecological challenges (Tom and Lynne, 2012). In Africa, Water hyacinth was noticed in 1879 in Egypt. Henceforth, this aquatic weed has widespread in Central, West Eastern, and South Africa regions. It was therefore termed as a noxious weed in the sub-tropical parts of Africa. For instance, in Ghana, water hyacinth was reported in 1987 in Tano Lagoon. The immediate impact of this aquatic was a decline in fish catchabilities as a result of dense mats on the fishing shorelines and docking areas. Besides, the weed caused delays in deployment of fishnets and biodiversity menaces leading to the extinction of fish species in the coastal regions (Forpah, 2009).

In Kenya, water hyacinth was first observed in 1986 in Lake Naivasha (Mironga et al., 2012). On the Kenya side of Lake Victoria, water hyacinth was reported in 1992 in beaches of Mfangano, Dunga, Miuru and Rusinga and the aquatic weed became menace from the year 2000 especially along Koginga, Sikri and Usao beaches. Effluents aided its rapid spread from Homa Bay Capital Fish Factory and sewerage discharge into the lake. Lake Victoria is a trans-boundary water resource shared by Kenya, Uganda, and Tanzania. It acts as the primary source of food, employment opportunities, foreign exchange, and revenue to the government as well as the raw material for fishery industries in Kenya (Agroforestry, 2013). However, water hyacinth infestation in the lake has posed severe ecological and socio-economic problems to the riparian communities along the shorelines. For instance, ecologically, the macrophyte plants have been declining over the years resulting in a shortage of zooplankton which is the primary source of food for freshwater lake fishery (Patel, 2012). Socio-economically, the dense mats of water hyacinth on the lake have led to massive decline in fish catchability by 45 percent due to inaccessibility of major fishing grounds causing a mismatch between supply and demand for fish products (Feikin *et al.,* 2014). Moreover, vast masses of decaying water hyacinth on the lake has lowered the quality and quantity of water and hence, increased the cost of treating water for domestic use. The presence of large dense of water hyacinth has also promoted the breeding of disease-causing vectors such as mosquitoes responsible for malaria, Perugia responsible for nematode, snail responsible for Bilharzia and Salmonella accountable for typhoid.

Many studies have been conducted about water hyacinth in Lake Victoria. Most of these studies have mainly focused on the technical aspects of mechanical, biological and chemical control of water hyacinth in the lake (Patel 2012; Venter et al., 2013 and Dagno et al., 2007) leaving a dearth of information on the socio-economic aspects of policy intervention that may be pertinent towards the better management of water hyacinth in Lake Victoria. This study was, therefore, carried out to provide the missing socio-economic aspects by analyzing the fisherfolks' preferences for improved management of water hyacinth in Lake Victoria.

II. THEORETICAL FRAMEWORK

The study used contingent valuation framework to analyze the fisherfolks' preferences for improved management of water hyacinth in Lake Victoria. The CVM framework was preferred over the discrete choice experiment approaches since it yielded the aggregate (nonuse and use) value of the proposed socio-economic aspect (Ndambiri *et al.,* 2015). The hypothetical market was used as a proxy to estimate fisherfolks WTP for the policy intervention.

The Contingent valuation framework is anchored on Microeconomic Theory of Welfare Change. According to this theory, households can either maximize their utility subject to income constraint or minimize their expenditure subject to a given utility constraint (Varian, 2015). Given the two approaches, this study applied the expenditure minimization approach to estimate fisherfolks WTP for improved management of water hyacinth in Lake Victoria.

In this case, consider the following general expenditure function for a fisherfolk in Lake Victoria;

$$\mathrm{e(p,q,u) = y} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where p is the price vector, (q) is the level of water hyacinth infestation along the shoreline, (u) is the level of utility and (y) is the minimum income requirement to allow a fisherfolk to maintain utility level (u) in Lake Victoria. Also consider another scenario where a policy measure was proposed by LVEMP to manage the high level of water hyacinth infestation along the shoreline. This policy therefore put in place all the appropriate strategic measures for eradication of water hyacinth in Lake Victoria. A fisherfolk was then asked to state the amount he/she was WTP to help implementation of this policy. The primary expenditure function before the policy measure (status quo) was stated as follows:

$$\mathrm{e(p,q_0,u_0) = y_0} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where; $\mathrm{u_0}$ is the initial level of utility that a fisherfolk derived given the price p, $\mathrm{y_0}$ minimum level of a fisherfolk income needed to attain utility level $\mathrm{u_0}$ and $\mathrm{q_0}$was the original level of water hyacinth infestation along the shoreline. The new expenditure function after implementation of the policy measures was stated as follows:

$$\mathrm{e(p,q_1,u_0) = y_1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where; $\mathrm{q_1}$ was the new level of water hyacinth infestation after the implementation of the policy measures along the shoreline; $\mathrm{y_1}$was the minimum level of a fisherfolk income needed to attain utility level$\mathrm{u_0}$. According to Hicksian Welfare Principle, utility and prices are assumed to be constant throughout. Following this principle, $\mathrm{u_0}$ was held constant at its primary expenditure level. A fisherfolk's WTP for improved water hyacinth management was given by the difference between the two expenditure functions $\mathrm{y_1}$ and $\mathrm{y_0}$ since a fisherfolk was to pay a certain amount to ensure implementation of policy measures for improved management of water hyacinth along the shoreline. This compensating variation (C) was expressed as follows:

$$\mathrm{C = WTP = y_1 - y_0} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$\mathrm{C = \{e(p,q_1,u_0) - e(p,q_0,u_0)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Further assume that $\mathrm{q_1}$ is greater than $\mathrm{q_0}$ while $\mathrm{u_0}$ was held constant, $\mathrm{y_1}$ was less than $\mathrm{y_0}$. This resulted to a negative sign which symbolized that a fisherfolk had to depart with some dollar amounts of money to help in supporting improved management of water hyacinth along the shoreline.

III. RESEARCH METHODOLOGY

The study area

Homa Bay shoreline is located in formally known as Nyanza Gulf (Winam Gulf) on the Kenyan side of Lake Victoria. It borders Rachuonyo to the North, Kisii to the East, Migori to the South and Kisumu to the West. The total area is approximated to cover about 185.3km2, length of 60km, and varying width of about 3-30m, mean depth of about 6-43m and elevation of 1136m. It is made up of four administrative wards namely; Homa Bay Central, Hama Bay Town West, Homa Bay Town East, and Homa Bay Arujo ward. The main physical features are Homa Hill and Sikri Island upon which several shorelines are established. It is situated along the lakeshore lowland which ranges between 1143 to 1220m above the sea level. The area experiences two folds of rainy seasons with long rains between the months of Match-May and short rains in the months of September-November. The average temperature range is 17.10℃-34℃ which is highest in December and Match and lowest in April and November. Majority of households in Lake Victoria depended on fishing as the main economic activity which acts as a source of food, employment, and income. Water hyacinth infestation ranges from low to high with low outbreak covering up to 5m while high infestation of water hyacinth forms a dense mat of more than 5Km from the shoreline to complete coverage of the Lake at the advanced stages of infestation.

Population and sampling

According to MoA, (2016); there were approximately 1800 fisherfolks along the Shoreline. In this study, all 1800 fisherfolks were targeted. A multistage proportional -to -size cluster sampling involving four stages was followed. In the first stage, Homa Bay Shoreline was purposively selected for this study since it was the shoreline profoundly affected with water hyacinth infestation, had the highest number of fisherfolks and fishing as the main economic activity. Stage two, fisherfolk were clustered into four groups based on their administrative wards as follows; Homa Bay Central, Homa Bay Arujo, Homa Bay Town West, and Homa Bay Town East. Stage three, the number of fisherfolks in each cluster was obtained by determining the proportion of total number of fisherfolks in each administrative ward against the computed sample size of 268 fisherfolks. In the final stage, fisherfolks were picked systematically for the survey in the four clusters at an interval of every fourth fisherfolk.

Sample Size Determination

The sample size was determined by the use of Fisher's formula since it helps in sample size determination when population is known.

$S=\chi^2NP\ (1-P)/d^2\ (N-1) + \chi^2P\ (1-P)$………………………………………………………………………. (6)

Where:

S=Sample size

χ^2=Table value of Chi-square for 1 degree of freedom at 95% confidence level (3.841)

N= Population Size

P=population Proportion (assumed to be 0.5 since this would provide the maximum sample size)

d= Degree of accuracy expressed as a proportion (0.06)

Therefore:

S=$3.841*1800*0.50(1-0.50)/0.06^2*(1800-1) +3.841*0.50(1-0.50) = 268$ fisherfolks

Table 1: Summary of Distribution of Fisherfolks in the Four Administrative Wards

Name of Administrative Ward	Total Population	Sample Size
Homa Bay Central	695	103
Homa Bay Arujo	430	64
Homa Bay Town West	385	58
Homa Bay Town East	290	43
Total	**1800**	**268**

Source: Homa Bay Sub County Annual Report, (2016) and Reseacher own Computation

Survey technique

This study used questionnaire guided survey technique. The researcher with the help of three trained enumerators administered the research questionnaires to the fisherfolks in Lake Victoria. This technique was chosen since it helped interviewers to clearly explain to respondents all the variables required for the study, assist respondents who do not know how to read and write to fill research questionnaires, enabled researcher to obtain first-hand information and also to motivate them to participate in the data collection exercise.

Survey implementation

A pilot study was conducted to enhance the reliability and validity of data in this study. Information sourced from this pilot study aided in the determination of Bid values upon which mean WTP was anchored. Additionally, results from this study were used as a chief arsenal for improving the structure of the final research questionnaire to capture all the relevant components and anomalies of the study. Given all these adjustments, the final questionnaire was prepared and administered to 268 respondents by a researcher with the help of three trained enumerators.

Payment Vehicle

This study used special trust fund which was a neutral payment vehicle to help in minimizing objections and protest responses by fisherfolks along the shoreline. Based on this payment vehicle, fisherfolks were going to make a one-time contribution to help in the management of water hyacinth infestation in Lake Victoria. This special trust fund method was highly recommended due to its credibility and ability to improve the hypothetical scenario. It was thus, superior over other payment vehicles such as; fees, tax and amenity bills (Morrison, 2014).

Valuation Format

The study used payment card valuation method to source information regarding fisherfolks WTP for improved management of water hyacinth in Lake Victoria. In this format, fisherfolks were given card containing different ranges of WTP values. The use of PC format gave fisherfolks chance to scan through all the WTP values and then settled on their suitable or highest WTP value. Data obtained from this format was less scattered thus minimum samples required to yield robust estimates. PC format does not also suffer from starting point bias unlike other valuation formats commonly used in literature today. However, it has a weakness of giving a very low proportion of zero responses as compared to other formats even though it has the possibility of generating protest zero responses (Alberini, 2013).

The general valuation question was formulated as follows; "suppose the LVEMP and other environmental management authorities concerned with water hyacinth management along the shoreline would be fully implemented, what is the highest amount of money you will be WTP towards the special trust fund to help in fully realization of its goal in Lake Victoria? The PC contained seven values comprising of the Kshs. 0,100,200,300,400,500,600 and more than 600. The fisherfolks were required to circle only one amount in the card at a time to support the proposed improved management of water hyacinth in Lake Victoria by LVEMP Kenya.

Analytical framework

Following Bigerna, (2014) and Neha, (2013), the study adopted the Tobit model which is also known as censored ordinary regression for situations where the dependent variable is observed for values above zero but is censored for zero values or less than zero. This model is for metric dependent variable and is constrained in that we can only observe it at a given range, i.e., above or below some cut-off level. Censoring can be from below or from above commonly known as left or right censoring. This model is superior due to its inclusive property that is, it uses all information including those from censoring, and the ability to provide consistent estimates for all the parameter under investigation unlike other competing models (Genz, 2014). In this study, fisherfolks WTP is not directly observed and thus may take some zero values as well as positive values for the rest of the population. Given the unique properties and broad application of the Tobit model, it was used in this study for the observed maximum fisherfolks WTP values. Assume MWTP* be a latent variable which cannot be observed when it is zero or less than zero but is seen when it is (positive) above zero values.

The standard Tobit model for this study was stated as;

$$\mathrm{MWTP_i} = \begin{cases} \mathrm{MWTP}^* = \beta \mathrm{X_i} + \varepsilon_i; \text{if } \mathrm{MWTP}^* > 0 \\ 0 = \text{if } \mathrm{MWTP}^* \leq 0 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

$$\text{with } \varepsilon_i \sim \mathrm{N}(0,\, \sigma^2)$$

Where:

MWTP*=Fisherfolks unobserved maximum willingness to pay for improved management of water hyacinth

MWTPi = Actual fisherfolk maximum willingness to pay for improved management of water hyacinth

X_i= a vector of explanatory variables

β = a vector of coefficients

ε_i= the stochastic term

IV. RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents

Table 2 showed the socio-demographic characteristics of fisherfolks. Most of the fisherfolks (138) representing 58.2% were male, and (99) representing 41.8% were female. The finding showed that 74.2% were married while 25.8% were single. The results revealed that 54.6% had attained a primary level of studies, 38% had reached the secondary level of learning, and only 3.4% had a University education level. The alternative uses of the lake other than fishing related activities were as follows; Source of domestic water 31.2%, transport 47.3%, recreation 11.8%, and irrigation 9.7%. The mean age of fisherfolks was 33.12 years, 5.92 people household size, kshs. 20,324.05 monthly incomes from fishing-related activities, 4.6km distance from the place of residence to the nearest landing site/ fishing ground and 6.89 years fishing experience.

Table 2: Socio demographic characteristics of respondents

Characteristics	Frequency (f)	Percentage (%)
Gender		
Male	138	58.2
Female	99	41.8
Marital status		
Married	176	74.2
Singles	61	25.8
Education Level		
Primary	139	58.6
Secondary	90	38.0
University	8	3.4
Alternative Use of the Lake		
Source of Domestic Water	74	31.2
Transport	112	47.3
Recreation	28	11.8
Irrigation	23	9.7

Variables	**N**	**Min**	**Max**	**Mean**	**Std. Deviation**
Age	237	17	63	33.12	9.775
Size of Fisherfolk Household Size	237	1	13	5.92	2.893
Income from Fishing Activities	237	1100	65000	20324.05	11831.324
Distance to Landing Site	237	1	25	4.61	5.085
Experience	237	1	28	6.89	6.031

Source: Survey data, (2017)

Table 3 indicated Fisherfolks contributions towards the proposed management plan and estimation of their mean WTP amount. The study results showed that 28.3% of fisherfolks contributed kshs.100, 21.9% kshs.200, 17.3% kshs.300, 5.5% kshs.400, 3.8 % kshs.500 and 1.7% contributed kshs.600 while 21.5% did not contribute towards this proposed improved management water hyacinth plan. The difference in the highest amount contributed by fisherfolks was as a result of variation in income levels and perception about water hyacinth infestation along the shoreline. The fisherfolks' mean willingness to pay for improved management of water hyacinth was Kshs.175.11 with a minimum of zero and maximum of Kshs.600, the standard deviation of 144.73 and an aggregate contribution of Kshs. 42,500 (US$ 42.5) monthly respectively.

Table 3: Fisherfolks' contribution and estimation of mean WTP

Contribution Values	Number of Fisherfolks	Total amounts (KES)	Percentage (%)
0	51	0	21.5
100	67	6,700	28.3
200	52	10,400	21.9
300	41	12,300	17.3
400	13	6,500	5.5
500	9	4,500	3.8
600	4	2,400	1.7
Total	**237**	**42,500**	**100.0**

	N	Min	Max	**Mean**	Std.Deviation
Highest Amount Fisherfolk WTP For Improved Water Hyacinth Management	237	0	600	**175.11**	144.73

Source: Survey data, (2017)

Table 4 outlined the relationship between various socio-economic determinants of fisherfolks WTP decision for the improved management of water hyacinth in Lake Victoria, Kenya. The variable income from fishing activities was found to have a significant level (P=0.000), and a positive relationship with the maximum WTP amount. This showed that an increase in a fisherfolk's income resulted in an increase in the maximum amount of money a fisherfolk would be WTP for improved management of water hyacinth. It was therefore evidenced that wealthy fisherfolks were more WTP for improved management of water hyacinths than the poor fisherfolks. The study by Mironga, (2015) found the same result.

The variable age of fisherfolks was significant at 1 % level with a p-value of (P=0.000) but with a negative coefficient. This represented an inverse relationship between age of fisherfolks and WTP for improved management of water hyacinth. This result was in agreement with the expected sign of a negative since older fisherfolks had a lot of responsibilities such provision of basic needs for the entire household, payment of school fees for the children and medical expenses which collectively could not allow them to contribute more toward improved management of water hyacinth. A similar result was obtained by Ndambiri, (2015).

The variable experience of fisherfolks had a negative coefficient but with a high significant level at 1% with a p-value of (P=0.000). The result showed an inverse relationship between fisherfolk experience and WTP for improved water hyacinth management in Lake Victoria. This was against the hypothesized positive relationship with a fisherfolk's WTP for improved management of water hyacinth along the shoreline. The probable reason was that as fisherfolks become more experienced in fishing, the more the expertise to carry out fishing activity in lake with different levels of water hyacinth infestations. The respondents with higher experience were WTP less for improved management of water hyacinth than those with less experience. A similar result was realized by Sylvie, (2012). Nonetheless, some CV studies obtained contrary results (Chindah, 2011).

The variable gender of a fisherfolk was significant at 1% level (P=0.000) with a positive coefficient. This result was in line with the hypothesized positive association with the WTP for improved management of water hyacinth. The implication was that fishing is a labor-intensive economic activity which attracts more males than the females. Moreover, men were more accessed to information regarding water hyacinth infestation, its negative effects on fishery sector and management measures as compared to women. This result correlates with the finding by (Carlsson et al., 2000 and Lee &Paik, 2010). Conversely, Banga, (2013) obtained an inverse association between gender and solid waste segregation and recycling techniques in Urban Kampala.

The variable distance from the place of residence to the nearest fishing ground was significant at 1% significance level (P=0.000) with a negative coefficient as was expected. The fisherfolks near the shorelines were WTP for improved management of water hyacinth than those from off-shorelines. The study by Falola, (2012) found a similar result.

The variable perception of fisherfolks concerning water hyacinth infestation was significant at 1% (P= 0.000) with a positive coefficient as was in the priory expectation. The fisherfolks who perceived water hyacinth infestation to be an environmental menace and very serious were WTP more for improved management of water hyacinth in Lake Victoria than those who perceived it to be less serious. A study by Ogwang et al. (2014) obtained the same result.

The variable membership of a fishing group was also significant at 1% significance level with a P-value of (P=0.000) but with a negative coefficient. The fisherfolks who engaged in fishing groups had a lot of financial constraints and also contributed in kind towards the management of water hyacinth through their group's initiatives. A study by Hagos, (2012) also obtained an inverse result.

Table 4: Tobit regression results on the determinants of fisherfolks' WTP decisions for improved management of water hyacinth in Lake Victoria

Variable	Coefficient	Std. Error	Z-Statistic	Prob.
LnAge	-0.087***	0.023	-3.742	0.000
LnDistance	-0.134***	0.028	-4.712	0.000
LnExperience	-0.074***	0.020	-3.625	0.000
LnIncome	0.261***	0.052	5.017	0.000
Fisherfolks' perception	0.103***	0.024	4.241	0.000
Marital status	-0.037	0.042	-0.882	0.378
Gender	0.122***	0.030	4.066	0.000
Fishing group	-0.061***	0.017	-3.563	0.000
Education	0.024	0.021	1.144	0.245
SUMMARY STATISTICS				
Mean dependent variance 5.284				
S.E. of regression 0.175				
Sum squared residual 5.217				
Log likelihood 68.128				
Left censored observations 0.000				
Right censored observations 0.000				
Uncensored observations 186.000				
Total 186.000				

Source: Survey data, (2017)

V. CONCLUSION

The primary objective of this study was to estimate the amount of money fisherfolks were WTP for improved management of water hyacinth in Lake Victoria. The mean WTP was found to be Kshs. 175 .11 per fisherfolk with a total contribution of Kshs. 42,500 (US$ 42.5) monthly. The other objective was to examine socio-economic factors influencing fisherfolks' WTP decisions for improved management of water hyacinth in

Lake Victoria. The variables age, distance, experience, income, perception and gender were significant at 1% and met the priory decision for the sign of the coefficients except for the variable distance. The Lake Victoria management authorities both at the county and central government levels should take the opportunity to raise funds for improved management of water hyacinth in Lake Victoria. The findings show a robust positive relationship between fisherfolks' income and willingness to pay for the improved water hyacinth management. The government should support fisherfolks by creating an enabling working environment, provision of modern fishing equipment, and construction of storage plants. This will allow the fisherfolks to generate more income thus raising their contribution to support improved management of water hyacinth in the region. The Lake Victoria management authorities should support the young fisherfolks through environmental awareness and mentoring programmes. This will help in broadening their knowledge in matters related to the improved management of water hyacinth in Lake Victoria given that the literacy level among the fisherfolks is very low.

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