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Estimation Of The Value Of Goods And Services Produced By Protected Areas: Case Of The Ndock Sare Community Forest In Senegal

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Abstract

The community forests of Senegal, and particularly those of the Groundnut Basin, play an important role in the lives of rural populations. They are significant sources of supply of various products and services. But despite their economic and ecological importance, community forests have never been the subject of an economic evaluation. This is likely to obscure the decision-making auspices of sustainable management of community forests. This study, based on vegetation surveys and socio-economic surveys, assessed the value of ecosystem goods and services. The results of the analysis showed that the forest has 21 species distributed among 08 families and ~~that~~ this diversity varies from one area to another. With this specific diversity, the basal area is

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evaluated at 2.64 m2/ha and the cover of 6081.17 m²/ha for a density of 327 individuals per hectare. The forest has a carbon storage capacity evaluated at 15.32 tons. The goods and services of the forest were estimated at 3,391,757 F CFA/year. This value is divided between direct uses estimated at 1,236,575 F CFA/year, indirect uses of 168,495 F CFA/year and an existence value of 1,986,687 F CFA/year. The study also showed that the exploitation of the forest is the most viable management option, as strict conservation imposes a social cost of 370,058 CFA francs per year on the population. In the context of decentralization, these results can serve as a basis for policy dialogue and decision-making processes on the sustainable management of forest resources.

Keywords: Community Forest, Ecosystem Services, Use Values, Groundnut Basin, Fatick, Ndock Sare

Introduction

The Sahelian countries have been facing an accelerated degradation of their ecosystems for the last few decades. This phenomenon is often linked to climate change such as global warming, the advance of drought and desertification (Nabaloum, 2010) . This climatic deterioration is all the more felt because it is exacerbated by particularly negative anthropic activity, which consists essentially of inappropriate agricultural practices, abusive deforestation and bush fires.

The groundnut basin covers the regions of Diourbel, Kaolack, Fatick, Kaffrine and parts of Louga and Thiès, and 70% of the population depends on agriculture and livestock (PAGERNA, 2002). This area, which is the most densely cultivated in Senegal, is not spared the consequences of ecosystem degradation. It experiences most of the problems of the Sahel: desertification, erosion, soil poverty and loss of biodiversity.

Faced with these climate changes, the populations have developed adaptation strategies that consist of creating conditions for the regeneration of ecosystems and the maintenance of biological diversity (Diop, 2010). Among these initiatives is the joint management of natural resources, which translates into the establishment of community forests that currently remain the only sources of non-timber forest products (Sanogo, 2011). Despite their commitment, some communities are unable to sustainably manage their community forest due to poor governance and insufficient technical support (Dieng, 2008). However, other communities that have benefited from technical support have succeeded in sustainably managing their set-asides (Sanogo, 2011).

The present work is part of a sustainable management of the community forest of Ndock Saré. The aim is to characterize and evaluate the

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values of the forest's ecosystem goods and services in order to define a sustainable management option.

Presentation of the Ndock Sare area

The community forest of Ndock Saré (Figure 1) covers an area of 11.95 ha. It is shared by the villages of Ndock Saré, Ndock Peulh, Ndock Tamsir, Keur Médoune, Diaby Kondel and Keur Ndiouga. Administratively, the land of Ndock Sare is located in the rural community of Patar Lia, arrondissement of Ouadiour, department of Gossas, region of Fatick.

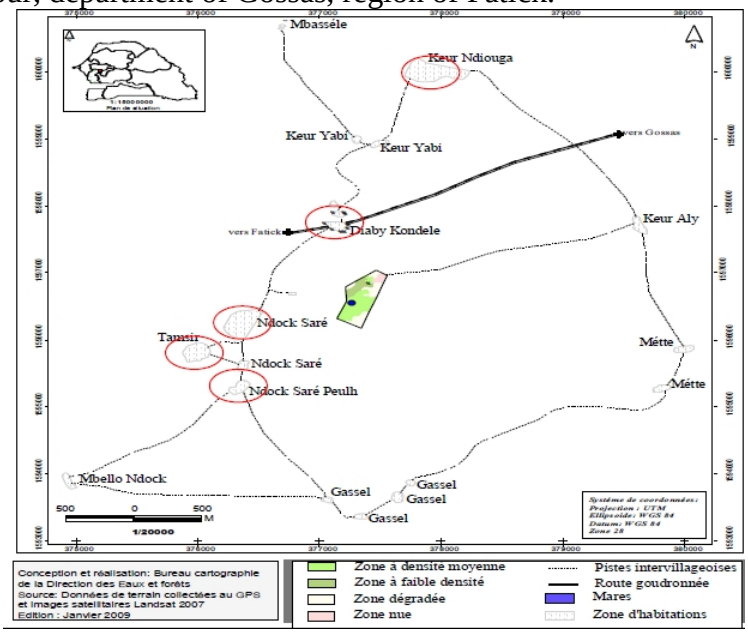

Figure 1: Presentation map of the Ndock Sare community forest

Materials and methods

We characterized the woody stand using the systematic sampling method with square plots of 30 m on each side, i.e. an area of 900 m² (Boudet, 1984). In total, 24 plots with an area of 2.16 ha were surveyed (Fig. 2).

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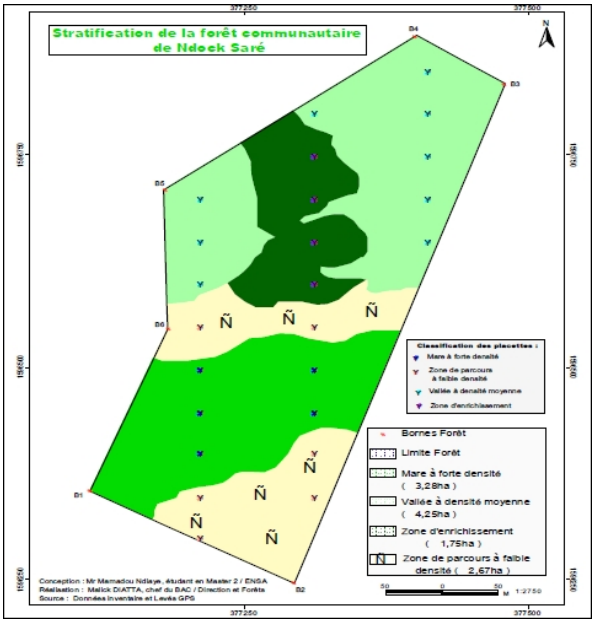

Figure 2: Parcel map of the Ndock Sare forest

For the collection of socio-economic data, sampling was done taking into account the ethnic diversity of the villages around the forest. The sampling unit was the household in each village and was selected randomly.

The Fisher et al. formula (1994) in Dione (2011) was used to ensure good sample precision. For populations less than 10,000, the sample size is given by the following formula:

$Nf=n/(1+n/N)$ with $n=1/d^2$

Where: Nf: desired sample size; N: population size (number of households); d: desired degree of precision. It measures the differences between the observed proportions of the sample and the theoretical proportions. The lower d is, the more representative the sample is. If d= 10%, it means that there is a 90% chance that the sample is representative. Since the sample population equals 74 households, the sample size was limited to 30 households, which corresponds to a precision level of 14%.

To this end, for each village on the outskirts of the Ndock Sare community forest considered for this study, the number of households and the corresponding sampling rate are presented in Table 1 below.

Table 1: Distribution of households by village

Villages	Number of households	Survey rate
Ndock Sare	33	36.36
Ndock Peulh	03	66.67
Ndock Tamsir	08	50
Diaby Kondel	10	40
Keur Medoune	20	40

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The data were managed with the Excel spreadsheet. The statistical treatment was done with Excel and XLSTAT. With Arcview 3.2 software, we represented the plots.

For the evaluation of the aerial phytomass, the method of Brown (1997) was used. It considers that for species with a diameter at breast height (D) between 5 and 148 cm, the aboveground biomass (B.A) is given by the following allometric relationship:

$B.A.\ kg$ =42.69-12.80D+1.24D^2 cm (3)

The amount of carbon stored by a plant is obtained by multiplying its aboveground phytomass by the factor 0.45 (Diedhiou, 2010)

The estimation of the economic value of forest goods and services was done based on the components defined by Figure 3.

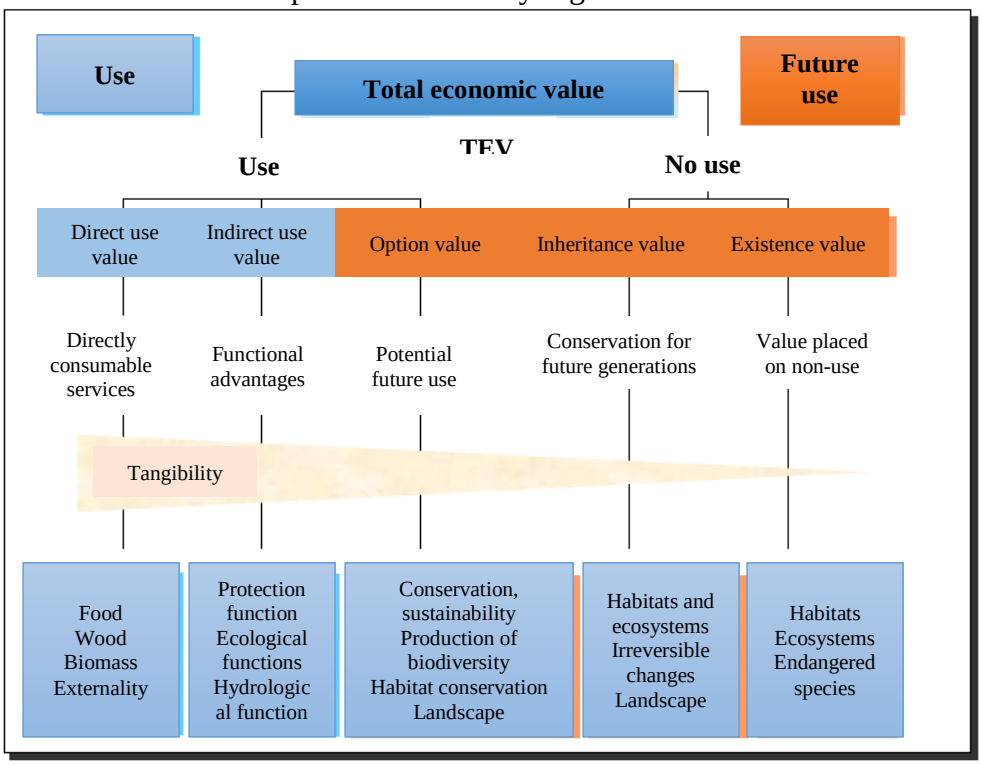

Figure 3: Total economic value of biodiversity (Centre d'analyse stratégique, 2008a).

The principles that have been associated with the different valuation methods are summarized in Table 2.

Values	Valuation méthods	Principle
Direct use value		
- Non-timber forest products ; - Service and firewood	Market price method	At the end of the survey, the quantities and prices applied to the various forest products were known.

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Traditional pharmaceutical products	Transportation cost method	All species used for medicinal products were identified. The time taken by traditional practitioners for harvesting was determined. A transport cost of 3 F CFA/minute was applied.
Indirect use value		
Carbon sequestration	Market price method	The amount of carbon sequestered by the five dominant species (Balanites aegyptiaca, Combretum micranthum, Diospyros mespiliformis, Mitragyna inermis and Guiera senegalensis) was multiplied by the price of a ton of carbon, which is €60.
Non-use value		
Option value	Contingent valuation	The populations were invited to give their opinion on the opportunities and future uses they can expect from the forest. Then they were asked to give their CAP so that their expectations are realized.
Existence value	Contingent valuation	The populations were asked to express their willingness to pay for the conservation of the community forest.

Results

Estimation of direct forest use values

Traditional pharmaceutical products

The use of traditional pharmaceutical products is very important in the southern countries where, according to the World Health Organization (WHO) reports, 4/5 of the population depend on traditional medicines for their health.

This direct use is different from the option value that the forest ecosystem can hold as a source of genes that can be commercially exploited in the future. The following results were obtained from interviews with traditional practitioners (Table 3).

Table 3: Economic value of the ten medicinal woody species

Specis	Number of outings per year	Average time (in min.)	Economic value (in FCFA/year)
Acacia adansonii G &P.) Kun.	24	600	1800
Anogeissus leiocarpus (DC.) Gui.	32	960	2880
Balanites aegyptiaca (L.) Del.	15	525	1575
Combretum micranthum (G.) Don.	36	540	1620
Guiera senegalensis (J.F) Gmel.	36	540	1620
Capparis tomentosa (Lam.)	20	500	1500
Ficus gnaphalocarpa (Miq.) Steud. ex Miq.	12	300	900
Heeria insignis (D.) Kun.	15	450	1350
Celtis integrifolia (Lam)	24	840	2520
Hymenocardia acida (Tul.)	15	450	1350
TOTAL			**17 115**

Since there are five people engaged in this activity in the village of Ndock Saré, the economic benefits derived from the medicinal use of the ten most exploited species are estimated at 84,075 CFA francs per year. This value, although low, should not lead one to underestimate the socio-economic importance of traditional pharmaceutical products. Indeed, traditional medicine does not correspond to the mere absorption of semi-processed natural products; it is carried out in a particular social context that contributes as much to the effectiveness of the treatment as the remedy itself.

Non-timber forest products (NTFPs)

The economic value of these harvested non-timber forest products is 87,500 F CFA/year (Table 4). This value, although substantial, does not include the value of externalities that result from the dissemination of seeds by harvesters. Thus, market prices are disconnected from both the costs of regenerating the ecosystem when use is destructive and from positive externalities when it contributes to increasing the resource.

Table 4: Total NTFP food removals at the village level

Types of NTFPs food	Average extraction (kg)	Market price (F CFA)	Economic value (FCFA)
Diospyros mespiliformis (Hochst.) Ex A.DC	200	50	10 000
Balanites aegyptiaca (L.) Del.	50	100	5 000
Ziziphus mauritiana (Lam.)	300	200	60 000
Acacia adansonii G &P.) Kun.	250	50	12 500
TOTAL			**87 500**

Fuelwood and Service Wood

Our surveys showed that all family farms use fuelwood and service wood. The most commonly used species and the average quantities harvested are shown in Table 5.

Table 5: Estimated use value of wood

Species	Average amount collected per household (carts)	Price per unit (F CFA)	Economic value (F CFA)
Balanites aegyptiaca	5	1 500	7 500
Combretum micranthum	6	2 000	12 000
Guiera senegalensis	8	2 000	16 000
TOTAL			**35 500**

Source: Survey results

The economic estimate of these forest products for the 30 households surveyed gives an average value of 1,065,000 CFA francs per year.

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Since all the species used for these services are found in the forest in greater numbers, by correlation, this value of direct use of the forest can be estimated at 89 100 F CFA/ha/year.

In addition to direct uses, the forest is also the object of an ecological utility whose economic evaluation resorts to other factors which go beyond the local framework of the village.

Indirect use value: carbon sequestration

Knowing the economic value of this ecological function now is therefore important for two reasons: first, so that this benefit is not overlooked in the development of a sustainable forest management approach; second, because maintaining this ecological function may, in the future, constitute a significant source of funding.

The five dominant species in the community reserve were used to estimate the economic value of this function (Table 6).

Table 6: Economic value of the carbon sequestration function

Species	Amount of carbon stored (ton)	Price per ton (F CFA)	Economic value (F CFA/year)
Balanites aegyptiaca	3,65	39,957.42	143,654.58
Combretum micranthum	0,58	39,957.42	22,827.30
Guiera senegalensis	1,48	39,957.42	58,248.98
Mitragyna inermis	7,52	39,957.42	295,967.79
Diospyros mespiliformis	2,09	39,957.42	82,257.01
TOTAL	**15,32**	**39,957.42**	**602,955.66**

Source: Survey results

Considering a parity of €1 =655.957 F CFA, the present value of the ecological function of carbon sequestration of the community reserve is estimated at 16,815 F CFA/ha/year.

Since this service is not subject to competition, it is not surprising to find a value that seems somewhat low, given the importance of this ecological function.

Existence value of the forest

Like many natural assets, the Ndock Saré community reserve generates what economists call non-use benefits for the community.

The results of the 35 people interviewed are shown in Table 7.

Table 7: Distribution of revealed consent (CTP) (F CFA/ha/year).

CTP revealed	Number of responses	Frequency (%)	CTP revealed	Number of responses	Frequency (%)
2 000	11	31.4	5 000	1	2.85
2 500	5	14.28	5 500	1	2.85
3 000	3	8.57	6 000	2	5.71
3 500	4	11.43	6 500	1	2.85

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4 000	1	2.85	7 000	2	5.71
4 500	2	5.71	8 000	2	5.71

Source: study results

Given the disparity of the CTPs revealed, we consider a median value of 4 750 F CFA/ha.

In considering the area of the forest and the size of the population interviewed, the existence value of the forest is estimated at 1 986 687 F CFA/year.

These different approaches have made it possible to estimate the total economic value of the forest (Table 8).

Table 8: Total economic value of the forest (F CFA/year)

Use value	Direct use value	NTFPs for food	*87 500*
		Firewood and service wood	*1 065 000*
		Traditional pharmaceutical products	*84 075*
	Indirect use value	Carbon sequestration	*602 955*
Non-use value	Existence value		*1 986 687*
TOTAL			***3 826217***

The total economic value of the goods and services provided by the Ndock Sare community forest amounts to 3,826,217 CFA francs per year. This estimate shows the importance of the existence value in relation to the direct use value and the indirect use value (Figure 4).

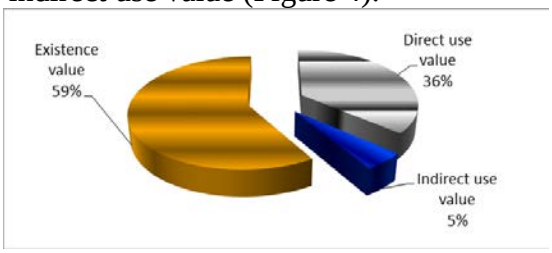

Figure 4: Distribution of total economic value of the forest

This distribution of forest values is consistent with most studies of environmental economic value estimates. Intangible values (existence and heritage) are higher than tangible values (Garba, 2009).

The value of direct uses is higher than that of indirect uses. This can be explained by the fact that the forest is destined for exploitation, contrary to most estimates that have been made on fully protected areas. The populations have more regard for direct uses.

Discussions

The results of the economic value estimation of the forest gave a direct use value higher than the indirect use value, which is in line with the

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aspirations of policy makers who always give more importance to tangible values compared to non-tangible values.

This same logic is further supported by the people who, in defining the community forest utility matrix, give more importance to direct uses compared to the value of ecological functions.

However, it must be recognized that this total economic value of the forest provides a useful but insufficient indication of the importance of forest use at the local level. Indeed, in these socio-economic systems, which are largely disconnected from the market economy, market prices are not necessarily the best indicators of the value of these forest products, and moreover, the information provided by the populations is sometimes rather nuanced.

The major objective of this approach, which is not to express the richness, complexity and variability of the forest ecosystem, is therefore to reduce this economic valuation to a simple monetary estimate useful as a decision-making tool. The theoretical approach to valuation thus requires a certain number of adaptations to reality, which explains why there is no certain and definitive economic value for these resources. The various estimates proposed are therefore orders of magnitude, the reliability of which must be discussed in the light of the assumptions made in order to carry out the estimate. From a decision support perspective, the economic evaluation of ecosystem goods and services has resolutely proven the need for forest exploitation. The strategies developed for sustainable management have shown the relevance of involving all the development actors who intervene in the village of Ndock Saré.

Conclusion

The study showed that the forest generates a certain number of ecosystem goods and services, estimated at approximately 3,826,217 CFA francs per year, or 320,185.52 CFA francs per hectare per year. The economic impact of the forest is quite significant at the household level. Thus, the exploitation of forest products contributes up to 1,112,500 F CFA to household income.

However, it should be remembered that the values obtained for this environmental assessment are not necessarily exhaustive. They essentially make it possible to highlight the economic importance of biodiversity and to establish more scientific arguments to be used with political decision-makers for greater consideration of biodiversity. It is in the image of this decision making that it is appropriate today, for a sustainable management of the forest, to move to its organized exploitation, given the social cost of 370 058 F CFA borne by the populations in the dynamics of conservation. The management strategies that are defined can help optimize the income.

In addition to the ecological and economic stakes, the economic evaluation of biodiversity constitutes a decision-making tool, a new card to be played in the game of negotiations that can therefore argue in its favor. In this sense, with the Clean Development Mechanism, the evaluation of the carbon sequestration function can help negotiate financing.

The cost-benefit analysis of forest management options has shown that at present a resource harvest is more objective. In view of these promising prospects for ecological sustainability, it can probably be accepted that the forest can underpin a well-functioning economic system and thus lead to sustainable development, provided that the following actions and guidelines are undertaken.

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