

# Local Population Perspectives of the Ecosystem Services Provided by the Kebe Block Forest in the East Region of Cameroon

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## ABSTRACT

The Kebe block forest in the East Region of Cameroon serves as a research and teaching forest. Despite the importance of this forest for research and teaching, it provides for the local population living around the Kebe block of Belabo an important source of goods and services needed for survival. In order to ensure a more sustainable management of the ecosystem services provided by this forest, this study set out to evaluate the level of dependence of local households on the ecosystem services provided by this forest. Multiple regressions were used to assess the influence of household socio-demographic and economic factors on the ecosystem services identification rate. Based on a list of 27 goods and services, grouped into three ecosystem services, the identification rate by local households was the highest for the provisioning service (89%), followed by regulation (9%) and cultural service (2%). Multiple regressions showed that monthly household incomes and length of time spent in the village were the two variables that significantly influenced the rate of identification of provisioning and cultural services, respectively. No factors were identified as influencing the rate of identification of regulation service. Thus, this study documents the importance of ecosystem services and their identification rate perceived by local households and the influence of local knowledge on households' decisions to conserve natural resources of the Kebe block forest.

**Keywords:** Cameroon, ecosystem services, forest, Kebe block, local population, multiple regressions

## Introduction

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Tropical forests provide to peoples that live in close proximity several goods and services known as ecosystem services (ES), which are very important for their well-being (Ahononga et al., 2020; Egoh et al., 2012; Gouwakinnou et al., 2019; Lhoest et al., 2020). According to the Millennium Ecosystems Assessment (MEA, 2005), these ES are classified into provisioning, regulation, cultural, and support services. Ecologically, natural ecosystems contribute to the bio-geochemical cycles of elements, which enable them to mitigate climate change impacts (Chimi et al., 2018), soil erosion regulation, resilience, pollination, and water and soil protection (Gouwakinnou et al., 2019; Leakey et al., 2022). Culturally, these forests which represent the sacred areas for local or autochthons populations living in and around them provide goods and services that are used in different cultural and spiritual practices (Gouwakinnou et al., 2019). Concerning provisioning services, they contribute to food security (Egoh et al., 2012; Leakey et al., 2022) and provide several agricultural services, timber, and non-timber forest products (NTFPs) like food and medicinal plants (Chimi et al., 2020; Leakey et al., 2022; Ngansop et al., 2019), thus supporting different activities (Gouwakinnou et al., 2019). Economically, Lhoest et al. (2020) found that ES contributes significantly to incomes of households living near forests. Nevertheless, despite the numerous services rendered by forests to humanity, these forest ecosystems suffer today from an alarming anthropogenic disturbance, leading to deforestation and forest degradation and precipitating a decrease in the availability of ES (Zekeng et al., 2019) and the loss of some animal and plant species, some of which are not yet known by scientists (Maréchal et al., 2014).

Considering the alarming anthropogenic pressures exerted on forest environments and the importance of knowing the value of goods and ES provided by forests for policy making (Egoh et al., 2012; Gouwakinnou et al., 2019), it becomes very important to assess the factors that influence the sustainable management of ES provided by forests. This process starts with the identification of these ES. In fact, it has been found for example that local populations have different ways to assess the importance of ES. This correlates with the factors that

determine the identification rate of these ES. Gouwakinnou et al. (2009) found that several sociodemographic factors have a significant influence on the ES identification rate.

In order to ensure the sustainability of the research and teaching functions assigned to the Kebe block forest, ensure adequate provision of ES necessary for the well-being of the local populations, and design the best integrated management strategies for this forest managed by the Institute of Agricultural Research for Development (IRAD), there is a necessity to assess the perspectives of the local population regarding the importance of ES provided by the forest as well as the sociodemographic, economic, and environmental factors that impact the use of these ES. Thus, the aims of this study are (1) to identify local household perspectives of the diversity of ES provided to them by the Kebe block forest, (2) assess the perspectives of local households on the importance of ES from the Kebe block forest for their well-being, and finally (3) to assess the sociodemographic factors that influence households' identification rate of ES obtained from the Kebe block forest.

## Methods

### Study Area

This study was carried out in Ebaka, Mbiombi, Yebi, and Yanda villages surrounding the Kebe block forest, which is located in the Belabo sub-division, Lom, and Djerem division of the East Region of Cameroon. Ecologically, this area is characterized by a relief which is quite diversified and relatively flat, with few hills at an average altitude of 600–800 m. The climate is especially an equatorial Guinean type, with four unevenly distributed seasons, that is, two dry seasons (a short dry season from June to August and a long dry season from mid-October to March) and two rainy seasons (a short rainy season from March to June and a long rainy season from mid-August to October). The average temperature varies between 23°C and 25°C and the average rainfall is 1600 mm/year. The soils are essentially lateritic (Moby et al., 1979). Phytogeographically, the Kebe block is part of the Guinean-Congolese domain and characterized by semideciduous forest (Letouzey, 1985). The populations living around the Kebe block is estimated at approximately 1500 inhabitants, with approximately 120 households. The wild shifting cultivation (agriculture), logging, poaching, and the collection of NTFPs are the most common activities for which local populations collect goods and services which contribute significantly to their well-being (Chimi, 2020).

### Data Collection

Data collection for this study was carried out in four villages surrounding the Kebe block forest. Thus, the ES identified in the field were categorized into provisioning, regulatory, and cultural services on the basis of information furnished by the MEA (2005).

Based on the identified ES, the forest-poverty toolkit developed by the International Union for Conservation of Nature, the Overseas Development Institute, and the Center for International Forestry Research under the auspices of the World Bank's Forestry Program (PROFOR, 2009) was used for data collection, serving in assessing local population perspectives together with the identification rate of ES by households. This methodological approach involved representing in table format the different ES identified and then reorganizing them in function of the main ES groups and in columns. Then, for each sampled household, the exercise consisted first of presenting and explaining to them the information on ES provided in the table. Second, to indicate to them how to complete a table, 50 pebbles were given to help them to fill each column from the table corresponding to a specific ES with the number of pebbles precisely expressing the important level



**Figure 1.**  
*Toolbox Method Used to Collect Data. (A), Filling the Toolbox by Local Household; (B), Filling the Toolbox with the 50 Pebbles Organized in the Different Columns According to the level of Dependence on ES.*

of each ES they benefit from. Third, the number of pebbles per each specific ES given by each household was recorded. During this exercise, we ensured that all the pebbles were used by the respondents such that the cumulated scores recorded by the different ES gives at the end a total of 50 pebbles. Thus, the most important ES identified was that where the column received the greatest number of pebbles and vice versa (Figure 1). It should be noted that in order to have more reliable information about the households, the table was filled out in the presence of family members under our supervision and guidance. In addition to the data on the identification rate of the ES, the sociodemographic parameters of the surveyed households were collected. Similarly, information on local knowledge regarding the importance of ES was collected (Ahononga et al., 2020). This information was collected through the completion of the table provided to the respondents. A total of 52 households were surveyed in the study area.

### Statistical Analysis

Data analysis was done using R (version 4.2.) software. Descriptive analysis was used to characterize the ES identification rate and also local perspectives on the importance of ES provided for their well-being. Multiple linear regression models using Gaussian family and logit function were used to examine how the sociodemographic household characteristics (household size, family monthly incomes, main activity, and the number of years passed in the village) influence the identification rate of the three ES groups (provisioning, regulation, and cultural services). Dependent variables include the main occupation, number of years spent in the village, household size, and family monthly incomes. Response variable used was the level of identification of each ES group.

## Results

### Ecosystem Services Identified by Local Households

Based on the literature review done and completed by findings from the field, the ES identified in the study area are presented below in function of the three main groups, including provisioning, cultural, and regulation services. Those found in literature but not identified by the local population were not taking into account in this study.

- Provisioning services (19 in total) identified include firewood, timber, mushroom, caterpillars, snail, insects (termites and grasshoppers), liana, Djansang and andok amend, Marantaceae leaves, honey, hazel nut, Okok (*Gnetum* spp.), livestock feed (pasture), medicinal plants, river fishes, snakes, wine palm, and wild animal food and agriculture products;

- Regulation services (5 in total) identified include water, soil/erosion, climate, pollination, and soil fertility;
- Cultural services (3 in total) identified include cultural practices, spiritual value, and tourism/ecotourism.

### Ecosystem Service Identification Rate in the Study Area

According to the three ES groups above, we found that the identification rate was higher for provisioning services (89%), followed by regulation services (9%) and cultural services (2%) (Figure 2).

Specifically, for each group of ES studied, we found that (Figure 3):

- For provisioning services, the ES identified were agricultural products (10.5%), medicinal plants (7.2%), firewood (7.2%), wild animal food (6.7%), river fishes (6.4%), palm wine (6.1%), and other provisioning services which had an identification rate lower than 5%;
- For regulating services, erosion regulation (4.6%), climate regulation (4.5%), and water regulation (3.5%) are those which were identified by the local population;
- For cultural services, cultural practices (1.5%), spiritual values (0.7%), and tourism/ecotourism (0.1%) were those identified.

### Perspectives of Households Regarding the Importance of Each Ecosystem Service

The local populations' dependency on ES or the degree of importance that they gave to each ES identified is presented in Table 1. Globally, the six provisioning services perceived by more than 40% of households as being very important were agricultural products, medicinal plants, river fishes, palm wine, wild animal food, and firewood. Agricultural products were regarded by 55% of households as the most important provisioning service used for their well-being. Concerning regulation services, climate regulation was identified by 61% of households as very important. However, erosion regulation and soil fertility were identified by

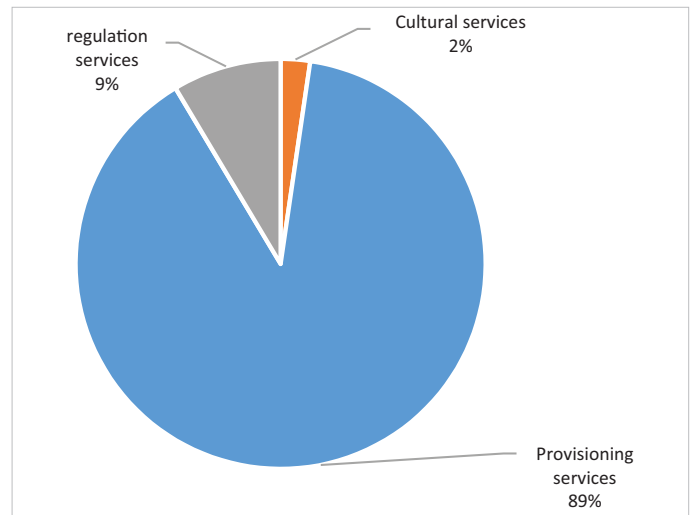


Figure 2.  
Identification Rate of Ecosystem Services by the Local Population in the Study Area.

more than 30% of the households to be important. Concerning cultural services, they have been all perceived by the households as less or not important (Table 1).

### Sociodemographic and Economic Factors Determining the Identification Rate of Ecosystem Services

Concerning provisioning services, we found that among all the household sociodemographic and economic factors considered, only the household income had a significant influence on the identification rate of provisioning services ( $p = .037$ , Table 2). The main activity of households, the number of years spent in the village, and the size of

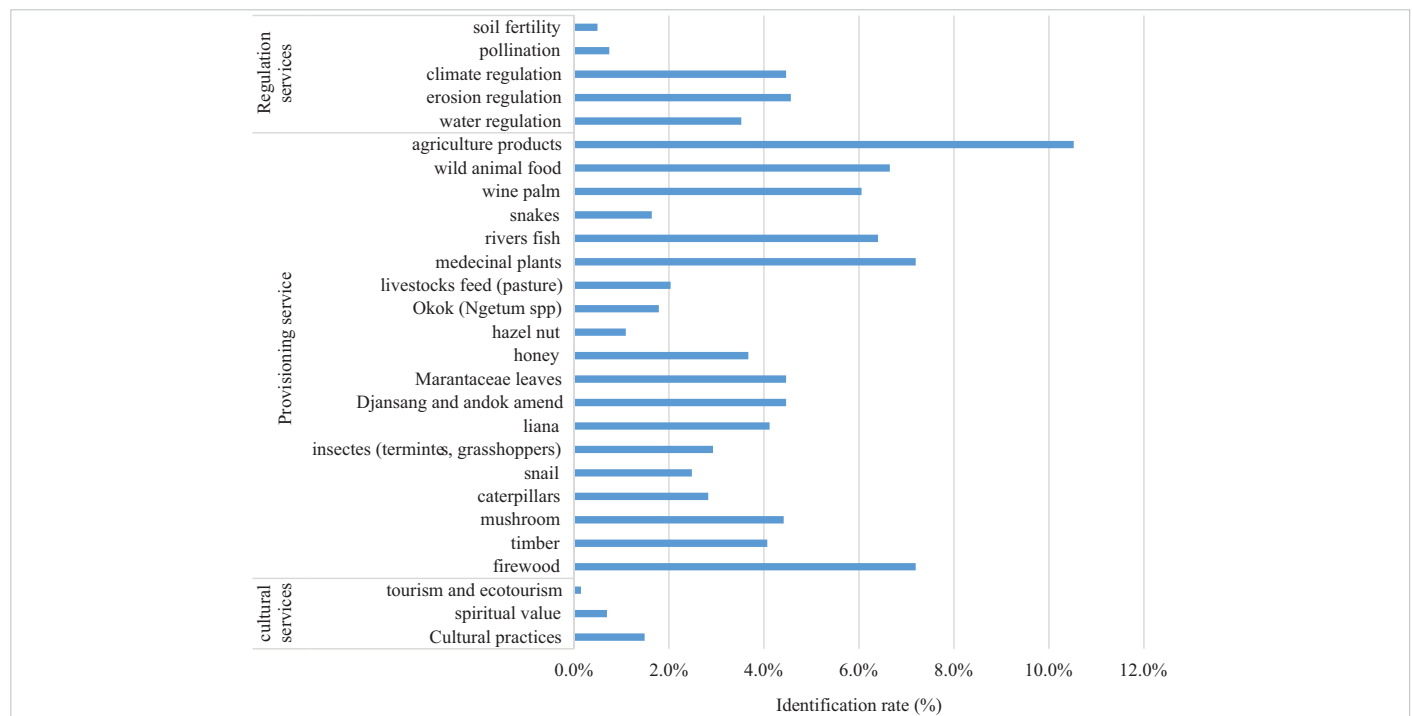


Figure 3.  
Identification Rate in Function of Each Ecosystem Service in the Study Area.

**Table 1.**  
*Household Perspectives on the Level of Importance of Ecosystem Services in the Study Area*

Ecosystem Services		Importance of Service			
		Very Important (%)	Important (%)	Less Important (%)	Not Important (%)
Cultural services	Cultural practices	2.63	10.53	42.11	44.74
	Spiritual value	0.00	13.13	20.01	66.84
	Tourism and ecotourism	0.00	0.00	2.63	97.37
Provisioning services	Firewood	15.79	47.37	36.84	0.00
	Timber	5.26	28.95	60.53	5.26
	Mushroom	0.00	18.42	78.95	2.63
	Caterpillars	0.00	15.79	65.79	18.42
	Snail	0.00	10.53	63.16	26.32
	Insects (termites and grasshoppers)	2.63	10.53	73.68	13.16
	Liana	13.16	18.42	60.53	7.89
	Djansang and andok amend	5.26	39.47	55.26	0.00
	Marantaceae leaves	15.79	21.05	57.89	5.26
	Honey	5.26	26.32	57.89	10.53
	Hazel nut	0.00	0.00	39.47	60.53
	Okok ( <i>Ngetum</i> spp.)	0.00	0.00	65.79	34.21
	Livestock feed (pasture)	0.00	18.42	36.84	44.74
	Medicinal plants	28.95	52.63	18.42	0.00
	River fish	21.05	55.26	21.05	2.63
	Snakes	0.00	5.26	50.00	44.74
	Wine palm	26.32	42.11	21.05	10.53
	Wild animal food	21.05	65.79	13.16	0.00
	Agriculture products	55.26	28.95	15.79	0.00
Regulation services	Water regulation	2.63	23.68	60.53	13.16
	Erosion regulation	2.63	44.74	47.37	5.26
	Climate regulation	61.25	36.75	2.00	0.00
	Pollination	0.00	5.26	42.11	52.63
	Soil fertility	12.40	30.00	27.60	30.00

households were not having a significant influence on the identification rate of provisioning services ( $p > .05$ ; Table 2). Concerning regulation services, among all the explanatory factors considered, none had a significant influence on the identification rate of regulation services ( $p > .05$ ; Table 2). However, the number of years spent in the village was the factor that significantly influenced the identification rate. Concerning cultural services, only the length of time spent in the village (years) significantly influenced the identification rate of cultural services by the local population living around the Kebe block forest ( $p = .0426$ , Table 2).

## Discussion

### Identification Rate of Ecosystem Services by the Local Population

This study investigated local population perspectives regarding the identification rate of ES and its importance for the well-being of households in the study area. We also examined the sociodemographic and economic factors of households that influence the identification rate of provisioning, cultural, and regulation services in and around the Kebe

block forest. We found that this forest provides several goods and services to local populations. As uncovered by other authors, we found that the identification rate of provisioning services was higher compared to cultural and regulation services (Gouwakinnou et al., 2019). In fact, for local populations, the provisioning services are the key elements indispensable for their well-being, since they represent a supplying source of goods and products that they use daily for their subsistence. For example, Egoh et al. (2012) found that agricultural products in the rural sector are essentially used for home consumption. According to Inimbock et al. (2021), medicinal plants are used by local populations for treatment owing to the absence of hospitals in their localities, which explains why the local population prefer to use traditional medicine. In the same vein, Gouwakinnou et al. (2019) found that firewood is a principal energy source in rural areas. However, even though the tendency concerning the identification rate is similar, their identification rate varied in function of households. In line with Gouwakinnou et al. (2019), regulation and cultural services appear to be important for local populations but not as important as provisioning services which constitute the principal source of income and subsistence.

Table 2.  
 Influence of Sociodemographic Parameters of Households on the Ecosystem Service Identification in the Study Area

Variable	Provisioning Services			Cultural Services			Regulation Service		
	Estimate	t-Value	Pr(> z )	Estimate	t-Value	Pr(> z )	Estimate	t-Value	Pr(> z )
(Intercept)	<b>1.000e+00</b>	<b>1.916e+15</b>	<b>&lt;2e-16***</b>	-0.356	-0.825	0.4289	<b>1.000e+00</b>	<b>1.916e+15</b>	<b>&lt;2e-16***</b>
Household size	-3.017e-17	-5.610e-01	0.587	0.096	2.164	0.0557	-3.017e-17	-5.610e-01	0.587
Family monthly incomes	<b>1.748e-21</b>	<b>7.730e-01</b>	<b>0.037*</b>	-0.000	-0.036	0.9720	1.748e-21	7.730e-01	0.457
Main activity: NTFP collection	-1.088e-16	-2.370e-01	0.818	-0.384	-1.008	0.3374	-1.088e-16	-2.370e-01	0.818
Main activity: breeding	2.143e-16	3.580e-01	0.728	0.4293	0.864	0.4079	2.143e-16	3.580e-01	0.728
Main activity: fishing	-3.806e-16	-6.280e-01	0.544	-0.449	-0.893	0.3930	-3.806e-16	-6.280e-01	0.544
Length of time spent in the village (years)	6.698e-18	8.540e-01	0.413	<b>0.004</b>	<b>0.615</b>	<b>0.0426*</b>	6.698e-18	8.540e-01	0.413

Note: NTFP = non-timber forest product. Signification of codes according to the significance threshold: 0 \*\*\*\* 0.001 \*\*\* 0.01 \*\* 0.05.

Contrary to the findings of Gouwakinnou et al. (2019), several cultural and regulation services were not identified by local populations. This can be explained by the fact that some of these specific services had no explanations in the local language, making it difficult for them to be identified. This represents one limitation of the current study. However, concerning cultural services, they identified cultural practices, spiritual value, and tourism/ecotourism. The Kebe block forest does not have a cultural character, which explains why the local populations did not identify any sacred forest or trees in this area. However, these populations use the parts/organs of some trees for some cultural and spiritual practices. This is the case, for example, of the seeds of *Garcinia kola*, *Cola acuminata*, and *Aframomum* spp. that are used in some traditional ceremonies like traditional weddings. The bark of *Canarium schweinfurthii* collected and dried are used spiritually to fight against bad spirits and in exorcism activities.

For populations living around a forest, provisioning services (e.g., medicinal plant, caterpillar, firewood, and wild animals) provided by the forest ecosystem is more important for the well-being of local populations (Chimi et al., 2022; Egoh et al., 2012; Leakey et al., 2022; Ngansop et al., 2019). Agricultural products were identified by households as being the main provisioning service. In fact, agricultural activities represent a major activity of local populations around the Kebe block forest, and this contributes enormously toward the households' well-being. Agriculture constitutes a means of subsistence and a major source of income (Egoh et al., 2012). Nevertheless, the limited importance given to timber is due to the fact that it is an area where logging is prohibited, with local populations given the right to only cut trees that are found on their lands.

#### Household Factors Determining the Identification Rate of Ecosystem Services

Provisioning services were the most identified by households compared to other services. However, it was found that only the monthly incomes of households were having an influence on the identification rate of provisioning services. In fact, with the low level of incomes, the local populations are constrained to diversify their resources in order to ensure their well-being; in this sense, in addition to agricultural products serving not only to generate incomes for the households through their sales but also for their nutrition, the forest resources appear therefore as an important resource for their well-being. All households practice agriculture and collect products in the forest (NTFP) and perceived these forest resources as very important resources for their well-being. These findings can be justified by the fact that no significant difference was found regarding the identification rate of these provisioning services. Only the time spent in the village was identified as the factor significantly impacting the identification rate of cultural services. This is explained by the fact that, the more time someone spends somewhere, the more they learn about the local knowledge and how to live with the peoples of that community. Nevertheless, no explanatory factor significantly influenced the identification rate of regulation services by the local population. Because regulating services are not tangible, sensitization campaigns and the integration of the notions of ES in the basic education system would be advisable (Ahononga et al., 2020; Egoh et al., 2012; Gouwakinnou et al., 2019).

#### Implications for the Sustainable Management of the Kebe Block Forest and Conclusion

We found through this study that local populations regard forests as providing provisioning, cultural, and regulation services that are all necessary for their well-being (Egoh et al., 2012). These various non-suitable



uses of forest resources have as corollary the transformation of the natural landscapes, habitats, and species loss (Zekeng et al., 2019), which weakens this natural ecosystem and therefore compromises its basic objectives. The convention on biological diversity adopted by the United Nations in 1992 stipulates the putting in place at national and international level of strategies aimed at the conservation and the sustainable management of biodiversity (Megevand et al., 2013). Cameroon's adherence to this vital requirement was at the origin of the creation of a number of protected areas and national parks in the various agroecological zones.

The law confers to the government some legality concerning the management of these protected areas; however, it authorizes through usage rights the local populations living near these forests to collect freely and in an ecological manner NTFPs, which they need for their proper consumption. However, the common forest law makes the local populations owners of the bordering forests, where they can collect some goods and services freely. It is important to continue to promote the sustainable management of the Kebe block forest because in this case, it will continue to be a research area for IRAD while contributing to the well-being of the local population through the provision of provisioning services and serving as an area where the local population can in the long run use to teach future generations about the importance of forests and the traditional knowledge which favors sustainable management of the forest. It is only through this that a win-win partnership will be put in place where all the major stakeholders will be satisfied and will work together for the sustainable management of the Kebe block forest.

This study assessed local population perspectives regarding the identification rate of ES by households living in the villages around the Kebe block forest. A total of 27 ES were identified and grouped into provisioning, regulation, and cultural services. Agricultural products were identified as the most common provisioning service provided to local populations, whereas climate regulation was the most common regulation service perceived by the local peoples. Cultural service was less important for households. We equally found that the households were impacting significantly the identification rate of provisioning services; however, the number of years spent in the village was a factor that had a significant influence on the identification rate of cultural services. The sustainable management of provisioning services depends on the good health of ecosystems and the good provision of regulating and cultural services. The management team charged with managing the Kebe block forest should organize awareness-raising campaigns geared toward educating the local population on the importance to reinforce the preservation of the forest so that it continues to furnish the services they need for their well-being and for the benefit of future generations.

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