Rwandan Population's Willingness to Pay Ecosystem Services Provided by Forest Ecosystems

Egide KALISA[1] and Gabriel HABIYAREMYE[2]

1. *University of Rwanda, College of Science and Technology, School of Sciences, Po. Box3900 Kigali-* ***Republic of Rwanda***

2. *Independent Institute of Lays Adventists of Kigali, Faculty of Environmental Studies; Department of Environmental Management Po. Box 6392 Kigali* - Rwanda

Corresponding Authors***: Email: kalisa.egide@gmail.com***

Email: kalisa.egide@gmail.com

Abstract

Forests worldwide are known to be critically important habitats in terms of the biological diversity they contain and in terms of the ecological functions they serve. The values of forests therefore embody the values of the biological diversity they contain since it seems unlikely that the vast majority of the biological resources in question could occupy non-forest habitats. The ecological services provided by forests ecosystem are similarly many. Ecosystem services are the benefits people obtain from ecosystems, and they are often public goods. Public goods are an example of market failure, because consumers can enjoy the benefits without paying. Almost everyone agrees that ecosystem services are valuable, but there are few tools for private action that account for the public's values. Ecosystem valuation can be a difficult and controversial task, and economists have often been criticized for trying to put a "price tag" on nature. Therefore, this paper aimed at assessing Rwandan Population's Willingness to pay ecosystem services provided by Forest Ecosystems. The study was carried out in five provinces of Rwanda represented by six districts and collected data were arranged and manipulated using Microsoft Excel covered 1st January to 31st July 2013. The results indicated that over 75% of the study population has knowledge of functions of forest ecosystem services and the most valuable forest ecosystem service in Rwanda is erosion control and sediment retention.

Keywords: *Forest; Ecosystem Services; Rwanda; Population*

Introduction

Forests worldwide are known to be critically important habitats in terms of the biological diversity they contain and in terms of the ecological functions they serve. Ecosystem services are the benefits people obtain from ecosystems, and they are often public goods (Millennium Ecosystem Assessment 2005).

Public goods are an example of market failure, because consumers can enjoy the benefits without paying (Davis and Holt 1993). In addition, everyone agrees that ecosystem services are valuable, but there are few tools for private action that account for the public's values (Swallow et al. 2008).

Ecosystem services are the direct or indirect contributions that ecosystems make to the well-being of human population (Environmental Protection Agency (EPA), 2009). Also, ecosystem services are the benefits of nature to households, communities and economies (Daily, 1997). Thus, the term ecosystem services is usually interpreted to imply the contribution of nature to a variety of goods and services, which in economics would normally be classified under three different categories (Barbier, 2007): (a) goods (e.g. products obtained from ecosystem such as resource harvests, water and genetic materials); (b) services (e.g. recreation and tourism benefits or certain ecological regulatory and habitat functions such as water purification, climate regulation, erosion control and habitat provision) and (c) cultural benefits (e.g. spiritual , religion beliefs and heritage values).

Among different ecosystems, forests seem to be of great importance to human population. A forest is a large area of land covered by a thick growth of trees and other plants. It is the home for many different birds, insects and other animals (Joeldgreat, 2012). Forest ecosystems are system that supports human life. They provide a suite goods and services that are vital to human health and livelihood, natural assets called ecosystem services (The U.S Department of Agriculture (USDA), 2007). The world's forests hold importance for all of their inhabitants as well as for the overall health of the planet. The benefits of forests to society and to the diversity of life make it vital that they are protected from deforestation and other potential negative impacts of civilization (Agar, 2013).

Forest ecosystems deliver a vast array of products and services to the society. Perhaps the most famous product from the forest is wood, which also has an enormous diversity of applications and purposes, such as construction, furniture and fuel. But apart from that there are a large number of non-timber forest products, like medicinal plants, honey, fruits and bush meat (Millennium Ecosystem Assessment (MEA), 2005).

The availability, use and importance of these products vary per region and per culture. Especially in developing countries, many

people are dependent upon these products, forming an important part of the diet, like proteins from animal products. Most often the poorest and vulnerable parts of society depend very much on the forest. This group can also revert to the forest resources in periods when their conditions get worse; the forest is then functioning as a safety net (MEA, 2005).

Apart from concrete products, forests also deliver all kind of Ecosystem Services. Forests play an important role in the global and local water cycle. The specific role very much depends on the local circumstances, conditions and the forest type. Positive effects of forest are attracting rainwater, purification of water and regulation of water flows.

In areas with relief trees protect the soil against erosion (Mitchell *et al.*, 2007). Forests also influence local climate. Dependent on the latitude forest influences the temperature in a region: in the tropics, forest has a net cooling effect through evapotranspiration while at higher altitudes, mainly boreal forests, there is a net warming effect because the relative dark color of the canopies absorbs warmth from the sun (albedo effect). On a global level, forests stabilize climate by regulating energy and water cycles. Rainwater that is generated by the Amazon tropical forest enables the beef and plants production as well as the biofuel industry in Brazil, which are of great importance for the economy. The deforestation in Southeast Asia can have consequences for the rainfall patterns in Southern Europe and the Northwest coastal area of the United States (Mitchell *et al.*, 2007).

The payment of ecosystem services is to determine society's willingness to pay for the benefits provided by ecosystem services and goods. Therefore in economics, valuation concepts relate to human welfare (Bocksteal *et al.*, 2000). Therefore, the economic value of ecosystem function or service relates to the contribution it makes to human welfare, measured in terms of each individual's own assessment of his or her well–being (Bockstael *et al.*, 2000). An influential paper by (Costanza *et al*., 1997) estimated the combined value of all the world's ecosystem services at US$ 33 trillion a year.

Most forest service's values are not paid (Costanza *et al*., 1997). Putting a price on natural assets, recognizing the environmental, economic, and social values of forest ecosystem services is one way to promote conservation and more responsible decision making (USDA, 2007).

Capturing the value of nature's capital will help protect the Nation's private forests and grassland and the essential public benefits they provide (USDA, 2007).

Costa Rica presents one of the first national efforts to value forest ecosystem services. In 1996, Costa Rica adopted Forestry Law No. 7575, recognizing four critical services provided by the nation's forests: carbon sequestration, hydrological services, biodiversity protection, and scenic beauty (Douglas, 2001).The Forestry Law establishes a framework for payments to landowners for ecosystem services, set forth in a program entitled PSA (*Pagos por Servicios Ambientales*) that is administered by the National Forestry Fund, FONAFIFO. Landowners are compensated for providing ecosystem services via reforestation, sustainable management, preservation, and regeneration activities. Payments to landowners are made over a 5-year period, during which they relinquish their ecosystem service rights (Chomitz *et al.*, 1998). Under contract, landowners agree to manage or protect their forests for 20 years in accordance with a management plan, an obligation that is written into a conservation easement and applies to all future purchasers of the land (Chomitz *et al.*, 1998).

2. Methodology

This study was carried out five Provinces of Rwanda represented by six districts.

The Eastern Province was represented by Nyagatare district; The Northern Province was represented by Gicumbi district; Rusizi district in Western Province was also surveyed

In the Southern Province, the survey was done in four Sectors of Huye district; Two Districts of Kigali City were surveyed; Gasabo district and Nyarugenge District

The survey was conducted from 1st January to 31st July 2013, and elaborated questionnaire was used. The questionnaire was composed by nineteen questions related to forest ecosystem functions and their potential values, based on the paper by Costanza et al., 1997. Six categories of respondents were interviewed including: farmers, students, leaders, teachers (primary and secondary teachers), traders and lecturers (university teachers). Each respondent might know a forest in his/her region. The respondent valued forest ecosystem services and allocated the value that could be paid to each ecosystem function. Collected data were arranged and manipulated using Microsoft Excel and the

same software was used for data entry and analysis for average of different parameters. The state of knowledge of functions of forest ecosystem was evaluated according to the percentage of study respondents who answered "YES" to a question asking if he/she knows a given function. The willingness of Rwandan population to pay for forest ecosystem services was assessed according the value given to each function of forest ecosystem. Each function of forest ecosystem service was evaluated between 500 and 2000rwfs/ha a year.

3. Results

In this research, 21 (62%) of respondents were males and 38% females. All respondents have attended school and have all completed primary studies, 18% continued their secondary studies, and among them 16% have completed secondary studies and 65% the university (Table1).

3.1 Characteristics of study population

Table 1: Characteristics of study population (N = 34)

Characteristics	Mean [QI: Interquartile Interval) or n (%)
Age (years)	27.6[13-30]
Residence period (years)	12.8[3-21]
Gender (male)	21(62)
Education level	
• Primary school	6 (18)
• Advanced level	6 (18)
• University	22 (64)
Occupation of respondent	
• Student	14 (41)
• Teacher	2 (6)
• Lecturer	2 (6)
• Leader	6 (17)
• Seller	5 (15)
• Farmer	5 (15)

3.2 Knowledge of and Value provided by study respondents for each function of forest ecosystem

The Table 2 shows Rwandan Population knowledge about the functions of forest ecosystem and their value according to the average value provided for each function and the total average value. In general, all of these functions are valuable to give the total average value of 1328 rwf/ha a year.

Table 2: Knowledge and value provided by respondents for each forest ecosystem function

Function of forest ecosystem	Knowledge study respondents for each function of forest ecosystem (%)	Average value(rwf)
Gas regulation	100	1585
Climate regulation	100	1576
Disturbance regulation	100	1700
Water regulation	100	1476
Erosion control and sediment retention	97	1756
Soil formation	97	1720
Nutrient cycling	100	1391
Waste treatment	88	1430
Pollination	94	1394
Biological control	100	1276
Refugia	97	1652
Food production	91	1548
Raw materials	97	1682
Genetic resources	88	1050
Recreation	94	1331
Cultural	82	1400
Other function	76	1558
Total average value		**1483**

Over 75% of the study population has knowledge of functions of forest ecosystem services. Genetic resources appear to be lowly valued with an average value of 867 Rwf/ha a year and erosion control and sediment retention highly valued with an average value of 1756 Rwf/ha a year.

3.3 Allocation of money from payment of forest ecosystem services

It is interesting to see how people prefer to use money after payment of forest ecosystem services (Table 3). The results indicate that 24% of respondents prefer to use that money for Biodiversity conservation, 24% for reforestation, 24% for poverty reduction projects, 17% for agriculture and animal resources and 11% for education (Table 3).

Table 3: Allocation of money from payment of forest ecosystem services

Preferred uses	Respondent n (%)
Biodiversity conservation	8 (24)
Reforestation	8 (24)
Poverty reduction projects	8 (24)
Agriculture and animal resources	6 (17)
Education	4 (11)
Security	0
Health	0

4: Discussion

Considering the average age of respondents 27.6 [13-30] years and the average residence period 12.8 [3-21] years; each respondent was able to give accurate information about ecosystem function of a forest and their potential value in his/her region. The average value of all average values for all forest ecosystem services is 1483rwf/ha a year (Table 2). In comparison with an influential paper by Costanza *et al*. (1997) estimating the combined value of all the world's ecosystem services at US$33 trillion a year; Rwandans evaluate forest ecosystem services, one of most ecosystem services

and provide the value related to the contribution they make to their welfare. According to the result of this study, forest ecosystem services are valuable for the annual value between 1050 and1756 rwf/ha. The most valuable forest ecosystem service in Rwanda is erosion control and sediment retention with an average value of 1756 rwf/ha a year (Table 2). It is also important to consider forest ecosystem services, which became after erosion control and sediment retention according to results; such as soil formation, raw material, food production, climate regulation or gas regulation.

Many factors influence people to highly value erosion control and sediment retention. The majority of Rwandans lives or find food through the soil, and Rwanda is also a country of thousand hills; people want to see their soil protected against erosion. The soil is the first wealth of Rwandans.

The common source of energy for cooking in Rwanda is the forest in the form of firewood (Twagiramungu, 2006). As one of many other raw materials from forest ecosystem services; firewood may explain why raw materials appear on the third position after erosion control and sediment

retention. Disturbance regulation, water regulation and soil formation are linked with erosion control and sediment retention in environment protection reason why they are closer with it in terms of average values (rwf/ha) annually (Table 2).

Genetic resources got the lowest average value (1050 Rwf/ha a year) compared to other functions; this is explained by the choice and priorities of people. Another forest ecosystem service, which had low value, is biological control. These two forest ecosystem services are not widely different if we consider their meaning. The logic is the same in the middle on Figure 1; related ecosystem services are closer comparing their average values. These observations show that Rwandan people have an idea about forest ecosystem services and have the capacity to arrange according what they benefit from them. This is well understood considering education level and occupation of respondents in Table1 and Table 2.

Beyond suggested forest ecosystem services in the questionnaire, 76% of respondents were able to find another forest ecosystem service and value it.

Based on the average value given to those new services 1558rwf/ha a year (Table 2). It was expected that the payment of forest ecosystem services was allocated to any preferred use. It is interesting to see how people value functions of forest ecosystem and if they had to pay; there was no lost because 24% of respondents allocate the payment in biodiversity conservation, 24% of respondents allocate the payment in reforestation and 24% of respondents allocate the payment in poverty reduction projects (Table 3) These three preferred uses of payment of forest ecosystem services are related with forest ecosystem protection. This means that ecosystem services may contribute themselves in good management of forest ecosystem. Agriculture and animal resources and education on the other hand may contribute to people's life improvement and management of forest ecosystem.

Security and health seem to be ignored by respondents, but is not the case in Rwanda. It is a matter of priorities related to individual's own assessment of his or her wellbeing (Bocksteal *et al* 2000). All these preference uses of payment of forest ecosystem services are important to explain how Rwandans value forest ecosystem services and could pay for these services.

5. Conclusion

The results of this study show that a Rwandan population knows what forest is

and their functions. This study provides significant values of forest ecosystem services. According to respondents, Rwandans value all forest ecosystem services related to their importance in welfare for their daily life and they price each service.

The improvement of biodiversity conservation, reforestation, poverty reduction projects, agriculture and animal resources and education will rise up according to this study; if the values of forest ecosystem services were to be paid. In Rwanda, to pay forest ecosystem services will increase protection and productivity of forest ecosystems. Therefore, strengthen the conservation of forest ecosystem services, the payment is needed and is possible if the government is involved by setting laws and policies related to it.

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