Economic Value of Ecosystem Restoration for Sustainable Development: A Case Study of River Migori, Kenya

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***Abstract*: River resources are major sources of ecosystem services which provide social benefits and economic benefits to humanity. Increasing population levels, industrialization and intensified land use have posed threat to the rivers and have decreased their potentials. It is very necessary to evaluate the value that people attach for the restoration of such resources. This study therefore, used contingent valuation method (CVM) to estimate the economic value that households confer to the restoration of River Migori in Kenya for sustainable development. Payment card approach was used to elicit the residents' WTP amounts. A sample of 80 respondents was obtained through multistage sampling technique who participated in the CVM survey. The study found out that the residents are willing to pay mean amount of Kshs. 5,086.25($48.25) and a total amount of Ksh. 406,900($3,859.27). The results of the Tobit regression found that the socio-economic factors which influence the individual willingness to pay amounts are gender, marital status, household size and income. In the main, the study found the general acceptance to restore the river resource which is relevant for policy formulation and which indicates that ecosystem restoration is a favored option for sustainable development.**

***Keywords*: CVM, River Resource Restoration, WTP, Sustainable Development, Tobit Model**

I. INTRODUCTION

The current upsurge in the degradation of natural ecosystem has become a global concern and has been a counter-movement against the drive to alleviate destructive impacts. The increase in human population has been credited with the responsibility of ecological degradation which the move for ecological restoration is attempting to mitigate. Changes in land use have also significantly led to challenges in the management of ecosystem services (Feld et al., 2011). The ecosystem services refer to the direct and indirect benefits that biodiversity and ecosystems provide to humans beings. Ecosystems offer a wide range of services from cultural, to regulatory and support services which directly or indirectly influences the well-being of humans through recreation, landscape values and fisheries maintenance (Vörösmarty et al., 2010). There has always been need to value these economic services due to the benefits that may be drawn from enacting public environmental policies. The economic valuation of water resources encompasses attaching value to availability of water, quality and possibility to use it variedly and give an estimate on the costs and benefits of pursuing these projects(Nilsson et al., 2016). Clear information about ecosystem and its related socio-ecological dynamics is necessary to accelerate policy formulation in ecosystem management, particularly in areas with increasing populations. It is important in the management of natural resources and for conservation. Widespread ecosystem degradation together with increased demands for goods and service they provide has been a major contribution towards global biodiversity loss(Jones, 2017).

Water is the most essential natural resource in the world. However, most of the freshwater systems are under threat by human activities and is liable to the anthropogenic climate change. Water systems are affected by the global change of land cover, urbanization, industrial development and engineering schemes such as reservoirs, irrigation and inter-basin transfers. On the global scale, over 80% of the world population is living in areas which water security exceeds 75th percentile. More than 30 out of 47 largest rivers which join to the oceans show moderate to high threats at the river mouths (Ouiminga & Tamini, 2018). Rivers around the globe are sternly degraded or threatened therefore undermining their ability to provide crucial ecosystem services. Their use in domestic consumption, daily activities, commercial production, in industries, for energy, for transportation and tourism are essential for economic growth and development. They are necessary in environmental regulation, biodiversity support, transportation of sediments and nutrients, dilution of pollutants and wastes and in flood and drought regulation(Nilsson et al., 2016).

River ecosystems in developing and developed economies are faced by excessive mining which decreases flows, development of infrastructure, pollution which makes them unfit for human and wildlife consumption and also invasive species. These activities that intensify land use, industrialization, and increase in population and change in climatic condition accelerate river resource degradation (Halkos & Matsiori, 2014). In Europe, freshwater and coastal ecosystems have been degraded posing negative effect to its rivers, catchments, floodplains and estuaries. Increased demand for water resources in urban areas and for agricultural use has led to degradation which contributes to pollution, in-stream modification and riparian habitat and also the regulation of flow(Lewis et al., 2017). In Kenya, River Migoriis a case in point for water resources that have been continuously subjected to degradation. This river serves used for industrial purposes and generation of electricity. The residents also directly benefit from this river for provision of potable water, fishery, agricultural irrigation and sand mining. For a very long time, inappropriate agricultural activities, deforestation, disposal of residential wastewaters, over-extraction and industrial discharge have polluted this river with organic contaminants. The river banks have been corroded through silting; water pollution by fertilizers, pesticides and herbicides from agricultural activities and these worsen the economic value of the water resource. The increasing rate of population, urbanization and economic activities exerts pressure on this river which hence leads to degradation. Most of the residents have lost the services of this river and therefore, there is need to improve the river water quality and to in order to lessen health hazards and restore water resources services that have been affected by degradation. River restoration will implicate costs and therefore, this study determined to estimate the residents' total willingness to pay for the restoration of River Migori ecosystem sustainable development.

The major objective for most economies in the world is to attain the state of sustainable development. In order to achieve this goal, there should be a balance between the exploitation of natural resources for economic development and ecosystem conservation which is crucial for human wellbeing and livelihood(van der Bliek et al., 2014). There is need to have more knowledge on the contribution of ecosystem services exploring the benefits and loses incurred in development interventions. The SDGs intend to restore ecosystem through improvement in water and sanitation services. It mentions the importance of integrating ecosystem values into planning, development process and poverty reduction(Huq, 2015).

II. LITERATURE REVIEW

Welfare Economics Theory

The main objective of the theory of welfare economics is to improve the well-being of the people or concerned economic agents. This study makes an assumption that, households make decision to maximize their utility from the restoration of river resource subject to income constraints. An explanation of welfare through Pareto criterion holds that, to attain efficiency the change in policy should make an individual better off without making at least one person worse off. Pareto optimality considers that public intervention is important for efficient resource allocation. For the public action to be considered worthwhile in the criterion, it should be less than the benefits gained. The modern application of welfare economics attempt to attach value on the improvement or degradation of environmental goods which can be used to determine the net gain or loss from policy implementation, and the Pareto efficiency. Changes in the quality and quantity of environmental resources may affect the welfare of individuals. It may lead to increased market prices for these resources or even exposure to health risks like for our case.

Welfare changes can be estimated through consumer surplus, compensating variation or surplus and through equivalent variation or surplus. For consumer surplus, the income is held constant with variation in utility. In the case of, compensating variation or surplus, the gains or loss is measured while holding utility constant at the initial levels whereas equivalent variation or surplus, welfare change is measured while holding utility at an alternative level. All these Hicks welfare measures relates to payment or compensation in order to maintain the utility levels, depending on the position of the consumer against the resource. Welfare changes that increase welfare, for instance river resource restoration, it is referred to as compensating surplus. This measure refers to the consumers' willingness to pay for the resource to retain the level of utility.

Contingent valuation method (CVM) is therefore used to create hypothetical scenario so as to estimate the economic value of river resource restoration to fit the Hicksian welfare estimation. This estimation is necessary since river restoration does not have market value. To establish a relationship between expenditure and the Hicksian surplus measure, the function can be expressed as bellow as modeled by (Haab & McConnell, 2002);

$$M = e(p, q, u) = min_x\{p.x/u(x, u) \geq u\} \quad \text{(Equation 1)}$$

Where; M – the minimum income required for maintaining level of utility given price, vectors

q – Vector of Environmental goods
p – Vector of Prices
u – Vector of Utility levels when $u = v(p, q, y)$
x – Vector of private goods
y – Income

Lettingp_0,q_0,u_0 and m_0 to represent the status quo and p_1, q_1, u_1 and $m_1$to be the restored state, the compensation surplus can be denoted as;

$$WTP = CS = [e(p_0, q_0, u_0 = m_0] - [e(p_0, q_1, u_0] = m_1 \quad \text{(Equation 2)}$$

$q_1$is preferred to q_0 since the restoration of the river resource results into welfare gain.in equation 2, the compensated surplus measure indicates that the consumers are willing to pay for welfare gain. CVM has the ability of estimating the Hicksian measure for the proposed policy change towards environmental good and can be viewed as a means of estimating changes in expenditure function (Mitchell & Carson, 1989). Therefore, in order to determine the economic value of river resource restoration, households' WTP has to be estimated using CVM.

The respondents of the survey were presented with the hypothetical scenario of the river in order to make them appreciate the status quo. Pictures of the river were presented so that the respondents could have enough information regarding the environmental product that they will be required to valuate. The payment vehicle that was used was special trust fund. This vehicle was chosen for its suitability in reducing objections and protest responses by the residents. This fund hypothetically requires that the respondents make a one-time contribution for the purpose of river restoration (Fonta et al., 2011). Payment card format was used to elicit the residents' preferences based on the policy proposal aimed at restoring the river resource for sustainable development. The respondents were presented with cards in which they were expected to circle the maximum amount they were willing to pay towards river restoration. The true willingness to pay therefore is a figure that is equal to or greater than the circled value but lower than the next higher value in the card. This criterion is advantageous for its ease of use by the respondents in easily identifying preferred WTP value from the given sets. It also gives data which is less scattered and therefore, even with a small sample size, a robust estimate can still be obtained(Mitchell & Carson, 1989).

III. METHODOLOGY

Study area

The study was conducted in two Sub-counties, Suna West and Suna East in Migori, Kenya which has a total population of 393,012 according to Kenya national bureau of statistics sponsored national census of 2019. It lies within longitude 0.9366^0 S and latitude 34.4198^0 S and covers an area of $2{,}588km^2$. It experiences tropical climate type with winter and summer seasons thus the rainy period and the dry spell. It experiences bimodal rainfall with the maximum occurring in March-April and the short rainfalls in July-August. It is located within the moist semi-deciduous forest type with an average yearly precipitation of average 1369mm. The average monthly temperature is 21.1^0C according to Koppen-Geiger climate classification.

Research design and Sampling Procedure

Cross-sectional approach was employed in conduction the research study. This involves data collection at one point in time through administration of structured questionnaires. Multistage sampling technique was used to identify the participants in the study. In the first stage, the study used stratified random sampling technique to establish the strata in terms of 8 administrative wards. The second stage, simple random sampling technique was used to identify 10 households per ward to be interviewed. This gave a total of 80 respondents for this study. A pilot test was done on 15 respondents in order to verify the wordings, sentence structure and the relevance of the questions. The questionnaires were administered through personal interviews by the researcher using local dialect for effective explanation of the hypothetical scenario and quality data collection.

Data Analysis

The study used Tobit model to examine the factors which influence the residents' WTP for the restoration of the river resource. This model is considered superior because of its property of inclusivity in that it uses all information even from censoring, and for its capability of providing consistent estimates for all parameters under investigation as compared to other models (Genz et al., 2014).

$$WTP = f\,(\text{Age, gender, distance, education, income, marital status, household size})$$

The standard Tobit model for this study according to (Smith & Brame, 2003) is stated as;

$$TWTP_i = \begin{cases} TWTP^* = \beta X_i + \varepsilon_i ; if TWTP^* > 0 \\ 0 = if\ TWTP^* \leq 0 \end{cases}$$

(Equation 3)

$$with \varepsilon_i \sim N(0, \sigma^2)$$

Where:

TWTP*= Residents unobserved maximum willingness to pay for the restoration of the river

$MWTP_i$ = Actual residents maximum willingness to pay for the restoration of the river

X_i= a vector of explanatory variables

β = a vector of coefficients

ε_i= the disturbance term

The Tobit model expanded in terms of the variables was specified as follows:

$$TWTP^* = \beta_0 + \beta_1 INC - \beta_2 AGE + \beta_3 EDU + \beta_4 GEN + \beta_5 MST - \beta_6 HHS + \beta_7 DIST + \varepsilon_i$$
$$with \varepsilon_i \sim N(0, \sigma^2)$$

Where:

$MWTP^*$=maximum residents willingness to pay value for the restoration of the river

$\beta_0 - \beta_7$= Regression coefficients

INC= Household income

AG =Age of the residents

EDU = Education level of the residents

GEN =Gender of the residents

MST =Marital status of residents

HHS= Household size

IV. RESULTS AND DISCUSSION

A. Ward of the Respondents

The survey was conducted in two sub-counties of Migori County. Stratified sampling technique was used whereby the population was divided into 8 wards as outlined by IEBC and the simple random sampling technique was used to select 10 respondents per ward. Table 1 represents the data on respondents per ward.

Table 1:Ward of the Respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
Suna central	10	12.5	12.5	12.5
Kakrao	10	12.5	12.5	25.0
Kwa ward	10	12.5	12.5	37.5
God jope ward	10	12.5	12.5	50.0
Wiga ward	10	12.5	12.5	62.5
Wasweta 2 ward	10	12.5	12.5	75.0
Ragana ward	10	12.5	12.5	87.5
Wasimbete ward	10	12.5	12.5	100.0
Total	80	100.0	100.0	

Source: Field data, 2020

B. Socio-demographic Characteristics of the Respondents

The socio-demographics that were collected from the respondents were age, gender, level of education and marital status.

Age of the Respondents

Table 2: Age of the Respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
below 20 years	3	3.8	3.8	3.8
20-30 years	15	18.18	18.18	22.5
31-40 years	28	35.0	35.0	57.5
41-50 years	25	31.3	31.3	88.8
51-60 years	8	10.0	10.0	98.8
Above 60 years	1	1.3	1.3	100.0
Total	80	100.0	100.0	

Source: Field data, 2020

The majority of the respondents interviewed were aged between 31-40 years followed closely by the age group between 41-50 years which is represented by 35.0 per cent and 31.3 percent respectively. 3.8 percent of the respondents were below 20 years, 18.18 percent aged between 20-30 years, 10.0 percent aged between 51-60 years while only 1.3 percent accounted for the respondents above 60 years as presented in table 2. This reveals therefore, that the majority of the respondents interviewed were in a productive age.

Gender of the Respondents

Table 3: Gender of the Respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
female	37	46.3	46.3	46.3
male	43	53.8	53.8	100.0
Total	80	100.0	100.0	

Source: Field data, 2020

As in table 3, the study results about the gender of the respondents indicate that male respondents were highly represented by 53.8 percent while female respondents were represented by 46.3 percent. This is due to the fact that, in many households men are regarded by every family member as the head and is therefore responsible for making major family decisions.

Marital Status of the Respondents

The data presented by table 4 reveals that the majority of the respondents, 58.8 percent were married couples. Those who were single were 26.6 percent followed by those who are widowed at 15.0 percent. This gives a true picture of a society whereby the three marital statuses is composed of many who are married with few widows.

Table 4: Marital Status of the Respondents

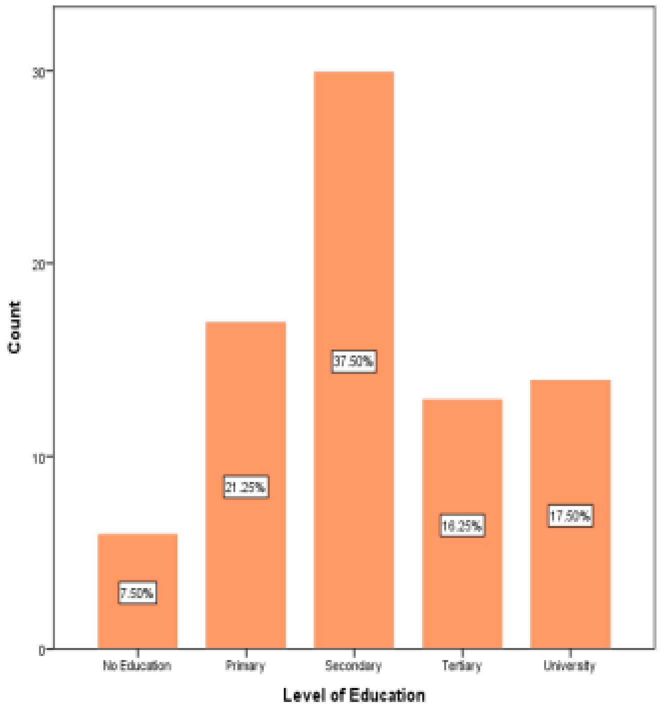
	Frequency	Percent	Valid Percent	Cumulative Percent
Married	47	58.8	58.8	58.8
Single	21	26.3	26.3	85.0
Widowed	12	15.0	15.0	100.0
Total	80	100.0	100.0	

Source: Field data, 2020

Respondent Level of Education

The findings represented by figure 1 reveal that the majority of the respondents to the survey, 37.50 percent had secondary education. This is followed by 21.25 percent who had primary education, 17.50 percent with university degrees and 16.25 percent with tertiary education. Only 7.50 percent of the respondents had no formal education. This information therefore reveals that a majority of the respondents had formal education which is likely to influence they behavior towards willingness to pay towards restoration of an ecosystem for sustainable development. The educated respondents are likely to pay more for the restoration due to the fact that they have knowledge on degradation of an ecosystem.

Fig 1: Respondent Level of Education

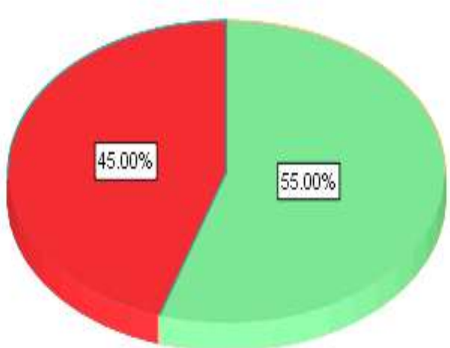


Source: Survey Data, 2020

Employment Status of the respondents

This variable analyzed the number of respondents who had formal employment both in public and private sectors. The research found out that out of the respondents interviewed, only 45.0 percent had formal employment. A majority, 55.0 percent had no employment and stated that they depended on subsistence farming. The employment status influences the disposal income of the respondents which determines their standard of living and hence affects their willingness to contribute towards the restoration of an ecosystem for sustainable development. Those are employed are expected to be more willing to pay since they have more income.

Figure 2: Employment Status of the respondents



Source: Survey Data, 2020

Respondent Household Income per Year

Table 5: Respondent Household Income per Year

	N	Minimum	Maximum	Mean	Std. Deviation
Income per year	80	10000.00	700000.00	133650.0000	143350.86636

Source: Survey Data, 2020

The data in table 5 shows that the mean household income per year is Ksh. 133650.00 with the least household income taking home Ksh10000.00 in a year while the highest income earner indicated that they bag Ksh 700000.00 each year. The standard variation for the household income was found to be Ksh 143350.86636. With an increase in the household income, propensity to consume also increases and this therefore leads to an increase in the probability of the respondents' willingness to pay for the restoration of an ecosystem for sustainable development.

Respondent Household Size

Table 6: Respondent Household Size

	N	Minimum	Maximum	Mean	Std. Deviation
Household Size	80	1.00	12.00	4.6375	2.05767
Valid N (listwise)	80				

Source: Survey Data, 2020

The average household size of the respondents was found to be about 5 people. The minimum household size was 1 person with a maximum of 12 people and a standard deviation of 2.05767. This finding rightly fits the condition of Migori County demographics in which every woman can expect to have 5 children in her life time. According to the reproductive, maternal, neonatal and child health report, (KNBS, 2015) the total fertility rate in Migori County lies at 5.3 which is higher than the national rate of 3.9.

Source of Water

Table 7: Source of Water

		Frequency	Percent	Valid Percent	Cumulative Percent
	Tap	12	15.0	15.0	15.0
	River	49	61.3	61.3	76.3
	Borehole	19	23.8	23.8	100.0
	Total	80	100.0	100.0	

Source: Survey Data, 2020

The research also established the source where the respondents draw their water for household consumption. It found out that a greater percentage, 61.3 percent relied on the river as the major source of water while 23.8 percent drew water from boreholesand15.0 percent stated that they use water from tap.

Perceived Quality of the Sources

Table 8: Quality of the Sources

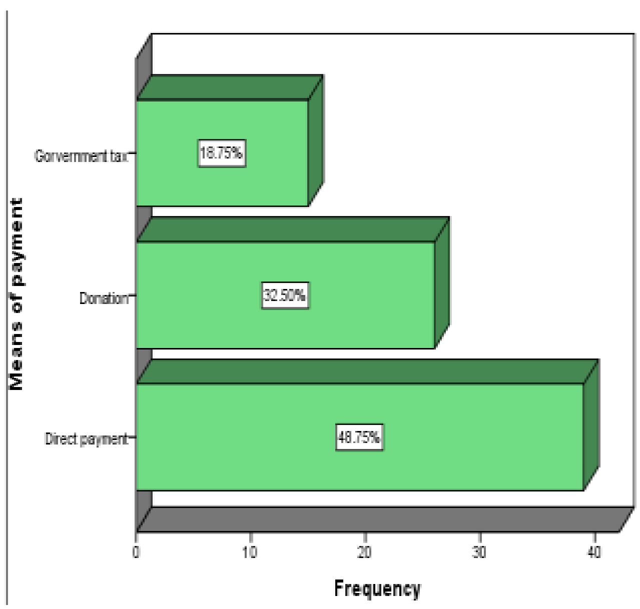
	Frequency	Percent	Valid Percent	Cumulative Percent
Very good	5	6.3	6.3	6.3
Good	15	18.8	18.8	25.0
Poor	37	46.3	46.3	71.3
Very poor	23	28.7	28.7	100.0
Total	80	100.0	100.0	

Source: Survey Data, 2020

The respondents were asked to rate the quality of the major sources that they used. A greater percentage, 46.3% of the respondents perceived sources to be poor with 23.8% classifying them to be very poor. 18.8% rated them to be of good quality while 6.3% rated them very good. Since majority use river water, the study assumed that most of the respondents, who stated poor and very poor referred to the current state of the river, hence need for restoration.

Preferred Means of Payment

Figure 3: Preferred means of Payment



Source: Survey Data, 2020

Figure 3 presents data on the respondents' preferred means of payment towards the restoration of an ecosystem for sustainable development. Many respondents showed their preference for direct payment represented by 48.75 percent. 32.50 percent preferred payment through donations and payment in kind. A smaller percentage, 18.75 percent however, preferred deduction to be done in form of government tax.

Willingness to pay for the restoration of an ecosystem for sustainable development

Table 9: Willingness to pay for the restoration of ecosystem

Mean WTP	5,086.2500
Median WTP	3,000.0000
MinimumWTP	100.00
MaximumWTP	50,000.00
TOTAL WTP	406,900.00

Source: Survey Data, 2020

In Table 9, the respondents' willingness to pay values is presented. The survey used an open-ended valuation format in order to elicit the respondents stated preference value. This method allows the respondents to freely choose the amount they are willing. It is however prone to strategic bias since most of the respondents may over quote or under-quote values in the view that they may influence the policy recommendation by their response. The payment vehicle that was chosen for the study was a special trust fund where the respondents were expected to make one-time payment towards the restoration of ecosystem for sustainable development. The results therefore, indicate that the respondents are willing to pay a total of Ksh. 406,900.00 with a mean willingness to pay of Ksh 5,086.25 and median of Ksh. 3,000.00. The results for the total, mean and median willingness to pay can be attributed to the fact that majority of the respondents were middle class and low income earners.

Determinant Factors of Total Willingness to pay towards Ecosystem Restoration

The Tobit regression analysis in table 10 was used to determine the factors Influencing Residents willingness to pay towards Ecosystem Restoration. The chi square value (Prob> chi^2=0.000) for the model was significant at 1% level of significance, implying that the explanatory variables jointly influence the residents willingness to pay. The pseudo R^2 was 42.88% meaning that the willingness to pay is explained more by the variables. The coefficient signs show the change in the probability of the willingness to pay; positive indicates an increased probability while negative indicates decreased probability to pay. The variables; gender, marital status, household size and income were found to significantly influence the total willingness to pay value at 5% level of significance. However, the variables; age, education and employment status were not significant.

The variable gender was found to be significant (P>|z|=0.0100)with a positive coefficient. This means that men were more willing to pay towards ecosystem restoration for sustainable development as compared to female gender. The implication for this could be that, men are more exposed to the information regarding ecosystem restoration. Further, it can be due to the fact that men are the household budget controller and therefore, have a lot of money at their disposal.

The study of John et al., (2019) on water hyacinth management also found out the same results.

The variable marital status of the respondents also tested significant (P>|z|=0.0100), with a negative coefficient. This finding indicates that the married couples are more willing to contribute towards the ecosystem restoration for sustainable development as compared to the singles. A survey conducted by Bamwesigye et al., (2020) on the willingness to pay for forest existence value and sustainability posit that marital status has an influence on response to payment behavior. Married couples tend to be cautious towards environmental hazards that may affect the health of their children and hence tend to be more willing to contribute towards its conservation.

The variable household size was found to significantly influence the respondents willingness to pay towards ecosystem restoration for sustainable development at 1% level of significance (P>|z|=0.009), with a positive coefficient. The large families demand large quantities of water for domestic use therefore it will be expensive to purchase water or difficult to obtain water from a different source. Further, they are likely to spend much on the health services caused by poor quality water and hence are more willing to pay towards river restoration (Cook et al., 2016).The residents' income (P>|z|=0.0100), significantly influence the residents' decision for river restoration with a positive correlation. This implies that with an increase in the household income, there would be a significant increase in the likelihood of the willingness to pay for river restoration *ceteris paribus*. In economic theory, river is therefore treated as a normal good where the demand shifts with the direction of income change. A study by (Ouiminga & Tamini, 2018) which came up with a similar finding opine that for the sustainable management of the river, the residents' actions must be consistent with economic theory.

V. CONCLUSION

The study aimed at examining the economic value of river resource restoration for sustainable development. It considered the amount which the residents were willing to pay for the restoration of River Migori in Kenya using responses from the contingent valuation payment card format. A total of 80 respondents were sampled for this study from Suna-West and Suna-East Sub-Counties. The results of the revealed preference evaluation reveal that, the residents are willing to pay mean amount of Kshs. 5,086.25 and a total of Kshs. 406,900 in a year. The socio-economic factors that influence the payment amounts were found to be gender, marital status, household size and household income. Since river restoration may not be static, it is necessary to work with a three-year plan in order to achieve the desired conditions. Therefore, it will be necessary to put in place measures that will sensitize the river resource users on the necessity of restoration and to decongest riparian lands. The willingness to pay amounts can be used in the policy formulation since the individuals' preferences are determinate.

Table 10: Factors Influencing Residents WTP towards Ecosystem Restoration

Wtp	Coef.	Std. Err.	Z	P>|z|	[95% Conf.	Interval]
Gen	.1892985***	.0711823	2.66	0.010	.0474323	.3311647
Age	-.0798799	.183402	-0.44	0.664	-.4453995	.2856398
Mst	-.2915899**	.1161382	-2.51	0.014	-.523053	-.0601267
Educ	.1254755	.1651906	0.76	0.450	-.2037489	-.0601267
Hhs	.2300989***	.0857426	2.68	0.009	.0592141	.4009837
Employ	-.0512866	.1935965	-0.26	0.792	-.4371238	.3345506
Income	.7516822***	.1037919	7.24	0.000	.5448251	.9585392
_cons	-1.600253	1.010719	-1.58	0.118	-3.614612	.4141067
/sigma	.6173436	.0508707			.5159585	.7187287

Log likelihood = -76.423195

Number of obs = 80

LR $chi^2(7)$ = 114.73

Prob> chi^2 = 0.000

Pseudo R^2 = 0.4288

3 left-censored observations at wtp< = 4.6051702

76 uncensored observations

1 right-censored observation at wtp> = 10.819778

***Significant at 1% level, ** Significant at 5%level, *Significant at 10% level

Source: Survey results, 2020

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