ABSTRACT

This paper aims to assist policy makers in formulating efficient and sustainable wetland management policies by providing results of a valuation study on the Yiganda wetland, one of the segments of Lake Tana wetlands. A choice experiment is employed to understand and identify the preference and values of the wetland community for the various ecological and economic functions of the Yiganda wetland. A random parameter logit model, in addition to the multinomial logit models, is estimated to account for heterogeneity in the preferences of the public for the various functions of the wetland. The results indicate that there are positive and significant economic benefits associated with ecological and economic attributes of the Yiganda wetland. Socio-economic characteristics of respondents have significant impacts on the choice of respondents. Using a random parameter model we find that preserved ecology function surface area and fish stock are the two greatest contributors to welfare. The results also reveal that there is considerable preference heterogeneity across the public and on average they derive positive and significant values from sustainable management of this wetland.

Keywords: Choice experiment, multinomial logit models, random parameter logit model, valuation, wetlands, Yiganda wetland.

1.INTRODUCTION

Wetlands are ecosystems or units of the landscape that are found on the interface between land and water (Ramsar Convention Bureau, 1997). They are among the Earth’s most productive ecosystems, providing valuable ecological functions and services. The Ethiopian Water Resources Management Policy uses the same definition of wetlands as the Ramsar Convention. Ethiopia; however, neither has a national policy for wetland development nor signed the Ramsar convention. Nonetheless, it is very recently that awareness of importance of wetlands has been growing in Ethiopia. Wetlands are estimated to cover 1.14% and 3.7% of the total landmass of the country and the Amhara national regional state, respectively. This may appear small but it is very important for the country's ecology and for many people who use these areas. Fishing, growing crops, grazing, transportation, and drinking water for humans and livestock are among the major benefits of wetlands to many peasants of Amhara region. Despite these benefits currently due to population pressure and the subsequent demand for more resources to sustain rural livelihoods, wetlands are under threat in the region.

Wetlands of Lake Tana are at the top of the list of “wetlands of international importance”. The Yiganda wetland is one of the largest segments of Lake Tana wetlands. This wetland is located in Bahir Dar city administration, southern tip of Lake Tana and adjacent to Zegie peninsula. The site is one of the water fowl census areas. It is a lowland plain and is regularly flooded with water. The total area of the wetland is around 533ha. The wetland is surrounded by five rural kebeles which accommodates 3164 households. Yiganda wetland had the highest species diversity and evenness. The site is internationally recognized as important bird area (IBA). Currently this area is not protected and the ecological and biodiversity function of the area has been severely affected by the community.

Economic Valuation of the Yiganda wetland will provide useful information for the improved and efficient utilization of resources within and surrounding the wetland as well as for sustainable management and policy decisions. The information will also draw attention to the potential economic losses arising from continued degradation and thus give an impetus for wise use of the wetland resources by the community. Understanding the economic incentives that are driving resource use will also be helpful in better management of the Wetland.

Thus; this paper addresses the following objectives:

- Estimate the marginal willingness to pay and welfare impacts of improvements of each attribute of the wetland area and estimate marginal rate of substitution between attributes of the Yiganda wetland which will help extract relevant information to improve the values of the wetland and ensure the sustainable management of the wetland.
area.

- Identify socio-economic determinants of willingness to pay for different attributes.
- Identifying major causes and agents responsible for the overall degradation of the Yiganda wetland and other similar wetland areas.

2. Data Collection and Survey Design

The data sources for this paper were based on primary data collected from residents of the residing kebeles, using a stratified random sampling framework. The main sampling unit of the survey was the household. The choice experiment survey was then administered to be representative of the sample population in terms of income, social status, proximity to the wetland area. There are four steps involved in the design of our choice experiment:

(i) Definition of attributes and attribute levels, (ii) experimental design and survey administration, (iii) questionnaire development, and (iv) Choice of Sample and Sampling strategy. These four steps should be seen as an integrated process with feedback. The development of the final design involves repeatedly conducting the steps described here, and incorporating new information as it comes along.

2.1. Experimental Design and Survey Administration

The next step in choice experiment survey design is the experimental design. Experimental design deals with how to create choice sets in an efficient way, i.e., how to combine attribute levels into alternatives and choice sets. A design is developed in two steps: 1) obtaining the optimal combinations of attributes and attributes levels to be included in the experiment, and 2) combining those profiles into choice sets.

More recently, researchers in marketing have developed design techniques based on D-optimal criteria for nonlinear models in a choice experiment context. Thus; four principles have been identified for an efficient design of a choice experiment based on a nonlinear model: 1) Orthogonality, where attribute levels within each choice set are not correlated; 2) level balance, where attribute levels occur the same number of times within a choice set; 3) minimal overlap, where attribute levels are not repeated within a choice set; and 4) utility balance, where each alternative within a choice set has approximately the same utility.

In this paper, the OPTEX procedure in the SAS statistical software was used to produce a design that met principals 1, 2, and 3 above. Although utility balance is an important characteristic that results in arguably more efficient designs and estimations, it requires acquisition of prior information, which was not possible in this case, given a limited budget and complicated field logistics in addition with absence of prior information.

3. Econometric Model Specification

3.1 Theoretical Framework

Traditional microeconomic theory constitutes the basic theoretical foundation of the choice experiment application. Hence consumers are assumed to seek to maximize utility subject to a budget constraint. Specifically, the choice experiment approach combines the characteristics theory of value (Lancaster, 1966) and the random utility theory (McFadden, 1974).

3.2 The Characteristics Theory of Value

The choice experiment method has its theoretical grounding in model of consumer choice. Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. According to the characteristics theory of value, the probability of choosing a specific alternative is a function of the utility linked to the same alternative. Moreover, the utility derived from each alternative is assumed to be determined by the preferences over the levels of the attributes provided by that alternative. The assumption that individuals derive utility from the characteristics of a good rather than from the good itself, implies that a change in one of the characteristics (such as the price) may result in a discrete switch from one good to another will however affect the probability of choosing that specific commodity on the margin.

Table 1: Wetland attributes and attributes levels to be used in the choice experiment.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Definition</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish stock</td>
<td>The program rehabilitates and improves the condition and the level of abundance for endangered fish species through introduction of the species, improving the quality of the wetland water, reducing the wetland degradation (through installing appropriate treatment plant). This will improve the quality</td>
<td>Low (current deteriorating status) Medium (increase fish stock by 20%) High (increase fish stock by 40%)</td>
</tr>
</tbody>
</table>
of wetland water & enhance the abundance and biodiversity of the various fish specious.

**Preserved ecology function**

The plan is designed in response to the mismanagement of the highly ecological function

- Low (current degraded status)

**surface area**

surface area of the wetland. The program is to design the wetland so as to preserve and conserve the highly important ecological functioning lake side of the wetland for its ecological functions and use some part of it for agricultural production.

- Moderate (preserve 50% of EFSA for ecological services)
- Intensive (preserve 100% of EFSA for ecological services)

**Fenced Surrounding Vegetation**

The planned measure is to protect the area by prohibiting open access and afforestation of the degraded area with a variety of tree species and grasses and allow for proper utilization of the surrounding vegetation cover.

- Open access (current degraded status)
- Fenced surrounding vegetation

**Monetary Payment**

The total cost for the individual per month if the alternative was chosen in terms of increase in tax.

- No payment
- 10 birr
- 20 birr

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Scenario A (Current Status quo)</th>
<th>Scenario B</th>
<th>Scenario C (Status quo)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fish Stock/Abundance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 increase in the fish stock</td>
<td>40 increase in the fish stock availability</td>
<td>Low (deteriorating)</td>
</tr>
<tr>
<td></td>
<td>availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preserved ecology function</strong></td>
<td>Half protection of the EFSA</td>
<td>Deterioration of ecological services of the wetland</td>
<td></td>
</tr>
<tr>
<td><strong>surface area (PEFSA)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3. Random utility theory (RUT)
In choice experiment, where the respondent is asked to choose the most preferred among a set of alternatives, random utility theory can be used to model the choices as a function of attributes and attribute levels. According to the random utility theory (McFadden, 1974), the individual is assumed to make choices based on the attributes of the alternatives with some degree of randomness. RUT says that utility derived by individuals from their choice is not directly observable, but an indirect determination of preferences is possible, and assumes that the utility function of a good can be broken down into two parts, one deterministic or systemic part (V) and one stochastic part (ε), which is independent of the deterministic part and follows a predetermined distribution and this implies that predictions cannot be made with certainty.

3.4. Econometric model specification of Yiganda wetland choice experiment

The choice experiment modeling was specified with the assumption that the observable utility function would follow a strictly additive form. The analysis of the choice experiment is estimated using multinomial logit (MNL) and random parameters logit (RPL) models. Under the MNL model; two different models are estimated, the basic and extended models. The basic model estimates the importance of attributes, which are included in the choice experiment, in determining the choice of respondents among different alternatives (options with varying levels of attributes). The extended model, in addition to attributes, incorporates the socio-economic characteristics. Since socio-economic characteristics do not vary for a single respondent they will be interacted either with the alternative specific constants (ASC) or attributes. The random parameters logit model (which is also called the mixed logit model) relaxes the restriction of the MNL model and is able to overcome limitations enumerated in the MNL model.

There are three indirect utility functions derived from the above three models, each representing the utility generated by the respective choice options. Option 1 and 2 involve an improvement in the wetland attributes relative to option 3. Option 3 represents the status quo, current status.

For three utility functions, one representing utility from the status quo levels of attributes, there will be two ASCs since MNL is homogeneous of degree Zero in attributes. Since the attribute parameters are not alternative specific, i.e. the effect on the choice probability of choosing option 1 when an attribute changes is exactly the same as for alternative 2, we have a generic design choice experiment. Thus, we estimate the models with a common intercept (ASC) for choice options 1 and 2.

3.5 Model 1: The MNL model:

A. The Basic Model

The model was specified in such a way that the probability of selecting a particular scenario alternative was a function of attributes of that scenario and of the alternative specific constant. Even though heterogeneity of preferences is likely to exist, the basic model is based on the assumption that preference of individuals is homogeneous. The indirect utility from the proposed wetland improvement would take the following form:

\[ V_i = \beta + \beta_{fsh} fsh + \beta_{pfsa} fsa + \beta_{fsv} fsv + \beta_{mp} mp ; i = 1, 2, 3 \ldots \ldots \ldots 1 \]

Where, \( V_i \) represents indirect utility for the three alternatives, \( \beta \) stands for alternative specific constant, and \( \beta_{fsh}, \beta_{pfsa}, \beta_{fsv}, \text{ and } \beta_{mp} \) are coefficients of fish stock, preserved ecology function surface area, fenced surrounding vegetation and monetary payment respectively.

More specifically, the three indirect utility functions can be represented as:

\[ V_1 = ASC + \beta_{fsh} fsh + \beta_{pfsa} fsa + \beta_{fsv} fsv + \beta_{mp} mp \ldots \ldots \ldots (1.1) \]
\[ V_2 = ASC + \beta_{fsh} fsh + \beta_{pfsa} fsa + \beta_{fsv} fsv + \beta_{mp} mp \ldots \ldots \ldots (1.2) \]
\[ V_3 = \beta_{fsh} fsh + \beta_{pfsa} fsa + \beta_{fsv} fsv + \beta_{mp} mp \ldots \ldots \ldots (1.3) \]
Where: $V_1$ and $V_2$ represent the indirect utilities derived from improvements in the wetland while $V_3$ represents the indirect utility from the status quo option. The $\beta$ values; $\beta_{fsh}$, $\beta_{PEFSA}$, $\beta_{FSV}$, and $\beta_{mp}$, are the coefficients associated with each of the attributes; fish, PEFSA, FSV, and monetary payment, respectively. Here it has to be noted that the $\beta$ coefficients are each confounded by a different scale parameter $\mu$, and hence; cannot be interpreted as the contribution made to utility by each attribute in any absolute sense as they are. In other words, they are dependent on the variance of the error involved in the estimation process, (Swait and Louviere 1993).

B. The Extended Model:
This model is the extension of the basic model in such a way that some socio-economic variables are also included. This can be an important part of the model estimation process as the socio-economic variables may help to account for observed preference heterogeneity and overcome problems associated with violation of the IIA assumption in the basic model, and thus individual preferences will be unbiased. However, they cannot be introduced alone into the modeling. Because respondent characteristics do not vary across alternatives, ‘Hessian singularities’ arise in the model estimation process unless the socio-economic characteristics are introduced as interactions with either the attributes or the ASCs (Bennett and Blamey, 2001). Further all socio-economic characteristics are not included due to possible multi-collinearity problems and after repeated trials 5 variables are interacted with the ASC. Note that in many choice experiments, the socioeconomic characteristics are interacting with the alternative-specific constants. In that case they will not affect the marginal willingness to pay. Further interacting with the alternative specific constants is the most common approach to introduce observed heterogeneity. The socio-economic variables include are: age, year of education, family size, sex and household monthly income. The extended model may be specified as:

$$V_i = ASC + \beta_{fsh}f_{sh} + \beta_{PEFSA}PEFSA + \beta_{FSV}FSV + \beta_{mp}mp + \gamma_1(ASC \times age) + \gamma_2(ASC \times redu) + \gamma_3(ASC \times famsiz) + \gamma_4(ASC \times sex) + \gamma_5(ASC \times incm)\ldots$$

(2)

Where: i=1, 2, 3 for the three scenario options; ASC=0 for the status quo and 1 for options 1 and 2. Interaction of the socio-economic characteristics with the alternative specific constant is the most commonly used solution to deal with the heterogeneity problem as well as possible violation of the IIA assumption (Bennett and Blamey, 2001, Birol et al., 2005, Alpizar et al., 2001). Interaction of socio-economic characteristics with attributes is also possible in order to test for a socio-economic characteristic difference in preferences for various specific attributes.

Model 2: The RPL model:
Under the random parameters logit model, the alternatives are not independent, i.e. the model does not exhibit the IIA property, and there is an explicit account for unobserved heterogeneity. Thus the RPL model relaxes the restrictions of the above two models and is able to overcome limitations enumerated in the MNL model. The random utility function in the random parameter logit model will take the following form (Birol et al., 2005):

$$U_{ni} = V_{ni} + \epsilon_{ni} = Z_i(\beta + \mu_n) + \epsilon_{ni}$$

(3)

Where: respondent $n$ receives utility $U$ choosing option $i$ from a choice set $C$. Utility is decomposed into a non-random component ($V$) and a stochastic term ($\epsilon$); and the indirect utility is assumed to be a function of the choice attributes $Z$ (fish, PEFSA, FSV and monetary payment) with parameters $\beta$, which due to preference heterogeneity may vary across respondents by a random component. Socio-economic characteristics may or may not be included in the model.

4. Estimation and Discussion of Results

A. Results of the MNL model:
The estimated results of the multinomial logit model are presented in two models, model 1 which consisted of the attributes only and model 2 which includes the socioeconomic variables. The MNL model estimation results are given in Table 3 below.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1 (the basic model)</th>
<th>Model 2 (extended model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coeff. (P-value)</td>
<td>Coeff. (P-value)</td>
<td></td>
</tr>
<tr>
<td>ASC</td>
<td>-.2539 (.4038)</td>
<td>-.3428E-1 (.9741)</td>
</tr>
<tr>
<td>Fish Stock</td>
<td>1.382*** (.0000)</td>
<td>1.411*** (.0000)</td>
</tr>
<tr>
<td>PEFSA</td>
<td>1.289*** (.0000)</td>
<td>1.307*** (.0000)</td>
</tr>
</tbody>
</table>
Coefficients from the first two columns of the above table represent estimates from the basic multinomial logit model (Model 1). The coefficients of all attributes (fish stock, PEFSA, FSV and payment attribute) are statistically significant at the 1% level. All of the wetland management attributes, included for the study, are significant factors in the choice of a wetland management scenario. At this stage the parameters does not reveal that much information to us. The sign tells us whether the probability of choosing an alternative increases or decreases when the level of the attribute increases. It may be mis-leading to reveal the relative importance of the attributes in terms of the effects on the respondents’ choices from the relative magnitudes of the parameters unless they are measured on the same scale. The three attributes (fish stock, PEFSA, FSV) have the expected positive signs. This implies that an increase in the level of any of the above three attributes in an alternative increases the probability of choosing that alternative. In other words, the wetland community most likely choose those wetland management plans which result in more fish stock, preserved ecological function surface area and fenced grazing land and forest area. The sign of the payment coefficient indicates that the effect on utility of choosing an alternative with a higher payment level is negative, which is consistent with the demand theory that “cheaper” alternatives or plans are preferred to ‘more expensive’ options after other characteristics are held constant. Overall, these results indicate that positive and significant economic values exist for higher levels of various attributes of the wetland, but do not want to be charged higher prices.

While the positive and significant sign on the ASC coefficient implies that a positive utility impact occurs in any move away from the status quo, the negative sign of the ASC coefficient, in our study, implies that a negative utility impact could occur in any move away from the status quo and care needs to be taken in designing wetland management plans. Unless some care is taken in the design of the improvement plans so that disutility might not occur in the new wetland

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Coefficient 1</th>
<th>Coefficient 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSV</td>
<td>1.1840***</td>
<td>1.209***</td>
</tr>
<tr>
<td>Monetary payment</td>
<td>-.1542***</td>
<td>-.1566***</td>
</tr>
<tr>
<td>ASC*Age</td>
<td>-.5213E-1***</td>
<td></td>
</tr>
<tr>
<td>ASC*Yrs of education</td>
<td>.1757***</td>
<td></td>
</tr>
<tr>
<td>ASC*family size</td>
<td>-.2537***</td>
<td></td>
</tr>
<tr>
<td>ASC*Sex</td>
<td>.6961*</td>
<td></td>
</tr>
<tr>
<td>ASC*Income</td>
<td>.3394E-2***</td>
<td></td>
</tr>
<tr>
<td>Log-L for Choice</td>
<td>-646.737</td>
<td>-591.663</td>
</tr>
<tr>
<td>Rsq Adj</td>
<td>.184</td>
<td>.249</td>
</tr>
<tr>
<td>Iteration completed</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Number of Obs.</td>
<td>900</td>
<td>900</td>
</tr>
</tbody>
</table>

***Significant at 1% level; **Significant at 5% level; *Significant at 10% level
management plans. However, the coefficient of the ASC in our study is insignificant, which implies that the designed scenario improvement designs in any way will not significantly add disutility to the wetland community.

In the extended MNL model (model 2), five socio-economic characteristics (age, years of education, family size, sex and households’ disposable income) are interacted with the alternative specific constant. All the socio-economic characteristic coefficients, except sex, are statistically significant at 1 percent level. Sex is significant at 10 percent level. Thus, these socio-economic characteristics are significant determinants in the choice of alternative scenario of improvements.

The log likelihood ratio test, which is a better test of model fit for logit models, rejects the null hypothesis that the regression parameters are equal at 5 percent significance level. Hence improvement in the model fit can be achieved with the use of the extended model (model 2). The overall explanatory power of a model can also be assessed using the value of log-likelihood and the McFadden’s pseudo $R^2$. The larger the value of log-likelihood and pseudo-$R^2$, the better is the fit of the model to the observed data. In this study the extended extended model (model 2) has relatively better explanatory power than the basic model in both criteria. This may be due to the fact that the second model has incorporated observed heterogeneity by allowing for interaction of socio-economic characteristics with ASCs. However; the sign of the attributes are the same with the basic model (Model 1) with a small difference in their magnitudes which are as a result of observed heterogeneity in tests among respondents. Among the co-variables, interaction variables age and family size have negative signs. This means that individuals who are older and with large number of children are less likely to choose the two new alternatives compared with leaders of households who are younger and with small number of family size. This fact implies that household leaders with older age have less concern about the future generation and conservation of resources (i.e. less bequest vales). This fact is somehow contrary to the findings of other studies in developed countries. This has been expected to be as a result of the factors such as most of them earn income on the cost of environmental conservation and have a fear of decline in income from such management scenarios due to less awareness creation done before. The fact that interaction between the family size and ASC is negative is contrary to findings of other valuation studies which have shown that having more children has a positive influence on the respondents’ valuation of environmental goods (e.g., Kosz 1996) due to the ‘bequest motives’. Education and income have positive signs. Confirming the results of several environmental valuation studies, those respondents with higher levels of income and education are likely to prefer wetland management scenarios that provide higher levels of the ecological, social and economic wetland attributes due to environmental consciousness.

On the other hand underlying the MNL model is the assumption of IID error terms which has an equivalent behavioral assumption, the assumption of IIA. The IIA assumption states that the ratio of the probabilities of any two alternatives should be preserved despite the presence or absence of any other alternative within the set of alternatives included within the model (i.e. $P_i/P_j$ will remain unaffected by the presence or absence of any other alternative within the set of alternatives modeled). If the IIA property is violated then MNL results will be biased and hence a discrete choice model that does not require the IIA property, such as random parameter logit (RPL) model, should be used. To test whether the MNL model is appropriate, the Hausman and McFadden (1984) test for the IIA property is employed. The test, known as the Hausman-test of the IIA assumption, is conducted in two stages; first the analyst estimates an unrestricted model complete with all alternatives before estimating a model synonymous with the alternative hypothesis using a restricted number of alternatives.

In specifying the second “restricted” model the same specification (in terms of the attributes) should be used. The test-statistic is shown below:

$$q = [b_u - b_r] [V_r - V_u]^{-1} [b_u - b_r]$$

Where: $b_u$ is a column vector of parameter estimates for the unrestricted model and $b_r$ is a column vector of parameter estimates for the restricted model; and $V_r$ is the variance– covariance matrix for the restricted model and $V_u$ is the variance–covariance matrix for the unrestricted model.

Even if the standard Hausman test could not be completed as the difference matrix was not positive definite and hence the violation of the IIA assumption is not known in the MNL model, according to Alpizar et al. (2001), there is also another problem with the MNL specification i.e., there is a limitation in modeling variation in taste among respondents. This problem arises due to observed and/or unobserved heterogeneity. Observed heterogeneity can be incorporated into the model by allowing for interaction between socioeconomic characteristics and attributes of the alternatives or ASC terms but it could not detect unobserved heterogeneity. Thus an alternative method of estimation, which does not require the IIA assumption and can account for unobserved heterogeneity in preferences across respondents, should be used.

B. Results of the RPL:

As stated above, the MNL model does estimates of utility based on the assumptions of IIA property and homogeneous preference across respondents. Assumptions about the IIA property can be tested to check whether MNL can be used or not. Preferences; however, are in fact heterogeneous and accounting for this heterogeneity enables estimation of unbiased estimates of individual preferences and enhances the accuracy and reliability of estimates of demand, participation, marginal and total welfare. Furthermore, accounting for heterogeneity enables prescription of policies
that take equity concerns into account. An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary (Adamowicz and Boxall, 2001). As Birol et al. (2005) suggested in pure public goods, such as the wetland studied in this CE, a random parametric logit model, which did not require the IIA assumption and can account for preference heterogeneity across respondents, should be used as an alternative method of estimation in order to account for preference heterogeneity and problems associated with violation of the IIA assumption. Recent applications of the RPL model have shown that this model is superior to the MNL model in terms of overall fit and welfare estimates (Carlsson et al., 2003).

The RPL model is estimated using LIMDEP 8.0 NLOGIT 3.0. Before estimating the parameters, the model requires an assumption about the distribution of the coefficients and make choices on what parameters to randomly distributed and what parameters that should be fixed. In many choice experiments, it has been common to assume that the cost parameter is fixed. One reason for this is that then the distribution of the marginal WTP is given by the distribution of the attribute. In principle any distribution could be used, but the most common ones have been the normal and the log-normal distribution. Thus in this choice experiment study, all the parameters except the payment attribute were specified to be normally distributed (Carlsson et al. 2003).

The results of the random parametric logit model are reported in table 4.

Table 4: Results of the RPL Models.

<table>
<thead>
<tr>
<th>Variables</th>
<th>RPL</th>
<th>RPL with interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff. (P-value)</td>
<td>Coeff. (P-value)</td>
</tr>
<tr>
<td><strong>Random parameters in utility functions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASC</td>
<td>-1.152** (.0269)</td>
<td>.910 (.5166)</td>
</tr>
<tr>
<td>Fish Stock</td>
<td>2.091*** (.0000)</td>
<td>1.959*** (.0000)</td>
</tr>
<tr>
<td>PEFSA</td>
<td>2.252*** (.0000)</td>
<td>2.028*** (.0000)</td>
</tr>
<tr>
<td>FSV</td>
<td>.9411* (.0863)</td>
<td>.9281 (.1005)</td>
</tr>
<tr>
<td><strong>Nonrandom parameters in utility functions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monetary payment</td>
<td>-.1248*** (.0197)</td>
<td>-.129** (.0178)</td>
</tr>
<tr>
<td>ASC*Age</td>
<td>-.794E-01** (.0012)</td>
<td></td>
</tr>
<tr>
<td>ASC*Family size</td>
<td>-.314**</td>
<td></td>
</tr>
</tbody>
</table>
The log likelihood ratio test rejects the null hypothesis that the regression parameters are equal at 5% significance level and also has a higher value of pseudo $R^2$ than the MNL models presented above. Hence improvement in the model fit can be achieved with the use of the RPL model, and the RPL model is appropriate for analysis of the data set presented in this paper. As can be seen from the table, the signs of the coefficients of the attributes are the same as in the MNL. However, there is some difference in the magnitude of the coefficients.

Even if unobserved heterogeneity can be accounted for in the RPL model, the model fails to explain the sources of heterogeneity (Boxall and Adamowicz, 2002). One solution to detecting the sources of heterogeneity while accounting for unobserved heterogeneity is by including interactions of respondent-specific social, economic and attitudinal characteristics with choice specific attributes and/or with ASC in the utility function. This enables the RPL model to pick up preference variation in terms of both unconditional taste heterogeneity (random heterogeneity) and individual characteristics (conditional heterogeneity), and hence improve model fit.

After extensive testing of the various interactions of the four wetland management attributes with the respondents’ social, economic and attitudinal characteristics collected in the survey, the model that includes age, family size and household disposable income were found to fit the data the best. The indirect utility function is extended to include these interactions and the RPL model with interactions was estimated using LIMDEP 8.0 NLOGIT 3.0. The results are reported in the second column of Table 5.9. This model has a higher overall fit compared to the MNL and RPL model. The RPL model with interactions also results in significant derived standard deviations for the two attributes (fish stock and PEFSA), indicating that the data supports choice specific unconditional unobserved heterogeneity for these attributes and some respondents might prefer lower levels of these.
5. Measures of elasticity and marginal effects

A. Elasticities:

Formally, elasticity may be defined as a unit-less measure that describes the relationship between the percentage change for some variable (i.e. an attribute of an alternative of a decision maker) and the percentage change in the quantity demanded, ceteris paribus. The percentage change in quantity demanded need not be confined to the alternative to which the attribute observed to change belongs, but may also be observed to occur in other competing alternatives. It is for this reason that economists have defined two types of elasticities; direct elasticities and cross-elasticities. From Louviere, Hensher, and Swait (2000), direct and cross-elasticities may be defined as follows:

* A **direct elasticity**: measures the percentage change in the probability of choosing a particular alternative in the choice set with respect to a given percentage change in an attribute of that same alternative.

* A **cross elasticity**: measures the percentage change in the probability of choosing a particular alternative in the choice set with respect to a given percentage change in a competing alternative.

Not only is there a distinction between the form that elasticities may take, there exists also a distinction between how one may calculate the elasticity for an attribute. The two main methods of calculation are the **arc elasticity method** and the **point elasticity method**. We will ignore the differences between the two estimation methods for the present and note that NLOGIT outputs point elasticity.

The above equation is interpreted as the elasticity of the probability of alternative $i$ for decision maker $q$ with respect to a marginal change in the $k$th attribute of the $i^{th}$ alternative (i.e.,), as observed by decision maker $q$. Louviere, Hensher, and Swait (2000) show that through simplification, the direct point elasticity for the MNL model for each observation becomes:

$$E_{X_{i k q}}^{P_{i q}} = \frac{\partial P_{i q}}{\partial X_{i k q}} X_{i k q} P_{i q} \quad \text{(5)}$$

The above equation is interpreted as the elasticity of the probability of alternative $i$ for decision maker $q$ with respect to a marginal change in the $k$th attribute of the $i^{th}$ alternative (i.e.,), as observed by decision maker $q$. Louviere, Hensher, and Swait (2000) show that through simplification, the direct point elasticity for the MNL model for each observation becomes:

$$E_{X_{i k q}}^{P_{i q}} = -\beta_{i k q} X_{i k q} (1 - P_{i q}) \quad \text{and the cross-point elasticity of:}$$

$$E_{X_{i k q}}^{P_{i q}} = -\beta_{j k q} X_{j k q} P_{j q} \quad \text{(6)}$$

While it is possible to calculate point elasticities for categorically coded variables the results will be meaningless. We therefore calculate and interpret the point elasticities for continuous-level data only (i.e. only for monetary payment attribute in our choice experiment survey).

Examination of the subscripts used within the above cross-elasticity equation will reveal that the cross-point elasticity is calculated for alternative $j$ independent of alternative $i$. As such, the cross-point elasticities with respect to a variable associated with alternative $j$ will be the same for all $j, j \neq i$ and as a consequence, a choice model estimated using MNL will display uniform cross-elasticities across all $j, j \neq i$. This property relates to the MNL model because of the IID assumption of the model.

* Elasticity’s are obtained by averaging the observation specific values, rather than by computing them at the sample means. It is common to report elasticity’s rather than the derivatives.

* Note that for this model, the elasticity’s take only two values, the ‘own’ value when $j$ equals $m$ and the ‘cross’ elasticity when $j$ is not equal to $m$. The fact that the cross elasticity’s are all the same is one of the undesirable consequences of the IID property of this model.

B. Marginal Effects

In the discrete choice model, marginal effect measures the effect of a change in attribute ‘$k$’ of alternative ‘$i$’ on the probability that individual $q$ would choose alternative ‘$j$’; where $j$ may or may not be equal $i$. And it is described as follows:

$$\frac{\partial P_{j}}{\partial X_{i k q}} = P_{j} [1(j = i)] - P_{i} \beta_{j k} \quad \text{.........(8)}$$

Where: the function $1(j = i)$ equals one if $j$ equals $i$ and zero otherwise. These are naturally scaled, since the probability is bounded. They are usually very small, so NLOGIT reports 100 times the value obtained in the output to make sure that some significant digits are shown in the tables. The effects are computed by averaging the individual specific results, so the report contains the average partial effects.

The standard deviations are not the asymptotic standard errors for the estimators of the marginal effects. In principle, that could be computed using the delta method. However, the estimates computed by NLOGIT are average partial effects. They are computed for each individual in the sample, and then averaged. Computing an appropriate standard error for that statistic is difficult to impossible owing to its extreme nonlinearity and due to the fact that all observations in the average are correlated – they use the same estimated parameter vector. Nonetheless, tempting to use the standard deviations for tests of hypotheses that the marginal effects are zero is not usually advisable. There is
no meaning that could be attached to an elasticity or marginal effect being zero – these are complicated of all parameters in the model. The hypothesis that a variable is not influential in the determination of the choices should be tested at the coefficient level.

Below are the estimated elasticity’s and marginal effects for the cost attribute in table 5

Table 5: Elasticities and marginal effects for the monetary payment attribute

<table>
<thead>
<tr>
<th></th>
<th>Elasticity</th>
<th>Marginal effect(*100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Option1</td>
<td>Option2</td>
</tr>
<tr>
<td>MNL Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option1</td>
<td>-1.020</td>
<td>1.001</td>
</tr>
<tr>
<td>Option2</td>
<td>1.036</td>
<td>-1.312</td>
</tr>
<tr>
<td>Status quo</td>
<td>1.036</td>
<td>1.001</td>
</tr>
<tr>
<td>RPL Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option1</td>
<td>-.4538</td>
<td>.3853</td>
</tr>
<tr>
<td>Option2</td>
<td>.5938</td>
<td>-.8266</td>
</tr>
<tr>
<td>Status quo</td>
<td>.5741</td>
<td>.5585</td>
</tr>
<tr>
<td>RPL with interactions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option1</td>
<td>-.8192</td>
<td>.8032</td>
</tr>
<tr>
<td>Option2</td>
<td>1.1231</td>
<td>-1.207</td>
</tr>
<tr>
<td>Status quo</td>
<td>.8407</td>
<td>.8567</td>
</tr>
</tbody>
</table>

The result from the MNL model shows two properties of the MNL model. First the sum of direct and cross marginal effects is zero. This is a reasonable property and holds true for RPL also. Second, the cross elasticities are symmetric. This is perhaps not that reasonable in all instances and doesn’t hold true for RPL models. And this property is among the undesired properties of MNL models because of the IIA assumption.

Further; the direct elasticity and marginal effect coefficients shows negative signs, which implies that the monetary payment attribute has a negative impact on the choice probability of that alternative. And the reverse is true for the parameters of cross effects, which shows that an increase in the level of monetary payment attribute of one alternative will enhance the choice probability of either of the other two alternatives. However; the two cross effects are synonymous due to the IIA assumption of MNL models.

C. Estimations of the marginal willingness to pay

The parameters estimated in a linear statistical MNL or RPL models can be used to estimate the rate at which respondents are willing to trade-off one attribute for the other. When the attribute being sacrificed is a monetary one, the trade-off estimated is known as ‘part worth’ or ‘implicit price’ or marginal willingness to pay for the attribute in question (Bennett and Blamey et al., 2001). Implicit prices thus reflect individuals’ willingness to pay for an additional unit of an attribute of interest to be present, ceteris paribus. The implicit price for fish stock attribute for instance, is the ratio of the fish stock coefficient and the monetary payment (price) coefficient. Calculations of marginal willingness to pay will have a significant role for the policy making procedures. Comparisons of the implicit prices of different attributes will afford some understanding of the relative importance of attributes in which respondents hold for them. Policy makers, thus, will be better placed to design resource use alternatives. Attributes with relatively higher implicit prices will be favored. Estimates of implicit prices (marginal willingness to pay) for each of the attributes in the choice sets associated with the MNL and RPL models are shown in Table 6.
The corresponding t-statistics and standard errors were calculated using the delta method.

Table 6: Estimates of Marginal WTP (in birr) for each attribute

<table>
<thead>
<tr>
<th>Variables</th>
<th>Basic MNL Model</th>
<th>Extended MNL Model</th>
<th>RPL Model</th>
<th>RPL with interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff. (P-value)</td>
<td>Coeff. (P-value)</td>
<td>Coeff. (P-value)</td>
<td>Coeff. (P-value)</td>
</tr>
<tr>
<td>Fish Stock</td>
<td>8.964*** (.0000)</td>
<td>9.011*** (.0000)</td>
<td>16.748** (.0101)</td>
<td>15.183** (.0161)</td>
</tr>
<tr>
<td>PEFSA</td>
<td>8.356*** (.0000)</td>
<td>8.343*** (.0000)</td>
<td>18.043** (.0170)</td>
<td>15.717** (.0246)</td>
</tr>
<tr>
<td>FSV</td>
<td>7.678*** (.0000)</td>
<td>7.720*** (.0000)</td>
<td>7.540*** (.0001)</td>
<td>7.194*** (.0002)</td>
</tr>
</tbody>
</table>

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

The marginal WTP values for each of the wetland management attributes were estimated using the Wald procedure (Delta method) in LIMDEP 8.0 NLOGIT 3.0. For comparisons, estimates were calculated using both models. Pair-wise t-tests of WTP estimates of each attribute reveal that the WTP estimates from the two models differ significantly at 5% significance level. The ranking of preserved ecological function surface area and fish stock attributes differs for the MNL and RPL models. This reinforces the need to use the best-fit RPL model for welfare distributional impacts of benefits generated by the management of wetland attributes. From table 5, we can observe that the implicit prices for all attributes are positive and significant at the 1 percent level, implying that respondents have a positive WTP for an increase in the quality or quantity of each attributes. Using the RPL with interactions model, which has a better fit; these implicit prices suggest that, for instance, the wetland communities are, on average, willing to pay 15.18 and 15.72 birr per month for an improvement in the fish stock and PEFSA. The marginal willingness to pay is relatively low for the FSV attribute compared to the other two attributes, i.e. they are willing to pay 7.19 birr per month for new improvement plans in the surrounding vegetation attribute.

D. Estimation of welfare measures

A particular strength of choice experiment according to (Alpizar et al, 2001, Adamowicz et al, 1994 and Bennett et al, 2001) is its ability to generate estimates of the values of many different alternatives from the one application. Hence from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated. This feature of choice experiment arises because it specifically investigates trade-offs between attributes. Thus, different combination of the attributes, that are used to describe alternatives, can be evaluated. In theory, economic welfare measures are (a) the amount of money(given or taken away) that make a person as well off as they would be before a change, or (b) the amount of money(given or taken away) that make a person as well off as they would be after a change. Depending on how the choice experiment application is designed, it is also possible to use the results to derive estimates of the compensating surplus (CS) or the equivalent surplus (ES) that results from a change in resource use. The former measures the change in income that would make an individual indifferent between the initial (lower environmental quality) and subsequent situations (higher environmental quality) assuming the individual has the right to have the initial utility level. This change in income reflects the individual’s willingness to pay (WTP) to obtain an improvement in environmental quality. On the other hand, ES assumes an individual has implied rights to the subsequent utility level. Hence, it represents individuals’ WTP to avoid degradation in environmental quality (Freeman, 1993). Based on the indirect utility functions, the compensating surplus can be illustrated as follows:

\[
CS = \frac{-\left(V_0 - V_1\right)}{\beta_{\text{monetary payment}}} \quad ................ (9)
\]
Where, $V_0$ and $V_1$ represent the initial and subsequent utility states respectively. $V_0$ is the value of utility from the status quo levels of the attributes. Whereas $V_1$ represents the level of utility from various improvement scenarios levels of attributes. The alternative wetland management improvement scenarios are listed below:

1. High improvement scenario:
2. Medium improvement scenario I:
3. Medium improvement scenario II:
4. Medium improvement scenario III:
5. Medium improvement scenario IV:

Using the parameter estimates, from the random parametric logit model, the compensating surplus from the above scenarios are presented in table 7.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>WTP (birr per month)</th>
<th>Attribute Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>High improvement scenario</td>
<td>61.03</td>
<td>Fish Stock 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEFSA 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FSV 1</td>
</tr>
<tr>
<td>Medium impact scenario I</td>
<td>49.78</td>
<td>Fish Stock 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEFSA 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FSV 1</td>
</tr>
<tr>
<td>Medium impact scenario II</td>
<td>59.07</td>
<td>Fish Stock 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEFSA 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FSV 1</td>
</tr>
<tr>
<td>Medium impact scenario III</td>
<td>33.06</td>
<td>Fish Stock 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEFSA 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FSV 1</td>
</tr>
<tr>
<td>Medium impact scenario IV</td>
<td>25.53</td>
<td>Fish Stock 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEFSA 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FSV 0</td>
</tr>
</tbody>
</table>

This measure indicates the amount that respondents are willing to pay in order to experience an improvement in their utility (resulted from the status quo to the change alternative scenarios). As such, the respondents are willing to pay 61.03 birr to have a high change in attribute improvements from the status quo. From the four medium improvement scenarios, respondents have high willingness to pay (59.07 birr) for the second medium impact scenario. This shows the respondents value improvements in the PEFSA attribute more than others. However, all improvement scenarios have positive WTP values, implying that improvements in all the three attributes will enhance the welfare of the Yiganda wetland community.

6. Conclusions
With respondents’ preferences broken down into components associated with the attributes that go to make up a good, it is possible to use choice experiment results to investigate the relative importance of attributes and estimate the values associated with various combinations of attribute levels. The purpose of this study was to measure the value the community attaches to various ecological and economic attributes of the Yiganda wetland. A combination of the characteristics theory of value and the random utility theory constitutes the theoretical underpinnings for choice experiments. We employed three different attributes as the basic ecological and economic functions of the Yiganda wetland to the surrounding community.

The data is analyzed using two specifications of the standard multinomial logit model and the random parameters logit model. The results indicate that there are positive and significant economic benefits associated with ecological and economic attributes of the Yiganda wetland. The analysis showed that the preserved ecology function surface area attribute proved to be generating a higher impact on the utility for the wetland community than did the fish stock and fenced surrounding vegetation attributes. This was reflected in a higher willingness to pay for the preserved ecology function surface area attribute. The impacts of socio-economic characteristics of respondents on their valuation of wetland management attributes are significant and most of them conform to economic theory. Furthermore, there is considerable preference heterogeneity within the wetland community, which should be taken into consideration when designing provision of public goods, such as wetlands. The results of analysis of debriefing questions proved that the majority of the wetland community is looking for wetland management improvements.

The net benefit estimates reveal that social welfare maximization is achieved under the High impact scenario of wetland management, which provides higher levels of ecological and economic attributes. The results are contextual, i.e. they are the result of a certain study conducted in a specific community. The possibilities of transfers are finally an empirical question, i.e. it can be tested by further studies in similar and different areas. Keeping this in mind, we can still learn something by analysis of the obtained results. A comparison of the multinomial logit specification with a random parameter model shows that the less restrictive latter model can provide us with
information that cannot be shown by the standard model. There are heterogeneous preferences for preserved ecology function surface area and fish stock attributes, as the two coefficients of the random attributes have significant standard deviations. A positive mean WTP was found for the three attributes “fish stock”, “preserved ecology functions surface area” and “fenced surrounding vegetation”. An inclusion of these attributes will increase social welfare. “preserved ecology function surface area” and “fish stock” have high marginal WTP in our study. A natural extension of this survey is to estimate the marginal cost of providing the different attributes of a wetland which is of course beyond the scope of this study. In that way, the results can be used for constructing a socially efficient design of the wetland.

Lack of awareness regarding the various functions of wetland areas, open access status of the wetland, illegal fishermen and agricultural activity along the flooded area, lack of alternative source of income which leads them to illegal activities are the major factors that led to the degradation of the Yiganda wetland.

7. Policy recommendations

In this survey results show that the wetland communities are willing to pay for improvements in the ecological and economic functions of the Yiganda wetland. This result has interesting implication in that if local government preserves an ecology function surface area and improves the level of fish stock in the area with some scientific and legal measures, there would be a sustainable and efficient utilization of the natural resource as well as the overall economic benefit that goes to the wetland community will be enhanced.

To mitigate the problems associated with the degradation of the wetland there should be awareness creation through trainings and workshops regarding wetland resources in particular and functions of non-market environmental resources in general and the local government should set up a participatory wetland management mechanisms. The local government protection bureau should set suitable directions on how to make use of the wetland resources. The major damage in the wetland comes as the community is looking for a source of income to support their livelihood. Yet poverty has been the principal problem for the major degradation in the quality and quantity of the ecological and economic functions of the Yiganda wetland. Thus, improving alternative sources of income for the wetland community, especially in developing countries like Ethiopia, is also one major measure towards improving the quality of ecological functions of environmental resources.

Finally, with careful construction of the choice sets, close consultation with the stakeholders and critical understanding of the environmental and other non-marketed resource’s nature and problems, choice experiment can successfully be used to forward policy relevant information.

References


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