

The Market Price Method and Economic Valuation of Biodiversity in Bauchi State, Nigeria

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ABSTRACT

This study adopts the survey design to examine the feasibility and reliability of value estimates of the Market Price Method by applying it to Gubi Dam area in Bauchi State, Nigeria. The theoretical bases of economic valuation methods were also examined to clarify their premises, rationales and conditions under which they would be valid. Data were collected through interviews and focus group discussion conducted with the village heads, fishermen, fish sellers and consumers within Bauchi metropolis. From the data collected, about 18,140kg of fishes are harvested at the Gubi dam annually, generating N4,279,000,000 and N7,273,000 from wholesale and retail activities annually respectively. Also, 69,200kg of vegetable were harvested at the Gubi dam irrigation farm annually, generating N3,248,000 and N5,202,000 from wholesale and retail activities annually respectively. Among other things, the findings reveal that property rights related to ecosystems and their services are often not clearly defined, if property rights for natural resources are not clearly defined, they may be overused, because there is no incentive to conserve them. Using reasonable assumptions, the research concludes that the method proved to be applicable in the study area but needs to be improved upon, to make the value estimates credible and reliable in developing economies. Finally, it is recommended among things that the discounting of economic benefits should be made to reflect time value of money and that provisions for outgoings should be made to reflect elements of market failure in the method.

Keywords: *Consumer, Producer, Market Price Method, biodiversity*

INTRODUCTION

There is a wide array of services and amenities that biodiversity provides for people who might or might not value its individual components and the diversity of components. Some aspects of biodiversity are valued directly; while others are valued for their contributions to ecosystem support and, hence, to sustainable production of things that are valued directly. Although biodiversity might well have substantial economic value, compared to alternative consumptive resource uses, economic value does not tell us everything we need to know about the value of biodiversity, it mainly helps in the prioritizing policies in decision making (National Research Council (NRC), 1999). Environmental policies and conservation spending decisions are usually based on three sources of information: Assessments of facts provided by scientist; biased assessments of values provided by special Interests; and

objective assessments of Values. Economic valuation is an attempt to provide an empirical account of the value of services and amenities or of the benefits and costs of proposed actions (projects or policies) that would modify the flow of services and amenities. Economic valuation provides a utilitarian account (that is, an account of contribution to the satisfaction of human preferences). Therefore, it provides a particular perspective on value, in this case, on the value of biodiversity (NRC, 1999). Ecosystem valuation can be a difficult and a controversial task, and economists have often been criticized for trying to put a "price tag" on nature (www.ecosystemvaluation.org, June, 2006). However, agencies in charge of protecting and managing natural resources often make difficult spending decisions that involve trade-offs in allocating resources. These types of decisions are economic decisions, and thus are based, either explicitly or implicitly on society's values. Therefore, economic valuation can be useful, by providing a way to justify and set priorities for programmes, policies, or actions that protect or restore ecosystems and their services. Valuation of biodiversity has peculiar difficulties which stem from the fact that most environmental goods are non-marketable, non-rivalled, non-exclusive and inseparable (www.ecosystemvaluation.org). However, the aim of this paper is to assess the validity of the Market Price method of Economic Valuation of Biodiversity, identify problems and lapses associated with its application in Bauchi State, Nigeria with a view to amending its lapses. The study is restricted to the Market Price method among other methods used for the economic valuation of biodiversity.

MARKET PRICE METHOD OF ECONOMIC VALUATION OF BIODIVERSITY

Determinants of Economic Value: There are many useful measures of value. However, in conventional economics, the economic value that an individual places on a particular ecosystem service is presumed to be reflected by that individual's willingness to pay for it. Although, often immeasurable, this is generally understood to depend upon: (a) preferences, (b) income, (c) the cost in time and money of gaining access to the service; (d) the availability of perfect substitute, and (e) the availability of near-perfect or, at least acceptable substitutes (www.ecosystemvaluation.org March, 2007).

Valuing Biodiversity: A basic principle for valuing biodiversity should be the association of diversity with some useful characteristics that it possesses or useful services that it provides or enhances. If biodiversity is desirable, it should be so because of these characteristics or services. According to Johnson, Davis and Shapiro (2005), this approach is directly related to Heal's (2000) idea of regarding biodiversity as a commodity. He suggests that biodiversity is important from an economic perspective because it provides or enhances ecosystem productivity, insurance, knowledge and ecosystem services. Thus, valuation of biodiversity is not based on genetic distances but in terms of the value of characteristics or services that an ecosystem provides or enhances when managed effectively, obtaining in this way an endogenous (that is, having no apparent external cause) measure for biodiversity valuation. Biodiversity contributes to our knowledge in ways that are both informative and transformative. Knowledge about the components of biodiversity is valuable in stimulating technological innovation and in learning about human biology and ecology. Experiencing and increasing our knowledge, biodiversity also transforms our

values and beliefs (Daily, 1997). Below is a review of the types of goods and services that mankind obtain directly and indirectly from biodiversity and its components. The economies of most developing countries (including Nigeria), depend more heavily on natural resources such as oil and agriculture resulting in biodiversity-related sectors contributing larger shares of their GDPs. The small fraction of the value of these ecological systems that is accounted for in nations' economic ledgers contrasts starkly with the fact that human survival depends on functioning ecological systems. Cohen and Tilman (1996) note man's limited ability to value ecological parallels and limited appreciation of his dependence on these systems and they conclude that no one yet knows how to engineer systems that provide humans with the life-supporting services that natural ecosystems produce for free. In some developing countries and among some population segments in developed countries, terrestrial wildlife also continues to be an important subsistence resource. In some areas of Botswana, for example, over 50 species of wild animals provide as much as 40% of the protein in the diet; and in Nigeria, game accounts for about 20% of the animal protein consumed by people in rural areas (McNeely, Miller Reid, Mittermeier and Werner, 1990).

Economic Value: The Total Economic Value (TEV) of biodiversity is made up of the following: Use Value, Option Value, Quasi-Option Value, Passive-Use Value and Bequest Value (NRC, 1997; Randall, 1987). Use Value is generated when a person uses an environmental service actively, typically by consuming it directly or combining it with other goods and services and the person's own time to "produce" an activity that generates utility. It is likely to be reflected (at least in part) in behaviour such as purchases and visits. Naturally, it includes the expected value of future use. Option positions the value of assurance that things (such as biodiversity) that are available now will still be available when we need them. Quasi-Option is the value of waiting to decide on the disposition of an asset motivated by the possibility that we will be able to make a "better" decision later, perhaps because we will have more information. Passive-Use Value captures the idea that people might enjoy satisfaction from "just knowing" that a particular habitat is being maintained in good condition. Contributions to voluntary organizations that provide habitat preservation and political support for pro-habitat policies are consistent with passive-use value. Bequest Value motives assume that one's heirs will enjoy use or passive use. TEV includes all these kinds of economic values. There is no claim that economic value, however, constitutes the totality of value. There are many ways of valuing, but, total economic value represents a comprehensive application of the economic way of valuing.

Economic Valuation Data: Data for economic valuation are basically direct and indirect evidence from markets, and the three generally accepted approaches to estimating monetary values of ecosystem services are:

- a. *Revealed Willingness to Pay (Market Prices):* When people purchase something (for example, a home) or spend time and money to get somewhere (for instance, a fishing spot) they reveal that they are willing to pay at least what they actually spend, they may be willing to pay more. Ecosystem services, such as clean water are used as inputs in production, and their value may be measured by their contribution to the profits made from the final goods.

- b. *Expressed Willingness to Pay (Survey Results)*: Many services are not traded in markets so people may never reveal what they are willing to pay for them. The value of some ecosystem services can be measured by estimating what people are willing to pay to avoid the adverse effects that would occur if these services were lost, or to replace the lost services.
- c. *Derived Willingness to Pay (Circumstantial Evidence)*: Surveys can be used to ask people directly what they are willing to pay based on a hypothetical scenario. Alternatively, people can be asked to make trade-offs among different alternatives, from which their willingness to pay can be estimated (www.ecosystemvaluation.org, March 2007).

Monetary Measures of Ecosystem Value: Money is an enormously useful and universally accepted basis for expressing and comparing economic values because the amount that people are willing to pay for something reflects how much of all other for-sale goods and services they are willing to give up to get it. In the case of ecosystems, it is important that measuring the economic value of something based on this notion does not require it to be bought and sold in markets. It only requires that someone estimate how much purchasing power (in monetary terms) people would be willing to give up to get it (or would need to be paid to give it up) if they were forced to make a choice.

The Process of Economic Valuation of Biodiversity: The objective of any valuation is the determination of value, whether in monetary terms or as a ratio of measurement of goods demanded in exchange and the valuation process involves:

- (1) The problem that has to be defined;
- (2) The data required are to be identified, acquired, classified, analyzed, interpreted; and
- (3) The data are applied to the various methods to arrive at the determination of value (Ifediora, 2009; Johnson, Davis and Shapiro, 2005).

Economic valuation depends heavily on information that is fundamentally noneconomic and also requires evidence of willingness to pay (WTP) and willingness to accept (WTA) - paying money is the sincerest expression of WTP and accepting money and relinquishing an amenity constitute the sincerest expression of WTA. Much of the information originate from experts whose specialties are far from economics, for example, ecologists and hydrologists.

Market Price Method: The market price method estimates the economic value of ecosystem products or services that are bought and sold in commercial markets. It can be used to value changes in either the quantity or quality of a good or service. It uses standard economic techniques for measuring the economic benefits from marketed goods, based on the quantity purchased or supplied at different prices.

The standard method for measuring the use value of resources traded in the market place is the estimation of consumer surplus and producer surplus using market price and quantity data. The total net economic benefit, or economic surplus, is the sum of consumer surplus and producer surplus.

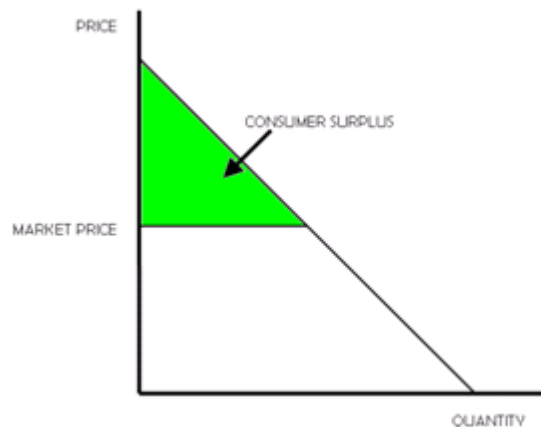


Fig. 1: The Demand Curve and Consumer Surplus. Source: Stanlake and Grant, 1999

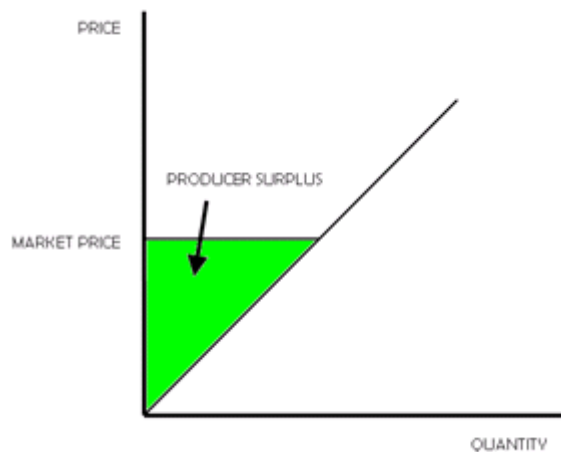


Fig. 2: The Supply Curve and Producer Surplus Source: Stanlake and Grant, 1999

EXAMINATION OF INPUTS OF THE MARKET PRICE METHOD

Consumer Surplus: One of the major inputs of the market price method is the estimation of the Consumer Surplus. The method uses the maximum consumer surplus revealed, which in economics is not. Stanlake and Grant (1999) in their book, "Introductory Economics" state that consumer surplus occurs when people pay less than the value they place on the product based on their marginal utilities. They went on to explain "marginal utilities":

"The person (i.e. the consumer) would have been prepared to pay £6 for the first bottle (of wine), £5 for the second bottle, £3.50 for the third bottle, £2 for the fourth. If the actual price charged is £3.50, the person will buy three bottles receiving a benefit of £2.50 on the first bottle, £1.50 on the second and no consumer surplus on the third ..."

In the application of the Market Price method, the consumer surplus was not based on marginal utility but on maximum WTP. This is a major setback because the method would overestimate the consumer surplus, making it a faulty input; it would definitely affect the eventual output - the value estimate.

Willingness to Pay (WTP): Major factors that affect price are demand, supply and government intervention. Stanlake and Grant (1999) observe that demand is not the same thing as desire, need or want; the strength of desire, need or want will not, in itself, have any influence on price. Only when desire is supported by the ability and willingness to pay does it become an effective demand and may be defined as the quantity of the commodity which will be demanded at any given price over some given period of time. In essence, people may be willing to pay a higher price for consumer goods but may not have the ability to do so. Therefore it is not all the people who are willing to pay higher that are able to do so and even though they desire, need or want an item and even agree that the value should be higher than the market price. If the prices go higher, they may not be able to afford the item. This would mean that the estimation of the consumer surplus may not be realistic, unless enquiries are also made into the income of the consumers.

Discounting Factor: The Market Price method made provision for economic loss for one year only and has therefore ignored the issue of discounting all future streams income for the period of possible closure. Discounting provides a common matrix which enables comparison of costs and benefits that occur at different points in time. Use of discounting is integral to cost benefit analysis and cost effectiveness analysis. Discounting converts the stream of costs and benefits over time into a stream of 'present' values.

Upsizing (Zero-Emission Concept): The concept of value ought to be reviewed in biodiversity based on the concept of zero emission. The market prices of commodities need to incorporate the value of other uses for the spent commodity. In order for the value estimates to be more credible, more information about the usefulness of biodiversity should be sought diligently. In his book, "The Road to Zero Emissions", Gunter (1998) talks about Generative Science which proceeded on the assumption that in any transformation of a resource, all by-products (should) be studied for their value-added potentials. It has become clear in recent years that the fundamental role of micro organisms in global processes can be exploited in maintaining and restoring environmental productivity and quality.

Indeed, micro organisms are already playing important roles, both in the prevention of pollution (for example, through waste processing and environmental monitoring) and in environmental restoration (for example, through bioremediation of spilled oil). Modern biotechnology is providing tools that will enhance the environmental roles of micro organisms, and this trend should accelerate as the appropriate basic and applied sciences mature (Colwell 1995; Zilinskas, Colwell, Lipton and Hill, 1995). These knowledge are vital data in ensuring reliable and credible value estimates of biodiversity. It is appreciated that human ability to predict which species are important for particular services is limited by the absence of detailed experimental studies of the ecosystem in question. It is impossible to predict how new knowledge will be used. Bacterial genetics was an obscure field of research in the 1950s, but it led directly to what is now called molecular biology. A biologically diverse environment offers broad opportunities for developing new ways of appreciating one's place, the scope of one's enjoyments, and oneself (Kellert and Wilson 1993; Norton 1986; and Wilson 1984). Habermas (1993) notes that only humans can participate in debates about morality, so the interests of nonhumans or of the biosphere itself are represented only to the extent that humans speak for them.

METHOD

This study adopted survey research design. The study area is Gubi Dam in Bauchi State, Nigeria. The primary data used were sourced through personal interview and focus group discussion conducted with the village heads of Firo and Galga villages, fishermen, fish sellers and consumers in Bauchi, Nigeria. Purposive sampling method was used to select the participants for the study. Explanatory technique was used for qualitative data obtained while the quantitative data were presented on tables using appropriate unit of measurement like kilogram (kg). Gubi Dam is sited in Firo Village, Bauchi Local Government Area of Bauchi State with a surface area of 600 hectares (Ita, Sado, Balogun, Pandogari and Ibitoye, 1985). The Firo villagers are mainly farmers, cattle rearers, fishermen, dairy farmers and paid menial employees at the Gubi water works. The major activity at the Dam is the supply of potable water to Bauchi metropolis. However, other commercial activities such as vegetable irrigation, fishing and fish farming are practised there. For the Market Price Method to be applicable, it is assumed that commercial activities are restricted due to pollution or other environmental hazards at the Gubi dam. The various assumptions taken would be specified in the course of using the method. The valuation has been broken into two to reflect the two major activities at the study area; namely Fishing and Irrigation Farming.

RESULTS AND DISCUSSION

Investigation revealed that about 100 people are engaged in fishing activities while the major types of fishes at the dam are *Tarwada* (Cat Fish or *Ictalurus Furcatus*), *Karfasa* (Tilapia or *Tilapia Guinasana*), *Kawara* (*Alestes Nurse* (ln)), *Lulu* (*Schilbe Mystus* (ln)), *Akunu* (*Barbus Occidentalis*), Gold Fish (*Electris Nan Chevalier*) and *Lakki* (*Barillu Senegalenses*). The major ones harvested however are *Tarwada*, *Karfasa*, *Kawara*, *Lulu* and *Akunu*, while the peak of fishing activities is from April/May up till September/October, at the end of the rainy season. The irrigation farmers live in Galga village across the river and are engaged mainly in small-scale vegetable planting, namely, tomatoes (*Lycopersicon Esculentum*), pepper (*Piper Methysticum*), onions (*Allium Cepa*), cabbage (*Brassica Oleracea*) and lettuce (*Lactuca Sativa*). Irrigation is practised mainly in the dry season from October to May. They equally have fishermen.

Other activities at the Gubi Dam include religious activities in which ceremonies such as water baptism are performed by Churches and students' excursions (Field Survey, 2008). Interview with the villagers reveal that major occupation in the neighbourhood are Fishing, Fish Farming, Cattle Rearing, Local Milk (Nono) Production and Irrigation Farming. From these however, fishing and vegetable irrigation farming are directly related to the nature of this research since the cattle rearers are nomadic, and not restricted to the study area. Again, water treatment and supply to Bauchi metropolis cannot be regarded as directly relevant for this work because it is not competitive and more of a social service. The fish farmers raise fishes that are mainly sourced from other places.

Ecosystem Products of Gubi Dam Sold in the Market: Table 1 shows the varied ecosystem products related directly to the Dam, at different seasons. The vegetables are farmed only in the dry season along the riverine areas, which are flooded during the raining season. The vegetables are harvested several times during the season.

Fishing Activities (Using Market Data):

Step 1: Determining the Demand Function before Closure

Total Retail for the Year is N7,273,000; Annual demand is 18,140kg; Initial Market Price (i.e. $N7,273,000 \div 18,140\text{kg}$) = N401/kg; while Average WTP = N750/kg.

Consumer Surplus = $(N750 - N401) \times (18,140 \div 2)$ = N3,165,430

Step 2: Determining the Demand Function after Closure

It is assumed that the price of fish would rise to N500/kg after closure while quantity demanded would fall to 60% i.e. 10,884kg per annum. WTP remains N750/kg.

New Consumer Surplus = $[(N750 - N500) \times 10,884] \div 2$ = N1,360,500

Step 3: Determining the Economic Benefit to Consumers

This is the difference between the Consumer Surplus before and after the closure
i.e. $N3,165,430 - N1,360,500$ = N1,804,930

Step 4: Determining the Supply Function (Producer Surplus) before Closure

Total Wholesale for the Year is N4,279,000; Annual demand is 18,140 kg;

Initial Wholesale Price = N236/kg;

while Variable Cost of fishing @ N60/kg = N1,088,400 p.a.

Producer Surplus = $N4,279,000 - N1,088,400$ = N3,190,600

Step 5: Determining the Supply Function (Producer Surplus) after Closure

The Wholesale Price remains at N236/kg; and it is assumed that harvest will drop by 60% after closure to 10,884kg p.a.; Total Wholesale for the Year would fall to N2,568,624; and Variable Cost @ N85/kg (due to closure) = N925,140p.a.

New Producer Surplus = $N2,568,624 - N925,140$ = N1,643,484

Step 6: Determining the Loss in Producer Surplus Due to Closure

This is equal to difference in Producer Surplus before and after the closure

i.e. $N3,190,600 - N1,643,484$ = N1,547,116

Step 7 - Determining the Total Economic Loss due to Closure

This is equal to lost Consumer Surplus and lost Producer surplus:

i.e. $N1,804,930 + N1,547,116$ = N3,352,046.

Farming Activities

Step 1: Determining the Demand Function before Closure, using Market Data

Total Retail for the Year is N5,202,000; Annual demand is 69,200kg; Initial Market Price (i.e. $N5,202,000 \div 69,200\text{kg}$) = N75/kg; while Average WTP = N120/kg.

Consumer Surplus = $[(N120 - N75) \times 69,200] \div 2$ = N1,557,000

Step 2: Determining the Demand Function after Closure

It is assumed that the price of vegetables would rise to N95/kg after closure while quantity demanded would fall to 60% i.e. 41,520kg p.a. Average WTP remains N120/kg.

New Consumer Surplus = $[(N120 - N95) \times 41,520] \div 2 = N519,000$

Step 3: Determining the Economic Benefit to Consumers

This is the difference between the Consumer Surplus before and after the closure

i.e. $N1,557,000 - N519,000 = N1,038,000$

Step 4: Determining the Supply Function (Producer Surplus) before Closure

Total Wholesale for the Year is N3,248,000;

Annual demand is 69,200kg;

Initial Wholesale Price = N47/kg;

while Variable Cost of farming @ N20/kg = N1,384,000p.a.

Producer Surplus = $N3,248,000 - N1,384,000 = N1,864,000$

Step 5: Determining the Supply Function (Producer Surplus) after Closure

The Wholesale Price remains at N47/kg; and it is assumed that harvest will drop by 60% after closure to 41,520kg p.a.;

Total Wholesale for the Year would fall to N1,951,440; and

Variable Cost @ N25/kg (due to closure) = N1,038,000p.a.

New Producer Surplus = $N1,951,440 - N1,038,000 = N913,440$

Step 6: Determining the Loss in Producer Surplus due to Closure

This is equal to difference in Producer Surplus before and after the closure

i.e. $N1,864,000 - N913,440 = N950,560$

Step 7: Determining the Total Economic Loss due to Closure

This is equal to lost Consumer Surplus and lost Producer surplus

i.e. $N1,038,000 + N950,560 = N1,988,560$.

Thus, the benefits of cleaning up pollution in order to reopen the area are equal to the Total Economic Loss for all commercial activities (fishing and irrigation farming) at the study area. (i.e., $N3,352,046 + N1,988,560 = N5,340,606.00$).

The site, like most other Nigerian Dams have greater potentials than the level of activities currently going on there, especially with regards to fishing and irrigation farming. The fishermen operate mainly at the banks and hardly explore the deeper regions where better and bigger catches are possible, mainly because they use crude fishing equipment like canoes, nets, lines and small traps that can catch maximum of five average-sized fishes at a time. The situation is the same with vegetable farmers as small tracts of land are cultivated by individual farmers with little or no knowledge of modern farming techniques. It was observed that most of their crops have yellowish leaves and are also infested with worms and other pests signifying lack of use of fertilizer and pesticides. There are no traces of hybrid plants developed in modern times. All these signify little knowledge of modern farming techniques. The implication of these is that the current harvest does not portray the potentials of the study area.

It was observed that the market price method is feasible based on the study area although there may be underestimation of value. Also, not all commercial activities within the study area are directly linked to the Dam and its possible closure. These include sales of *Nono* (local milk) and cattle rearing. It was observed also that Gubi Dam was built with fish ponds right from inception, but these have hardly been put to use. There are no evidence of the concept of Zero-emission being practised in the study area, so the market data are limited to sale of fish and vegetables without any use for the residual, which otherwise, would have generated more market transactions. Although it is impossible to predict how new knowledge will be used, it is now generally accepted that residues, if well researched, have hidden values (Gunter, 1998), which could be reflected with a meagre percentage. In everyday life, people make estimates in their homes, offices, building sites, etc., with provision made for contingencies at percentage varying (say) from 5%, the same could be applied to the Market Price method to make the value estimate more realistic by making provision for hidden value(s). The method did not provide for discounting (i.e., time value of money), whereby the total economic loss could be calculated for the period for which the study area could possibly be closed to the public. For example, if the Dam would be closed for seven years then the total economic loss for the period could be calculated and discounted to the present to reflect the PV of the total loss. Using the PV of N1 formula of $\frac{1}{(1+i)^n}$ (also known as Discounted Cash Flow) the total economic loss for the possible seven years closure is calculated (Table 5).

This is a laborious approach, and if the period were extended, would quickly become cumbersome. A tidier method would be using the PV of N1 per annum table, which discounts a series of a specified amount of money receivable annually for a given period and is professionally referred to by valuers in Nigeria and most of the Commonwealth that follow the United Kingdom's valuation practice as "Years Purchase (YP)" (Ifediora, 1996). The calculation goes thus: N5,340,606 x YP for 7 years @ 5% = N5,340,606 x 5.7863* = N30,902,348.50. Thus, the Present Value of Total Economic Loss in seven years is N30,902,348.50; approximately N30,902,000 (* page 251 of Valuation Table and page 27 of Parry's Valuation Table). The method did not take the effects of market failures into consideration. Market failures occur when markets do not reflect the full social costs or benefits of a product. Market failures related to ecosystems include the facts that:

- a. *Many ecosystems provide services that are public goods:* The problem with public goods is that, although people value them, no one person has an incentive to pay to maintain the good. For example, if a stream is polluted by runoff from agricultural land, the people downstream experience a negative externality.
- b. *Many ecosystem services are affected by externalities:* The problem with negative externalities is that the people (or ecosystems) they are imposed upon are generally not compensated for the various damage they suffer.
- c. *Property rights related to ecosystems and their services are often not clearly defined:* If property rights for natural resources are not clearly defined, they may be overused, because there is no incentive to conserve them. For example,

unregulated fisheries are an open-access resource - anyone who wants to harvest fish can do so. Because no one person or group "owns" the resource, open access can lead to severe over-harvesting and potentially severe declines in fish abundance over time.

All these are not reflected in the Market Price method, but could have been accommodated as estimated outgoings to make the process more realistic. One of the positive findings is that the method has eliminated the problem of aggregation and double counting. There is no observation of double counting of any input in what ever way. One major criticism of the valuation work undertaken by Costanza *et al* (1997), is that of aggregation and double counting. For example, if the nutrient retention function is integral to the maintenance of biodiversity, then if both functions are valued separately and aggregated, this would double count the nutrient retention which is already 'captured' in the biodiversity value. This problem can be overcome through careful design of the study.

CONCLUSION AND RECOMMENDATIONS

The Market Price method had been developed by expert environmentalists based on many years of study. The idea behind the method is basically to improve on other existing methods of economic valuation of biodiversity and provide credible and more reliable value-based research to those who control federal and regional environmental spending. The method had proved to be applicable in the study area. However, the processes can still be improved upon, to make it more credible in Bauchi State in Nigeria particularly and other developing countries in general as it has proved to be in developed countries. Therefore, the following recommendations have been made. The Market Price method should be used to estimate economic loss for total period of closure to reflect total economic loss for the period of closure. The value estimates from the method should be discounted to allow for passage of time by providing the present values of all future streams of benefits (or costs), that is, the discounting or capitalizing of the net income, for the life of the benefits, with the discount rate to arrive at the present value.

A contingency allowance in percentage should be estimated based on professional judgement, and added to market data in the Market Price method, to at least reflect the concept of zero emission. In estimating WTP, the mean of individual marginal utilities should first be taken and then, the average of the whole should be used as input in the Market Price method as against the maximum WTP. It may also be necessary to collect information regarding respondents' income, thus, people's values are likely to be well-defined and give credibility or otherwise to their response on WTP. Provisions for outgoings should be made to reflect elements of market failure in the Market Price method. The method should deduct the market value of other resources used to bring ecosystem products to market (externalities), so as not to overstate benefits. The Market Price method should be applied to sites where its potentials are largely tapped to reflect the true benefits accruable from such site(s). However, it may be necessary to check these activities as not to over exploit the ecosystem. Finally, more research should be made into these methods and other methods of economic valuation of biodiversity to supplement the findings of this treatise.

Table 1: Gubi Ecosystem Products Sold in Market (Fish)

Ecosystem Products	Annual Produce (kg)		Wholesale Price (N/kg)		Retail Price(N/kg)	
	Peak Period (May - Oct)	Off-Peak (Nov - May)	Peak (May - Oct)	Off-Peak (Nov - May)	Peak (May - Oct)	Off-Peak (Nov - May)
Ictalurus Furcatus	3,900	1,520	250.00	400.00	400.00	600.00
Tilapia Guinasana	4,000	1,520	200.00	300.00	350.00	550.00
Alestes Nurse	1,500	900	170.00	250.00	300.00	450.00
Schilbe Mystus	1,500	900	170.00	250.00	300.00	450.00
Barbus Occidentalis	1,500	900	170.00	250.00	300.00	450.00
Total	12,400	5,740				

Source: Field Survey, 2008

Table 2: Annual Fish Wholesale at Gubi Dam

Ecosystem Products	Annual Produce (kg)	Annual Wholesale (N)
Ictalurus Furcatus	5,420	1,583,500.00
Tilapia Guinasana	5,520	1,256,000.00
Alestes Nurse	2,400	480,000.00
Schilbe Mystus	2,400	480,000.00
Barbus Occidentalis	2,400	480,000.00
Total	18,140	4,279,000.00

Source: Field Survey, 2008

Table 3: Annual Fish Retail at Gubi Dam

Ecosystem Products	Annual Produce (kg)	Annual Retail (N)
Ictalurus Furcatus	5,420	2,472,000.00
Tilapia Guinasana	5,520	2,236,000.00
Alestes Nurse	2,400	855,000.00
Schilbe Mystus	2,400	855,000.00
Barbus Occidentalis	2,400	855,000.00
Total	18,140	7,273,000.00

Source: Field Survey, 2008

Table 4: Annual Fish Production and Sales at Gubi Dam

Ecosystem Products	Annual Produce (kg)	Annual Sales (N)	
		Wholesale	Retail
Ictalurus Furcatus	5,420	1,583,500.00	2,472,000.00
Tilapia Guinasana	5,520	1,256,000.00	2,236,000.00
Alestes Nurse	2,400	480,000.00	855,000.00
Schilbe Mystus	2,400	480,000.00	855,000.00
Barbus Occidentalis	2,400	480,000.00	855,000.00
Total	18,140	N4,279,000.00	N7,273,000.00

Source: Field Survey, 2008

Table 5: Gubi Ecosystem Products Sold in Market (Vegetables)

Ecosystem Product	Quantity (kg) (Oct - Apr)	Wholesale Price (N/kg)	Retail Price (N/kg)
Lycopersicon Esculentum	18,000	40.00	60.00
Brassica Oleracea	12,000	65.00	100.00
Lactuca Sativa	6,400	35.00	65.00
Piper Methysticum	10,800	80.00	120.00
Allium Cepa	22,000	30.00	55.00
Total	69,200		

Source: Field Survey, 2008

Table 6: Estimated Annual Vegetable Production and Sales at Gubi

Ecosystem Products	Annual Produce (kg)	Annual Sales (N)	
		Wholesale	Retail
Lycopersicon Esculentum	18,000	720,000.00	1,080,000.00
Brassica Oleracea	12,000	780,000.00	1,200,000.00
Lactuca Sativa	6,400	224,000.00	416,000.00
Piper Methysticum	10,800	864,000.00	1,296,000.00
Allium Cepa	22,000	660,000.00	1,210,000.00
Total	69,200	3,248,000.00	5,202,000.00

Source: Field Survey, 2008

Table 7: Other Market Price Method Valuation Inputs

Data Input	Amount (N/kg)
Average Willingness To Pay (WTP)/kg of Fish	750.00
Average WTP/kg for Vegetables	120.00
Current Variable Cost of harvesting 1kg of Fish	60.00
Current Variable Cost of harvesting 1kg of Vegetable	20.00
Initial Market Price (Fish/kg)	401.00
Initial Market Price (Vegetable/kg)	75.00

Source: Field Survey, 2008

Table 8: Projected PV of Economic Loss for Seven Years

Period (Years)	Economic Loss P.A. (N)	Discounting Factor @ 5%	Present Value (N)
1	5,340,606.00	0.9524	5,086,393.15
2	5,340,606.00	0.9070	4,843,929.64
3	5,340,606.00	0.8638	4,613,215.46
4	5,340,606.00	0.8227	4,393,716.56
5	5,340,606.00	0.7835	4,184,364.80
6	5,340,606.00	0.7462	3,985,160.20
7	5,340,606.00	0.7107	3,795,568.68
Total =			N30,902,348.50

Source: Field Survey, 2008

REFERENCES

- Cohen, J. and Tilman, D.** (1996). Habitat Destruction and Structure of Plant Communities. *Science*, 274:1150-1151.
- Colwell, R. R.** (1995). *Technology Trends and Applications: Biotechnology. In: Proceedings Marshalling Technologies for Development 28-30 Nov 1994.* Washington DC: National Academy Press.
- Costanza R. R., d'Arge R., de Groot R., Farber S., Grasso M., et al** (1997). The Value of the World's Ecosystem Services and Natural Capital. *Nature*, 387: 253-260.
- Daily, G. C.** (1997). *Nature's Services: Societal Dependence on Natural Ecosystems.* Washington DC: Island Press.
- Gunter, P.** (1998). *Upsizing: Road to Zero Emission.* Sheffield. Greenleaf Publishing.
- Habermas, J.** (1993). *Justification and Application: Remarks on Discourse Ethics.* Cambridge MA. MIT Press Ltd.
- Heal, G.** (2000). *Nature and the Market Place: Capturing the Value of Ecosystem Services.* Washington DC. Island Press.
- Ifediora, G. S. A.** (2009). *Appraisal Framework.* Enugu: SNAAP Press Ltd.
- Ifediora, G. S. A.** (1996). *Valuation Tables.* Enugu: SNAAP Press Ltd.
- Ita E. O., Sado E. K., Balogun J. K., Pandogari A. and Ibitoye B.** (1985) Kainji Lake Research Institute Technical Report Series No. 14: www.fao.org/docrep, February, 2008.
- Johnson T., Davis, K. and Shapiro E.** (2005). *Modern Methods of Valuation* (9th Edition). London: Estate Gazette Ltd.

- Kellert, S. R. and Wilson, E. O. Eds.** (1993). *The Biophilia Hypothesis*. Washington DC: Island Press.
- McNeely J., Miller K., Reid W., Mittermeier R. and Werner T.** (1990). *Conserving the World's Biological Diversity*. Washington DC and Gland Switzerland: World Resources Institute, IUCN, Conservation international, WWF, World Bank.
- Norton, B. G. (ed)** (1986). *The Preservation of Species: The Value of Biological Diversity*. Princeton NJ: Princeton University Press.
- National Research Council (NRC)** (1997). *Valuing Ground Water: Economic Concepts and Approaches*. Washington DC: National Academy Press.
- National Research Council (NRC)** (1999). *Perspectives on Biodiversity: Valuing Its Role in an Everchanging World*. Washington DC.: National Academy Press.
- Randall, A.** (1987). *Total Economic Value as a Basis for Policy*. New York: Trans American Fisheries Society.
- Stanlake, G. F. and Grant, S. J.** (1999). *Introductory Economics* (6th edition). Singapore: Longman.
- Wilson, E. O.** (1984). *Biophilia*. Cambridge MA: Harvard University Press.
- Zilinskas R. A., Colwell R. R., Lipton D. W. and Hill R.** (1995). *The Global Challenge of Marine Biotechnology: A Status Report on Marine Biotechnology in the United States, Japan, and other countries*. College Park: MD Press Limited.

www.ecosystemvaluation.org. Accessed June 2006.

www.ecosystemvaluation.org. Accessed March 2007.