Land Use Change and Livelihoods in the Plantation Nouvelle de Ngambe Tikar (Pnnt) Community Forest, Center Region of Cameroon

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Abstract: This study aims at identifying changes in land use composition, structure and distribution in PNNT Community Forest in the Center Region of Cameroon, from 2001 to 2020 and to investigate the impact of the search for livelihoods on the change. Obtained results revealed that there are four major land uses in the PNNT community forest; Moist evergreen forest, degraded forest, savanna and bare soils. Land use change analysis indicated that, the surface area covered by moist evergreen forest reduced by 5% while that of savanna reduced by 15.4% from 2001 to 2020. The findings indicated that 255,87 hectares of moist evergreen forest was lost between 2001 and 2020; an average of 13.47 hectares per year. The surface area of savanna reduced significantly from 1919.28 hectares in 2001, 1658.39 hectares in 2011 and to 1124,91 hectares in 2020. Results further revealed a substantial increase in the surface area of bare soil by 17% and degraded forest by 3.4% over 19 years. The total surface area of degraded forest increased by 174.4 hectares from 2001 to 2020. The land use with the most significant positive change was bare soils which increased from 396.61 hectares in 2001 to 1272.45 in 2020; a global increase of 875.84 hectares. Agricultural expansion, increased logging and harvesting of non-timber forest were identified as drivers of land use change in the community forest.

Keywords: Land Use Change, Livelihoods, Community Forest, Plantation Nouvelle De Ngambe Tikar, Cameroon

1. Introduction

On a global scale, anthropogenic activities such as agriculture, industry and transport underlined with various socio-economic, political and institutional factors have resulted in land use changes [1]. Land use change driven by human activities and natural factors resulted in the global loss of native biodiversity and the alteration of ecological processes and services across different ecosystems [2]. In some parts of Africa, the expansion of agriculture influenced by rapid population growth has been recognized as a primary driver of land use change [3]. Most land use change is a direct result of people's responses to economic opportunities as mediated by institutional factors [4, 5] and the land use changes include changes from forest to farmland which is typically accompanied by deforestation. About 20% of the global population depends on forests for employment, forest products livelihoods and incomes [5-8]. Moreover, about 83% of the extreme poor living in developing countries depend on forest resources for all or part of their livelihoods [9, 8]. In Cameroon, the forest sector contributes to about 2.8% of the GDP

(US$695.3 million) and provides direct employment to 22,000 people [10, 8]. It is estimated that the number of people employed temporally or permanently in the sector at more than 2,478,880. Community forest refers to forests in which local communities use and have some degree of formal responsibility and authority for forest management. In Cameroon, community forest also aims at providing rural communities with income generating mechanisms for equitable socio-economic development of their communities, therefore alleviating poverty [11-14]. Non-timber forests products (NTFPs) play a key role in the daily life of millions of people living in the rural areas of Cameroon [8]. The collection and sales of NTFPs constitute an important source of food, cash [15, 16, 8], and employment for rural dwellers. This activity creates at least 283,000 direct and indirect jobs at various levels of the NTFPs value chain [16, 8]. Since the late 1980s, community forests (CFs) have emerged in a growing number of developing countries, largely because of failing centralized forest policy [13]. Currently, approximately 18% of global forest is under community ownership or administration [17, 13]. Most people living in community forests are dependent on the forest to sustain their livelihood. Therefore, several activities are undertaken by local populations to satisfy their daily needs, as well as to generate revenues through industrial logging, NTFPs collection, subsistence agriculture, agroforestry, hunting, fishing and charcoal production [18, 19, 13].

The study therefore aim at exploring the relationship between land use change and livelihood activities within the PNNT community forest. In addition examine the distribution of the land uses within the community forest; compare land use change from 2001-2020; and finally discuss the livelihood activities within the community forest and influence on land use change.

1.1. Legal Framework of Community Forest in Cameroon

Community forest has emerged as one of the keys to the involvement of local actors in forest conservation and sustainable management. It aims at improving the living conditions of local populations while ensuring the sustainability of the resource. In Cameroon, it is governed by forestry Law N° 94/01 of 20 January 1994 on the forest, wildlife and fisheries regime and Decree N° 95-531 of 23 august 1995 laying down modalities for the implementation of the forest regime [20].

This decree defines community forests (CFs) as a portion of non-permanent forest domain (DFNP) that the state assigns to a community at the request of the community and is managed based on an agreement signed by both partners. The first of such agreement was signed in 1997 and since then the number of CFs applications has steadily increased. Historically, the East region is number one in terms of CFs created and operating within the country.

The decree of application states that forest situated adjacent to one or more communities or villages in which they carry out many activities can be designated as community forest (Art 27-2). The community forest certificate should be signed by the Ministry of Forestry and Wildlife (MINFOF) offering free technical assistance to the villages concerned.

The forest susceptible to be attributed to the communities as their property (Art 27-3) must not have a surface area of less than 5000 hectares. The community forest is under a management convention between the communities and the administration for a period of 25 years renewable. A simple management plan has to be established and to be revised after 5 years [22].

The process of creation and management of community forest is based on two conventions:

Temporal management convention with application for the attribution of community forest. This convention hands over the right of the community forest to the villages for a maximum non-renewable period of 2 years.

Final management convention, a minimum renewable period of 25 years.

The exploitation of community forest is carried out by communities in place or sub-contracted as a Sale of Standing Order (SSO). It has to be exploited using an exploitation permit or a personal authorization to cut (Art 95-1) with prior accord from forest administrators in place.

Regular measures for the attribution and management of CFs include:

1. Ordinance N° 0677/LC/MINEF/DF/CFC of 23 February 2001 which limits the industrial exploitation of community forest.
2. Ordinance N° 0518/MINEF/CAB of 21 of December 2001 that put in place modalities of application of rights of adjacent communities of some forest space.
3. Decision N° 1985/D/MINEF/SG/DF/CFC of 26 June 2002 that specify modalities of operation of community forest in the context of the implementation of simple management plan.
4. Decision N° 0098/D/MINFOF/SG/DF/SDFC of 12 February 2009 on the adoption of documents entitled "manual on the attribution processes and management norms of community forest".

Table 1. Evolution of community forest in Cameroon.

Year	Application for community forest	Temporal convention	Final convention	Active community forest
2010	480	0	187	140
2011	490	35	200	140
2012	510	50	230	150
2013	530	63	250	110
2014	547	105	250	113
2015	552	114	250	81
2016	700	183	255	160

Source: MINFOF, 2016.

1.2. Current Situation of Community Forests

The first community forest was attributed to adjacent communities in 1997. In 2016, MINFOF statistics indicated that:

1. 683 applications for the attribution of community forest

was registered from 1997 to date with a surface area of 2,191,385 hectares of forest.

2. 193 community forests acquired temporal management convention giving a surface area of 825,524.5 hectares.
3. 274 community forests acquired final convention with a surface area of 940,205.9 hectares.
4. 182 active community forests has an Annual Exploitation Certificate (AEC) with an area of 28,272.5 hectares of forest.

It can be observed from the analysis that the demands for attribution of community forest, the number of temporal convention and final convention increased from 2010. Out of the 467 potentially exploitable community forests, only 182 has an annual exploitation certificate giving a 35 percent rate

of forest attributed. The volume of wood attributed to community forests between 2010 and 2014 varies between 120,000 and 150,000m^3 while the average yearly volume exploited is 20,000m^3 (table 2). The average annual gap remains at 110,000m^3. The reasons for this increase in gap is due to selective exploitation of species by community forest, the late application for the annual exploitation certificate and the weak exploitation capacities of most community forest linked to lack of finance. Wood sold in the domestic market coming directly from sawing operations in non-permanent forest domain was estimated to be about 662,000m^3. This resulted to an annual average contribution rate of about 3% for the internal market [20].
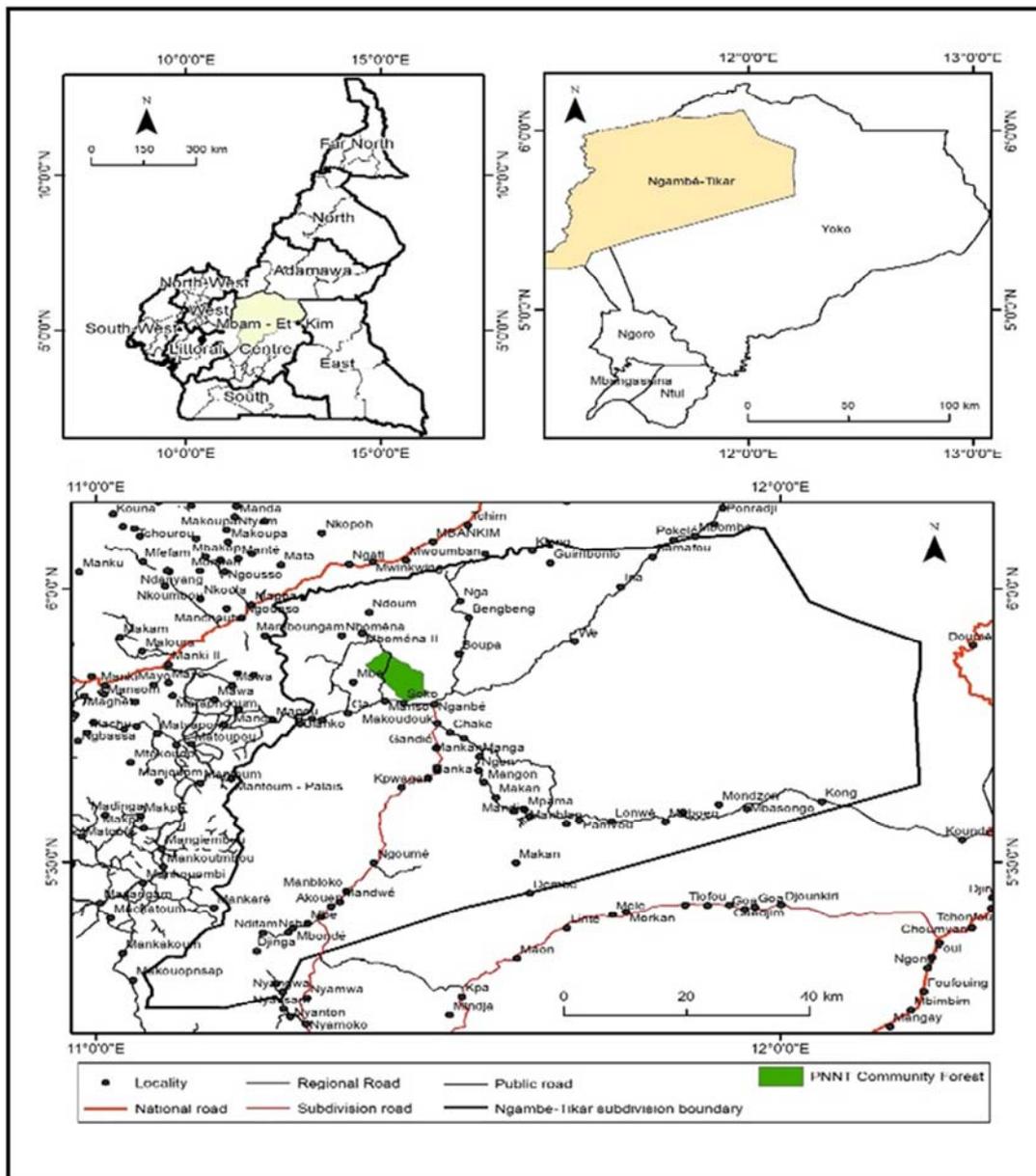
Source: Interactive Forest Atlas, 2016.

Figure 1. Location of study area (a) the Ngambe-Tikar in Cameroon, (b) Ngambe-Tikar in the Mbam and Kim division (c) PNNT community forest in Ngambe-Tikar sub-division.

Table 2. *Attributed wood volume to community forest between 2010 and 2014.*

Year	Authorized logging volume	Logging volume exploited
2010	18000	140000
2011	30000	146000
2012	10000	146500
2013	17000	120000
2014	35000	120000

Source: MINFOF, 2016.

2. Method

2.1. Location of Study Area

PNNT community forest was created on the 26th June 2002 with surface area of 5000 ha. It is located in the Ngambe-Tikar Sub-division of Mbam and Kim division, center region of Cameroon [22]. It is located between latitude 5°47' to 5°62' north of the Equator and longitude 11°29' to 11°34' east of the Greenwich Meridian (figure 1). The area has an average altitude of 825 meters. The average temperature is 27°C and rainfall ranges between 1500mm to 2000mm per year. Ngambe-Tikar experiences an equatorial climate of the Guinean type with two rainy seasons (from April to July and the second from September to November) and two dry seasons (November to March and mid-June to mid-August). The soil is clayey and the subsoil consists of rocks and granites [22].

2.2. General Methodology

This study focused on trends of land use changes and its influence on livelihoods in the PNNT community forest. It involved the use of mixed methods to complement each other consisting of primary and secondary data. Remote sensing technique and Geographical information system (GIS) were used to generate data on spatial and temporal changes in land use. This study employed moderate resolution Landsat images from Earth Explorer [23] to analyze land use change from 2001 to 2020 (19 years). The analysis was performed using the Landsat-7 Thematic Mapper (TM) for 2001 and 2011 and the Landsat-8, Operational Land Imager (OLI) for 2020. The random forest (RF) algorithm was further used for classification and ArcGIS 10.4 software for mapping. Primary data on livelihood activities was collected with the use of mainly questionnaires, focus group discussion and key informant interviews. Three Focused Group Discussions (FGD) were organized with women and men of adjacent communities involved in farming, collection of NTFPs and logging in the community forest. Key informant interviews were further used to collect complementary information about the community forest. This constituted mainly information about livelihood sources, achievements and challenges. In total, 65 respondents participated in the interview. The data collected through household questionnaire survey were descriptively analyzed using Excel and SPSS version 25.0.

2.3. Image Acquisition and Pre-processing

Three Landsat images were used in this study as follows: Landsat 7 Thematic Mapper (TM) images captured on 05 February 2001 and 16 January 2011 as well as Landsat 8 Operational Land Imager (OLI) images captured on 1st January 2020 (Table 3). The images were downloaded from the Glovis websites [23].

Table 3. *Data and sources used for the analysis of land use change in the study area.*

Satellite	Sensor	μm	Band	Scene width (km)	Spatial resolution	Date of acqiusition	Season	Source
Landsat 7	Thematic Mapper (TM)	0.45–2.35	7	170 km ×183 km	30 m	05 February 2001	Dry	http://glovis.usgs.gov/
Landsat 7	Thematic Mapper (TM)	0.45–2.35	7	170 km ×183 km	30 m	16 January 2011	Dry	http://glovis.usgs.gov/
Landsat 8	Operation al Land Imager (OLI)	0.43–1.39	11	170 km ×183 km	30 m	1st January 2020	Dry	http://glovis.usgs.gov/

Source: Authors' conception.

This time analyses of land use change in PNNT community forest require a proper selection and preparation to ensure the compatibility of the Landsat images. In this study, the images were selected from the same season (dry season) and with cloud cover not exceeding 10% with a spatial resolution of 30m.

2.4. Classification Methods

The supervised classification method by employing minimum distance algorithm was used in this study and land use map for each Landsat scene was generated. A supervised classification is the type of classification whereby the user collects samples of the land cover classes (training data) for different land cover classes and the image classification software determines each class by what it resembles most in the training signatures to perform the classification [2]. Post-classification processing was carried out and included recoding, majority filtering, clumping, elimination and mosaicking. This was to produce accurate change detection. The classified images were recorded into the four classes: Moist evergreen forest, degraded forest, savanna and bare soils.

3. Results

3.1. Land uses in the PNNT Community Forest

Four main land uses identified within the PNNT community forest: Moist evergreen forest, degraded forest, savanna and bare soils. The moist evergreen forest constituted mainly the core area with almost no human intervention except hunting and collection of some Non-Timber Forest Products (NTFPs). The degradation of the moist forest area resulted to the degraded land use class. This area was characterised by forest exploitation at a local scale and the establishment of agroforestry like cocoa plantations. Degraded forest had very little canopy cover as compared to the moist evergreen forest. The savanna land use class was mostly characterized by cassava, cocoyam, plantain and cocoa farms, within which some forest trees were interspersed. When the moist evergreen forest is highly degraded, it give rise to the savanna. The bare soil made up the last class of land use in the PNNT community forest. It comprised of newly cleared area for agricultural extension, rocks, areas ravaged by natural and human induced bush fire. The area was characterised by traditional slash and burn methods of farming with a greater rate of deforestation (Table 4).

Table 4. Land use change in the PNNT community forest from 2001-2020.

Land use type	Area coverage per year						Change in land use over the years		
	2001		2011		2020		2001 to 2011 (ha)	2011 to 2020 (ha)	2001 to 2020 (ha)
	Area (ha)	Area ratio (%)	Area (ha)	Area ratio (%)	Area (ha)	Area ratio (%)			
Moist evergreen forest	2711.22	52.6	2542.58	49.3	2455.35	47.6	-168.64	-87.23	-255.87
Degraded forest	131.3	02.5	238.09	04.6	305.7	05.9	106.79	67.61	174.4
Savanna	1919.28	37.2	1658.39	32.2	1124.91	21.8	-260.89	-533.48	-794.37
Bare soils	396.61	07.7	719.34	13.9	1272.45	24.7	322.73	553.11	875.84
Total	5158.41	100	5158.41	100	5158.41	100			

(−) indicates decrease.
Source: Landsat 7 and 8 classification (2001, 2011 & 2020).

3.2. Spatio-temporal Variation in the Trends of Land Use Change

The spatial and temporal variations in land use change over the nineteen years in the PNNT community forest were analyzed using supervised classification method. The land-use classification maps produced for the study area in 2001, 2011 and 2020 are presented in figure 2. The statistics on surface area and percentage change of each land use type based on the classified images of the study area are further indicated. Classified maps of 2001, 2011 and 2020 produced from downloaded Landsat images from the Glovis websites [23] are shown in figure 2. The estimated land cover class and land cover changes per class are presented in table 4.

## 3.3. Trends of Land Use Cover Change in PNNT Community Forest

Obtained results indicated that moist evergreen forest surface reduced from 2711.22 hectares in 2001 to 2542.58 hectares in 2011, a total change of 168.64 hectares (16.86 hectares per year). The area of the moist evergreen forest further reduced from 2542.58 hectares in 2011 to 2455.35 hectares in 2020, a change in land use cover of 87.64 hectares (9.69 hectares per annum). The findings indicated that 255.87 hectares of moist evergreen forest was lost in the PNNT community forest between 2001 and 2020 (average of 13.47 hectares per year). The area lost was converted to degraded forest or savanna.

Degraded forest on its part experienced a positive trend. The surface area of degraded forest substantially increased from 2% of the total land use (131.3 ha) in 2001 to 5% (238.09ha) in 2011. The surface area further increased to 6% (305.7ha) in 2020. The total surface area of degraded forest as indicated by the results from the classified maps increased by 174.4 hectares from 2001 to 2020.

The results showed that the surface area covered by savanna in the community forest had a negative trend from 2001 to 2020. The surface area reduced from 1919.28 hectares (37%) in 2001 to 1658.39 hectares (32%) in 2011. There was a significant loss in the surface area of savanna land use of 2602.89 hectares over ten years from 2001 to 2011. The surface area further dropped from 1658.39 hectares (32%) in 2011 to 1124.91 hectares (22%) in 2020. In a whole the surface area covered by savanna in the PNNT reduced by 794.37 (37% to 22%) from 2001 to 2020.

The land use having the most significant increase from 2001 to 2020 classification of landsat images was bare soils. Bare soils constituted mainly of areas newly cleared for agricultural extension, rocks, areas ravaged by natural and human induced bush fire. The area was also characterised by traditional slash and burn methods of farming. The area covered by bare soils increased and almost doubled from 8% (396.61 ha) in 2001 to 14% (719.34 ha) in 2011. Over a period of ten years the bare soils in the community forest drastically increased in size by 322.73 hectares (6%). Increase in population influence in the adjacent communities further increased the surface area of bare soil from 14% (719.34 ha) in 2011 to 25% (1272.45ha) in 2020. The findings revealed that the surface area covered by bare soil in PNNT experienced the highest rate of increase from 2001 to 2020. The results showed that the surface area increased from 396.61 hectares in 2001 to 1272.45 hectares in 2020; a global increase in area of 875.84 hectares (Table 4).
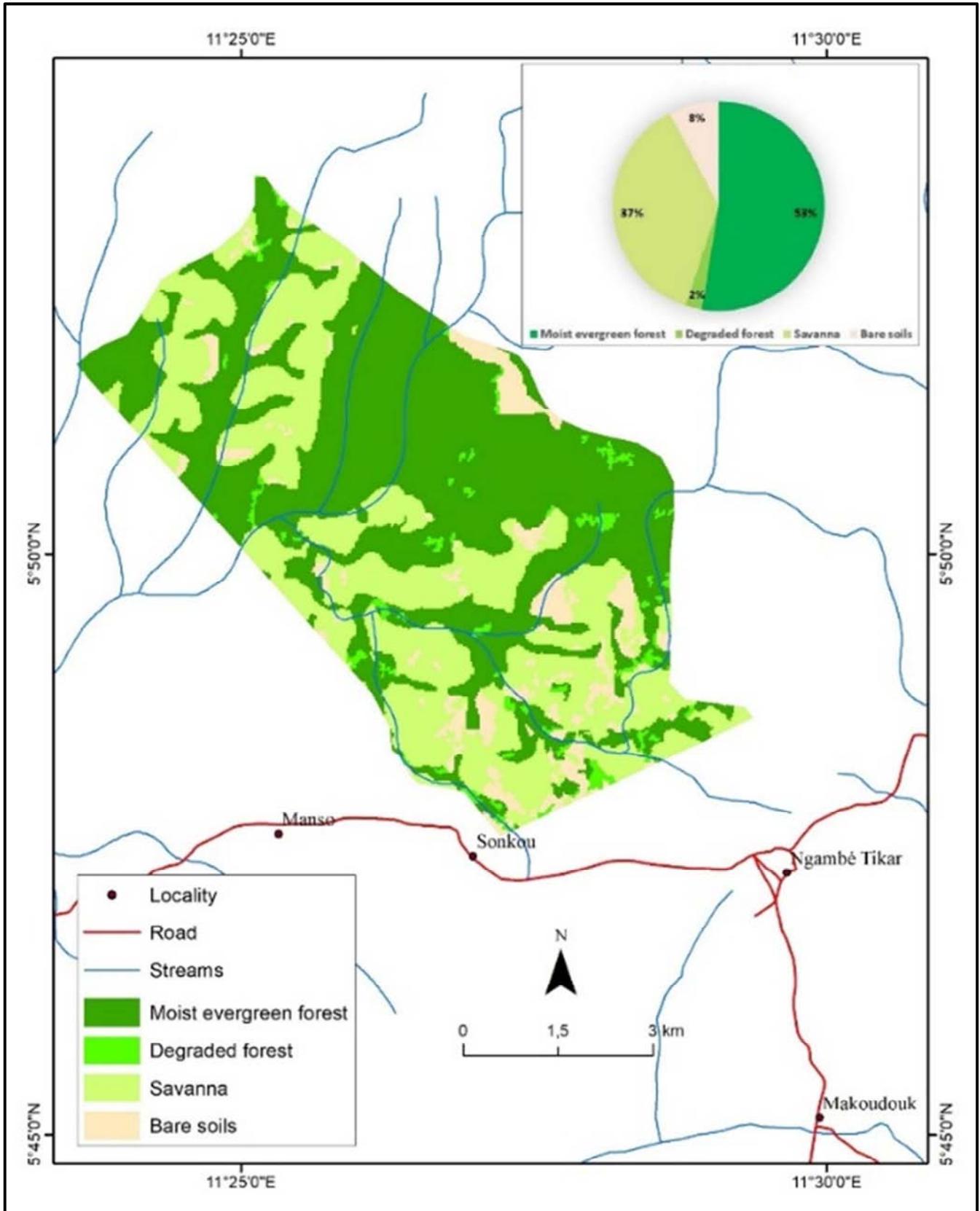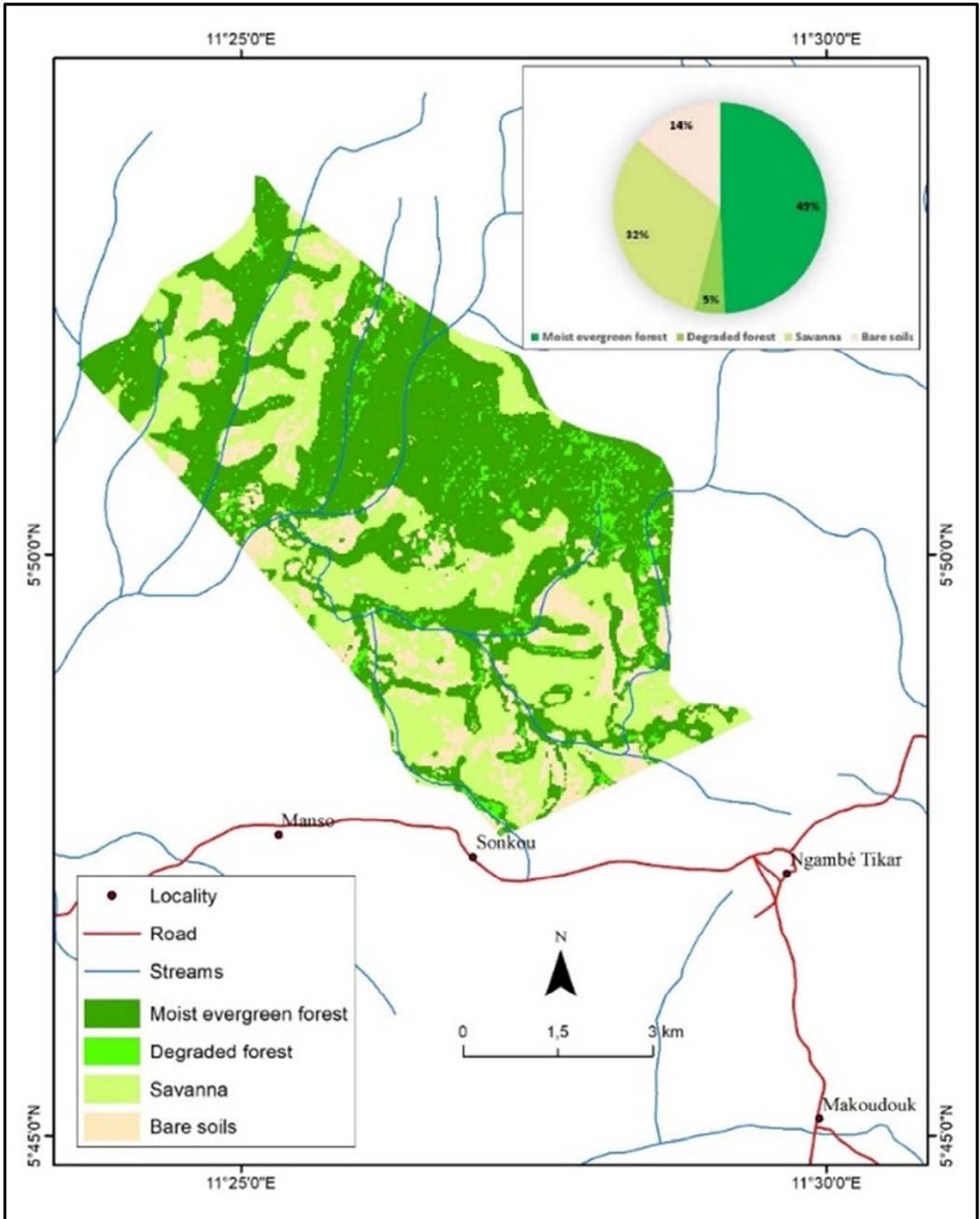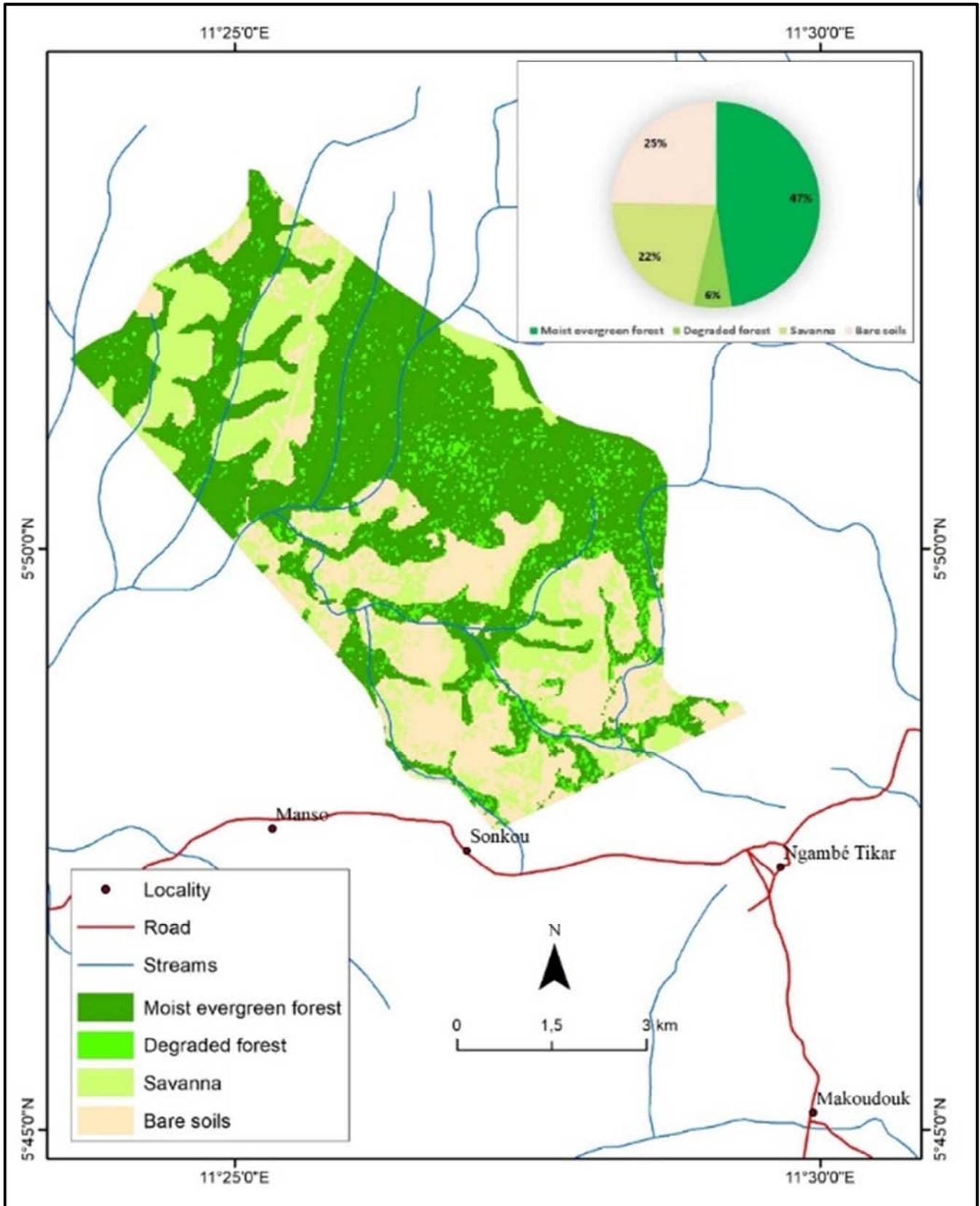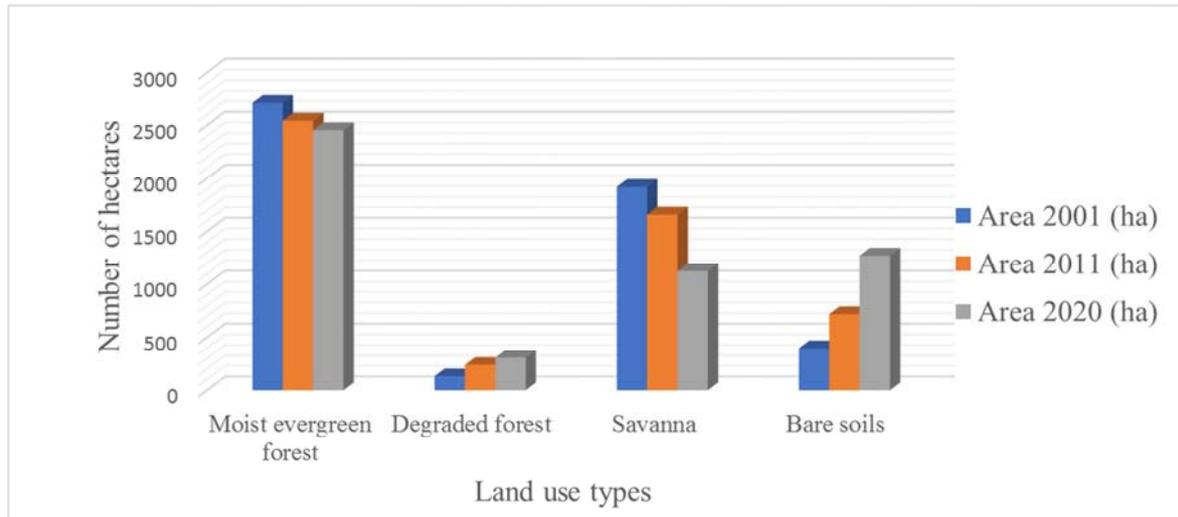
Source: Landsat 7 and 8, 2001, 2011 and 2020 images.

Figure 2. Land use map of PNNT community forest: (A) Land use map of PNNT community forest in 2001; (B) Land use map of PNNT community forest in 2011; and (C) Land use map of PNNT community forest in 2020.

Source: Table 4 data.

Figure 3. Land use change in PNNT community forest.

3.4. Livelihood Activities in PNNT Community Forest

Population living in forest areas in Cameroon to a greater extent depend on forest resources for their livelihoods. The forest represents a kind of huge free "supermarket" providing food, medicines, construction and equipment materials, as well as ceremonial elements [24]. Their standard of living therefore closely depends on the quality of the forest [25]. All households in PNNT community forest area practice subsistence agriculture (men, women and youth); crops are cultivated mainly in individual fields. Main crops cultivated include: maize, cassava, plantain and cocoyam destined for consumption and sale. The main cash crop in the study area is cocoa. In addition to agriculture, there is also the involvement of women and men in the collection of non-timber forest products such as *njansang* and bush mango. Most of the collection of non-timber forest products is done by women, but there are also some men and children who collect it. Globally, about 200 ha of annual crops (the most dominant is maize), 40 ha of mixed cropping (cocoa and plantain) and 5 ha of irrigated farm existed in the PNNT community forest.

Findings through field observations revealed that the continuous increase and expansion of human activities in the search for livelihood improvements have triggered the change in land use within the community forest from 2001 to 2020. The intensification of human activities seeking to ensure food supply and to improve the income of the growing population is the major proximate driver of land use change [26]. The results from household survey showed that more than 85% of the population carried out expansion in human agriculture and other livelihood activities, a key driver to land use change in the PNNT (figure 3).

Source: Field survey, 2020.

Figure 4. Agricultural expansion in the PNNT community forest: (A) a farm land cleared and burnt; (B) a newly cleared piece of land for agricultural expansion in PNNT; (C) full grown cocoa farm in PNNT; and (D) a mixed crop land in the PNNT.

The results further revealed that the exploitation of timber species at a small scale is one of the factors behind the change in land use. The PNNT community forest is reach in many timber valuable timber species (table 5). Villagers exploit the timber species for domestic markets of Ngamber-Tikar, Bafia and in the city of Yaounde.

Table 5. Timber species in PNNT Community Forest.

No	Species	No	Species
1	White Acajou	17	Emien
2	Red Acajou	18	Eyong
3	Aiele	19	Frake

No	Species	No	Species
4	Alep	20	Fromager
5	Aningre-A	21	Illomba
6	Aningre-R	22	Kossipo
7	Ayos	23	Kotibe
8	Bahia	24	Lotofa
9	Bibolo afum	25	Mutondo
10	Bilinga	26	Niove
11	Bongo	27	Onzambili
12	Bosse-clair	28	Red padouk
13	Dabema	29	White padouk
14	Dibetou	30	Sapelli
15	White doussie	31	Sipo
16	Red doussie	32	Tali

Source: Simple management plan, 2015.

An inventory of fauna species carried out through a semi-structured interview was carried out with hunters and fishermen to get both the land and aquatic animals in the PNNT community forest (table 6).

Table 6. *Inventory of animal species found within PNNT community forest.*

Local name	Name in the dialet	Index of abundance
Buffle	Nzou	++
Bush pig	Nguene-nguene	++
Sanglier	Ngah	+++
Antelop	Nzana	++
Gazelle	Mbongbong	++
Cynocephali	Doudou	+++
Python	Lesse	++
Cephalophes a dos jeune		+++
Cephalophes a bandes dorsales noire		+++
Cephalophes bleus		++
Ecureuils divers		+++
Herissons		+++

Local name	Name in the dialet	Index of abundance
Pangolins		++
Genettes		++
Civettes		+++
Moustac		+
Rat de gambi		++
Cob		++
Varan		++
Vipers and other snakes		++
Tortoise		++
Pintades		+++
Perdix and other birds		+++
Eagle		+

+++: very abundant ++: Abundant +: Rare.
Source: Simple management plan, 2015.

About 80% of the people in the developing world depend on Non-Wood Forest Products (NWFPs) for their primary health and nutritional needs and/or in terms of meeting their subsistence consumption and income needs. In many countries NWFPs form an important component of forest products exports [27, 25]. The survey of household through interviews, questionnaires and information from secondary data indicated that there are many NTFPs present in the community forest used by the local people for livelihood improvements. Principal products include: *Anonidium mannii, Gambeeya lacourtiana, Garcinia kola, Irvingia gabonensis, Ricinodendron heudelotii, Tetrapleura tetrptera, Afrostyrax lepidophyllus and Fagara macrophyla.* These NTFPs are used as spices, commercialized and cosmetic purposes (table 7).

Table 7. *Main Non-timber forest products in PNNT community forest.*

Scientific name	Part of product used	Frequency	Observation
Anonidium mannii	Fruit	Rare	Comestible
Gambeeya lacourtiana	bark	Abundant	Comestible
Garcinia kola	Grains and bark	Rare	Comestible, commercialised, used to ferment palm wine, species under-exploited
Irvingia gabonensis	Fruit and amande	Rare	Comestible, spices, commercialised
Ricinodendron heudelotii	Amande	Abundant	Spices, commercialised
Tetrapleura tetrptera	Fruit	Abundant	Spices, commercialised
Afrostyrax lepidophyllus	Bark	Rare	Spices
Fagara macrophyla	bark	Rare	Commercialised

Source: Simple management plan, 2015.

4. Discussion

Land use in forest varied by cover class and physiographic zone [28]. The major land uses identified in the PNNT community forest were moist evergreen forest, degraded forest, savanna and bare soil. The classified surface map of the PNNT community forest area ratio showed that moist evergreen forest, degraded forest, savanna and bare soils were the dominant land cover types. The moist evergreen forest covered 52.6%, savanna 37.2%, bare soils 7.7% and degraded forest 2.5% in 2001. From 2001 to 2011 the moist evergreen forest and savanna witnessed a reduction in surface area by 3.3% and 5% respectively while degraded forest and bare soil experience a significant increase in surface area by 2.1% and 6.2% respectively. This was a similar scenario from 2011 to 2020 as moist evergreen forest and savanna surface area reduced by 1.7% and 10.4% respectively while degraded forest and bare soil experience an increased in surface by 1.3% and 10.8% respectively of the total land cover types. In a whole, from 2001 to 2020 the surface area of moist evergreen forest reduced by 5%, savanna by 15.4% while degraded forest increased by 3.4% and bare soil also increased by 17% of the total land cover (Table 4).

The main reasons behind the land use and land cover changes included rapid population growth, rural-to-urban migration, reclassification of rural areas as urban areas, lack

of valuation of ecological services, poverty, ignorance of biophysical limitations, and use of ecologically incompatible technologies [29]. The moist evergreen forest has been converted to degraded forest and savanna through the exploitation of timber by the population from various villages found around the PNNT. The major timber species (Table 5) are exploited either for personal use in the construction of houses and other household furnitures or for sale in the major urban centers of the central region like Bafia and Yaounde. This is exacerbated by the creation and expansion of cocoa farms in the area by the growing population. This reality on the field was consistent with the trends of conflicts between food production and conservation objectives which have been predicted to increase [30, 5]. The growth in the population due to natural increase and migration has resulted to scarcity of land, thus encroachment into PNNT community forest. Findings from the field survey further revealed that village heads (chiefs) are selling hectares of land in the community forest for agricultural expansion. The degraded savanna land use area are converted to bare soil through slash and burn methods of farming. The survey revealed that, the continuous increase in the surface area of bare soil by 17% from 2001 to 2020 was due to poor farming methods that provoked rapid degradation of the land. Similar studies in south-central Senegal have found that increased demographic pressures have resulted in an increase in cultivated and settlement lands at the expense of other land covers [3, 2].

In terms of livelihood activities in the PNNT community forest, agriculture involving the cultivation of food crops such as maize, cocoyam, cassava and plantains as well as cash crop such as cocoa dominated in the study area. Results further revealed that the populations are involved in the exploitation of timber and the harvesting of major non-timber forest products in the community forest for family consumption and for sale. These human activities contributed at different decree to land use change in the PNNT. In addition, a study in the Kenya [2] have shown that human activities like agriculture, free livestock grazing, wood extraction for fuel wood and charcoal-making as well as wood for domestic use and settlement expansion were observed to adversely cause changes in land use in the Kilombero Valley Floodplain, Southeastern Tanzania. Similar findings [25] in the Bamboko Forest Reserve in Cameroon indicated that unsustainable harvesting methods and excessive harvesting of NTFPs have resulted in a fall in quantity collected and degradation of the forest reserve. Field survey revealed a similar scenario in the PNNT where human activities was noticed to be the major force behind land use change between 2001 and 2020.

5. Conclusion

The objectives of this study was to assess land use change and livelihood activities in PNNT community forest from 2001 to 2020. The results of the study clearly revealed that PNNT has experienced significant changes in land use over 19 years. There was a substantial reduction in the surface area of moist evergreen forest and savanna land uses in the PNNT. The results showed a significant increase in the surface area of degraded forest and bare soil in the study area. The search for livelihoods resulted in agricultural expansion, increased logging and harvesting of non-timber forest products, thereby provoking a change in land use change in the community forest. To ensure sustainable development in the PNNT, the follow up of the ongoing land use change over long periods is very pertinent and the implementation of better policies and strategies are imperative in the area.

Author Contributions

Nghobuoche Frankline designed the study, analyzed the data, and prepared the manuscript with contributions from the co-authors who took part in the conceptualization of ideas, the methodology, fieldwork and the review of the manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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