# *Factors Determining Willingness to Pay for Wetland Conservation: The Case of the Nariva Swamp in Trinidad and Tobago.*

**Carlisle A. Pemberton**
*Senior Lecturer*

**Kathleen Mader-Charles**
*Graduate Student*

*Department of Agricultural Economics and Extension*
*University of the West Indies,St Augustine, Trinidad and Tobago.*

*The Nariva Swamp is the largest wetland in the eastern Caribbean, and is situated along the eastern coast of Trinidad. It is the habitat of a diverse array of plants and animals including the Anaconda (Eunectes murinus) and the endangered Manatee (Trichechus manatus).*

*Several human communities surround Nariva Swamp. These activities, from agriculture to the clandestine cultivation of illegal crops have caused the Nariva Swamp to have experienced tremendous changes to its ecology and hydrology.*

*Several studies have been conducted to estimate the WTP of the population of Trinidad and Tobago to conserve the Nariva Swamp. However the factors determining the WTP of the population remain largely unexplained. This study was therefore conducted in an effort to understand the factors that would contribute to the willingness to pay for the conservation of the swamp, and to add to the body of knowledge that exists on the subject of WTP for conservation in developing countries.*

*An open-ended bid question on the maximum WTP was presented to a representative sample of households in Trinidad and responses regressed against ten independent household and choice variables. The results showed that only three choice attributes variables were significant in determining WTP. These were variables scoring the importance of future, bequest and existence values.*

## 1. INTRODUCTION

### 1.1 The Nariva Swamp

The Nariva Swamp in the largest freshwater wetland in the Eastern Caribbean, and is situated along the eastern coast of Trinidad at 10°23′N latitude and 061°04′W longitude. This wetland covers approximately 6,234 hectares comprising state lands, the Bush Bush Wildlife Sanctuary, and part of the Ortoire Nariva Windbelt Forest Reserve.

The Nariva Swamp supports a diverse array of rare and vulnerable species, and is the habitat of animals and plants at crucial stages of their developmental cycles. Nariva swamp is a complex of freshwater swamp forests, permanent herbaceous swamps, seasonally flooded marshes and mangrove forests. All are separated from the sea by two parallel sandbars and a large area of flooded marshes. (Ramsar 1992)

The Nariva still sustains the Anaconda (*Eunectes murinus*) and the endangered, but once thought extinct to Trinidad, Manatee (*Trichechus manatus*), and considerable populations of crustaceans and molluscs. The fauna of Nariva is extremely rich and includes 57 species of mammals of which 32 are bats, 171 species of birds and several species of reptiles. Troops of red howler monkeys (*Alouatta seniculus*) and weeping capuchin monkeys (*Calbifrons trinitatis*), three species of oppossums (*Caluromis philander*, *Didelphis marsupialis* and *Marmosa robinsoni*), the three-toed and silky anteaters (*Tamandua tetradactyla* and *Cyclopes didactylus*) and the tree porcupine (*Coendu prehensilis*) may also be found in the Nariva swamp. Fish species include the much sought after Cascadoux (*Hoplosternum littorale*) (Petrotrin 2004).

Nariva is surrounded by several human communities who utilise the resources of the swamp for their sustenance. Their activities within the swamp range from agriculture to the clandestine cultivation of marijuana. In fact, many of the problems of ecological degradation in the swamp are attributable to the unsustainability of many of the activities that take place there.

Particularly within the last two decades, Nariva swamp has been experiencing tremendous changes to its ecology and hydrology. The neighbouring communities of Nariva swamp have relied on the resources of the swamp to grow rice and vegetables, to fish, gather fire wood, trap animals for the pet trade and to collect material for art and craft purposes. These activities have been carried out for many years with little negative impact on the ecology of the swamp until the commencement of large scale rice production.

The cultivation of rice was formalised by the establishment of the Plum Mitan Rice scheme in 1957, in an area of the swamp called Block A. With large scale rice farming, came heavy mechanisation, such as the use of combine harvesters, extensive use of fertilisers and pesticides and an increase in channels for water control (Ramsar 1995). These activities have led to the loss of habitat, changes in the hydrology and to a general decline in the ecological status of the swamp.

### 1.2 Conservation of Wetlands

The significance of wetlands lies in their anthropocentric value, which has been

overlooked primarily because they have been perceived to be barren wastelands with no immediate or apparent cash value (Schiller and Flanagan, 1997). In contrast to this view, the values of wetlands to humanity are numerous. Wetlands are able to provide clean water by acting as filters for solid and industrial waste as well as breakdown and retention of toxins. In flood prone or low lying areas, wetlands act as sponges absorbing excess water and then releasing this water gradually to the water table thereby averting disasters after heavy rainfall.

Over time, there has been an increasing global recognition of the need to conserve floral and faunal diversity of wetlands for a number of reasons. Critical among those reasons are for the maintenance of genetic diversity and for medicinal purposes. Effective and integrated management of wetlands provide a range of natural products that can add revenue and create employment in local economies, while providing opportunities for outdoor recreation and for the perpetuation of the movement toward environmentalism through education.

Important for the conservation of wetlands is an appreciation by the population of the social value of wetlands. This social valuation is normally conducted by non-market valuation techniques major among them being contingent valuation. Contingent valuation ascribes a social value to an environmental asset by obtaining the WTP of the population for the asset. Paying for conserving the environmental asset is one contingent market that is often used in contingent valuation. What this paper explores is the issue of what are the factors that determine the WTP of the population as obtained in these surveys. This issue is important since knowledge of the factors determining WTP can be used to properly design surveys to obtain unbiased estimates of the WTP.

### 1.3 Objectives of the study

The first objective of this study was therefore to explore the theory underlying the determination of the willingness to pay in contingent valuation. The second objective was to consider the case of a sample of households in Trinidad and to empirically determine the factors affecting the willingness to pay for the conservation of the Nariva wetlands on that island.

## 2. Theoretical Framework

### 2.1 Willingness to Pay

The basis of contingent valuation lies in welfare economics, which may be defined as the study of how relatively well off a society is, with given allocations of private and public goods.

The allocation of resources introduces the concepts of measurement and efficiency. Haab and McConnell (2002) state that the nature of public goods makes it difficult to measure their efficiency of allocation, since they do not have markets and market prices such as those of private goods. Over the last five decades, economic analyses have been increasingly applied to non-traditional areas, and are now being used to obtain the values of public goods to improve their allocative efficiency. Such valuation has increasingly been done by the determination of willingness to pay (WTP) and willingness

to accept (WTA) by use of the technique of contingent valuation.

WTA and WTP are both measures of consumer surplus used to express changes in welfare. They may be expressed as a compensating or equivalent variation dependent on whether the change is positive or negative (Bateman and Willis, 1999) indicated in Table 1.

## 2.2 Contingent Valuation

Modifying slightly Hanley and Spash (1994), a Contingent Valuation exercise (to obtain WTP) can be split into five stages namely: -

1. Setting up of the hypothetical market - the hypothetical scenario should be such that it sets up the reason for payment for the public good and the bid vehicle must be decided upon.
2. Obtaining bids - this may be done either by face-to-face interviews, telephone interviews or by mail. Bids may also take the following forms: -
   - **Bidding games**
     Higher and higher bid amounts are suggested to participants, until their maximum WTP is attained.
   - **Payment card**
     A range of bids are offered to participants on a card which may also include typical expenditure for other public goods, commensurate with their income bracket. This method is believed to assist participants in calibrating their responses and to select their WTP.
   - **Open-ended question**
     The maximum WTP is solicited from participants with no suggestion of bid amounts. In this method it has often proven difficult for participants to decide on a value particularly if they lack a similar prior experience.
   - **Closed-ended referendum**
     A single bid amount is offered to participants to which are required aresponse of either 'yes' or 'no'.
3. Calculating the Mean WTP, which can be done using logit or probit regression analysis when the bid vehicle used is a closed-ended referendum.
4. Aggregating the Data. This refers to the process of converting the mean WTP value to a population total.
5. Evaluation of the CVM exercise.

## 2.3 Explaining Willingness to Pay

In contingent valuation studies, using the closed-ended referendum dichotomous type questions, other questions are sometimes asked to determine the maximum WTP of individuals. Such questions generally follow the referendum type question and are designed to provide a more direct measure of individual WTP, as opposed to the referendum type question, which can only calculate the mean WTP for the sample as a whole.

In explaining the WTP of an individual, it may be assumed that WTP is determined as follows:

$$WTP = \alpha_i z_j \qquad (1)$$

where **z** is an m-dimensional vector of variables, such as income, education, age and or attitude to the environment etc., and α is an m-dimensional vector of parameters

such that $\alpha_i z_j = \sum_{k=1}^{m} \alpha_{ik} z_{jk}$ and $\beta$ represents the bid parameter. Hence the process of explaining willingness to pay necessitates the determination of estimates of the vector α. This can be achieved by multiple linear regression analysis.

## 3. Empirical Procedures

### 3.1 The Survey

Equation 1 was estimated using regression analysis. To obtain data for this regression analysis, a survey was conducted among households in Trinidad and Tobago.

### 3.2 The Sample Design

The sample frame was the listing of all households in Trinidad based on the 1990 census. The sample size chosen was 515 households.

The sample design was a stratified random design used by the Central Statistical Office's (CSO) Continuous Sample Survey of Population (CSSP).

The selection of the sample was done employing a two stage sampling process in which the selections in the first stage were called primary sampling units or Enumeration Districts (EDs) and in the second stage the selections were called the ultimate sampling units or households. Enumeration Districts consisted of approximately 150 to 200 households.

The first step involved the division of the sample frame into fourteen (14) administrative or geographical areas, eight (8) of which are designated as 'urban' and six (6) are described as 'rural', based on their socio-economic characteristics and physical infrastructure.

Due to the variations in population size of each of the administrative districts, EDs within each administrative area were selected based on probability proportional to size (PPS) of the administrative area. This translates to more selections being made from larger administrative areas. Further, to ensure adequate representation of all groups contained within the administrative area, the population within each individual ED was classified according to skills and assigned a code based on a majority of highly skilled, skilled or unskilled labour force. The EDs were then ranked according to skill codes in descending order. This ordering of the EDs was necessary for the use of the systematic random selection of EDs at this first stage and the sampling interval used was forty (taken from the 'grand sample' fraction). At this first level of selection a total of eighty-five (85) EDs were selected.

The next step involved the selection of the ultimate sampling units or households. For this, systematic selection (of the ultimate sampling units) was also used to draw the sample of 515 households used in this research. The sampling interval used was five (5).

### 3.3 The Questionnaire

Two bid questions were presented to respondents in the questionnaire. The first bid question was a closed-ended referendum where a single one of nine (9) bids ranging from $5.00 to $800.00 was randomly presented to each respondent requiring a "yes" or "no" response. The question asked was as follows:

> "Would you make a one-time contribution of $_____ to the Nariva Swamp Conservation Fund to

help ensure protection of the swamp in a natural state through the protection programme described above? "

If the response to this question was "yes", then the respondent was asked to respond to a second bid question, where the maximum WTP for conservation of the wetlands was solicited from participants, with no suggestion of bid amounts. This open-ended bid question was as follows:

"What is the largest one-time contribution that you would make to the Nariva Swamp Conservation Fund to ensure protection of the swamp in a natural state through the protection programme described above?"

The selection of bid levels for the respondents was random for the first question (closed-referendum), hence a random sample of respondents responded to the second (open-ended) bid question. Further, the strategy of presenting the second (open ended) question to only the "yes" respondents of the close-ended referendum question effectively reduced or eliminated the amount of protest responses to the open ended bid question.

The questionnaire also contained questions to elicit characteristics of the respondent including age, household income, educational level etc. The questionnaire also contained a series of question that attempted to obtain the attributes of the choice of the levels of maximum WTP stated.

These attributes included:

- Whether the respondent had visited the swamp or not.
- The attitudes and opinions with respect to natural resources and environment and
- a score to measure the reason for conservation of the swamp in terms of the percent of the dollar value of the maximum WTP that was represented by current use value, future use value, bequest value and existence value.

### 3.4 Explaining WTP by Regression Analysis

Determination of WTP required the estimation of the Equation 1
by means of linear regression. Using SPSS Version 11.0.1 to improve the reliability of the outcome, the dataset was adjusted to remove outliers and several econometric tests were performed.

The model estimated was as follows:

***Dependent variable***

Y - maximum WTP for conservation of Nariva swamp

***Independent variables***

$x_1$ - current use value score of respondent
$x_2$ - future use value score of respondent
$x_3$ - bequest value score of respondent
$x_4$ - existence value score of respondent
$x_5$ - Whether respondent had visited the Nariva swamp
$x_6$ - gender of respondent
$x_7$ - age of respondent
$x_8$ - education of respondent

$x_9$ - income of household of the respondent

$x_{10}$ - a Likert type scale score measuring the strength of opinion of the Nariva Swamp respondent toward protection of the Nariva Swamp

### 3.5 Outliers

Hanley and Spash (1993) have noted that outliers are a distinct possibility in contingent valuation survey data. According to Cook and Weisberg (1999) an outlier is a case (or observation) that is somehow different from the rest of the data, that is a particular case with a response that does not seem to fit the pattern of the data. They state: "An outlier must outlie something." Also they add that outliers may indicate important new information and should not be always taken as adverse occurrences. Hanley and Spash (1993) state that outliers in contingent valuation may occur as the result of strategic bias where the respondent may understate the WTP for a welfare improving change, because of the "free rider" problem or as excessively large bids, because the respondent may believe that their bid is purely hypothetical and so may overstate their WTP for an environmental benefit.

This study, took the approach suggested by Mitchell and Carson (1989: 226) to remove such outliers. Since the regression analysis was undertaken, a method of outlier identification in multiple regression analysis was adopted. This approach focuses on the identification of an outlier as an observation that does not fit the pattern of the estimated regression equation and hence has an abnormally large or small (negative) residual error term. On the assumption that the residuals are normally distributed such an abnormal residual can be detected as an absolute standardised residual with a value greater than 3, suggesting that such a residual will have normally less than a one percent probability of occurrence, if the observation indeed belonged to the general pattern of regression.

### 3.6 Econometric Tests

Several tests and plots were performed to determine if the regression model met the assumption required for its estimation using ordinary least squares. The Durbin-Watson test was used to test for auto-correlation. Normality plots were used to indicate the normality of the residuals. As recommended by Kinnear and Gray (2000) this normality plot was of the standardised residuals against the standardised predicted values. Normality would be indicated by a straight line plot.

As the data used for the regression was cross-sectional the possibility of heteroskedasticity was especially tested for. Four tests (Breusch-Pagan, Glesjer, Harvey-Godfrey and White) were used for heteroskedasticity although as recommended by Ramanathan (2002) the White test was the most highly favoured of these tests. Finally the Condition Index (Number) Test for multi-collinearity was carried out (Kmenta, 1986).

## 4. RESULTS

### 4.1 Outlier Detection

Table 1(a) shows the results for the first run of the regression model to identify outliers.

As seen in the table, observations 188 and 291 were identified as outliers with maximum WTP of $2000.00 and $5000.00 respectively whereas the mean WTP for the rest of the sample was 231.02.

Figure 1 also shows the plot of the standardized residuals against the standardized predicted values was indeterminate and not demarcating a pronounced straight line plot.

Table 2(b) shows the results for the second run of the regression model to identify outliers. As seen in the table observations 8 was identified as an outlier with a maximum WTP of $1000.00.

Figure 2 shows the normality plot after the removal of the outliers and this plot showed a more distinct straight line plot although several "lines" were apparent and not one smooth curve as would be expected in the case of perfect normality.

Table 3 shows that variables $x_2$ (future use value), $x_3$ (bequest value) and $x_4$ (existence value) are significant at the 5% level. Therefore none of the variables representing the characteristics of the respondent, as well as the choice attribute variables measuring the strength of opinion of the respondent toward protection of the Nariva Swamp ($x_{10}$), whether they had visited the Nariva swamp ($x_5$) and current use value were significant ($x_1$).

The results form the tests of heteroscedasticity (Table 4) showed that only the Harvey-godfrey test suggested the presence of heteroscedasticty . However since the White test was the favoured on and it was supported by two other tests no problem of heterscedasticity was found.

The results of the condition index test for multicollinearity showed that the maximum value forth index was 24. Hence since this value was below 30, this was taken as an indication that a serious problem of multicollinearity did not exist in the regression.

## CONCLUSIONS

Only three of the choice attribute variables were significant This suggests that bid equations that neglect such choice attribute variables run the risk of arriving at biased estimates of the WTP for environmental goods. Personal and household characteristic did not play a great role in the choice of the maximum WTP.

In general the regression model gave a poor fit to the data suggesting either that the model was mis-specified in terms of its functional form or important variables were missing from the equation. Perhaps the former reason is the more pertinent and this suggests the use of a nonlinear regression function. This type of function will be explored in further research planned in this project.

## REFERENCES

*Cook, R.D. and Sanford Weisberg, S., 1999. Applied Regression Including Computing and Graphics. New York: John Wiley and Sons Inc.*

*Freeman A. Myrick (1994). The Measurement of Environmental and Resource Value – Theory and Methods Resources for the Future 1616 P Street, NW Washington, DC 20036-1400.*

*Haab, Timothy C. and Keneth E. McConnell. 2002. Valuing Environmental and Natural Resources:*

*The Econometrics of Non-market Valuation. Cheltenham, UK: Edward Elgar Publishing Ltd.*

*Handley, Nick and Clive L. Spash. 1994. Cost Benefit Analysis and the Environment. Cheltenham, UK: Edward Elgar Publishing Ltd.*

*Kmenta, Jan. 1986. Elements of Econometrics (Second Edition). New York: Collier Macmillan Publishers.*

*Kinnear Paul R., Colin D. Gray (1999). SPSS for Windows Made Simple: Release 10; 4th edition Taylor & Francis Group.*

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

*Petrotrin (2004). Wetland: Our Precious Gift. [cited 28th November 2005] <http://www.petrotrin.com/wildfowltrustweb/article1.htm>*

*Ramanathan, Ramu (2002). Introductory Econometrics with Applications (Fifth Edition). University of California, San Diego: Harcourt College Publishers.*

*Ramsar (1992). A Directory of Wetlands of International Importance. Trinidad & Tobago 6TT001 [cited 18th January, 2004] <http://www.wetlands.org/RDB/Ramsar_Dir/Trinidad&Tobago/TT001D02.htm>*

*Ramsar (1995). The Ramsar Convention on Wetlands. Ramsar Advisory Missions: Report No. 35, Nariva Swamp (1995). [cited 8th August, 2003] Available on the internet < http://www.ramsar.org/ram/ram_rpt_35e.htm*

*Schiller, Eugene and Shanon Flanagan. 1997. Protecting Wetlands. Public Management (US). 79(10) p19, 7p, 3bw.*

**Table 1: Consumer responses to changes in welfare**

| | Environmental Change | |
|---|---|---|
| | **Positive** | **Negative** |
| **WTP** | Compensating Variation | Equivalent Variation |
| **WTA** | Equivalent Variation | Compensating Variation |

(Haab and McConnell, 2002)

## Table 2 Identification of outliers

**Casewise Diagnostics[a] (b)**

| Outlier Case Number | Std. Residual | Y | Predicted Value | Residual |
|---|---|---|---|---|
| 8 | 3.104 | 1000 | 44.9045 | 955.0955 |

a. Dependent Variable: Y

**Casewise Diagnostics[a] (a)**

| Outlier Case Number | Std. Residual | Y | Predicted Value | Residual |
|---|---|---|---|---|
| 188 | 3.748 | 2000 | 304.7889 | 1695.211 |
| 291 | 9.995 | 5000 | 478.7098 | 4521.290 |

a. Dependent Variable: Y

## Table 3: Results of Regression Analysis

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 114.916 | 157.804 | | .728 | .467 | | |
| | V28 | .607 | 1.580 | .027 | .384 | .701 | .858 | 1.165 |
| | V29 | 1.079 | .524 | .165 | 2.058 | .041 | .650 | 1.539 |
| | V30 | 1.719 | .759 | .213 | 2.266 | .024 | .470 | 2.129 |
| | V31 | -2.170 | .818 | -.254 | -2.654 | .009 | .455 | 2.199 |
| | V33 | 31.320 | 53.870 | .038 | .581 | .562 | .959 | 1.043 |
| | V60 | 5.854 | 42.189 | .009 | .139 | .890 | .920 | 1.086 |
| | V61 | 1.215 | 1.575 | .055 | .771 | .441 | .815 | 1.227 |
| | V77 | 6.707 | 5.028 | .102 | 1.334 | .184 | .717 | 1.394 |
| | Income of the Respondent | 2.56E-05 | .001 | .003 | .035 | .972 | .831 | 1.203 |
| | NWLIKERT | -3.384 | 5.827 | -.038 | -.581 | .562 | .961 | 1.041 |

a. Dependent Variable: V27

## Table 4: Test results for heteroscedasticity

| Test | Value of Test Statistic | Critical Value of Ch-square ($\alpha = 0.05$) | Reject Homoscedasticity? |
|---|---|---|---|
| Breusch-Pagan | 7.584 | 18.31 | No |
| Glesjer | 16.827 | 18.31 | No |
| Harvey-Godfrey | 22.278 | 18.31 | Yes |
| White | 4.508 | 5.991 | No |

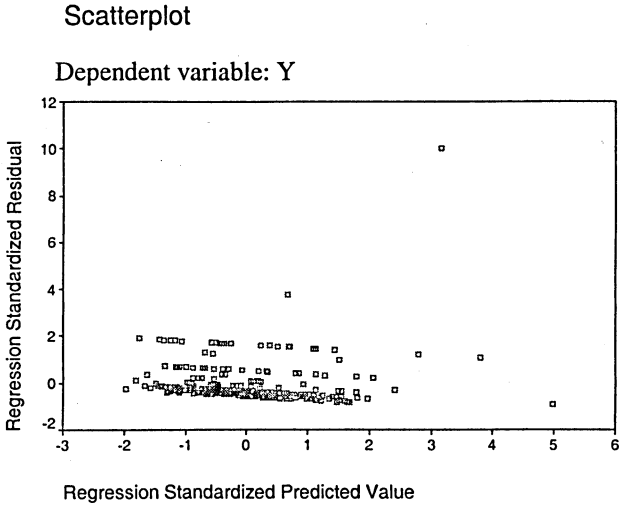


**Figure1: Scatterplot – Original Data**

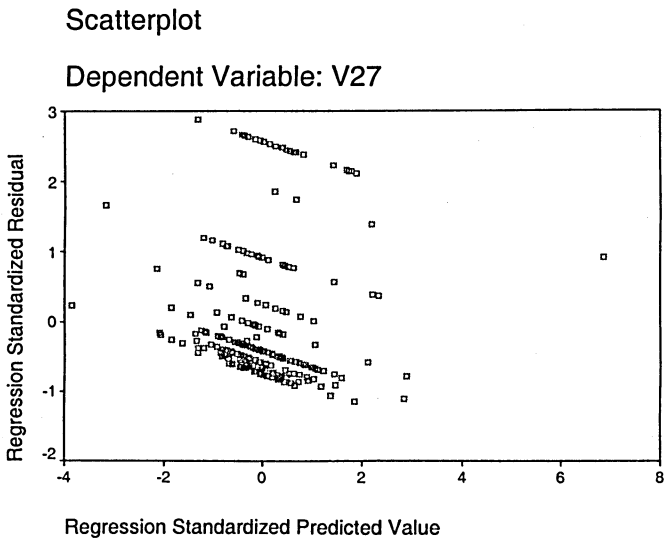


**Figure 2: Scatterplot – Data with outliers removed.**