THE PRODUCTIVITY METHOD OF ECONOMIC EVALUATION OF BIODIVERSITY APPLICATION IN BAUCHI STATE, NIGERIA

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ABSTRACT

This paper examined the feasibility and reliability of value estimatesof the Productivity Method by applying it to Gubi Water Treatment Plant in Bauchi, Nigeria. The theoretical bases of economic valuation methods were also examined to clarify their premises, rationales and conditions under which they would be valid. Interviews were conducted with management officials of the plant and Bauchi State Ministry of Water Resources. From data collected N127,900,000 was revealed as annual cost of water treatment before pollution control. The research concluded 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. Among other things, culture, as reflected in management and attitude, had been a major cause, observed to be affecting the effectiveness of the method in the study area. Finally, recommendations were made for the discounting of economic benefits to reflect time value of money and that environmental laws to be enforced for the method to be more effective.

Keywords: *Biodiversity, Ecosystem, Ecovaluation, Willingness-To-Pay.*

INTRODUCTION

Value-based research is often the only objective and credible source of information that policy makers have about values and the only way to discourage wasteful environmental investments that are not in the public interest. Prioritizing policies in decision making on conservation spending requires information about Facts and Values which are sourced through:

(1) Value-free facts provided by scientists;
(2) Interest groups bombardment with their spin on Values; and
(3) Value-based research (National Research Council (NRC), 1999).

As difficult and controversial as value-based research is, it is the only objective source of information that policy makers have about values. Often it is the only credible basis for opposing the special interest spin on values, and the only way to discourage wasteful environmental investments that are not in the public interest (Daily, 1997).

Theoretically, biodiversity, or a contraction of biological diversity, connotes variety or diversity within the biological world (Encarta, 2009). Although biodiversity might well have substantial economic value, compared with 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 (Wilson, 1998). 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 (NRC, 1999).

Ecosystem valuation can be a difficult and 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 must 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 programs, policies, or actions that protect or restore ecosystems and their services (Evenson, 1995). Valuation of biodiversity has peculiar difficulties as enumerated in the reasons below (*www.ecosystemvaluation.org, June,* 2006):

Non-market goods: Most environmental goods, such as clean air and water, and healthy fish and wildlife populations, are not traded in markets. Their economic value (i.e. how much people would be willing to pay for them in monetary terms) is not revealed in market prices. The only option for assigning monetary values to them is to rely on non-market valuation methods (Heal, 2000);

Non-rival goods: One person's consumption of most goods (e.g. housing) reduces the amount available for everyone else, but environmental goods are different. Clean water and air, beautiful views, and to some extent outdoor recreation, can be enjoyed by everyone in the same way as radio and television.

Non-exclusive goods: People cannot be excluded from enjoying most environmental goods and the cost of trying to exclude them is prohibitive (www.ao.uiuc.edu, July 2006).

Inseparable goods: Conservation practices at a given site contribute in many roundabout ways to environmental goods and result in environmental and economic benefits that accrue over great distances in time and space. It may be impossible to separate the economic benefits that result from one conservation practice undertaken at one site from another undertaken at another site.

METHODS OF ECONOMIC VALUATION OF BIODIVERSITY

Though biological resources are priceless, attempts are often made to assign some measurable value to biodiversity in order to attract the attention of government and commercial interests. It is difficult to put monetary values on the benefits people derive from the natural environment, but while this is a daunting task, several methods of valuation have been developed in attempts to give realistic value estimates of

biodiversity. The methods include (*www.ecosystemvaluation. org, March* 2007):

(a) Productivity Method
(b) Market Price Method
(c) Hedonic Pricing Method
(d) Travel Cost Method
(e) Damage Cost Avoided, Replacement Cost and Substitute Cost Methods
(f) Contingent Valuation Method
(g) Contingent Choice Method
(h) Benefit Transfer Method

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:

Revealed Willingness to Pay (Market Prices): When people purchase something (e.g. a home) or spend time and money to get somewhere (e.g. 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 good. Prices people are willing to pay in markets for related goods can be used to estimate their values.

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.

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: In conventional economics, it is generally accepted that a measure of value should be based on what people want and that people, and not the government, scientists, or preachers (Stanlake and Grant, 1999). 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 that it be bought and sold in markets, but requires that someone estimates 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 (Freeman, 2003).

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. The process involves: (a) the problem defined, (b) the data required is identified, acquired, classified, analyzed, interpreted; and (c) the data is applied to the various methods to arrive at the determination of value (Ifediora, 2009). Valuation of biodiversity relies on detailed information from the natural sciences. An environment might be valued as an asset, in which case its value would be the net present value of the services that it provides now and in the future.

Alternatively, some proposed action (a project or policy) might be valued; value would then be the net present value of the change in services that the environment will provide minus the cost of implementing the proposed action. Either way, valuation requires detailed knowledge of the service flows of the environment, of the costs incurred in preparing these services for human enjoyment, and of the responsiveness of service flows and costs to human interventions (Randall, 1987 and NRC, 1999).

The Productivity Method: The productivity method, also referred to as the net factor income or derived value method, is used to estimate the economic value of ecosystem products or services that contribute to the production of commercially marketed goods. It is applied in cases where the products or services of an ecosystem are used, along with other inputs, to produce a marketed good (Shiklomanov, 2000).

For example, water quality affects the productivity of irrigated agricultural crops, or the costs of purifying municipal drinking water. The basic principle of the Productivity Method is that environmental pollution control is a direct substitute for other production inputs, such as water purification chemicals and filtration. Thus, the benefits of improved water quality can be easily related to reduced water purification costs. In 2005, the Bauchi State Environmental Protection Agency (BASEPA) introduced some environmental pollution control measures in the catchment area of the Gubi Dam Water Treatment Plant in Bauchi, with the intension of improving the quality of raw water into the dam thereby reducing the cost of water treatment.

The main aim of this study is to assess the impact of the pollution control measures of BASEPA from 2005 to 2008 using the Productivity method of Economic Valuation of Biodiversity, with a view to highlighting their lapses and making appropriate recommendations on their remediation. Extensive research was limited to the Productivity method among other methods used for the economic valuation of biodiversity.

RESEARCH METHODOLOGY

The design adopted in this research is a surveyon Economic Valuation of Biodiversity and analysis of the procedures of Economic Valuation of Biodiversity as documented. The data used for the study were obtained from personal interviews conducted with Bauchi State Ministry of Water Resources (BSMOWR) and BASEPA key officers as well as observation.

Gubi dam in Firo Village, Bauchi Local Government Area of Bauchi State with a surface area of 600 hectares (Ita, et al, 1985) was taken as the case study. The dam is fed from four different rivers namely Ran, Tagwaye, Shadawanka and Gubi rivers in Bauchi while its catchment area, defined by topography, is bordered by major roads in Bauchi city - Ran Road from Awalah Roundabout, through Barkin Kura Street to Wunti Street, Yandoka Road and Jos Road then through the mechanic village right to Gubi village. The dam has capacity to pump about 45 million cubic metres of water daily (Field Survey, 2008).The data collected were analyzed using tabulated with amount and graphs.

RESULTS AND DISCUSSION

Table 1: Production Inputs for potable at Gubi Water Treatment Plant

Production Input	Classification
Water Treatment Chemicals	Variable
Overhead Costs (salaries, fuel, stationery, office expenses etc.)	Constant
Electricity Bills/Diesel for Generators	Constant
Maintenance of Plant & Machinery Items	Constant

Source: Field Survey, 2008

From the table 1, the only cost that would be affected by cleaner raw water inflow, as a result of better pollution control, would be the water treatment chemicals. Overheads, electricity and maintenance costs are not directly subject to the quality of water flowing into the dam.

Estimated Cost of Water Treatment Chemicals at Gubi: The production inputs for potable water at the Gubi Dam before pollution controls were introduced. N127,900,000.00 was used annually to treat water at Gubi dam annually before the pollution control measures were introduced.

Table 2: Annual Cost of Treatment at Gubi Dam in 2005

Water Treatment Chemicals	Yearly Consumption	Usage	Rate (N)	Amount p.a. (N)
Chlorine	30 tons	Disinfections	800,000/ton	24,000,000
Lime/Soda Ash	350 tons	Water softening & pH level	100,000/ton	35,000,000
Alum	700 tons	Flocculation	95,000/ton	66,500,000
Poly Electrolyte	2.4 tons	Catalyst to Alum	1,000,000/ton	2,400,000
			TOTAL	***N127,900,000***

Source: Field Survey, 2008

Pollution Control at Gubi Dam Catchment Area: The Bauchi State Environmental Protection Agency (BASEPA) is mainly responsible for this pollution control within the metropolis, including the Gubi plant water catchment areas. The following information gathered at BASEPA revealed the efforts of the Agency in controlling pollution within the catchment area.

Immediate Evacuation of Waste from Catchment Area: The Agency has within the years increased its disposal trucks from two in good working condition in 2000 to fifteen in 2008 and it has afforded it to be more effective in waste collection.

Relocation of Landfills outside Water Catchment Area: A landfill is a site used for burial of waste materials (Allaby, 1988), and BASEPA has relocated the disposal of waste material or refuse by burying it in natural or excavated holes or depression outside the water catchment area, while the initial landfill sites within the catchment area were evacuated.

Separation of Waste Materials: Refuse is also presorted, to remove materials that might have salvage value or cannot be composted. Waste products varies from garbage: decomposable wastes from food; rubbish: non-decomposable wastes, either combustible (such as paper, wood, and cloth) or noncombustible (such as metal, glass, and ceramics); ashes: residues of the combustion of solid fuels; large wastes: demolitions and construction debris and trees; dead animals; industrial wastes: such materials as chemicals, paints, and sand; and agricultural wastes: farm animal manure and crop residues.

Composting: This is the biochemical process in which organic materials, such as lawn chippings and kitchen scraps, are decomposed to a rich, soil-like material (Botkin et al, 1998). Composting operations of solid wastes include preparing refuse and degrading organic matter by aerobic microorganisms after separation.

BENEFIT OF POLLUTION CONTROL TO GUBI WATER PLANT

Nature plays a major purification role at the Plant since it removes many impurities before the water reaches the dam through natural filtration (www.en.wikipedia.org, May, 2008) However, the efforts of the Agency is further limited for the following reasons: Firstly, the measures hardly affect disinfection because pathogens come mainly from sewage water and its treatment is not presently addressed by the Agency. Thus the maximum effect it has on Chlorine is insignificant. In many developing countries the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only (en.wikipedia. org, May, 2008). Furthermore, Gubi has no problem of turbidity, save during the rainy season as a result of erosion and not from manmade pollution.

Thus, the measures' effect on Alum and Poly Electrolyte are negligible. The measures however have a significant effect on reduction of Lime/Soda Ash because water hardening and acidity level is reduced considerably. Other effects of the pollution control measures include reduction in chemical elements such as lead, from battery water and other chemical disposed off indiscriminately; nitrogen and phosphates from agriculture runoffs. However, these elements are not particularly treated during the treatment process; since they attach themselves to particles during flocculation and when these particles are removed many of these elements are equally removed but the remaining are passed to the consumer (BSMOWR, 2009). Thus the effects of removing these items from water do not affect the cost of treatment chemicals considerably.

Fig. 1: Map of Bauchi showing Gubi Catchment

Table 3: Benefits of Pollution Control Measures

Benefits	Implication(s)	Reduction (%)
Water hardness reduced	Reduction in Lime	15%
Reduced turbidity	Reduction in Alum	2%
	Reduction in PE	2%
Reduced Acidity	Reduction in lime	15%
Reduced Pathogens	Reduction in Chlorine	5%

Source: Field Survey, 2009

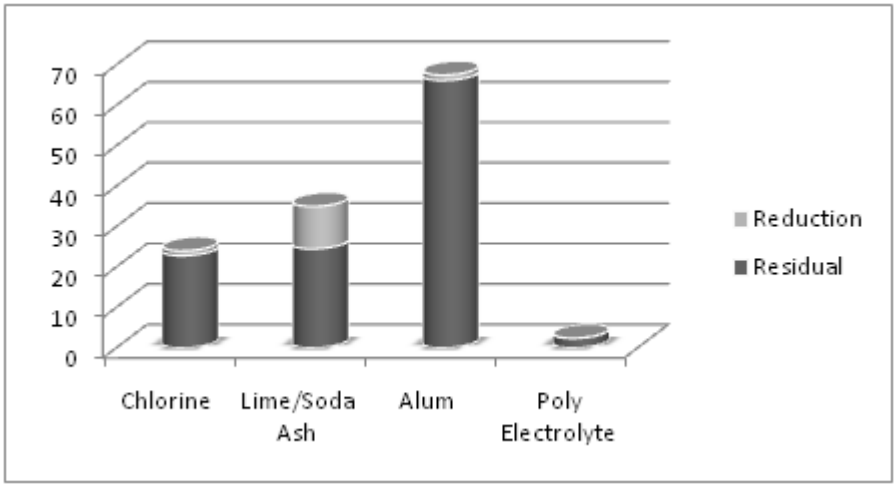
Table 4: Cost Benefits of Pollution Control Measures

Implication(s)	Reduction (%)	Cost Implication (N)
Total Reduction in Lime	30%	19,950,000.00
Reduction in Alum	2%	700,000.00
Reduction in PE	2%	48,000.00
Reduction in Chlorine	5%	1,200,000.00
Total Reduction in Cost Annually		N21,898,000.00

Source: Field Survey, 2009

Thus, the total benefit from the pollution control measures embarked upon by BASEPA as it affects Gubi dam catchment area is N21,898,000.00 or 17.12% of initial total cost.

Fig. 6: Reduction in Cost of Treatment Chemicals (Nm)



Source: Field Survey, 2009

Table 5: International and Contract Prices of Treatment Chemicals at Gubi Dam

Chemical Item	International Prices (N)	Contract Prices (N)
Chlorine	31,200/metric ton	800,000/metric ton
Lime/Soda Ash	22,750/metric ton	100,000/metric ton
Alum	11,050/metric ton	95,000/metric ton
Poly Electrolyte	520,000/metric ton	1,000,000/metric ton

Source: Field Survey, 2009

The survey carried out observed that this method is feasible based on its application on the study area although, some factors may influence the benefits based on the following findings: The pollution control measures proposed by BASEPA do not have a significant impact on the cost of inputs because sewage water treatment, which would have greatly reduced the use of chlorine and its potential hazards was not considered. The distance between Bauchi and the Dam has provided nature a means of removing many impurities before they reach the dam through natural filtration much more than the Agency could do. During survey it was discovered that the treatment chemicals are usually supplied at exorbitant prices. These prices have not made the benefits of better pollution control attractive enough.

The relocation of the landfills outside the Gubi dam catchment area is a commendable effort but some unscrupulous staff of the Agency still dump waste illegally within the catchment area for meagre fees. The Productivity method made no provision for discounting of future streams of benefits for as long as the benefits remain. Since the benefits will remain as long as the pollution control continues, the benefits should be valued "in perpetuity" - a professional valuation term signifying the continuity of the benefits. Using the total benefit of pollution control measures i.e. N21,898,000.00, the future streams of benefits can be valued in perpetuity using the Present Value of N1 per Annum (or Discounted Cash Flow) Table thus: N21,898,000 x YP in perp @ 5% = N21,898,000 x 18.2559* = N399,767,698.20. (*page 256 of Valuation Table - Davidson, 2006). Thus, the PV of Total Benefit of the effects of pollution control in perpetuity is N399,767,698.20, approximately N400,000,000.00. This method has eliminated the problem of aggregation and double counting. There is no observation of double counting of any input whatsoever.

CONCLUSION AND RECOMMENDATIONS

The method has proved to be applicable in the study area, however, the processes can still be improved upon, to make it more credible in developing countries as it has proved to be in developed countries. Among other things, culture (as reflected in management and attitude) has been a major cause, observed to be affecting the effectiveness of the methods in the study area. The following recommendations have been made:

1. The Productivity method should be used to estimate in perpetuity.
2. The Productivity method would be more effective only when major effective pollution control measures are taken. Sewage treatment would be the major pollution control measure needed in the study area. Major cities in the world, including Abuja, have sewage treatment plants and in addition, it has other environmental benefits apart from water treatment.
3. 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).
4. To get an unbiased value estimate using the Productivity method, cost data collection should be based on the market value with provision for contractors'

mark-up as provided for. The method has proved to be more reliable in developed countries where public officers are more accountable for their actions. Direct purchases can be made to purchase treatment chemicals directly from manufacturers as this would go a long way to reflect the true market values of these goods.

5. Effective pollution control for the dam can only be reflected by addressing the major treatment of water at any particular site for the Productivity method to be effective. In Bauchi sedimentation consumes the highest percentage of total treatment cost and pollution control measures should therefore address the peculiar problems relevant to each site for it to be effective.
6. There is need for environmental laws and enforcement to be in force in the country so that the methods, especially the Productivity method could be more effective. The culture in the country has allowed many people to flout the law and get away with it. For example, the dumping of wastes in prohibited areas by staff of BASEPA.

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