Accounting for Watershed Management Services in the Forest Reserves of Osun State, Nigeria

Toyin E Olatunji[1*] Abd-Rahman A. Onaolapo[2]

[1,2]Department of Management and Accounting, Faculty of Management Sciences,
Ladoke Akintola University of Technology, Ogbomoso-Nigeria
P.M.B. 4000 Ogbomoso-Nigeria
E-mail of Corresponding author: olatunjitoyin@gmail.com

Abstract

The role of forests in watershed productivity has been a subject of serious concern at various forums. The significance of forests in watersheds is evidenced by the prevention of siltation of water bodies as well as maintenance of water quality. In Osun state-Nigeria, the main services carried out by the watershed is domestic, industrial and community water supply, not much of navigation is possible. Thus, it was aimed to evaluate the contributions of forest reserves of Osun state-Nigeria to watershed management. Primary and secondary data were adopted in the study. The relationship between decline in forest holdings and water supply was examined; the contingent valuation of forest contributions to watershed was undertaken; and the mean WTP was extrapolated over the population to arrive at the total value of watershed service of forests as a guide to determining the accounting value to take for depreciation or accretion. Results showed that there was a strong relationship between both variables. Furthermore, the mean value of WTP is ₦3,623.29 and the total value is ₦12.40 billion. This value provides a basis for accounting for annual costing of services consumed. It was concluded that deforestation has adverse effect on watershed services and its value will enhance accountability and well informed decisions towards sustainability.

Keywords: Accounting, Watershed, Forests, Contingent Valuation.

I. INTRODUCTION

1.1 Background to the Study

Tropical forests have been described as significant in the world's ecosystem, not only because of its capacity to regulate carbon equilibrium, but also biophysical roles in water supply and efficacy. Zingari and Achouri(2007), observe that the recurrence of extreme weather events, climate change and the need for adaptation strategies have attracted both national and international attention to consider water, water-related ecosystems and watersheds. Associated with these considerations are the problems of water security, environmental degradation, food insecurity and poor livelihood conditions and human health.

It has thus become inevitable to study the interrelationship between forests and water. There is growing awareness of the many services forests provide such as watershed protection, biodiversity conservation and carbon storage. There is also growing awareness of the cost to society when these services are degraded or lost. The hydrological services of forests included the regulation of water quality and flow (Maranem, Friedman and Milder, 2011; NIVA5373,2007). It would seem that the value of these hydrological services will grow over time as water become more scarce in the near-future (Johnson, White and Perrot-Maitre, 2001).

Watershed has been described by Gunawardena (2011) as   an area which drains into a common drainage outlet whose boundary is easily defined and the area demarcated. All living beings within this watershed, and sometime outside of it (e.g. transboundary water transfers) use these resources to transport and provide goods and services. Sustainable watershed management is assured as long as these goods and services can be produced continuously over a period of time without degrading resources, especially the natural resources within the watershed.

Five key services emanate from watershed management, namely erosion control, enhanced soil quality, increased total water yield, stabilization of stream flow distribution and control of sediment in streams (Pattanayak,2004; Hamilton and Kong,1983; Pereira,1989; Bruijnzeel, 1990;Bonnel and Balak,1993).

1.2 Statement of the Problem

Watershed management is brought to the top of an agenda because these watershed resources continue to degrade over time and this is a cause for concern in terms of sustainability. Reid (2001) estimates that the majority of the world's population live downstream of forested watersheds and therefore are susceptible to the costs of watershed degradation. Further, about 13 percent of the world's land area is needed to protect water supplies for the global population — an area that will grow with the population(Johnson, et al., 2001). This is a much broader issue in relation to the survival of future generations (Gunawardena, 2011).

Pattanayak (2004), explains that unreliable information regarding the value of services from tropical forests can partly cause rapid disappearance of the world's natural forest cover. This, in turn endangers the environmental services provided by the forests. Watershed services, such as mitigation of floods, droughts and soil erosion by protected forests are examples of unpriced, undervalued life support services that can serve as beneficial to economic livelihoods in the tropics (Dasgupta, 2001). One of the key problems to accounting for the contributions/value of forest watershed management services lies in obtaining reliable and adequate data for that activity. This problem is not limited to the statistics alone (although this is a significant challenge in Nigeria's context), but also choice of methodology for assigning values for the observations. A few questions are raised, as follows:

  i.   To what extent do watershed management services depend on continued sustenance of forests?
  ii.   What is the perceived contribution of the forest reserves to watershed services in Osun State, Nigeria?
  iii.   What is the estimated accounting value of watershed services in forest reserves of Osun state, Nigeria?

This paper attempts to unravel watershed management by (a) reviewing the ecological and economic literature on watershed services, (b) describing a framework for estimating watershed service benefits, (c) presenting a case study that applies the proposed method to a specific watershed service, and (d) evaluating the forest watershed services for accounting purposes.

1.3   Research Objectives

The general objective of this research is to evaluate the contributions of forest reserves of Osun state to watershed management. The specifics are to

i.   examine the relationship between changes in forest reserves and water supply in Osun   state, Nigeria;

ii.   evaluate watershed management services of the forest reserves of Osun state.

1.4   Hypotheses

 The following hypotheses were proposed for this study. They are all stated in null form.

Hypothesis I: There is no significant relationship between sustainable forest management and water supply in Osun State.   .

Hypothesis II: There is no significant difference in the perceptions of stakeholders on the   value of forest watershed management services.

2   Theoretical and Conceptual Framework

Accounting for the value of watershed management services of forests is rooted in the theory of natural resource management, as exemplified by Hendriksen (1972), it is all about "capital- maintenance." This is a derivation of the Hicksian argument, which describes income as what may be consumed during a period while still remaining as well-off as at the beginning of that period (Hicks,1946; Glautier and Underdown, 1982). There is strong intertwining between economic theories and concepts and accounting principles.

The theory of externality is of relevance in considering non-timber forest products like its environmental services as biodiversity preserver, wildlife conserver/habitat, tourist attraction, the watershed protection, etc. Forests may have been kept for timber but it also provides "unintended" services, such as the watershed management. This is a form of positive externality in that the "unintended" service results to the benefit of people living within the watershed (www.bized.co.uk). Steinacker (2006), explained that externality problem can be conceived in two ways: if an action creates one type of externality, failing to act creates the opposite type. Thus, the concern of a timber contractor for sustainability of the forest resource could give rise to tree planting while the outcome of that sustained resource include watershed protection that benefits the local community.

The concept of sustainability is made clearer by the definition of the World Commission on Environment and Development (WCED, 1987). Here, sustainable development is defined as the development that meets the needs of present without compromising the ability of future generations to meet their own needs. Forests are one of the most important components of the terrestrial environmental system and a complete resource base. They provide not only various goods but also maintain the ecological balance and life-support systems essential for health and all round development of human kind (Verma,2003; Pattanayak, 2004). As observed by Olatunji (2012), forests are natural resources, which have many inherent advantages when viewed from environmental perspective they are renewable, recyclable, biodegradable and carbon neutral. They are truly sustainable.

There are multiple uses of forests by various stakeholders. Forests enhance overall watershed by mitigating the effects of natural and human disturbances. Johnson, et al. (2001), summarized the roles of forests as including the prevention of runoff in a watershed; reduction of soil erosion and sedimentation of waterways;

filtration of contaminants and influence of water chemistry; reduction in total annual water flow in a watershed; increase or decrease(regulation) of groundwater recharge; forest loss shifts aquatic productivity; and, may influence precipitation at a large regional scale but the effects of forest cover on rainfall in most areas is limited (NIVA5373, 2007). Although Johnson, et al., worked on developing markets for forest ecosystem services of watershed management, they raised a few questions which are relevant for our considerations, namely, what water-related ecosystem services are provided? Can these services be measured and monitored? What is the value of the ecosystem service? Are beneficiaries willing and able to pay for the ecosystem service?

The conservation of ecosystems is often seen as a cost rather than an investment society makes to sustain nature and human livelihoods. Yet, they are the lifeline of many stakeholders. For example, the hydrological services of forests, mainly water quality and water flow, are among the most valuable of the many ecosystem services from forests. When these ecosystems become degraded, downstream users like farmers, water supply companies and hydropower firms may suffer production losses and large investments in water treatment plants, dams, and flood control structures may be needed to replace the lost ecosystem services. It is only by understanding the financial values of these services and investing in their conservation that it may be possible to save the money spent to replace lost services and to increase investments in sustainable forest management (Verma,2003; FAO,2007).

Conceptually, this study is construed as progressing in stages, such as: establishing the links between changes in watershed protection, e.g. what occurs when forest cover is removed; to determining the relative change it triggers in watershed services provided; to evaluation of the economic impact of the change in watershed services on production; and, finally placing a value on the lost services. This is depicted in fig.1,
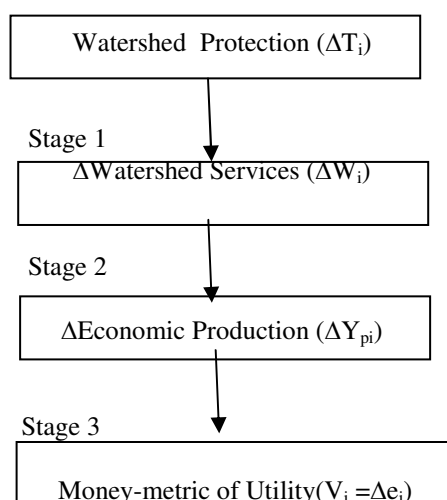

Fig 1   A Conceptual Framework for the Valuation of Watershed Services
Source: Pattayanak, 2004

3.   Valuation of Watershed Management Services of Forests

Verma(2003) used the Green Accounting approach to explain the valuation process by looking at the value of direct consumptive benefits- i.e. the value of growing forest stock, value of salvage, value of timber drawn by right holders, value of fuel wood requirement, etc.- the value of direct non-consumptive and indirect benefits of forests. The value of direct non-consumptive and indirect benefits included values of ecotourism and recreation benefits, watershed benefits, microclimatic factors, carbon sink, biodiversity and employment generation. These were then used to compute the total economic value of the forests and its contribution to State Gross Domestic Product.

Venkatachalam(1997), classified existing valuation methods into two, namely, revealed preference methods and stated preference methods. The revealed preference method comprising the travel cost method, the hedonic pricing, the production function and the defensive expenditure approaches were seen to be effective in some respects but suffer from various drawbacks, especially with respect to non-use values. Here, the stated preference methods come handy. The methods used here are contingent ranking and contingent valuation. Although often bedevilled by the twin problems of validity and reliability, the contingent valuation method has been widely used, even in developing countries. The problems of validity and reliability are surmountable with design and administration of surveys.

Venkatachalam(1997), suggested a marginal opportunity cost approach within an environmental accounting framework, especially the natural resource accounting aspects   (Pattanayak, 2004). Here, two approaches were identified, i.e. the physical accounting and the monetary approaches. Physical accounting for watershed would involve determination of water balance- the additions and subtractions to the existing stock of water at the river basin level.- as well as the quality information, such as pollution load from point and non-point sources; while the monetary valuation depends on the basis of valuation.

Pattanayak(2004) hinted, among other things, that the contingent valuation involve the use of a Willingness to pay (WTP) for watershed management services of forests. Here, the value of a watershed service is the money equivalent of a change in utility or a WTP amount. In this survey the respondents could be questioned as to their willingness to pay for watershed services and if 'yes,' the amount willing to pay.

4.0   Methodology

The study area is the forest reserves of Osun state. Located in the south-western Nigeria, Osun state lies between 7 degree and 8 degree 30minutes North (7^0 - 8^0 30' N) and longitude 4 degrees and 50 degrees East (4^0 - 50^0 E) having a population of three million, four hundred and twenty-three thousand, five hundred and twenty-five people (3,423,525) (Alamu, 2008; Nigerian Population Commission, 2007). The state had eleven legacy forest reserves which fell within her boundaries, after she was carved out of the then Oyo state. Only eight of these reserves are still in existence.

The nature of watershed in Osun State precludes navigation, irrigation is currently not a significant activity and fish/shrimps production are just beginning to gain prominence. Most of the use of water is for human and animal consumption as well as domestic uses. The bulk of water supply in Osun State comes from the state government water schemes at Ede Headworks and the Mini Water schemes spread across the state. Thus, the most appropriate source of data for watershed services is government Water Corporation.

Five forest reserves were surveyed. The local population around the five forest reserves (5 kilometre radius) is estimated at 300,000. The sampling procedure adopted is based on survey sample size formula is 390, as follows:

$$n = \frac{[(Z^2 * p * q) + ME^2]}{(ME^2)}$$

where,

n	=	sample size
p	=	level of precision anticipated in respect of the research problem.
		Since there is no precedence, 50% is selected.
q	=	1-p
ME=		Margin of Error that can be tolerated in this research is 5%.
Z	=	the alpha value is determined by calculating 1-confidence level,

1- 0.95= 0.05 to estimate the critical value given as 1-(alpha/2). i.e 0.975. The value is 1.96.

i.e.   n   = $[(1.96)^2 * 0.5 * 0.5 + (0.05)^2] / (0.05)^2$

n   =   0.9629/0.0025   = 385.16

The variables for this study were:

Objective (i)   Size and changes in forest reserves of Osun state (1992-2011)- independent;

Volume of Water produced and changes therein (1992-2011)- dependent.

(ii)   socioeconomic characteristics of respondents- independent

Willingness to Pay for Watershed Services (dichotomous) dependent

Mean Amount of Willingness to Pay for watershed services- dependent.

Data analysis was done as follows:

Objective (i)   t-test was used to test the degree of association between the two variables;

(ii)   LOGIT regression model was adopted to determine WTP; and

(iii)   an extrapolation of the mean WTP to determine accounting value to reflect in   the books.

Model Specification:

i.   to test the effects of forest reserves sustainability on water supply within the state the difference between the means of available forest reserves and the available water supply is compared using the student-t statistic expressed as::

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_{x_1 - x_2}} \quad \dots\dots\dots\dots\dots\dots\dots i$$

Where

t is the test statistic

$\bar{X}_1$, $\bar{X}_2$ are the sample means of variable 1-tree felling and variable 2 tree planting

S x_1-x_2 Is the estimated standard error of the differences and it is given as

$$\sqrt{\frac{S^2}{n_1} + \frac{S^2}{n_2}} \quad ....ii$$

where,

$$s^2 = \frac{(n-1)s^2 + (n-1)s^2}{n+n-2} \quad ....iii$$

and

n_1, n_2 are sample sizes for variables 1 and 2 respectively

S_1^2 and S_2^2 are the variances for variables1 and 2 respectively

$n_1 + n_2 - 2$ is the degree of freedom.

ii.　LOGIT regression model for the dichotomous choice of Willingness o Pay(WTP) for watershed services is given as -

$$L\frac{P(WTS)}{1-P(WTS)} = \frac{f(X1+x2+x3+\cdots+X9)}{f(WTS)} \quad ....iv$$

Where

X_1 = Gender of respondents

X_2 = Marital Status of respondents

X_3 = State of origin of respondents

X_4 = Education of respondents

X_s = Size of farm of respondents

X_6 = Annual Income of respondents

X_7 = Age of respondents

X_8 = Size of family of respondents

X_9 = Distance from Forest Reserves; and,

WTS is Watershed Services.

iii.　To determine the appropriate value for forest watershed services in Osun State, Nigeria the amount of WTP is regarded as per capita valuation of watershed services in the state and thus is extrapolated over the entire population for full values to be obtained –

V_{WTS} = X.(WTP_{WTS}). POP_{osun} v

V_{WTS} refers to the value of watershed services

X.(WTP_{WTS}) is the mean amount of Willingness to Pay for watershed services

POP_{osun} is the population of Osun state by 2006 Census.

5. Findings and Discussions

i.　Forest Reserves and Water Supply in Osun State, Nigeria.

TABLE 1   A Comparative View of Forest Reserves of Osun State

S/N	Name of Forest Reserve	Size (Ha) 1991	Size (Ha) 2011	DIFFERENCE
1.	Ago- Owu	31,744	19,847	-11,897Ha
2	Ede	1,344	1,044	-300Ha
3	Ejigbo	314	214	-100Ha
4	Ife F3	8,383	7,168	-1,215Ha
5	Olla	107	-	-107 Ha
6	Ikeji-Ipetu	4,349	2,849	-1,500Ha
7	Ila	256	230	-26Ha
8	Oba Hills	6,773	4,225	-2,548Ha
9.	Oni	5,632	0	-5632Ha
10.	Osogbo	594	0	-594Ha
11.	Shasha	31,232	23,064	-8,168Ha
	TOTAL	90,738	58,641	-32,097Ha

Source: Forest Management Department, Osun State Ministry of Environment, 2012

Table 1 shows the state of the forest reserves at two time periods, i.e. 1991 and 2010, and the changes therein. A trend of the changes in forest land use can be described as:

$$\Delta x = \frac{x_n - x_0}{x_0} = \frac{58,641 - 90,738}{90,738} = -0.3537 \text{ or } -35.37\%$$

Where,

Δx is the rate of change in forest holding within the reserves of Osun State, Nigeria;

X_0 refers to the size of forest reserves at year 0 being 1991;

X_n refers to the size of the forest at year n, i.e. 2010.

Table II Water Production by Water Corporation of Osun State, Nigeria

Obs	1	2	3	4	5	6	7	8	9	10	11	12
Cub. mt/d	74,818	47,354	66,792	57,252	50,771	52,576	75,880	75,880	71,294	56,295	50,295	42,380

Source: Osun State Water Corporation, 2013

Fig. 2   Statistical Data on Water Supplies in Osun State

The two variables, forest reserves and water supplies were subjected to the student-t tests and it showed t = 2.238; and at 5% level of significance produces a value of 0.047 which is significant implying that the null hypothesis is rejected. Thus, there is significant relationship between watershed services and sustainable forest management.

Contingent Valuation using the LOGIT model for the dichotomous response is

=f ($-3.55X_1 + 1.24X_2 - 0.21X_3 - 3.71X_4 + 0.61X_5 + 1.15X_6 - 0.35X_7 + 0.45X_8 + 4.11X_9 + 3.01$)

The P values and odds ratio are:

variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
P values	0.000	0.215	0.833	0.000	0.539	0.248	0.728	0.650	0.000
Odds ratio	0.147	2.225	0.914	0.763	1.204	1.212	0.887	1.146	14.390

Research Survey, 2012.

The combined influence of the nine variables to determine the willingness to pay for watershed and prevention of water pollutions was significant at P= 0.0000 which is less than 0.05 significance levels. Three variables exerted significant influence in the respondents' choice. These were X_1, i.e. Gender; X_4, Education; and, X_9, Distance from Forest Reserve (at 5% level of significance).

The mean values for the Willingness to Pay responses is given as:

Amount of WTP	< ₦ 1,000	₦1,001-₦10000	₦10001-₦20000	Above ₦20000	Total	Mean: ∑Fx/∑f
frequency	135	62	11	11	**219**	--
X	500	5,500	15,000	20,000	-	-
Fx	67,500	341,000	165,000	220,000	₦793,500	₦3,623.29

Source: Research Survey, 2012

The mean Willingness to Pay amount was ₦3,623.29. this value can be seen as the per capita value of the service in the state. Thus, the gross value of watershed services in Osun state can be expressed as:

Gross Contingent Value = Mean WTP * Population Osun State

i.e. Gross CV   =   ₦3,623.29 * 3,423,525 = ₦12,404,423,897.25

The value arrived is part of what could be capitalized for eventual determination of depreciation to accrue from year to year.

6.0   Summary, Conclusions and Recommendations

Forest environmental services are important consideration in determining the total economic value of the resource. One of the most significant of these services is the watershed service because the entire ecosystem depends on water and its functions. The ability to value the resource provides an impetus for the preservation of forests. Furthermore, valuing the asset will promote accountability as well as remediation action where necessary.

It was concluded that deforestation has adverse effect on watershed services among which is water supply. It was also concluded that the value of the resource could be arrived at through a contingent valuation. It was further concluded that the accounting functions is better served through such efforts and by extension it facilitates effective and well informed decisions to be made towards sustainability.

It was recommended that there should be an inter-ministerial committee to determine the true added costs of producing water in Osun State as a result of unbridled deforestation. It was also recommended that the statistical units of the forestry department be overhauled to improve quality of information obtainable to aid the evolution of suitable models as basis for standardization of accounting procedures and possibly standards of practice. The outcomes of this study should encourage the regeneration of forests to solve the problems of siltation of lakes and rivers. Training accounting personnel in the art environmental accounting will ease the burden of measurements and accounting.

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