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Perception of Mangrove Forest Protection and Utilization amongst Residents in Some Coastal Communities in the Niger Delta, Nigeria

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Abstract

Mangrove forest is a biodiversity hot spot, and provides numerous ecosystem services. It was thus hypothesized that the people will love mangrove forest because of the services it renders. To determine the importance of mangroves to the people 50 questionnaires each were administered to three localities (n=150)n namely: Tourist Beach (Site A), Borikiri (Site B) and Marine Base (Site C). The result showed that most respondents had college education (53%), and had been living in cleared mangrove forest for 11-20 years. Over 70% of the respondents liked mangroves while 30% don't like mangroves. Most people derived benefit from firewood (61.8%) followed by food (17.6%), building materials (4.9%) and medicinal herbs (4.9%). Contrarily, most people don't care about mangrove preservation ($F4, 12 = 4.82$, $P < 0.005$). In a scale of 0 to 5, where 0 indicates "no payments" and 5 indicates "highest payment" i.e. above $ 10, 000, the result shows that more people (42.7%) will pay the least amount of money ($0─1, 000) to preserve mangroves. This shows that although people liked and derived benefit from mangrove they are less interested in protecting it. Thus, the valuation of mangrove will further help to promote the need for global mangroves conservation.

Keywords: Non-Commercial; Timber; Non-Use; Riparian; Building; Water Side

Introduction

There is a gross under-estimation of the contribution of the environment towards the provision of ecosystem services [1-3]. Ecosystem services are categorized into provisioning, regulating, cultural and supporting in a context of world trends. Provisioning include firewood production, Timber (building), food, fishing, and weaving. Regulating include purification and protection; cultural include recreation while supporting include biodiversity. Economic activities take place in the environment, and use environmental resources freely provided by nature. These natural systems provide 'services' [4,5]. Thus, mangroves as an aspect of the environment provide ecosystem services such as fire wood, building materials, food, medicinal herbs, water and air purification, nutrient cycle, climate regulation, and carbon sequestration [6]. These services will not be rendered when the environment is degraded. But we don't only directly rely on the natural resources but also on the ecosystem services they provide. Despite the numerous economic benefits derived from mangroves, man still depletes them through deforestation, urbanization, oil and gas exploration and pollution [7,8], their population is also reduced because of the spread of invasive species [9]. Already there is a substantial unsustainable degradation of 15 out of 24 ecosystem services globally [10].

We need to understand the value people place on biodiversity, and in particular mangroves, in other to develop a method of quantifying ecosystem services [11]. A series of economic values associated with the environment had been proposed by several researchers in the past [12-15]. Environmental values can be broadly split into use and non-use values. Use values are associated with the values that come as a result of contact with, or use of natural resources. The three types of use values are: (i) Direct use values, associated with direct use of resources, which can be consumptive, for instance use of timber from rain forest in the furniture industry, fire wood from mangrove forest, and fish, as a source of protein by people from coastal communities; or non-consumptive, such as appreciation of scenic view and breathing of clean air from mangrove forest. Indirect use value, is when the environment performs some services through its functions to man. For example, water purification by wetland and carbon sink by mangroves [16]. Option use values are the values placed on environmental assets

by people who have in mind the future benefit of the good. Non-use values are those benefits that exclude direct contact between consumers and the good, for instance, existence values are important simply because components of the environment exist, even if we do not have direct benefit from them (e.g. endangered species), aesthetic values (for beauty or emotional appeal); scientific value (that may be subject for scientific research); educational values (teach us about ourselves or the world); cultural values (sustain or help define our culture and antiques); and spiritual values (define our faith). The sum of the components of use and non-use values is called the total economic value (TEV) [17]. In line with [18], mangrove ecosystem in Nigeria provides some economic value to the people as described in Figure 1.

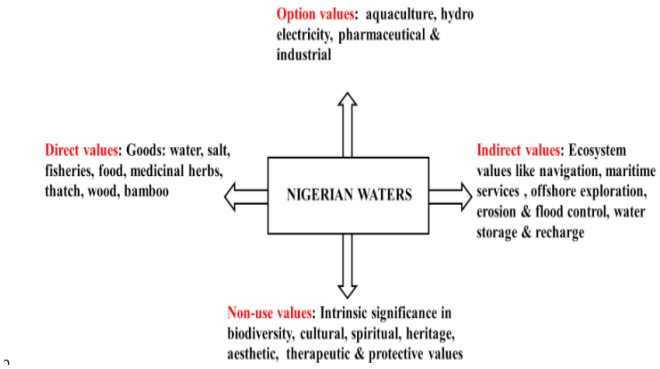


Figure 1: Nigeria waters provide the following economic value.

To estimate the value of the ecosystem services, a price tag needs to be placed on the resources of the environment [19]. Three broad economic models in line with this concept according to [20] are: (i) Conventional market approaches, which compares environmental good and some other good that already has a market value. Under this, we have (a) Substitute or alternative cost approach, which uses the cost of available substitute for the particular environmental good to give value to that good. For example, the value of firewood derived from mangrove forest that is used for cooking as compared to firewood that is bought from the local market; (ii) The production function approach, considers the environment as a factor of production, for example changes in environmental quality can lead to changes in productivity and production cost; (iii) The opportunity cost approach uses market process to estimate the value derived from using a resource in a way considering the values of alternative uses. This approach measures what has to be given up for the sake of preserving the environment. For example, rising population in the Niger Delta had resulted to the clearance of vast areas of mangrove forest for the construction of houses [8]. This method is also called contingent valuation, and uses surveys (e.g. questionnaires) to determine how much people are willing to pay to protect a given resource [21-23], in this case the mangrove forests.

This study is thus significant because there is a dearth of information on ecosystem services in Nigeria [24]. The Niger Delta is a biodiversity hotspot and provides both renewable and nonrenewable resources. Renewable natural resources present in this region are sunlight, wind energy, tidal energy, hydro energy and geothermal energy; nonrenewable resources are crude oil, natural gas, coal, copper, and aluminium. Other services provided in this region include: Rainforest (timber), wetland (filtration and erosion control), mangrove forest (medicine, flood and erosion control, habitat, food, etc), and aquaculture (fish, crabs, periwinkle, clam, mussel, crocodile, tortoise, turtle, manatee, etc).

Urbanization is a major cause of mangrove decline in the Niger Delta apart from oil and gas exploration [25,8]. There is also population explosion in Nigeria with about 182 million persons [26], which leads to human intrusion into mangrove forests. Moreover, the Atlantic coastal areas have the highest centers of human habitation. Between Senegal and Nigeria an estimated 60 million people representing 25 percent of the population live within 60 kilometers of the coastal areas [27]. In Nigeria specifically 20 million people live along the coastal zone [28]. Rising poverty level had made people to seek shelter in cleared mangrove forest areas.

In this study, the question of what the people will pay to preserve mangrove forest in place of urbanization and the usefulness of mangrove ecosystem services (Questionnaire study) were addressed. The questionnaire study was done in coastal communities because it has cleared mangrove forests areas that are inhabited by people. Mangrove loss to firewood was also estimated in financial terms. Specifically, the following research questions were addressed: (1) Are people willing to pay to preserve mangroves? (2) Which ecosystem service is more preferable by the people in different locations? (3) What is the cost to the environment in using mangrove for firewood?

Materials and Methods

Study Areas

The study areas are three coastal communities around Port Harcourt (Figure 2), namely: Tourist Beach (4˚46'N and 7˚15'E), Comprehensive Secondary School, Borikiri (4˚44'N and 7˚22'E), and Marine Base (4˚48'N and 7˚05'E). Tourist Beach is located at the fringes of the sea. It was formerly a mangrove forest, linked by creeks but was sand filled and converted to a beach resort, which housed a mini zoo. But presently the resort is closed down and the area used as residential quarters. Comprehensive Borikiri waterside was also formerly a thick mangrove forest linked by creeks before it was cleared and developed. The soil is muddy and reddish brown in color. It is filled with litter materials and contains burrowing organisms such as crabs, mudskippers etc. Marine Base waterfront was formerly a mangrove forest, but was also cleared

and converted to living quarters. The area houses some marine companies that operate boat transportation business. The mangrove soil is weather-beaten and brownish in color because of high human and industrial activities going on in that area. There are several abandoned speed boats berthed by the wharf. The population in all the study areas includes indigenes, non-indigenes, tenants and land lords who were interviewed in the study.

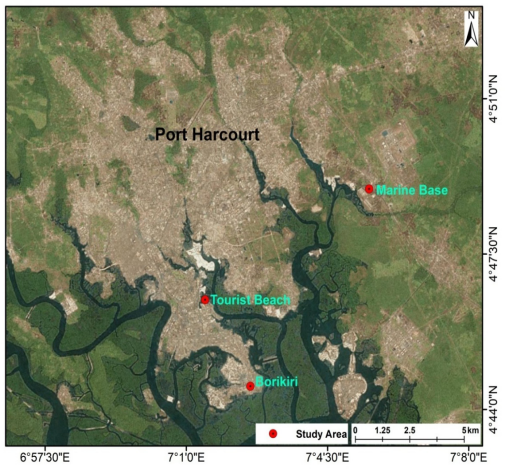


Figure 2: Map of study sites around Port Harcourt, Niger Delta, Nigeria. Sampling sites are Tourist Beach (A), Borikiri (B) and Marine Base (C).

Study 1: Questionnaire Administration

Questionnaires were used to derive random and objective views of the people concerning the value of mangrove forest (Appendix 1). The research was aimed at understanding the perception of the people on the value they place on mangrove forest through their response to some questions outlined in the questionnaire (Appendix 1). The target populations are people living in some coastal communities. Six questions were asked aimed at getting answers to whether people place value on mangrove forest or not. The questions in the questionnaire include: education, residency, tenancy; benefits, acceptability, and ecosystem services of mangroves. The key research question was: "Have you derived any benefit from mangrove forest, and if you have, how much will you pay to preserve the mangrove from being destroyed in place of infrastructural developments?"

Sample Collection and Research Design

Some students of the Department of Animal and Environmental Biology, University of Port Harcourt, were divided into three groups (i.e. A, B and C). Each of the groups was given 50 structured questionnaires, making a total of 150, which were distributed randomly in the three study communities respectively (i.e. Tourist Beach, Comprehensive Secondary School and Marine Base). The issue of pseudo replication was addressed through the averaging of number of responses per question of the questionnaire and per location. ANOVA was used which also takes care of multiple analyses for replications.

After the filling of the questionnaires they were retrieved and statistically analyzed. The coordinates of the three locations were taken with a Garmin GPS (Model Etrex 30). The geo-referenced locations were transferred from Google Earth into Arc GIS [29] to produce a study area map shown in Figure 2.

Contingent Valuation

The economic worth of mangrove was determined from the amount of money the residents were willing to pay to preserve mangrove following the example of Carson et al (1994). Four cost ranges were presented in the questionnaire as follows: (a) ₦0–1, 000 (b) ₦1, 100–5, 000 (c) ₦ 5, 100–10, 000 (d) > ₦ 10, 000. The importance is rated in a scale of 0 to 5, where 0 ($0) indicates no payment, while 5 (> ₦ 10, 000) indicates highest payment.

Study 2: Fire Wood Evaluation

Three different fire wood markets sited in each of the study areas were visited, and an average estimate of the price of a unit of fire wood was made (Table 1). The average cost of a standard size of fire wood in the market was found, and the number of fire wood that came out from an uncut 0.6 m tree stump was estimated. This value was used to estimate the price per tree, which was further used to calculate the cost of losing mangrove forest stands after determining an estimate of the number of trees in the forest. In a typical example of a mass deforestation of a mangrove forest, Arc GIS was used to calculate the area of mangrove forest lost in one of the coastal towns. Images were derived from Google Earth after getting the coordinates of the location through ground truthing.

Location	Mean length (m)	Mean width (m)	Area (m^2)	Price/stump ($)	P
Tourist Beach	0.6018 ± 0.05	0.0575 ± 0.002	0.0346	4	> 0.05
Borikiri	0.6087 ± 0.07	0.0507 ± 0.003	0.0308	4	
Marine Base	0.6343 ± 0.04	0.0616 ± 0.004	0.0391	4	

Table 1: Mean firewood sizes from different study locations in the Niger Delta and their market prices. It shows that there is no significant difference in wood sizes at the different study locations (P > 0.05). (n = 180)

Statistical Analysis

The number of responses received from the administered questionnaire was used to calculate the percentage, mean and standard deviation. A one-way ANOVA was used to determine if there was any significant difference in the amount of money to be paid to preserve mangroves forest [30]. The comparison of the three regions (Sites A, B, and C) on the 10 items of ecosystem service was analyzed with Mann-Whitney U-Test**,** due to the nominal value characteristics of variables. ANOVA was also conducted to test whether there is a significant difference in fire wood sizes in the different locations. The data was tested for normality and homoscedasticity and later log transformed before it was used for analysis since it was a count data. All analysis was done R [31].

Results

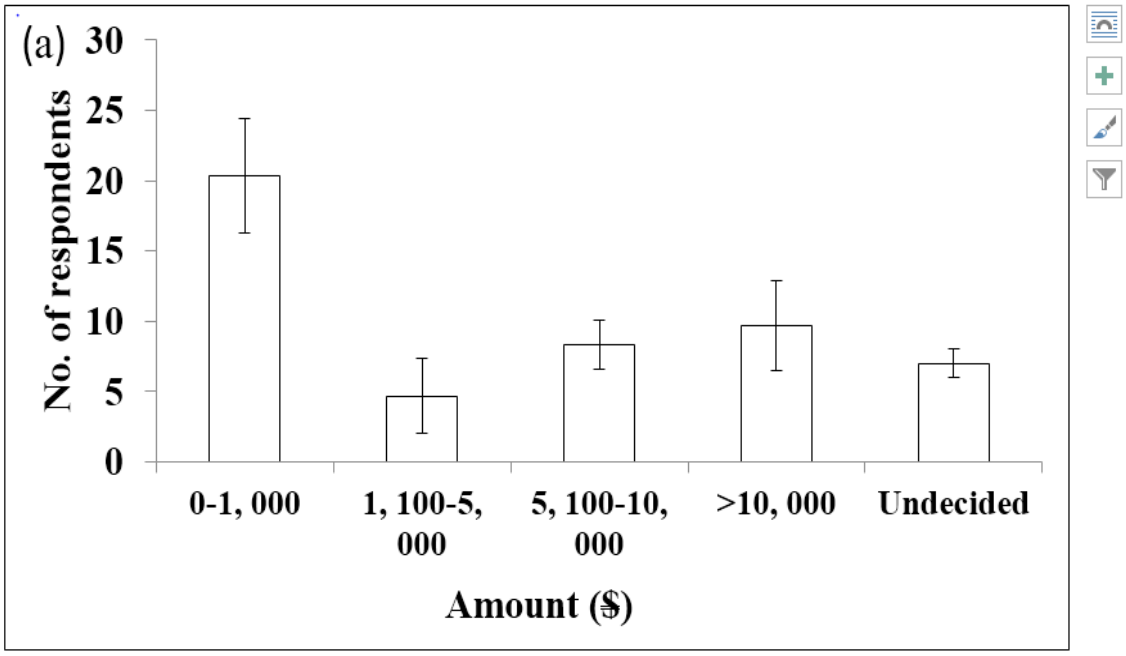
Questionnaire Study and Contingent Valuation

The ANOVA result indicates that there is a significant difference in the amount of money to be paid to preserve the mangroves ($F_{4, 12} = 4.82$, $P < 0.005$). More persons opted to pay the least amount of money (i.e. $ 0-1, 000) to preserve mangroves (Table 2, Figure 3).

Amount ($)†	Site A	Site B	Site C	Mean ± SE	P- value
0─1, 000	19	28	14	20.33 ± 4.1	< 0.05
1, 100─5, 000	10	2	2	4.67 ± 2.7	
5, 100─10, 000	9	5	11	8.33 ± 1.8	
>10, 000	4	10	15	9.67 ± 3.1	
Undecided	8	5	8	7.00 ± 1.0	

† Conversion unit indicates that 200 Nigerian Naira (N) gives 1US Dollar ($)

Table 2: Total amount of money to be paid to preserve mangrove forest in place of infrastructural development at three locations in the Niger Delta, Nigeria. Site A is Tourist Beach waterfront, Site B is Comprehensive waterfront, Borikiri and Site C is Marine Base.



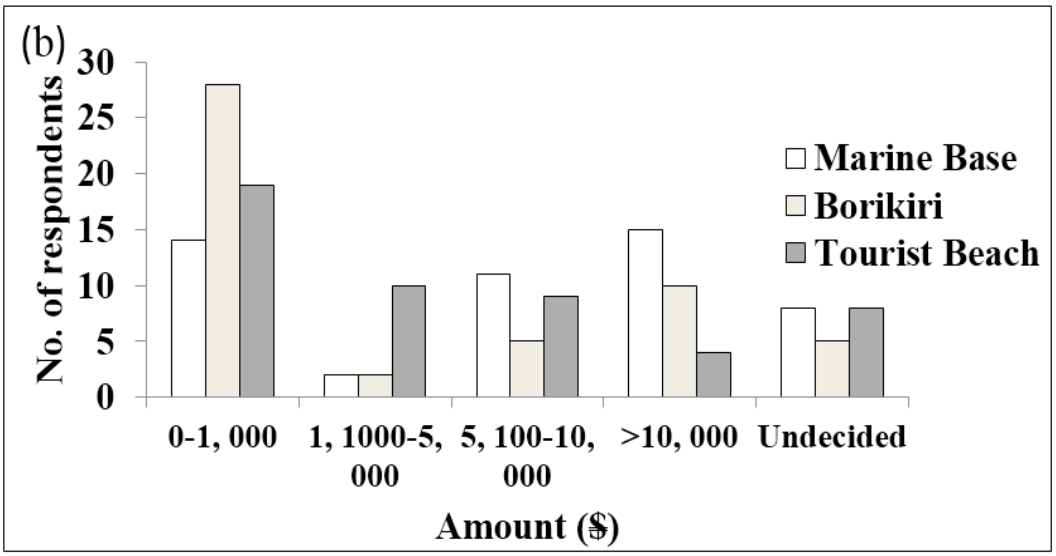


Figure 3: Mean number of respondents that will pay the following amount of money for the preservation of mangrove forest in (a) all locations put together and in (b) each study location. [Values are mean ± SD. Bars indicate the standard error. Different lowercase letters indicate significant differences ($P < 0.05$) amongst the different amounts to be paid to preserve mangrove forest.]

Ecosystem Services

Using Mann-Whitney U test, the result indicate that only responses of persons in locations A and C were significantly different (W=23.5, P=0.04) whereas comparison of responses of persons in locations B and C (W=35.5, P=0.28) and A and B (W=40.5, P=0.47) were not significantly different. However, firewood was the highest ecosystem service chosen by the people ($F_{9, 20} = 4.65$, $P < 0.05$, Table 3, Figure 4). This is because greater number of people stated that they derived more benefit from fire wood (61.77%), followed by food (17.65%) and medicinal herbs (4.9%).

Ecosystem services	Site A	Site B	Site C	Mean response (SE)	Percent response (%)
Firewood	38	11	14	21.00 ± 8.54	61.77
building	2	2	1	1.67 ± 0.33	4.9
Medicinal	0	1	4	1.67 ± 1.20	4.9
Food	0	7	11	6.00 ± 3.21	17.65
Recreation	0	0	1	0.33 ± 0.33	0.98
Purification	0	2	2	1.33 ± 0.67	3.92
Protection	0	0	3	1.00 ± 1.00	2.94

Weaving	1	0	1	0.67 ± 0.33	1.96
Fishing	0	0	1	0.33 ± 0.33	0.98
None	9	27	12	16.00 ± 5.57	38

Table 3: Ecosystem services derived from mangrove forest by the inhabitants of the three study locations of Tourist beach (A), Borikiri (B) and Marine Base (C) in Niger Delta, Nigeria.

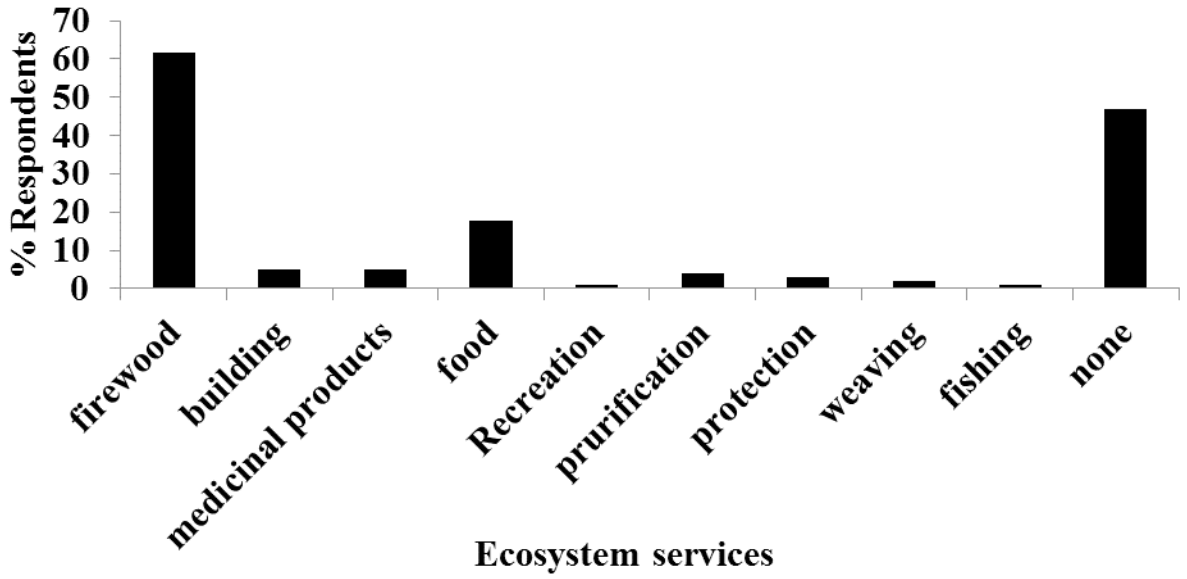


Figure 4: Percentage of respondents that derived benefits from ecosystem services of mangroves in the Niger Delta region, Nigeria.

Other Responses to Questionnaire

More persons interviewed had tertiary education (53%). On the question of length of years lived in the locations of study, more persons (15%) had lived in the area for a period of 11-20 years. On the question of tenancy, 42% were tenants, 26% were landlords and 32% were indigenes. When asked the question of whether mangrove was a relevant aspect of the environment 73% answered "yes" while 27% answered "no". Similarly, 70% of the people surveyed said that they derived benefits from mangroves while 30% said that they did not derive any benefit from mangroves.

Fire Wood Cost Estimates

The firewood from the different study location was not significantly different from each other in terms of location i.e. length and width ($F_{2, 177} = 0.07$, $P = 0.931$) (Table 1). The average size of fire wood from all locations was length (0.61 m) and width (0.06 m) (Figure 5). Three pieces of fire wood had a market value ₦ 0.5. Twenty-four pieces of a unit fire wood makes a tree stump of size 0.18 m^2 (0.6 × 0.3). Then a complete tree stem without the top branches and the root gives approximately seven 0.6 m of tree stumps (i.e. size 4.26 m). In addition, the size estimate of a tree branch was 1.065 m, which is summed up to give 5.33 m for a full tree.

The cost of a single tree stump sold in the market is $4.00. The three stumps when cut into final retail sizes produces seven pieces, this gives a cost of $28.00. Cost of other tree parts is estimated at one-quarter of the single tree stump, which gives $7.00. Therefore, the cost of an average complete mangrove tree is $35.00. For instance, in 1984, 4.2 million m^2 of mangrove forest was removed in Buguma, a coastal community in the Niger Delta. Assuming 1 m^2 of the mangrove forest contain a tree stand, where a tree stand is a mature mangrove tree that had been growing for the past 30-50 years in the locality [32]. The cost estimate of losing the mangrove forest to the environment will be ₦ 147 billion (4, 200, 000. 00 × $35).

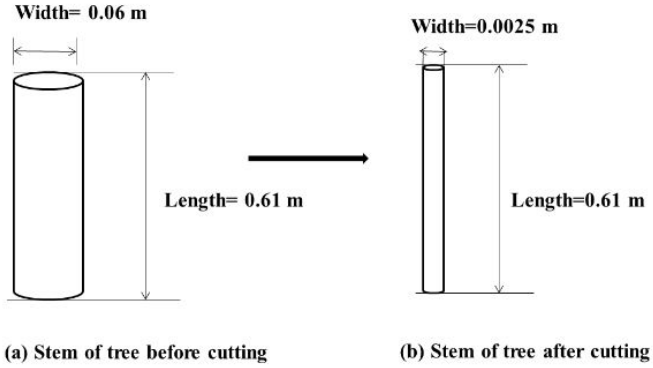


Figure 5: Mangrove tree stem cut into pieces to give final market size of fire wood in the Niger Delta region, Nigeria.

Discussion

At the three study locations it was found that only residents of Marine Base were favorably disposed to preserving the mangroves because higher no of persons were willing to pay higher amount of monies for the preservation of mangroves (Figure 3). This location has high population of educated people, which might be the reason for their understanding of the importance of mangrove forest protection. But in general, the highest amount of money to be paid by the respondent was within the least range i.e. ₦ 0-1, 000 (Table 2, Figure 3). This shows that the people have little regard for the protection of mangroves, even though 70 % of the people interviewed said they derived maximum benefits from it.

The nonchalant attitude exhibited by the people towards mangrove preservation shows that they placed little value on mangroves, not deliberately, but out of ignorance. This is because most of them revealed that they had no direct benefit from mangrove, as most of them either don't use firewood or use it occasionally during events. For instance, fire wood is used for cooking during big ceremonies (i.e. wedding, naming and birth day celebrations). This is because most people use modern method of cooking such as methane gas or kerosene stove in their homes. Surprisingly, some respondents that use fire wood for cooking don't know that the source of the fire wood was from mangrove trees. It is believed that the location of the study also played a role in influencing the perception of the people in the ecosystem services and utilization of mangroves. The area of study is a cleared mangrove forest used as human settlement. Clearing the mangrove forest for the sake of infrastructural development was more important to the people than the preservation. It is this reason that had made the people to explore and reclaim mangrove forest as a place for erecting their houses. This shows lack of understanding for non-use services provided by mangroves. This is the reason why majority of the people will pay the lowest amount of money to preserve the mangroves.

Ironically, in a scale of preference to determine the usefulness of mangroves, most members of the coastal communities interviewed chose fire wood. This is because it is the most common and less expensive cooking method by local inhabitants. Fire wood is often derived from red mangrove tree (*Rizophora racemosa,*Wurmb) because of its good heating quality. This is because it has the exceptional property of retaining heat energy for longer period of time as compared to wood from other mangrove and non-mangroves species. Mangrove ecosystem also serves as a spawning ground for fish and other aquatic organisms. Fish is a major source of protein for members of the coastal communities who also sell them to make money. Mangroves provide other ecosystem services such as medicinal herbs, dyes etc. A lot of people accepted mangroves as a vital aspect of the environment (73%), but lacked the knowledge of its non-use and indirect value. This requires more enlightenment on the non-use value of mangrove forest (e.g. recreation, protection, purification etc) by government and non-governmental agencies. The need for enlightenment is important because of the high number of people who are ignorant of the ecosystem services provided by mangroves (Figure 4).

In the same vein, excessive harvesting of mangrove trees for fire wood would lead to reduction of mangroves population and can lead to extinction. Therefore, care should be used in harvesting of mangrove forest for fire wood.

The level of ignorance (38%) is also attributed to the fact that the ecosystem services rendered by mangrove are not given in monetary terms. Thus, people don't see the need for its preservation. But if more calculations of wealth lost from deforestation of mangrove forest are made like the amount lost in Buguma (i.e. $142 billion), people will start to place value on the forests. More information on the monetary value will change the attitude of people on the need to preserve mangroves and other environmental resources, which are basically non-renewable. Studies on mangrove valuation in the Niger Delta are scarce in the literature. This study is therefore significant and timely because it has attempted to calculate the monetary value of mangrove trees lost to fire wood.

Conclusion

Mangrove forest and the entire environment sustain man through the different services they render, for instance air purification through carbon dioxide absorption and carbon sequestration to provide clean air are functions of mangrove

forest. But since this function is not equated in monetary terms there is little regard for the preservation of the mangroves. This study has shown that ignorance plays a key role in this behavior (38%) even though most persons had at least a college education (53%). There is a thus the need for re-orientation of the people, and the stoppage of the use of mangrove forest as residential quarters. Coastal areas in the Niger Delta should be given limited protection to prevent over exploitation of its resources. Protected areas should allow some resource extraction such as fishing, selective wood extraction, tourism and recreation. The primary goal is the management of natural resources for multiple goals, and the inclusion of humans in the management of environmental resources is win-win conservation.

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