Environmental impacts of smallholders and elites oil palm plantations on deforestation in the Sanaga Maritime and Ndian basin landscapes: case studies of Ngwéi and Ekondo Titi Subdivisions.

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Abbreviations and acronyms

CDC	:	Cameroon Development Corporation
CIFOR	:	Center for International Forestry Research
CIRAD	:	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
COMIFAC	:	Commission des Forêts d'Afrique Centrale
DCH	:	Diametre at chest height
DSCE	:	Document de Stratégie pour la Croissance de l'Emploi
FAO	:	Food and Agriculture Organization
FONADER	:	Fonds National de Développement Rural
HCVF	:	High Conservation Value Forests
GEOCOM	:	Geospatial Company
GHG	:	Greenhouse Gas
GIS	:	Geographical Information System
GMEM	:	Global Mapping and Environmental Monitoring
GPS	:	Global Positioning System
HLI	:	Higher Labor Intensity
NIS	:	National Institute of Statistics
IRD	:	Institut de Recherche pour le Développement
LULUCF	:	Land use, land use change and forestry
MINADER	:	Ministère de l'Agriculture et du Développement Rural
MINEPDED	:	Ministère de l'Environnement, de la Protection de la Nature et du Développement Durable
MINFOF	:	Ministère des Forêts et de la Faune
NGO	:	Non Governmental Organization
OECD	:	Organization for Economic Co-operation and Development
OPAL	:	Oil Palm Adaptative Landscape
PAMOL	:	PAMOL Plantations PLC
PDPV	:	*Programme de Développement des Palmeraies Villageoises*
PES	:	Payment of Environmental Services
REDD	:	Reducing Emissions from Deforestation and forest Degradation
RGPH	:	Recensement Général de la Population et de l'Habitat
RSPO	:	*Roundtable on Sustainable Palm Oil*
SAFA	:	*Société Africaine, Forestière et Agricole*
SAFACAM	:	*Société Africaine Forestière et Agricole du Cameroun*
SEPL	:	Socio Ecological Production Landscape
SMP	:	*Société de Modernisation du Palmier*
SOCAPALM	:	*Société Camerounaise des palmeraies*
SPFS	:	*Société des palmeraies de la Ferme Suisse*
SPROA	:	*Société des Plantations Réunies de l'Ouest Africain*
UN	:	United Nations Organization
UNDP	:	United Nations Programme for Development
WWF	:	*World Wide Fund for Nature*

Abstract
Over the past three decades, tropical forests have been the focus of international, national and regional discussions, due to various threats challenging facing their existence. Forest exploitation by the different actors (agro-industries, forest concessions under development, local populations) interfering and taking turns, depends on their interests, the methods used and the duration of each intervention. Since memorial time, forest resources have been recognized for their multifunctional utility in the traditional life of the local populations. But today, the sustainability of these resources is questionned while the local communities are constantly becoming poorer despite the fact that the international community is focusing on poverty reduction as an evidence of sustainable development. The environmental impact of these activities is a matter of great attention by environmental NGOs.

In reality, exogenous interests have been added to the traditional endogenous concerns creating a competing platform generating confrontations among actors on forest ecosystem resources. The situation prevailing at Ekondo-Titi and Ngwéi localities is similar. If, for economic reasons, forest companies had set their main interest on timber exploitation from the colonial period (German concessions, first cocoa plantations and coffee plantations), that option was enriched by the great interest in agriculture by the creation of agro industries (SOCAPALM, CDC, PAMOL) in the 1970s, resulting in large areas of natural forests deforested for monospecific cash crop plantations. Around the 1990s, new interests have emerged (mining) and in some cases new actors took over from agro-industries with the same consequences on the natural forest whipped out. The scientific importance of tropical forests in Africa as "true carbon sinks" for global climate regulation is no longer to be demonstrated. However, the mechanisms of deforestation and forest degradation, although known, are constantly extended, reducing at the same time the total forest areas.

In such a context, it becomes difficult to reconcile the positions of the actors with different concerns or interests, but who co-exist on the same forest zones. This situation creates a kind of dilemma that justifies the real complexity of finding appropriate solutions to deforestation in link with oil palm farming. Indeed, the parsimonious way of using resources by the forest traditional communities in which only self-consumption was known, evolved rapidly towards the productivism held by the local people and their elites. Moreover, external actors, particularly foreigners (multinationals, agro-industries), who do not hesitate to exploit these resources until they are exhausted, continue to propagate unsustainable exploitation methods.

Locally, there coexist two to three types of dualism. The first manifested by the practice of two forms of agriculture that are the so-called "subsistence" farming intended to feed the local populations and which faces the cash crop for the production of consumer goods oriented towards the external market. The second one is that subsistence agriculture partly become commercial in the jargon of the commercial food crop, since much of the crop from the peasant plantations replenishes national or even regional urban markets as in the case of plantain (Musa *parasidiaca*). The third case is the coexistence of two or three commercial crops in the same areas (cocoa-oil palm growing, cocoa-oil palm-rubber-tree cultivation); hence a strong dilemma and pressure on forest resources.

The above mentioned dilemma and dualism make it possible to justify this invitation to tender launched by WWF, working in a landscape dealing with oil palm in Cameroon. It also appears as part of the *oil palm adaptative landscapes* (OPAL), project implemented jointly by CIFOR, PDPV and WWF. The current study is part of the research on ecological sustainability of the oil palm plantations development activities in the framework of the OPAL project in Cameroon. It objective is therefore to evaluate the environmental impacts of oil palm expansion resulting in deforestation and forest degradation affecting biodiversity in the Ngwéi and Ekondi-Titi

subdivisions. Drawing inspiration from existing literature, the following points have been the main focus of the consultant in Ngwéi and Ekondo-Titi districts.

- Identifying the impacts of village, semi-industrial and industrial oil palm plantations development on ecosystem fragmentation, forest degradation and deforestation. To this effect, he will produce a map of land use and changes in these two territories (Ngwéi and Ekondo-Titi) following the development of palm plantations;
- Identifying and quantifying the environmental impacts of palm plantations on the Ngwéi and Ekondo-Titi landscape at the triple scale of the village, the conservation areas and the district;
- Analyzing the negative and positive impacts of village, semi-industrial and industrial oil palm plantations on ecosystems, habitat fragmentation, biodiversity conservation and local communities;
- Proposing mitigation and improving measures for the current oil palm system cultivation within the landscape.

The methodology used in this study is complex and is summarized in the following six points.

- Collecting and reviewing secondary data.
- Collecting primary data on the field with socio-economic surveys.
- Realizing botanical transects in order to identify the trees species.
- Sensitizing the populations on the socio-ecological production landscape (SEPL) through exercises and the collection of data on their landscape perception.
- Processing of low and very high resolution satellite images to quantify the evolution of land use and hence deforestation.
- Identifying and evaluating impacts via impact sheets, matrices and a final proposal for oil palm management plan.

The results show that, subsistence agriculture (1960-1970) and cocoa farming (1970-1990) have been the main deforestation driving force in the targeted sites. Since 2000, there has been significant deforestation related to oil palm cultivation at a rate of 67 to 150ha/year, respectively in the mangrove and Atlantic forests at Ekondo-Titi; then from 697 to 946 ha/year in the dense forest of Ngwéi.

0. General introduction

0.1. Context

The oil palm which has for cradle the Gulf of Guinea has been traditionally exploited from the wild in Cameroon. Two or three major forms of exploitation have been recorded in the country: industrial plantations, smallholder farms and elite farms. The enthusiasm expressed by local actors (local populations and elites) for this speculation stems from the economic crisis of the 1980s and the subsequent devaluation of the CFA Franc in 1994 (Ndjogui et al., 2014). It has been accompanied by a proliferation of artisanal and semi-artisanal transformation initiatives with a large range of processing equipment or elastic production of various capacities (Lebailly and Tentchou, 2009).

Cameroon (ranked at the fourth position in Africa) is one of the major oil palm production areas in Africa. The industrial exploitation of the palm tree began in the country around 1870 in the Sanaga Maritime and bears the seal of the Western missionaries. Between 1910 and 1947, the Germans followed by the English (PAMOL and CDC) established their exploitation in the Ndian basin in the South-West Region. The economic crisis of the 1990s greatly contributed to enhance the expansion of oil palm plantations both in the Sanaga Maritime and the Ndian basin. The direct effect of this dynamism was the return of the urban (elite) populations to their village encouraged by the government to boost the country economy through agriculture. In the Sanaga Maritime area, elitist and village plantations have been multiplied and added to the existing industrial plantations. In the Ndian basin, in addition to the existing industrial plantations, new industrial plantations (Herakles) were also added to the village or smallholders plantations. These actually contributed to the drastic increase in cultivated surface that progressed and seriously impacted the primary and secondary forest ecosystems, followed by mangroves and Atlantic forests. However, this boom of actors, coupled with existing or new agro-industries, is likely to generate considerable negative impacts on the receiving environment in general and forests in particular.

0.2. Problem statement

Degradation and deforestation of the Cameroonian forests have been accelerated for the last twenty years (i.e., since the massive investment of populations and agro-industries in the massive production of palm oil). This becomes a major challenge given the fact that the disappearance of the forest is a serious threat to the fauna of the territory. Beyond the numerous hectares of the forest that are lost and the different animal species that are threatened by deforestation, it is important to highlight that this practice counts for the greenhouse gases emission to the world at large and Asian countries in particular. Such high emissions are mainly caused by the release into the atmosphere of carbon from trees and soils (AFP 2012). Deforestation also causes considerable social consequences. In reality, it often runs in opposition to the rights of the indigenous people like it also violates community property rights (e.g. the case of SG Sustainable Oil Cameroon [SGSOC on 27 September, 2016]). This phenomenon therefore renders the local population and landowners vulnerable against these big enterprises that exploit and possess their land expected to contribute to maintaining their livelihoods. Consequently, landowners and indigenous populations are vulnerable to large-scale farming enterprises that take possession of the land they need to maintain their living conditions. Lastly, deforestation, which is closely linked to the exploitation of oil palm, has both positive and negative effects on the national economy. The expansion of this single crop farming system appears to be dangerous to the diversification of incomes in the villages' economy of these councils, exposing the population to any fluctuation in the raw materials prices. In the same light, it jeopardizes the sustainability of the economy (Pichler 2011). Several experts strongly agree that deforestation in tropical countries is caused by the growth in world demand for palm oil. Indeed, according to the United Nations (UN), this demand has increased

up to about 2.5 million tons per year since the last thirty years (UNCTAD 2012). Furthermore, the Organization for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO) forecast a considerable increase (30%) in palm oil consumption worldwide by 2019 (CNUCED, 2012). This phenomenon could be explained by the following factors:

- Palm oil is the cheapest vegetable oil found on the market;
- Its smooth characteristics and the fact that it is concrete in ambient temperature make it an interesting substitute for butter in the food technology industry.
- It is frequently use in food and cosmetics products as well as in the biofuel production (CNUCED, 2012).

In addition to palm oil extracted from the palm fruit pericarp, palm kernel oil extracted from endosperm is widely used in the cosmetic industries. The secondary transformation industries, mainly consisting of refineries and soap factories, transform industrial palm oil, but also artisanal, and to a lesser extent industrial kernel oil, in order to sell a variety of food and cosmetics products.

Each refining phase ends with marketable products. Thus, pre-treatment (flocculation - bleaching - filtration - polishing) produces pre-treated oil, while fractioning (reheating - cooling - filtration) help to separate fatty substances characterized by different merging points: olein, a fluid oil and stearin which is a concrete oil.

At the traditional and local level, oilcake coming from pressing palm fruits is also used in animal feeding and the cores are excellent combustibles used in palm oil processing units. Fourrier et al. (2001), show the importance of all parts of the plant (in addition to the fruits) useful in oil mills. It is noteworthy from the social and cultural point of view that the oil palm offers a lot of useful materials to the local communities, ranging from food to traditional pharmacopoeia and building materials, contributing to the well-being of local populations and their socio-cultural development. The palm stems can also serve as vannery (making of brooms, baskets, sieves ...) or for roofing. On the contrary, the sap is fermented for direct consumption (palm wine) or after distillation (palm alcohol; Jacquemard, 2012; Ndjogui et al., 2014). Lastly the trunk is used for constructions (Feintrenie and Levang, 2010).

Concretely, there has been an exponential growth in the palm oil production since the past four decades. This growth ranges from some few million tons in the 1970s to nearly 50 million tons in 2010 (Dufour, 2014). Palm plantings could be done either on fallows, on degraded areas or at the expense of the forest (deforestation). Oil palm cultivation needs fertilizers and pesticides for it growth (less than cocoa). For industrial plantings and plantations owned by elites, it requires fossil-based machinery. These parameters make the palm oil production, not necessarily sustainable in terms of environmental protection. In recent years, this has resulted in the emergence of new producers, such as Cameroon and Nigeria, who are offering modest competition to large Indonesian companies (Zone Bourse, 2012). Lastly, some analysts highlight the possibilities for these countries to becoming soon major palm oil producers in the world market (Zone Bourse, 2012).

In Cameroon, the increase observed in the expansion of surface area in palm oil cultivation is in line with the Government policies. Indeed, Oil palm Project (2001) controlled by the Ministry of Agriculture and Rural development is one of the most recent initiatives favouring oil palm plantations. Considered a "national priority", this project was launched within the framework of a "voluntarist policy of modernizing agriculture". It is focussed on promoting subcontracting a system favourable to privatized agro-industries that are supposed to embody the "new era" of the expansion of the oil palm in the country. The objective is to increase the planted areas by at

least 5,000 ha per year to reach the production of 250,000 tons of palm oil per year by 2010 (Table 1 and Table 2). These two tables show an undeniable increase in the surface area of oil palm plantations throughout Cameroon and the MINADER program will only boost this production.

Table 1 : Approximate planted areas in 2008 (compilation of data) and areas of agro-industrial palm oil plantations in 2010.

Company		**production Area (ha)**	**Number of exploited plots**	**Total management area (under concession)**
Agro-industries	CDC	16 000	18	68 167
	Ferme Suisse	4 000	4	12 319
	PAMOL	9 000	3	11 760
	SAFACAM	4 500	4	13 019
	SOCAPALM	28 000	10	56 641
	BIOPALM	0	1	22 967
	HERAKLES	0	7	25 835
	Sub Total 1 :	***61 500***	***47***	**210 708**
small holders and elites plantations	Supervised village plantations	15 000	--	15 000
	Independent traditional plantations	25 000	--	25 000
	Sub Total 2 :	***40 000***		***40 000***
Total :		**101 500**	**47**	**250 708**

Source : Agri Stat (2008), WRI and INC (2011), Bakoumé et al. (2002), OTAL, (2009), Carrere (2010 : p24).

These statistics have been modified by Carrere (2013), who focusses only on the intention and the illustration are as follow (Table 2).

Table 2 : Effective oil palm areas planted or under acquisition in Cameroon.

Denomination		**Acquired or under negotiation areas (ha)**	**Uses /utilities**	**Observations**
South West Agro-industries	CDC + PAMOL	25 000	Palm oil, kernel palm oil, soap industries	PAMOL is extending his plantations to Bakassi (3 000ha)
Bolloré Group	SOCAPALM, SAFACAM & Ferme Suisse	40 000	Palm oil	Existing before 2000
Bolloré Group	SOCAPALM, SAFACAM & Ferme Suisse	43 000	Biofuels, biodiesels	After 2,000, 60-year approval signed for 78,529 ha
Herakles USA	Sustainable Oil Cameroon	73086	Palm oil	19,843 ha granted in November 2013
SIVA Group et SNI	SIVA , Singapore	200 000	Biopalm energy	3,300 ha. Pending case
Sime Darby	Sime Darby, Malaisya	300 000	Palm oil and rubber (hevea)	In the Southwest wishes 600,000 ha Outstanding business
Good Hope	Good Hope, Malaisya	6000	Palm oil	In the South
Cargill USA	Cargill et API	50 000	Palm oil	Pending case
PALMCO	PALMCO Cameroun	100 000	Palm oil	Pending case

Smart Holdings	Smart Holdings	25 000	Palm oil	Pending case
GMG	Sud Cameroun Hévéa (GMG Singapour)	45 200	Palm oil and rubber	Granted
Sub Total 1 :		***907 286***		
small holders and elites plantations	Supervised village plantations	15 000	Palm oil	UNEXPALM
	Independent traditional plantations	85 000	Palm oil	
	Sub Total 2 :	***100000***		
Total :		**1 007 286**		

Source: Carrere (2013, p.13, 29). Carrere statistics show a total areas of 882,286 ha for industrial palm where the 25, 000 ha of CDC and PAMOL are to be added and thus the total accounting for 907,286 ha. Considering the surface extension in the plantations of the local villagers and the elites, we are faced with more than 1 000 000 ha of plam oil plantations of all categories.

0.3. Objective

This kind of evolution justifies this offer launched by the WWF, following palm oil activities in Cameroon within the framework of the research project « Oil Palm Adaptative Landscape » (OPAL), jointly implemented by CIFOR, PDPV and WWF. The present study is part of the research on the ecological sustainability of the development of activities linked to oil palm plantations in the framework of the OPAL project in Cameroon. It is focussed on the environmental impacts assessment of the extension of cultivated oil palm areas associated with deforestation and degradation of the biodiversity in the Ngwéi and Ekondo-Titi districts.

Drawing inspiration from existing literature, field work and his personal expertise, the consultant is going to focus on the following points in both subdivisions (Ngwéi and Ekondo-Titi):

- Identifying the impacts of smallholder, semi-industrial and industrial oil palm plantations development on ecosystem fragmentation, deforestation and forest degradation. To this effect, the consultant will produce a map of land use and changes in these two territories (Ngwéi and Ekondo-Titi) following the development of palm plantations;
- Identifying and quantifying the environmental impacts of oil palm plantations on the Ngwéi and Ekondo-Titi landscape at the triple scale of the village, the conservation areas and the district;
- Analyzing the negative and positive impacts of smallholder, semi-industrial and industrial oil palm plantations on ecosystems, habitat fragmentation, biodiversity conservation and local communities;
- Proposing mitigation and improving measures for the current oil palm system cultivation within the landscape.

0.4. Methodology

The overall objective of this consultancy is to contribute to the existing knowledge on the environmental impacts of the village oil palm plantations on the biodiversity and the preservation of the ecosystems in the Ngwéi and Ekondo-Titi districts. This study has actually mobilized diverse and complementary methods. Therefore, five complementary analysis methods were used to achieve this objective.

0.4.1. Literature review

This preliminary stage was based on the publications and reports available on village oil palm groves and local communities of the study sites. Information was gathered on the activities of the agro-industrial enterprises in Cameroon enabled us to get acquainted with the different

economic, social and environmental policies prevailing in Cameroon. The libraries of MINADER, the University of Yaoundé I, CIFOR, WWF, and CRESA Forêt-Bois ... were visited for this purpose as well as online publications that were accessed. Finally, GIS represents the second methodology designed to generate the data to be incorporated into EIA methods.

0.4.2. Remote sensing and GIS

These methods, widely used in environmental assessment, enable the processing treatment and give possible advantage to information obtained from satellite images. These methods are important as they help in gaining precision, integrating and then validating field observations. Initially, the LANDSAT diachronic images (MSS, TM, ETM + & 8 from 1975 to 2015) of the two districts were downloaded. Diachronical analyzes of the said multi-spectral images helped to observe the evolution of the land use from 1970s to 2015. This was followed by the purchase of two Google Earth images (0.60m) of the two councils. Also, two portions of Google Earth, IKONOS and GEOEYE images (0,80m), with very high resolution were consulted, visualized and processed. Figure 1 shows the different stages of image processing for achieving the results of these projects and mapping impacts.

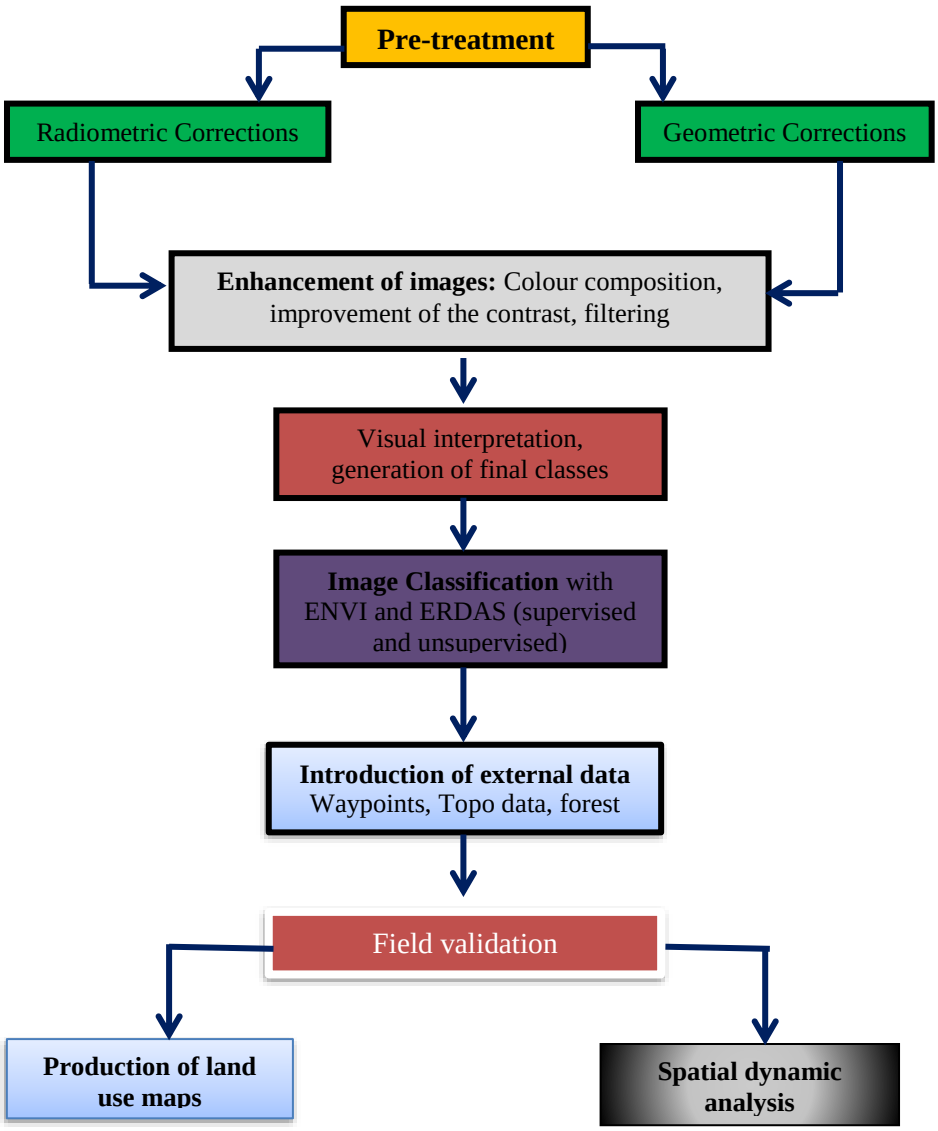


Figure 1 : Processing steps for the land use dynamics through satellite imagery.

These treatment steps include:

- Pre-processing and application of filters to visualize and recognize targets. It is important to note oil palm farms owned by elites and villagers were not, so texture filters do not always allow accurate readings. Images from Ikonos, Geoeye and/or Google earth sensors on portions of Ngwéi were proven indispensible in the identification of oil palm plantations.
- The number of images to be processed required a minimum of four (4) persons performing supervised classifications under ENVI 4.5 and / or Erdas 2014. These classifications are useful for understanding the dynamics and changes in land use before field observations. In addition, we have assessed land use areas (degraded forests, dense or high value forests, palm plantation, food crops, fallow land, etc.). The obtained layers have been vectorized and integrated into a GIS.
- The last stage consisted in producing the synthetic map for each year on the dynamics of village, semi-industrial and industrial palm plantations in Ekondo-Titi and Ngwéi under ARCGIS 10.0 and / or QGIS 2.2 after the integration of the data collected during field surveys.

0.4.3. Quadrat (plots) and transects methods

According to Tchindjang et al. 2016, more than one million hectares of land have been solicited by industrial companies involved in the palm oil production in Cameroon (table 1 a&b). Added to this, there have been recent clearings on acquired lands by the population or the elites. This expansion in cultivated areas, if not carried out on fallows, is going to reduce the habitat of **many animal and vegetal species,** which will finally lead to their disappearance. Fragmentation and reduction of these natural habitats for oil palm cultivation reason is incontestable in these two large production basins.

On another scale, the risk of disappearance of high conservation value forests, wildlife biodiversity and the reduction of the permanent forest estate remain a real concern as oil palm agro-industries have been developed mainly at the expense of the primary forest, generally classified known rich in biodiversity.

The quadrat method is advantageous in the sense that it helps in studying the dynamics of the fauna and flora in a quantitative and qualitative approaches. We worked in quadrats of 20 * 100m in each type of land use, especially in different types of oil palm plantation to compare with the dense forest. Table 3 shows the number of quadrats envisaged in each of the studied district (Ngwéi and Ekondo-Titi).

Tableau 3: quadras and transect sample

Type of land use	**Number of quadras envisagées**	**Number of transects**
Small holder oil palm plantation	2 quadras	2 transects
Elite oil palm plantation	2 quadras	2 transects
Industrial oil palm plantation	1 quadra	1 transect
Dense Forest	2 quadras	2 transects
Total	7 quadras	7transects

A systematic sampling enabled us to choose the exact location (GPS coordinates) of each quadrat. These locations were generated from the study site maps. Each quadrat was studied by two (2) members of the team accompanied by a local guide. The team checked for signs indicating the presence of animals (dung, nests, etc.) and plants, as recommended by White & Edwards (2001). Quadrats were entirely excavated and all the indices of the animals and plants were determined and listed.

0.4.3.1. Biodiversity fauna and flora records within the quadras

Flora recording

In order to analyze the impact of oil palm farming on plant biodiversity, we applied experimental plots on four types of vegetation's namely: a village or smallholders oil palm plantations, an elitist oil palm plantations, an industrial palm plantation and a forest area. To this effect, the team realised an experimental plot where recoded plant species were immediately identified. Also, transects were made inside the quadrats to identify and record traces of the wildlife presence.

Sample choice

The sizes of the plots were chosen based on the types of vegetation to be sampled. These plots were delimited in the palm plantations using a twine covering a land surface area of a rectangular form of 20m x 100m thus a surface area of 2000m^2 / by type of exploitation. Therefore, for the four types of exploitation, a total of 10000m^2 piece of land was fragmented. The choice of sampling 2000m² by type of exploitation is linked to the fact that in the agrosystems (palm plantations), vegetation is less densed and even less diversified.

In forest zones, we fragmented plots of 40m × 50m or 2000m2 to record the ligneous. The choice of such a size in the forest zone is due to the diversified nature of the dense forest species for which the surveys of floristic species should be maximized. To maximize the representativeness of information concerning the flora composition in the different types of vegetation, we took time to fragment the plots in the portion of the forest where there are laces of the forests characterized by the concentration of the trees. For this purpose, we avoided the edges of the forests as well as places close to the borders.

Details account of the ligneous and DCH measurement

In the forest zone plots, the team abstained from counting ligneous species so that later on it will be easier to determine the abundant cases of the forest before the installation of the palm plantation. By so doing, while recording the different vegetal species in the primary and secondary forest, we measured different tree trunk up to 1.30m from the ground having a ≥ 50cm diameter at the chest level. This threshold was chosen because of its high concentration in ligneous in the dense forest. This measure enables us to analyze the variance in the height of tree trunks by type of vegetation (photos 1a-c).

Photos 1.a. Inventory b. Epigenous biomass measurement c. Identification by cutting.

Fauna and flora data recorded within the framework of this study were respectively collected in the two subdivisions (Ekondo-Titi and Ngwéi). The following illustrations (tables 4 and 5, Photo 2) represent the different sites of the districts from where biodiversity was recorded

during the survey. These sites were chosen because they have the type of land use sought to conduct this research.

Table 4. Flora and fauna record

Region/ Divison	**Subdivisions**	**Record sites**
South-West / Ndian-division	**Ekondo-Titi**	Bongongo I
		Ekondo-Beach I
		PAMOL
Littoral/ Sanaga-Maritime	**Ngwéi (Makondo)**	Makai I
		Ndogo-Songbo

Source: *field survey data, November, 2016.*

Photo 2: floristic inventory within a palm plantation at Ngwéi

Tableau 5. Land use typologies

Ekondo –Titi subdivision		
Type of land use	Geographical coordinates beginning of the plot	Geographical coordinates End of the lot
Dense & wet forest	04 57 609 N - 009 09 068 E	04 57 367 N - 009 09 516 E
Elite oil palm plantations	04 57 037 N - 009 09 803 E	04 57122 N -009 09 958 E
Mangrove	04 60 740 N -009 00 496 E	04 60 877 N - 009 00 409 E
Small holder plantations	04 61 350 N - 009 00 724 E	04 61 382 N - 009 00 869 E
Industrial plantations	04 59 968 N - 009 05 457 E	04 60 147 N - 00 05 452 E
Ngwéi subdivision		
Type of land use	Geographical coordinates beginning of the plot	Geographical coordinates End of the lot
Dense & wet forest	03 73 860 N - 010 24 060 E	03 74 004N -010 240 55 E
Elite oil palm plantations	03 73 860 N - 010 24 205 E	03 73 439N - 010 24 197 E
Small holder plantations	03 81 425 N - 010 28 776 E	03 81 200N - 010 28 769 E

Source : field survey

In the different sites mentioned above, the transects method was used to collect fauna and flora data (White, 1983; White and Edwards, 2000). This method yielded quantitative and qualitative

data on the different habitats (natural and modified) in the project area. All through the use of the transect methods, quadrats measuring 20m x 100m (2000m^2) were regularly installed in the different types of habitat that was identified for the survey. Flora species were directly identified on the site thanks to a botanist systematiciant who was a member of the team (Marie Damien Essono). Considerable diameter (1.30m) of the individual trees identified were regularly evaluated at a chest level height. All the different vegetal species were identified thanks to the identification techniques like cutting of the bark of the tree. The local hunters who were present did the identification of animal biodiversity through the recognition of animal traces (photo 3). This was also done through various interviews on the wildlife composition in the natural habitats of the geographical areas hosting the project.

Photo 3 : Index of the terrestrial fauna presence in Ngwéi's by Makondo

We use an appropriate adhesive tape and a double decametre for the delineation of the plots surveyed. In addition, GPS was used to measure distances and record geographic coordinates for each square. Details on the different species identified were recorded in a register. However, a machete was used in the dense forest area to open the passage required for the installation of the small square. Flora and wildlife data collected on the different sites were analyzed and processed using the Excel software. This enabled us to produce analytical tables and to determine the various wealth or biological diversity index. For this purpose, the Excel software allowed us to calculate the Shannon, Simson and Pielou equitability (1966) indexes applied to the various habitats identified.

0.4.3.2. Materials used in plant surveys

The different floristic samplings carried out in the field require specific tools:

- To carry out the different recordings on the field, we used a flora-recording sheet (80 sheets) and fauna recording sheets (80 sheets, see Appendix 1) that we established according to our expectations.
- Each plot subjected to the different samples was delineated using a twine that was proportional to the size of the plot.
- The different plant species collected were directly identified on the field.
- However, considering the fact that certain trees in the forest have trunks more than 4 metres in DCH, the team used a tape metre to measure the different diameters of trees at chest level DCH $\leq$ 1.5m, and a double decametre for DCH > 1.5m
- The delineation of the surveyed plots was made using an adhesive tape and a double decametre. The GPS device served to measure distances and record geographic coordinates of each plot.

0.4.3.3. Methodology to estimate carbon stocks and standards used

In Cameroon, allometric equations are not yet validated. Nevertheless, within the framework of the REDD+ (GEF, World Bank), working sessions to this effect are ongoing at the Central African Forest Commission (COMIFAC). The assessment of carbon stock in the project zone just considered one compartment: the epigeal or aboveground biomass.

Aboveground or tree epigeal biomass

Chave et al., (2014) allometric equation was used to estimate the carbon stock according to the following formula:

AGBest = exp [-1.803 -0.976E + 0.97601 ln(φ)-0.0340+ 2.673 ln(D) – 0.0299[ln(D) 2] Où:

- E is a constancy = 0.178 x TS – 0.938 x CWD – 6.61 x PS X 10-3
- CWD : *Climatic water deficit* (equal to – 71 for the study area)
- TS : *Temperature seasonality* (equal to 781 for the study area)
- PS (*precipitation seasonality* equal to 59 for the study area)
- φ is the trees relative density considered for Cameroon : 0.64

0.4.4. Landscape method

Landscape refers to the combination of physical elements with cultural superposition of human presence. It also reflects interrelationships between environmental changes, socio-economic trends and patterns as well as political changes. Landscape approach is based on the principles of various natural resource management systems that recognize the value of different ecosystem services for multiple stakeholders and how these principles lead them to pursue different land use objectives or livelihood strategies (Tchindjang et al.2015).

A landscape is thus understood as a broad geographical construction that includes the biophysical, social, political, psychological and other components of an area (Farina 2006 cited by Sayer et al., 2007). In terms of space, landscape may extend over several villages or beyond a single administrative unit. A healthy and sustainable landscape is multifunctional (Wiggering et al., 2003). Some of these functions include agricultural production, extraction of natural resources, environmental functions (soil and biodiversity protection, water protection and purification) and cultural roles. Landscape functions are not always compatible given that conflicts could rise up and the challenge consists of balancing these functions thus the necessity of evaluating the performance of a given landscape.

The global landscape approach takes into consideration all types of landscape, without ignoring the diverse perceptions, including the subjective one, which emphasizes emotional observation (colors, shapes, odors, noises ...). Then, it analyzes the characteristics of the landscape (unity / diversity, monotony /contrast ...). Also, it analyzes the socio-economic data (activity, habitat, infrastructures, etc.) and finally the natural components. Quantitative perceptions enable landscapes qualification and classification to help developers. Thus, performance evaluation is a mean of keeping trace of the state of a particular landscape. It reveals the landscape dimensions (Ecoagriculture Partners, 2007).

The objective of the landscape method is to evaluate the situation, the performance and the evolution of the feature impulsed by the creation of oil palm plantations. The two chosen districts are located at the heart of the Cameroon dense forest, about 50 or 100km from the Atlantic coast. The original vegetation is dense Atlantic forest and mangrove. These are landscapes whose socio-ecological production is quite high, responding to the needs of the indigenous peoples who live there. The important biomass and the high biodiversity give access to a set of resources that are renewed by a natural cycle. Ngwéi as well as Ekondo-Titi were

very early involved in the oil palm production since the colonial period. The departure of the colonial masters permitted the establishment of two big agro-industrial companies (SOCAPALM in Ngwéi, then PAMOL and CDC in Ekondo-Titi). However, since 1990, elites and local population did not fold their arms. They have realised oil palm plantations that have seriously modified the landscape; the forest being gradually replaced by these estates. At the human level, there is a demographic expansion caused by the arrival of migrants in search of paid jobs in the elites and industrial plantations. Such a situation thereby contributes to social and ethnic recomposition. There is also significant economic diversification to meet the population needs.

The landscape approach on the field consists in conducting SEPLs exercises in the 56 villages and communities involved in the exploitation of the oil palm. This landscape assessment method coming from the SATOYAMA Initiative (within the framework of the COMDEKS project implemented in Cameroon by the UNDP), makes it possible to evaluate the landscape based on a fourfold plan:

- Ecosystems protection and biodiversity conservation ;
- Agricultural biodiversity ;
- Knowledge and innovation ;
- Social equity and infrastructure.

In this case, we have refined and led this evaluation in five (5) domains namely:

- Landscape and seascape diversity and ecosystems protection;
- Biodiversity, including agricultural biodiversity ;
- Knowledge and innovation ;
- Governance and social equity ;
- Livelihoods and well-being.

These five domains are distributed into 20 questions found in a sheet[1] (see **Appendix 2**). This exercise was done by assembling the population (men, women, children, employees, traditional authorities) in the chief's canton, quarters, community or any other traditional authority. In Ekondo-Titi, the exercise was carried out in the Masore and Bongongo II villages. In Ngwéi, the Makek and Seppe villages hosted the exercise.

In their codification system ranging from 1 to 5, SEPLs a sheets helped in accessing the landscape vulnerability within 50 years. It also enables to envisage measures and strategies that will enhance sustainable production and increase the growth in the resilience of the said landscape. The resulting interpretations will be complementary to those of the previous methods.

0.4.5. Observations and participative socioeconomic surveys

The above-mentioned investigation methods were complemented by a socio-economic survey with questionnaires in the study sites. This has to do with questions on the identification and characterisation of the exploitations (year of creation, size, source of finance, variety, productivity, commercialisation …) and on how the local population perceive the impact of exploiting oil palm. This six pages questionnaire is presented in **Appendix 3**. The questionnaire was forwarded to families that owned at least one oil palm plantation. As earlier stated, this socio economic survey complement the above-mentioned data and secondary sources from libraries.

[1] *70 SEPLs sheets were printed and 66 used.*

The Ekondo-Titi Council has 26 villages against 29 villages in Ngwéi. Thus, 260 questionnaires were printed for Ekondo-Titi and 290 for Ngwéi. A pluridisciplinary team of eight (8) enumerators was set per district. Using spatial analysis and qualitative and socio-economic survey, we were able to retrace the land use dynamics in this changing context. We can therefore appreciate the qualitative and quantitative loss of biodiversity at the same time with the topology of oil palm plantations (100 sheets per district) all thanks to GPS recordings.

Estimated size of the questionnaire
Number of days for data collection: **10 days**
Questionnaire size: **5 pages**
Number of questionnaires to be administered per village: **10**
Number of surveyors per village per village: **2**
This equal to 25 **x 3 equals to 75 questionnaires** per day per village; **i.e**. **75 x 4 = 300 questionnaires for 4 days per village.**
Ngwéi Subdivision : 29 villages *10 questionnaires = 290 questionnaires
Ekondo-Titi Subdivision : 26 villages * 10 questionnaires = 260 questionnaires

NB This method of sampling opinions is very pertinent given the fact that the villages concerned are not homogenous Data from one village cannot be used for the whole study since all the villages do not have the same realities given the different geographical and socio-cultural specificities in each village.

Administrative organization of the survey
The surveyors in each sub-division, worked under the supervision of the consultant who coordinated all the activities. They were equally trained for two days (4-5 November 2016) before the field trip. During these days, four types of indicators were envisaged (table 6).

Table 6 : impact indicators

Type of indicator	**Effects or impacts**	**Characterization/description of the indicator**
Ecological (pressure)	-forest ; - hydrography and fishing - soils - farming practices –agriculture (crops) - habitat - transportation infrastructure -industry -ecosystems quality	The environmental indicator makes it possible to appreciate how the industrial and village plantations or elites have influenced the state of the environment.
Economic (pressure)	- Economic assessment of environmental impacts - assessment of the population income - the cost of other activities	What are the economic effects that agro-industries have had on populations?
Waste (state)	- amount of waste produced by agro-industries and by village and elite farms - amount of recycled waste - the state of the environment or the impact of waste on water, health, soil, ecosystems	Management of wastes from agro-industries and assessment of policies and measures to control waste production, promotion of recycling, and environmental impacts
Social (responses)	- on human health - education and other social infrastructure - social harmony - on poverty - policies and measures to be established	What can be the social effects arising from the presence of industrial plantations? What policies and measures should be established?

Psychological/perception (responses)	- perception and representation of village plantations and agro-industries by the local populations - the perception of the future	How has the presence of agro-industries influenced the attitudes and aspirations of communities?

This approach helped to understand in a pertinent and transversal manner the different impacts caused by the local, elites, semi-industrial and industrial oil palm plantations on ecosystems and local communities of both districts.

In addition, **nine (9) water samples** were collected in these two sub-divisions (6 in Ekondo-Titi and 3 in Ngwei), so as to analyse and evaluate their degree of contamination and pollution

0.4.6. Specific methods used in environmental impact assessment (EIA).

EIAs include specific methods to be applied in this kind of studies. Before the field trip, an interrelation matrix was established. Thereafter, on the field, an impact statement (**Appendix 4**) was used per receiving environment to record all related observations. This sheet[2] is a prerequisite for a better impacts identification (Table 7) of various activities related to the oil palm exploitation on the various environmental components, including water, soil, fauna, flora, air, settlement, economic activities and other agricultural crops. The scoring or rating method (1 to 5) was used for each impact level of significance. On each sheet, GPS coordinates of the impacts location were recorded. Each sheet also includes mitigation measures and proposals for the environmental and social management plan (ESMP). This ESMP constitutes a dashboard summarizing all the observations made.

Table 7: oil palm plantation interrelation matrix

ACTIVITIES SOURCES of MPACTS	**ENVIRONMENT COMPONENTS**																
	BIOPHYSICAL ENVIRONMENT								**HUMAN ENVIRONMENT**								
	1. Atmosphere	2. Surface water	3. Underground water	4. Soil	5. Natural habitat écosystem	6. Flora	7. Fauna	8. NTFP	9. Employment	10. Conflitcs	11. Local economy	12. Human health	13. Security	14. Noise	15. Odour	16. Cultural heritage	17. Landscape Aesthetics
A. Preparation stage																	
A1. Nursery		X	X	X					X		X	X			X		X
A2. Clearing / deforestation	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
A3. Picketing/Hole digging				X					X		X	X	X		X		
A4. Planting of seedlings		X	X	X	X				X		X	X	X				
B. Operation stage																	
B1. Plant Care		X	X	X	X	X	X	X	X		X	X	X	X			X
B2. FFB harvest						X	X		X		X	X	X	X			
B3. Storage and preparation of nuts													X		X		
B4. Extraction of oil		X	X	X					X	X	X	X	X	X	X		
B5. Packaging and sales									X	X	X				X		

[2] 110 impacts sheets were printed

B6. Waste management	X	X	X	X	X	X	X	X			X	X	X		X		X
C. Plant renewal stage																	
C1. New nursery		X	X	X					X		X	X			X		X
C2. Clearing/ cutting down of old plants	X	X	X	X	X	X	X	X	X		X	X	X	X			X
C3. Picketing /Hole digging, pruning				X					X		X	X	X		X		
C4. Planting of seedlings		X	X	X	X				X		X	X	X				

After this matrix, the following lines will clarify the criteria and method for evaluating impacts.

0.4.6.1. Evaluation of identified impacts

Impacts assessment criteria

A combination of characterization criteria such as nature, occurrence probability, range or extent, magnitude or intensity, reversibility and duration of identified impacts, is necessary in the classification of these impacts. Assessment of identified impacts was done using Gaetan and Raymond (2000) scaling grid. Scores from 1 to 5 were assigned to the indicators, depending on the degree of impact. The absolute importance represents the average of the impacts ratings on the total number of rated indicators.

- **Impact nature**

Nature refers to the exact state of an impact in a given environment. This could either be positive (+) ▲ or negative (-) ▼.

- **Occurrence**

The occurrence or frequency of an impact determines the occurring probability of the impact: (intermittent or occasional characteristic). It is evaluated on a scale from 1 to 5:

- ✓ Rating 1: assigned to impacts very unlikely to occur;
- ✓ Rating 2: assigned to unlikely impacts;
- ✓ Rating 3: assigned to the likely impacts, i.e. which may occur;
- ✓ Rating 4: assigned to impacts that are certain to occur;
- ✓ Rating 5: assigned to impacts very certain to occur.

- **Range**

The impact extent or range is related to the spatial dimension such as length or affected. Surface. It can have a punctual, local or regional dimension. It is also rated from 1 to 5.

- ✓ Rating 1 indicates an impact located within a reduced space likely to affect less than 10% of the locality/village.
- ✓ Rating 2 indicates an impact which is not much developed and likely to affect less than 10% of the locality. That is to say, an impact which occurs only at the level of the area where activities are taking place.
- ✓ Rating 3 indicates an impact that is fairly wide and can affect 25% of the locality concerned by the activity.
- ✓ Rating 4 designates an extended impact which can reach at least 50% of the locality concerned by the activity.
- ✓ Rating of 5 indicates an impact that is very broad and likely to affect an entire region.

- **Magnitude**

This refers to the degree of force or tension of an identified impact, and is graded from 1 to 5.

- ✓ Score 1 indicates an impact of very low intensity.

- ✓ Score 2 indicates an impact of low intensity.
- ✓ Score 3 indicates an impact of a significant or considerable intensity.
- ✓ Score 4 designates an intensely felt impact.
- ✓ Score 5 indicates a very strong impact.

➢ **Duration (time or period)**

This refers to the space of time elapsed by an impact. It refers to the manifestation of the impact. The grading of the duration ranges from 1 to 5. Thus, we have used:

- ✓ Rating 1 to designate an impact of duration which is limited to the duration of the primary activity of the impact;
- ✓ Rating 2 is used to indicate a temporarily or short duration impact that can come to an end with the termination of the impact-source activity;
- ✓ Rating 3 to designate an impact of fairly long duration;
- ✓ Rating 4 to designate an impact that extends sometime after the end of the impact-source activity;
- ✓ Rating 5 rating to designate an impact which last for a long period of time and that can even become permanent despite the end of the activity causing the impact.

➢ **Reversibility**

It represents the characterization of an impact, which can be resorbed, or not by the natural reconstitution of the ecosystem. This indicator is also rated from 1 to 5.

- ✓ Score 1 refers to an impact that stops when the impact source activity stops.
- ✓ Score 2 designates an impact that can be rapidly resorbed according to the environment components, or a naturally and rapidly reversible impact.
- ✓ Score 3 indicates a persistent impact, naturally reversible after a short period of time.
- ✓ Score 4 is an impact that can be resorbed with time; or a persistent and naturally reversible impact, which however requires a considerable period of time or human intervention can accelerate the process.
- ✓ Score 5 indicates an impact that cannot be eliminated regardless of the natural ecosystem replenishment. It is a completely irreversible and persistent impact beyond the project duration.

0.4.6.2. Absolute importance or significance

Absolute importance or significance of impacts is determined by calculating the product of all the scores assigned to each indicator on the total number of indicators. This is illustrated by the following equation :

$$\textbf{Absolute importance} = \frac{\sum \boldsymbol{Scores}(\textbf{intensity x reversibility x magnitude x duration x occurence})}{5}$$

After scoring, the impacts were qualified according to the obtained results.

- Score between [1- 2] represents non-significant or negligible impacts;
- Score between [2.1 – 2.9] represents a minor impacts;
- Score between [3-4] represents significant impacts;
- Score between [4.1 - 5] represents very significant impacts.

The criticality threshold of the impacts is established as the rating value, which is higher than or equal to the average of the grid i.e. 3.

0.4.6.3. Methodology for developing the environmental and social management plan

The purpose of developing the ESMP is to ensure compliance with:

- Measures proposed in the impact assessment, including mitigation or compensation measures;
- Conditions laid down by the Government Decree;
- The expert or consulting bureau undertakings specified in the ministerial authorizations;
- Requirements for relevant laws and regulations.

Table 8 below summarizes the objectives (**SO**), methodology, results (**R**) and deliverables (**D**).

Table 8 : logical framework of activities progress

Objective	Results and findings	Methodology	Type of tools	Activities
SO1. Impact of the development of village, semi-industrial and industrial oil palm plantations on ecosystem fragmentation, forest degradation and deforestation. This requires a land use and changes detection map of these territories following the development of oil palm plantations;	**R1**. The environmental impacts related to oil palm cultivation and it consequences on the forest landscape of Ngwéi and Ekondo-Titi are determined, identified and quantified **D1.** The report establishing the oil palm development impacts on land-use characteristics, ecosystem fragmentation and deforestation should be produced. **D2**. This report includes diachronic evolution maps of the Ngwéi and Ekondo-Titi oil palm landscape and land use, in order to assess the changes in forest cover within the districts	Literature review (PalmForCam report, MINADER sectoral policies report, WWF) Primary and secondary field data collection Oral Source Sample surveys PRA/RRA	Impact sheet Focus group Survey SEPLs exercise Satellite images GPS GIS	**A3. Conception du Masque de saisie.** **A0.Validation meeting of the work plan and methodology with WWF** **A1: Administration of the questionnaire Interviews** **A2. Image Processing** **A3. Design of the input mask**
SO2.Determination, identification and quantification of the environmental impacts of palm oil plantations and their consequences in the Ngwei and Ekondo-Titi landscape at the triple level of the village, conservation areas and the entire sub-division	**R2**.The Comparative analysis of the environmental impacts inherent in village, semi-industrial and industrial oil palm farming in Ngwéi and Ekondo-Titi shows a correlation with ecosystem dynamics and impacts on habitat fragmentation, biodiversity conservation and local community rights **D1**. The report establishing the oil palm development impacts on land-use characteristics, ecosystem fragmentation and deforestation should be produced.	Primary and secondary field data collection Field observations (nature of site and land use) Oral Source Sample survey Historical Profile PRA/RRA	Impact sheet Focus group Survey Exercise SEPL Satellite images GPS GIS Quadras with data sheet transects	**A1: administration of the questionnaire Interviews** **A2. Image Processing** **A3. Data entry under Mask** **A4. Species counting** **AT 5. GIS and Mapping**
SO3.Analysis of negative and positive impacts of village, semi-industrial and industrial oil palm plantations on ecosystems, habitat fragmentation, biodiversity conservation and local communities	**D1**. The report establishing the oil palm development impacts on land-use characteristics, ecosystem fragmentation and deforestation should be produced. **D2**. This report includes maps of the diachronic evolution of the landscape and land use of Ngwéi and Ekondo-Titi in order to assess the changes in forest cover within the districts	Primary and secondary field data collection Field observations (nature of site and land use) Oral Source Sample survey Historical Profile PRA/RRA	Impact sheet Focus group Survey SEPLs exercises Satellite images GPS GIS Quadras with data sheet transects	**A.3 List, matrix and mapping of risk sources with GPS points** **Joint fieldwork with MINEPDED team**
SO4. A proposal on mitigation measures and improvement of the present system of oil palm farming within the landscape	**R3**.Effective measures to mitigate the adverse environmental impacts of oil palm farming and improve the current system in Ngwéi and Ekondo-Titi are proposed. **R4. Organization of a half-day validation workshop**. **D2**. Final report including maps of diachronic evolution of the landscape and land use in Ngwéi	Overlaying maps and graphics	Management plan Land use map	**A6. Validation workshop either R4**

	and Ekondo-Titi allowing to assess the changes in forest cover in the districts			

At the beginning of the third millennium, the oil palm cultivation is at the core of debates both for ecologists known as conservationists and considered as detractors, and for the defenders (known as economists) who see in the oil palm farming a good source of income for the population. To better understand this situation, it is necessary to start from the rapid spatial and commercial expansion of oil palm cultivation over the past three or four decades. Then, analyze the consequences of this expansion as well as the controversies and debates it provokes before leading to the initiatives of all the stakeholders to inscribe this plant in a perspective of sustainable development. The presentation of the results will be done on five (5) major points:

- Biophysical presentation and general situation of the oil palm plantations in both districts;
- Floristic inventory in both localities;
- Presentation of the landscape and its evolution;
- Dynamics of oil palm cultivation based on remote sensing data in the two districts;
- Identification of the inherent impacts in the two municipalities.

1. Biophysical presentation and general situation of palm plantations in the two districts

1.1. The Ekondo-Titi Council

1.1.1. Administrative location

The Ekondo-Titi council was created on 29/06/1977 by a Presidential decree N°77/205 that splits the Ndian council into four new subdivisions (Ekondo-Titi, Mundemba, Bamusso and Isangele). It has a population of about 56,503 inhabitants (RGPH 2005) on 1.750 km² with 15, 703 inhabitants for Ekondo-Titi urban area (figure 2).

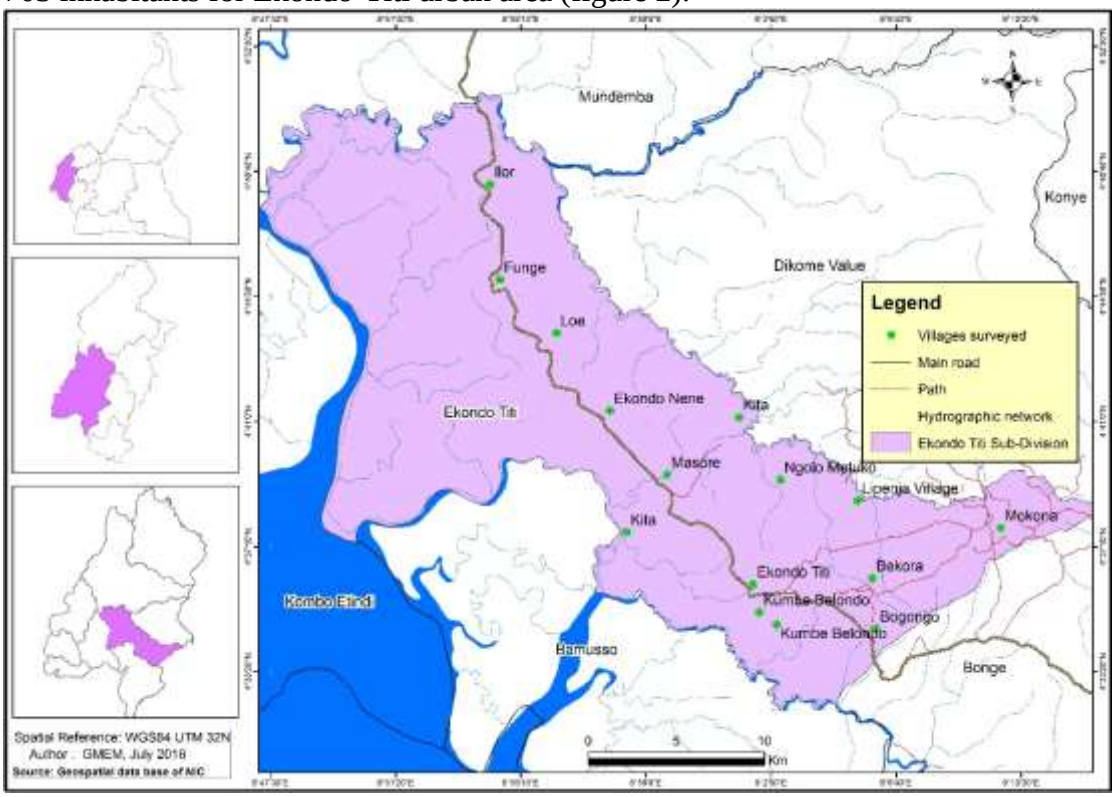


Figure 2 : Ekondo-Titi subdivision

The Ekondo-Titi sub-division comprises the maritime and the main land area. The main land area includes:

- 26 villages (Dibonda, Loe, Illor, Funge, Ekondo-Nene, Masore, Kitta, Nalende, Munyenge, Bisoro, Bafaka, Pondo, Kotto, Kumbe Balue, Ekwe, Njima, Iribanyange, Dora, Mokono, Bekatako, Lipenja, Bongongo I, Bongongo II, Lobe Town, Kumbe Balondo and Berenge), 1 C.D.C workers camp (Beyanga) and
- 3 urban spaces : Ekondo-Titi, Bekora and Lobe Estate.

The maritime area comprises about 19 kombos namely: Eweni, Aruchuku, Aboko, Funge Door mouth, Bakara, Benja, Stone creek, Godgift, Freedom, German Beach, Nyanga, Matutu I, Matutu II, Inesium I, Inesium II, Black Bush I, Black Bush III, Kombo Maria, Rumsa.

Ekondo-Titi council is situated some 56 km from Kumba, the economic headquarters of the South-West Region. It is bounded to the East and Southeast by the Mbonge Council, North-East by Dikome Balue Council, North-West by Mundemba Council, West by Kombo Itindi Council and South by Bamusso subdivision.

Located in the Ndian basin, the Ekondo-Titi district is home to agro-industrial farms of PAMOL and CDC (palm groves, banana and rubber trees). This district is very enclosed, especially during the rainy season, when most unpaved roads serving villages become non-motorized. Built on a lowland coastal plain with mangrove vegetation and Atlantic forest, it has a humid maritime climate (26 ° C annual average temperature for more than 4000 mm of annual rainfall). Its main tourist attractions are beaches devoted to tourism, landscapes of agricultural plantations

(palm plantations in particular) and the rock of Ekondo-Nene. Economic activity relies mainly on agriculture, fisheries and trade, in particular with active coastal trade with Nigeria.

1.1.2. Relief and hydrography

The Ekondo-Titi municipality is sub divided into two distinct biophysical environments. The maritime area which comprises about 19 Kombos (fishing ports) is surrounded by an evergreen mangrove forest ecosystem with a variety of biodiversity (i.e. birds, reptiles, fish and other animal species). This area is accessible through the creeks. However, this enclose territory is highly risky during the raining season due to its swampy nature. Nevertheless, these swamps also serve as a breeding ground for diverse fish species.

Generally, Ekondo-Titi continental area is made of lowlands belonging to the Ndian Basin. However, the range of Rumpi Hills with an altitude of 1764m above sea level stretch to part of Ekondo-Titi Sub Division, precisely in the Balue area (Bisoro, Bafaka, Kotto, Munyenge) and constitute the highlands (1000 m) of the Ekondo-Titi Council area.

With respect to hydrographical network, the Rumpi Hills constitutes the main catchment area from which the River Meme, Ndian, and Ma'a (which are the main rivers in the Sub Division) take their rise and flow into the Atlantic Ocean. These rivers increase in volumes in the rainy season and reduce in the dry season. The whole Ekondo-Titi zone constitutes essentially an amphibious feature characterized by an abundant and ramified hydrography. The hydrological conditions are relatively stable: mass of surface water hot all year (25 - 28°C); the salinity is moderate and always less than 35 ‰ because of the heavy rainfall that reduces it in the estuaries where it rarely reaches 20 ‰. The tide has a semi-diurnal regime with amplitudes that can reach 3 m.

1.1.3. Climate, vegetation and soils

Climate

Ekondo-Titi, as well as the entire Ndian Division has a monsoon equatorial maritime climate, (with 4000 mm of annual rainfall). The Climate is characterized by two seasons: rainy and dry. Maximum rainfall occurs between July and October when the South West Monsoon winds or the Westerly's are strongest (with 800 mm of monthly rainfall) and minimum between December and January when the North east trade winds or harmattan are dominant. Temperatures are uniformly high, mean annual being about 26˚C; it reduces by altitude to 16 or 20˚C towards the villages closed to the Rumpi Hills.

The climate of this council is thus influenced by the proximity of the Atlantic Ocean and Mount Cameroon on the one hand, and on the other hand by the meteorological equator where the Azores anticyclone converge from the northern hemisphere and that of Saint Helena coming from the south. This climate belongs to the equatorial coastal domain or "Cameroonian" type which is characterized by two seasons with a long rainy season (March to November) which can totally erase the dry season always punctuated by rain. This short dry season appears in several localities as a simple slowdown of rains. The average annual rainfall is around 5000 mm per year and the annual number of rainy days is always above 250. The temperatures are relatively high and constant (annual average: 26°C, annual thermal amplitude <3°C ; figure 3). Morning mists are persistent. The insolation is low and the humidity remains constantly high.

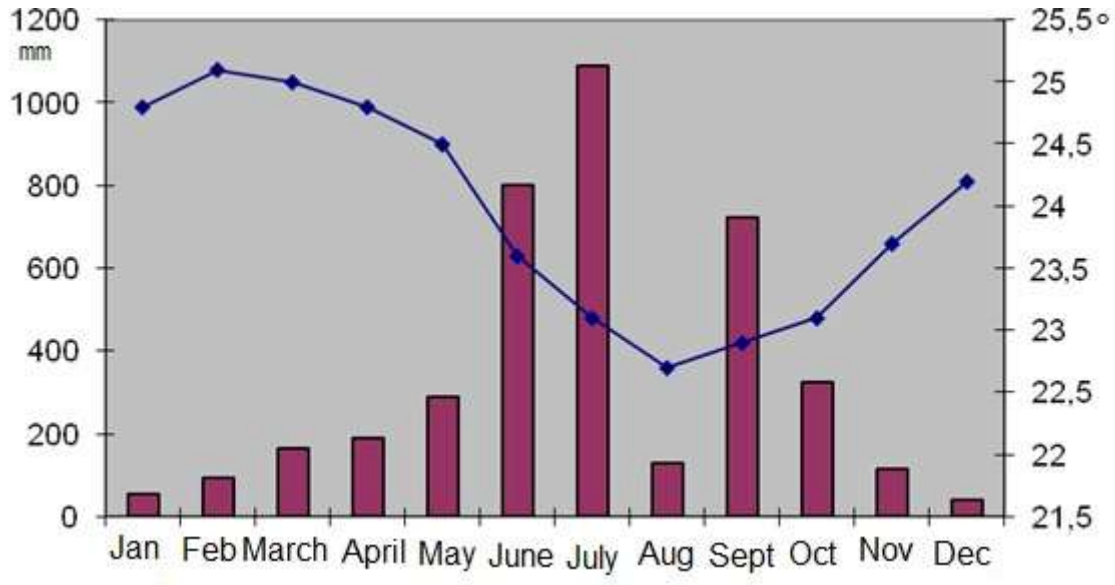


Figure 3: Ombrothermal diagram of Ekondo-Titi.

Vegetation

Requisite climatic conditions and relief gives the sub-division from the Atlantic coast, a mangrove swamp forest, an equatorial evergreen forest up to the foot of the Rumpi Hills and an Afro-Montana forest on the Rumpi hills where patches of Savannah also exist. Thus, Ekondo-Titi has many plant and animal resources including a mangrove forest, an Atlantic forest and large agro-industrial palm oil plantations. Ekondo-Titi, like the Ndian Department, is one of the main oil palm producing areas in Cameroon.

Climatic and topographic conditions allow diversified vegetation from the mangroves on the coast to the Afro-montane forest at the Rumpi Mountains, passing by the evergreen Atlantic forest at the foot of the Rumpi Hills (Figure 4). The vegetation is quite rich in biodiversity with tropical species of economic importance including hard wood like *Iroko, sapelle, mahogany*, mangrove etc, and a wide variety of NTFPs. However, this forest and biodiversity is alarmingly degrading by oil palm small holders and agro-industries like PAMOL and CDC, unsustainable illegal logging, subsistence and cash crop agriculture as well as poaching for bush meat.

The western part of Ekondo-Titi is mainly covered by mangrove vegetation (mangrove forest), characterized by the abundance of *Rhizophora racemosa* (red mangrove), *Avicennia* (white mangrove), which is often well developed along large channels, particularly on the convex banks of numerous meanders that twist in a network of creeks. There are several vegetation units surrounded by water and emerged sedimentation areas, including:

- open forest with *Avicennia* and *Phoenix*;
- high dense forest dominated by *Avicennia* and *Rhizophora;*
- riparian forest of large river *Rhizophora* ;
- periodically flooded forest with Arecaceae and *Guibourtia*;
- exceptionally floodable dryland forest with *Elaeis* plantations;
- degraded mangroves with *Rhizophora* stunted and deformed *Pandanus* habit;
- shrub mangrove with alternately *Dalbergia, Drepanocarpus and Hibiscus*;
- Herbaceous mangrove with *Acrostichum* that sometimes accompanies *Ormocarpum*.

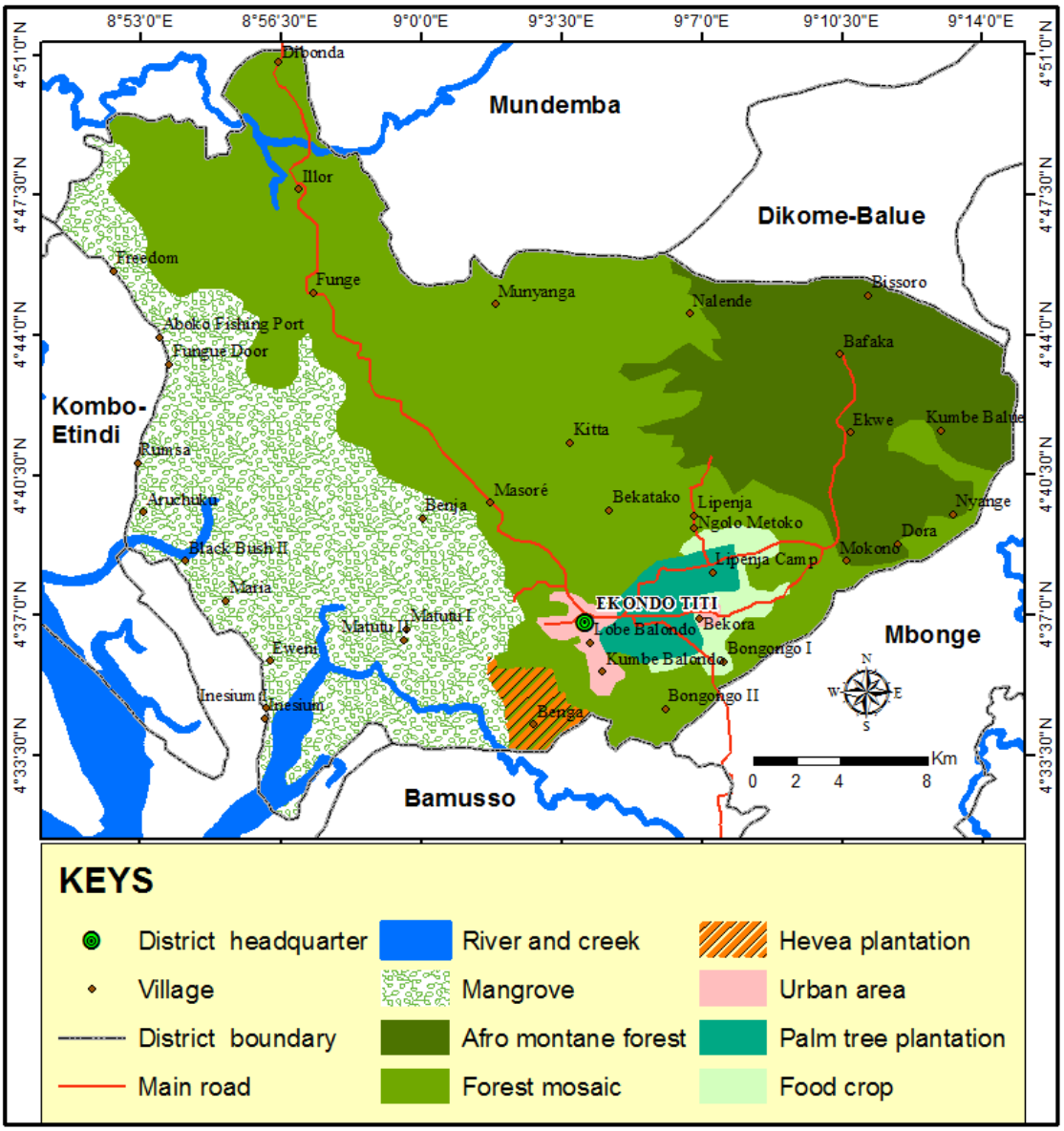


Figure 4 : The Ekondo-Titi vegetation

This mangrove after Din (1995, 1997), then, Din & Blasco (1998) is much diversified in terms of flora and fauna. There are 6 native species: Rhizophora *racemosa, Rhizophora harrisonii, Rhizophora mangle* (Rhizophoraceae), *Avicennia germinans* (Avicenniaceae), *Lagunculacia racemosa*, *Conocarpus erectus* (Combretacae) One can add an introduced species, Nypa fruticans (Aracaeus).

The coastal forest, (a variant of the Biafran forest), is a dense lowland moist evergreen forest with *Saccoglottis gabonensis* and *Lophira alata* (Letouzey, 1985). The flora is rich and varied, there are more than thirty commercial species such as moabi (*Baillonella toxisperma*), azobe (*Lophira alata*), bubinga (*Nauclea diderrichi*), iroko (*Chlorophora excelsa*), Bidou (*Saccoglotis gabonensis*), etc. Fruit trees (mango, pear, plum, guava, orange, grape, apple etc.) are common in the Ekondo -Titi villages.

Fauna

The Ekondo-Titi municipality is endowed with a forest composed of a rich variety of fauna. It also possesses a mangrove forest and creek which are breeding sites and habitat of diverse fish

and other aquatic species. Domestic animals: cattle, cat, dog goat, sheep, fowls, pig; are common in the villages.

The fauna composition is very diverse. Aquatic fauna includes mammals, molluscs, crustaceans, fish, etc. Among the leading species are manatees, crocodiles, tilapias, sea turtles, shad, etc. The terrestrial fauna is full of mammals (forest elephants, chimpanzees, gorillas, monkeys, pangolins, etc.), reptiles (vipers, lizards, pythons, etc.) and avifauna particularly rich with water birds species (Hartlaub duck, hornbills, grey parrots, hawks, etc.). In order to avoid uncontrolled exploitation of flora and fauna, a few protected areas have been established in the Ndian region, including Korup National Park and the Rumpi Hills Forest Reserve. However, the mangrove and its creeks are a spawning area and an important habitat for fish and other aquatic species. There are a variety of domestic animals (cattle, goats, sheep, poultry and pigs).

Soils

The distribution of soil types in the Ekondo-Titi area is related to the local vegetation, relief and climate. There are basically three distinct soil types in the Council: dark brown alluvial soils (Bekora up to Bisoro), lateritic soils (Masore up to Dibonda), silty alluvium (Kumbe Balondo, part of Lobe Town and the maritime villages), which are subject to seasonal flooding especially in the lowland villages. The hilly area of Rumpi Hills is a dissected plateau of old volcanic rocks with a lot of folded sedimentary belts. This soil type is very good for plantation agriculture especially oil palm and cocoa. The soils of this environment make it possible to produce a variety of food crops (cassava, yam, cocoyam, plantain, maize, melon, pineapple) and rent crops (cocoa, coffee, banana, rubber, palm oil).

1.1.4. History of the settlement

The people of the Ekondo-Titi Council area are part of the Balondo, Balue and Barombi tribes. Their vernacular languages are *Oroko* (Balondo & Balue) and *Abo* (Barombi). A total of 29 chiefdoms exist in the municipality, 28 of which are third-class degree chiefdoms and only Ekondo-Titi has second-class degree chiefdom

The Balondo and Balue are generally referred to as the Orokos of the Coast or North-West Bantus. Like all Bantus, they claim to have migrated from the North or Upper Nile to the South East (Ubangi Shari) due to climate changes or Sahara desertification as well as the Arab raids. From the South-East, they moved westwards through Congo Basin, and then Southwards, pushed by the Fulani jihads of Usman Danfodio to occupy their present site in the 18th and 19th centuries. These people have powerful *juju* societies. They practice ancestral worship and believe in mystery and destiny. They are also tolerant, receptive and open to the outside world. The Barombi people migrated from Abo clan in the littoral region to the present site. Each of all these three tribes have the same type of traditional rite and cultural heritage. With the evolution of the modern administrative structures, traditional councils have been created in addition to what is reflected. They are answerable directly to the chief of the village.

There are also immigrants who have migrated to settle in these areas which include; Nigerians, Ghanians, Bakweries and the North Westerners who engage in agriculture, fishing and other income generating activities including the civil service. The Oroko ethnic groups are concentrated in the main land (continental) area while the maritime zones are mostly populated by the Nigerians.

The culture of this municipality is portrayed through their music, dressing, housing, craft and food (dishes). A wide musical variety exists in the area with *Ekpe* and *Merengue* (General *Orocko* dance group), *Ambekoko* (Balue dance), *Jokki* (Balondo dance). Dressing in this area is common to the entire South-West Region of Cameroon as well as to the Sawa people of the

Littoral Region. These dresses are worn mostly in traditional occasions. The common craftwork found in the area include special baskets weaved and floor mats. These baskets are used in carrying load. Traditional dishes include plantain, *ekpang*, *akpana* etc.

Religion

Christianity is the predominant religion in Ekondo Titi Municipality, constituting about 85% of the population. The Christians are made up of different denominations which are Presbyterians (50%) and Catholics (20%) followed by New Christian Religious Movements like Apostolic (15%) and Full Gospel (5%), Jehovah's witnesses (3%) and « Deeper life » (2%). Proximity of the council to the Federal Republic of Nigeria has facilitated the influx of those Christian renewal movements. Nevertheless, there are also traditionalists who adhere to '*juju*' the shrine worship and Muslims, who constitutes about 5% of the population.

Demography

The rural population is larger (83%) and therefore the levels of schooling and literacy in the region are low. This is linked to the inadequacy of schools, teachers and teaching materials in many villages. The population of the region is relatively young, as 35% of the population is under 20 years of age. The age pyramid of the entire South-West Region is rather suggestive of this situation (Figure 5)

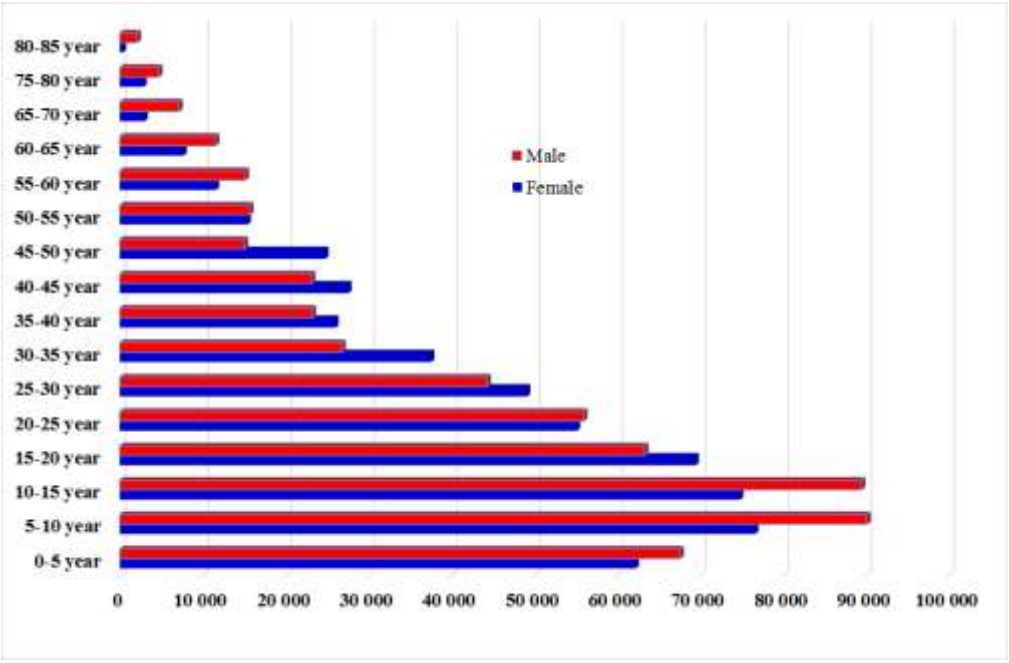


Figure 5: Age pyramid of the South-West Region (Source: RAMPAR 1996).

Ekondo-Titi municipality has an estimated total population of 54,096 (head counts, field survey, 2011) inhabitants and a total surface area of 1,750 km², giving a population density of 31 persons per km². Assuming a national annual population growth rate of 3%, it is projected to be 91,422 inhabitants by 2035.

The increase in population is partly due to the presence of the agro-industry (PAMOL) and increase in food production resulting from the economic growth, improvement in health care facilities, increase in educational infrastructure, and immigration.

There is an influx of population especially in the maritime area (creeks) related to the increased fishing activities of Nigerians and Ghanaians of the Ekondo-Titi coast. In the mainland area, the population increase is partly due to the presence of the giant PAMOL and CDC plantations. Another factor which might have led to a rapid increase of Ekondo-Titi town population might have been the creation of the military Battalion. Because their families and other people also

have come to take advantage of the consequent improvement in the business potentials of the town.

1.1.5. Infrastructures and other activities

Ecotourism

There are two destinations conducive to the development of ecotourism in the municipality of Ekondo-Titi namely Korup National Park, located 12 km from the Mundemba town (with 400 species of trees, 174 reptile species, 140 fish species, 327 species birds and 525 types of mammals); the Rumpi Mountains Forest Reserve at Dikome. We must also consider the ascent of Mount Rumpi (1764m) which, in Dikome, offers a spectacular view of a particular environment to be discovered. In addition, the entire South-West Region is an important ornithological site.

Thus ecotourism could be devoted to the vision of the creeks and the lifestyles of the population of these malarious zones. The same applies to the watching of the natural habitats of marine animals with the construction of watchtowers. The development of the culture of the peoples inhabiting these fisheries, including the festival of the *Ekpe* society (whose culture extends to Calabar in Nigeria), can also be envisaged. Outside the department of Ndian (Ekondo-Titi), this culture, is also well known in the department of the Manyu and the Meme. Therefore, it is necessary to envisage a broad tourism that should be extended to the exploitation of these potentialities with the aim of developing an integrated tourism offering diversified circuits. In addition to Korup National Park and the Rumpi Hills, this vision opens to Lake Kotto Barombi and Ekombe Falls in Bamusso.

Agro-tourism

The South-West Region is a large agricultural development zone, including PAMOL plantations that cover the whole Ndian basin (photos 15 a & b) and occupy more than 75% of the area and the Useful Agricultural Area (UAA) of the division. These offer beautiful tourist prospects including in the main cities of Ndian: Mundemba and Ekondo-Titi etc. The PAMOL plantations of Lobe in Ekondo-Titi (and even those of the CDC) and Ikassa (photos 4a-c) with their oil mills can motivate the visits of tourist looking for the discovery of the processing channels of these basic products and their sustainable production chain.

Photos 4 a & b : *PAMOL oil palm plantation at Ikassa (Mundemba) and freshly harvested fresh fruit bunches.*

Basic socio economic infrastructures

The basic socio economic infrastructures of the municipality include: four (4) health centers created by the government; plantations of CDC, PAMOL and other small holders; 50 primary schools, (public 36, missionary 8, lay private 6) and 16 secondary schools (11 Government, 1

missionary, 4 Lay Private); four types of financial institutions namely: Lobe Credit Union, Express Union, FIFFA and MC2 Bank. Maritime transportation is a very commercial activity realize with large sea engine boats. There is just one constructed market (Ekondo-Titi). Four (4) villages are connected to ENEO electrification scheme, 2 communities have pipe borne water, 2 functional boreholes and 15 good wells are found in the municipality.

Maritime transportation at Ekondo-Titi

The carriers leave from Ekondo-Titi to Ikang in Nigeria. Their boats carry non timber forest products such as *Eru* or *Gnetum africanum*, *bitter kola*, but also palm oil. In return, they bring back manufactured products (plastics, electronic equipment, and kitchen utensils), onion and yam.

1.2. The Ngwéi council

1.2.1. Administrative situation

The Ngwéi council was created by Decree N ° 2007/11 of 24 April 2007 establishing the councils. It is located in the department of Sanaga Maritime, Littoral Region. It is situated at 90 km from Douala and 170 km from Yaoundé. Pouma, Edéa 1st and Messondo are bordering councils (Figure 6). The Ngwéi District covers an area of approximately 500 km². The subdivision office is located at Makondo which represents the center of the Subdivision.

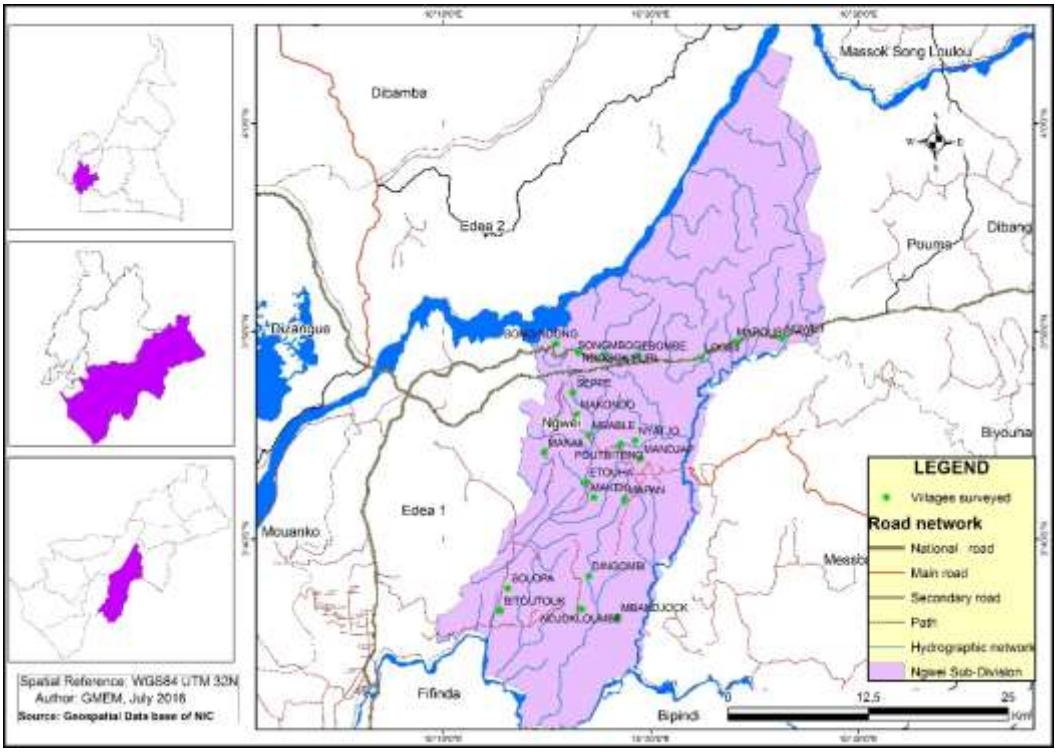


Figure 6 : The Ngwéi subdivision

1.2.2. Biophysical environment (relief, hydrography, vegetation, soil and climate)

The relief is represented by the inner plain bordering the rivers Sanaga and Nyong as well as low plateaus. Ngwéi is located in an area of low plateaux that follow the plain and which rise in steps towards the interior with an altitude of 100 to 300 m. The boundary of these plateaus passes through Kopongo and Song-Ndong as well as the confluence of Kellé and Nyong.

The soils of this council are like those of the Sanaga Maritime division, with 85% ferralitic yellow sandy structure, a low capacity of water retention, especially around the sedimentary basin of Douala. These soils have best physical properties: depth, water retention, fertility, etc.

The hydrographic network is rather dense and intertwined due to both moisture and impermeability of the crystalline rock basement. The Ngwéi district is bordered by the Sanaga (North) and Nyong (South) rivers and their tributaries including the Lep Nyock (Sanaga), Ngwéi and Kellé rivers (Nyong, Figure 7). These rivers are also cut off from rapids and falls, making them little navigable somehow.

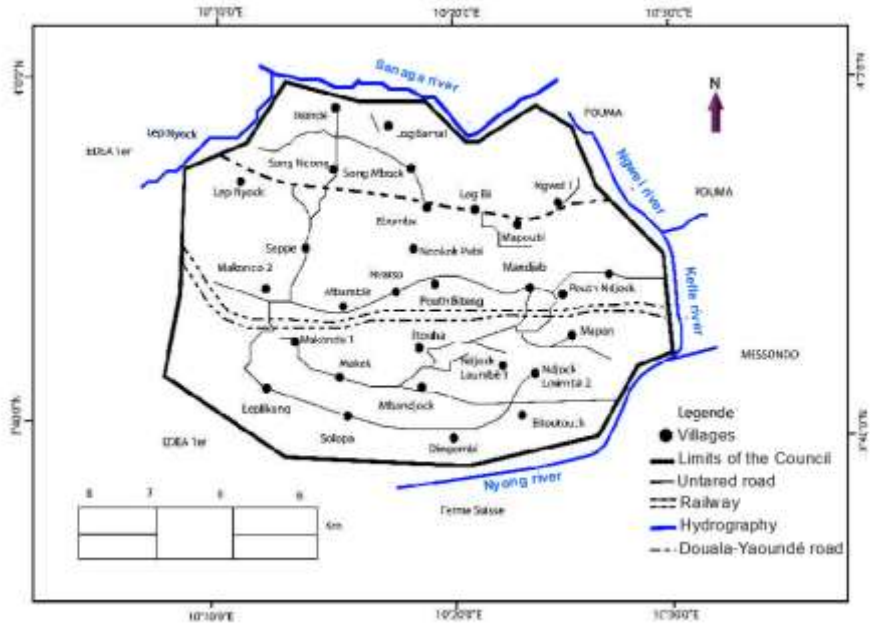


Figure 7 : Participatory schematic map of the Ngwéi district

The Ngwéi climate belongs to the maritime equatorial type with two seasons: a dry season that lasts from November to March and a rainy season from April to October. The maximum rainfall occurred in July and August. On the other hand, December and January months are less rainy (Figure 8). The sea monsoon accounts for high rainfall (nearly 3000 mm annually). Temperatures are relatively high with an average of 27 ° C and thermal amplitudes ranging from 3 ° to 4 ° C. Relatively high humidity ranges from 80% to 90% in the rainy season and 50 to 60% in the dry season All these climatic characteristics give this district of Ngwéi many assets for the development of agricultural activities in particular, allowing diversification of productions, spatial distribution and specialization of the crops.

At the topographical level, the Ngwéi lands have a gentle sloping structure favourable to the development of the oil palm. Indeed, oil palm is adapted on flat soils with slopes less than 12°. These conditions explain the location of the industrial palm plantations (SAFACAM, Ferme Suisse and SOCAPALM) nearby Ngwéi.

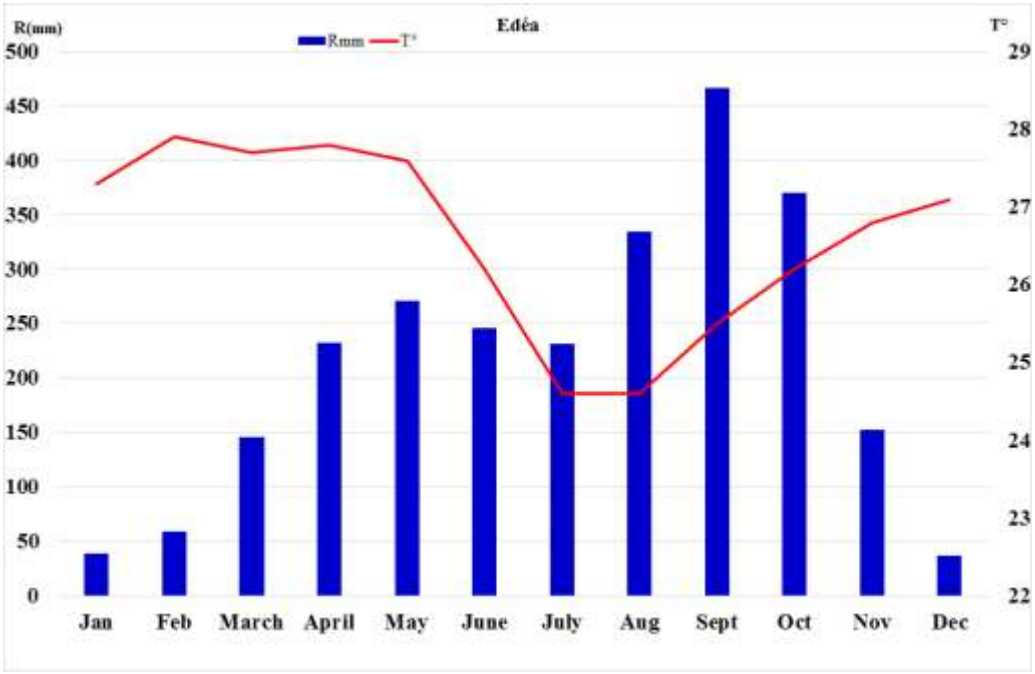


Figure 8 : Edéa ombrothermal diagram representative of Ngwéi

The vegetation consists of an evergreen rainforest. The low-lying coastal forest follows the mangrove and extends over a radius of 50 to 100 km from the coast. *Lophira alata* is the dominant specie here. Inland and up to 100-150 km, lies the dense and humid Biafran forest of low and medium altitude. This forest is now being attacked and progressively replaced on a large scale by agro-industrial plantations (oil palm, rubber and cocoa). The Ngwéi forest is characterized by very valuable species, whose exploitation could offer the Council enormous inputs in terms of municipal revenues. One could also envisage the multiplication of community forests in all the villages.

1.2.3. Demography

The population of the Ngwéi district is estimated at nearly 15,000 inhabitants (30 inhbts / km²) with two main ethnic groups: the Bassa and Mpo'o. To this must be added a few foreigners, including North-West (Bamenda) nationals who work in the palm groves and northerners (Far-North) who take care of the palm plantations of certain elites such as Ngué Martial (800 ha). In general, the local populations coming from this Council are very dynamic, because Edéa and Douala cities owe them a large part of their food supply products. The Council is also endowed with a very strong external elite just as dynamic. In addition, the idea of setting up a strong cooperative in the area is underway.

1.2.4. Activities and socioeconomic infrastructures

Economic activities

Agriculture represents the dominant economic activity of the Ngwéi district, with a preponderance of oil palm, followed by cocoa and plantain. These three crops are mostly controlled by men. Food crops (cassava, cocoyam, peanut, maize, taro ...), vegetable crops (okra, tomato, pepper ...) are mainly practiced by women. The artisanal fisheries practiced here by indigenous men, women and young people, is mainly oriented to domestic consumption. The so-called more popular fishing is practiced by the foreigners along the Sanaga River. Small businesses (catering, small food trade, etc.) are practiced by women and young people. Transport (car, motorcycle) is young people favourite activity.

Ngwéi in Sanaga Maritime, holds the largest number of elite plantations (over 100 ha) apart from industrial plantations, community forests and FMUs. In addition, this district houses a

large plantation (241 ha) that once belonged to SOCAPALM. SOCAPALM has for some years retroceded the right of exploitation to the local community especially the populations of Song-Dong village under the supervision of the subdivision officer which collects annually a lease right for the financing of community development projects. Moreover, local populations and external elites have also created palm groves of varying size. Finally, it is worth noticing that several programs aiming at developing agriculture have provided important support to these populations.

Located on the coastal plain and bordered by the Sanaga, this municipality has as a touristic attraction, palm groves for agro-tourism and the Douala-Edéa protected area. The main economic activity here is food crops and industrial agriculture, including palm groves. Nevertheless, there are many other touristic sites that just need to be valued: rocks, lakes and hills.

Socio-economic and educational infrastructures

The Ngwéi municipality has several socio-educational infrastructures, particularly in the education and health sectors.

In terms of accessibility and communications, we can mention:

- An existing railway network with a railway station in Makondo which only needs to be upgraded;
- A road axis Yaoundé -Douala (Makondo is inaccessible during the rainy season);
- A network of road trails though most of them are impracticable during the rainy season;
- The telephone networks MTN and Orange insufficient and non-existent in most villages.

For drinking water and electricity:

- 22 water wells, 35 undeveloped springs; 45 public and private drilling; 3 Scan water and 1 water tower. Unfortunately, 55% of villages do not have a single drinking water point ;
- 17 partially electrified villages;
- 6 integrated health centers lacking adequate means for the proper follow-up of the patients.

One can conclude that the economy of these two districts (Ekondo-Titi and Ngwéi) is mainly based on the primary sector dominated by agro-industries, the small holder and elitist low yields oil palm plantations. Food crops (cassava, cocoyam and banana-plantain) are mainly grown for subsistence and the vast areas occupied by oil palm plantations, cocoa plantations and commercial foodstuffs threaten food security.

However, despite the strong development of agriculture in these two districts, the following problems can be noted:

- Declining of the agricultural productivity and yields;
- Water-borne diseases: malaria, diarrhoea and even cholera;
- Food insecurity;
- Increasing poverty;
- Decreased water quality and lack of drinking water;
- Increased deforestation and fragmentation of ecosystems.

1.3. Palm trees and palm oil production in the Ngwéi and Ekondo-Titi districts

The quantitative data collected during the surveys were subjected to two complementary treatments. The 6 pages of survey were entered under EXCEL mask and then processed under XL STAT. This allowed us to obtain graphs corresponding to the observations made. The oil palm plantations synthesis sheets with their GPS waypoints were entered under EXCEL, which

allowed the discrimination of the oil palm plantation typology with 9 classes (Figures 9 and 10).

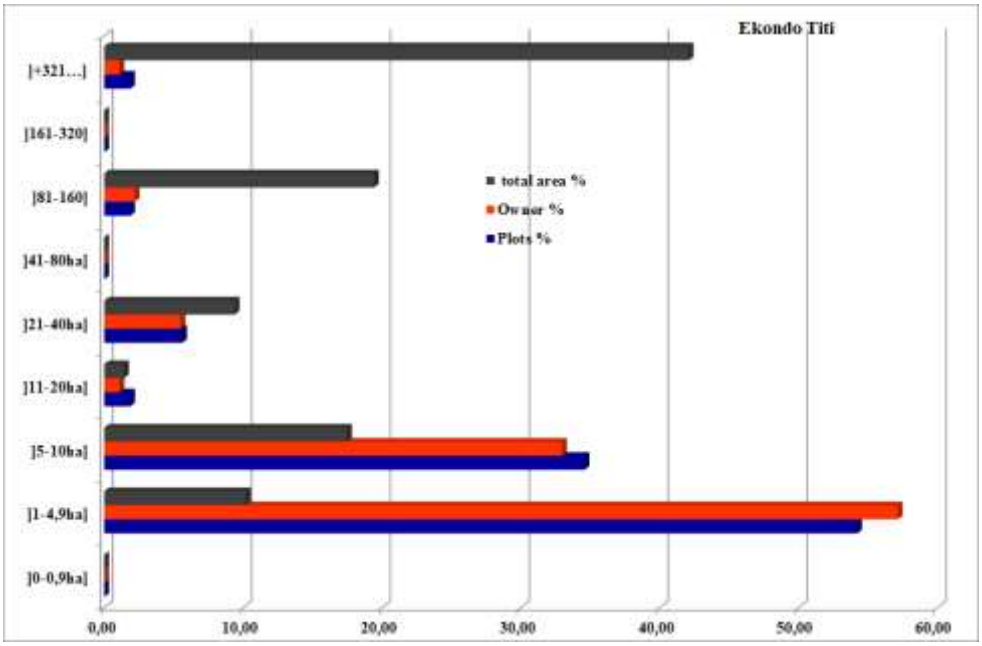


Figure 9 : Oil palm plantation classes in Ekondo-Titi

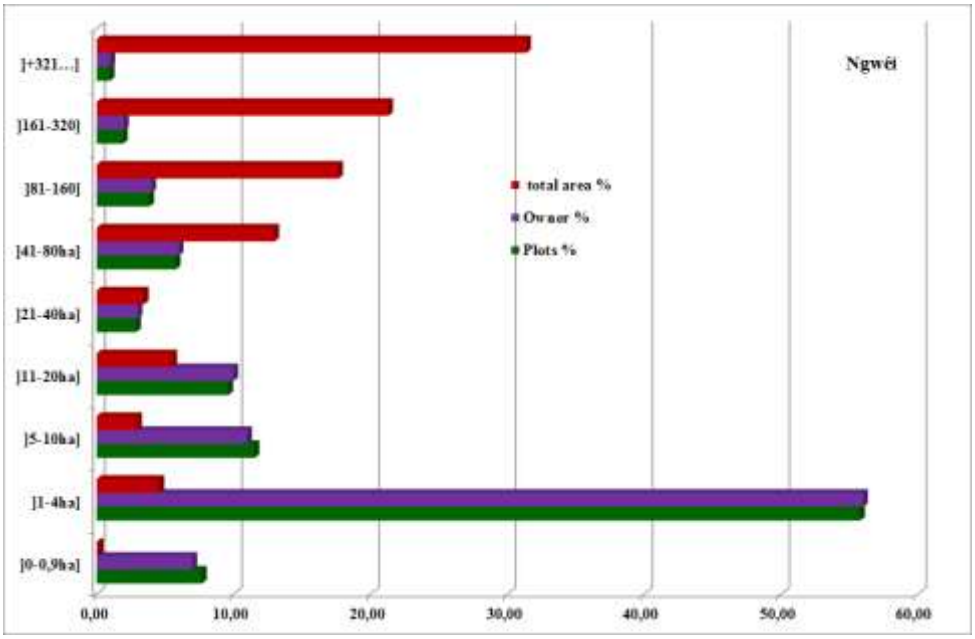
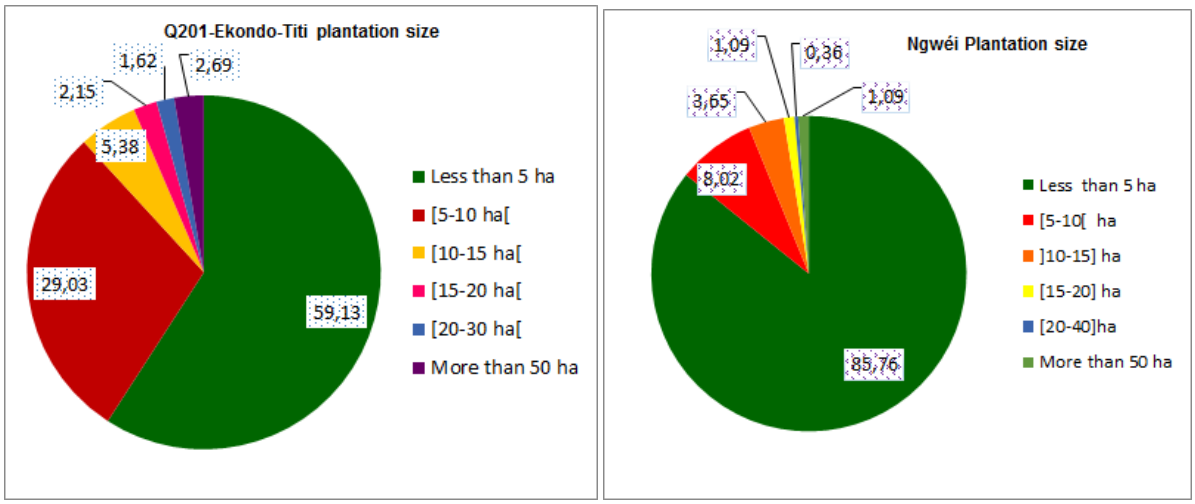


Figure 10 : Oil palm plantation classes in Ngwéi

Smallholders and small oil palm plantations (village plantations) are more numerous in the 1-4ha class. However, they cover only 10 to 15% of the total area, while elite holders (20- + 320ha) are small in number, but occupy more than 70% (Ekondo-Titi) to 80% (Ngwéi) of the total area of village and elitist palm groves. The high number of these small owners leads to a significant fragmentation of the forest ecosystem and consequently its rapid degradation. We are then witnessing a real atomization of space, increasing the pressure on forest ecosystems. Therefore, the grouping of these small landowners would be a good start in the fight against massive and wild deforestation related to oil palm farming. Moreover, detailed surveys show that palm plantations less than 5ha (***Q201b-What is the size of your oil palm plantation***) account for 59.13% in Ekondo-Titi vs. 85.76% in Ngwéi (**Figure 11a & b**).



Figures 11a &b: Size of the palm plantations in the two districts

The statistical processing of these records also yielded interesting results by district in terms of palm plantations evolution graphs in the two councils (**Figures 12 and 13**). These graphs show that the establishment of village and elitist oil palm plantations, which began timidly, has been subsequently intensified for both small and large producers.

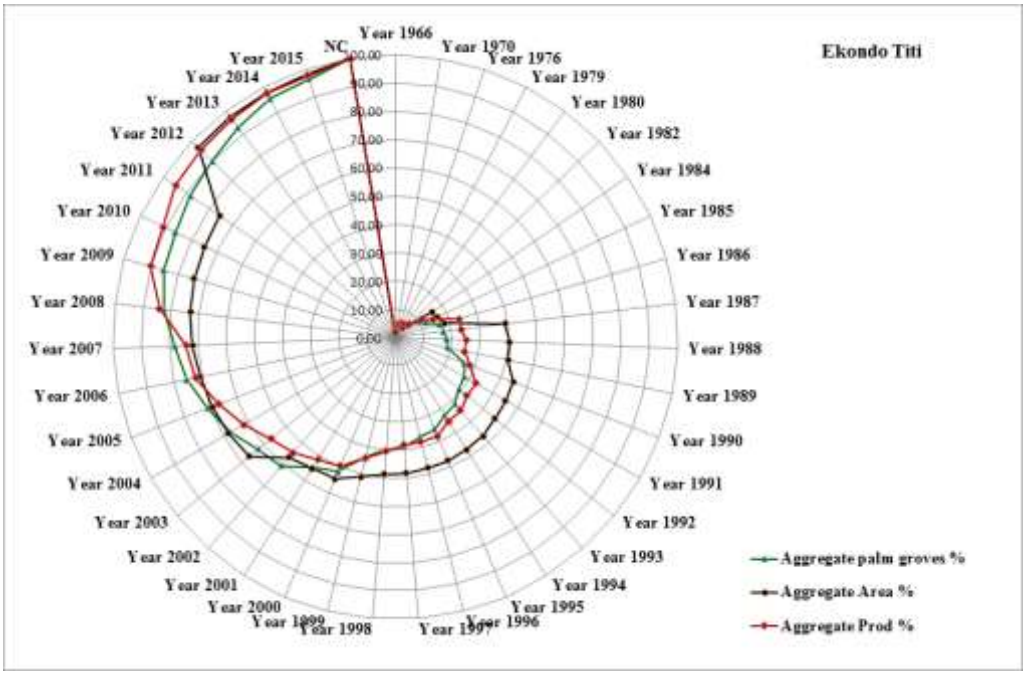


Figure 12: Cumulative evolution of production and area of palm plantations in Ekondo-Titi

One can notice that oil palm village farming began timidly in 1966 and was somewhat stagnant until 1987. The areas will increase until 2000, when the elites enter the competition and the 50% mark is reached in terms of area and production. In 2008, the production went above the area and the total of palm plantation until today.

On the Ngwéi side, things seem to be slightly different. After a very slow start in 1995 (with an average production of oil palm plantations between 30 and 35%), the current increase began in 1996 with a real atomization of space (more than 60% of areas against 40 to 50 % of palm groves and production). The year 2002 marks a major turning point with the boom in the oil palm land (89%), which will only see production correlated to it in 2010 (Figure 11b). The

atomization of space is more important in Ngwéi and is a real concern with regard to forest resources conservation. Also, there is no immediate correlation between the exploited areas and productions.

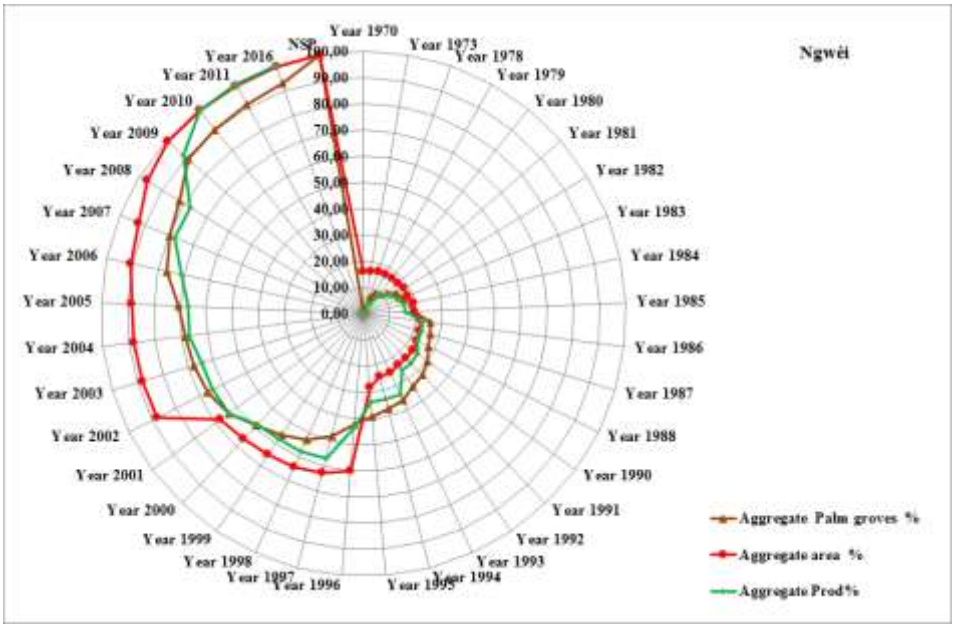
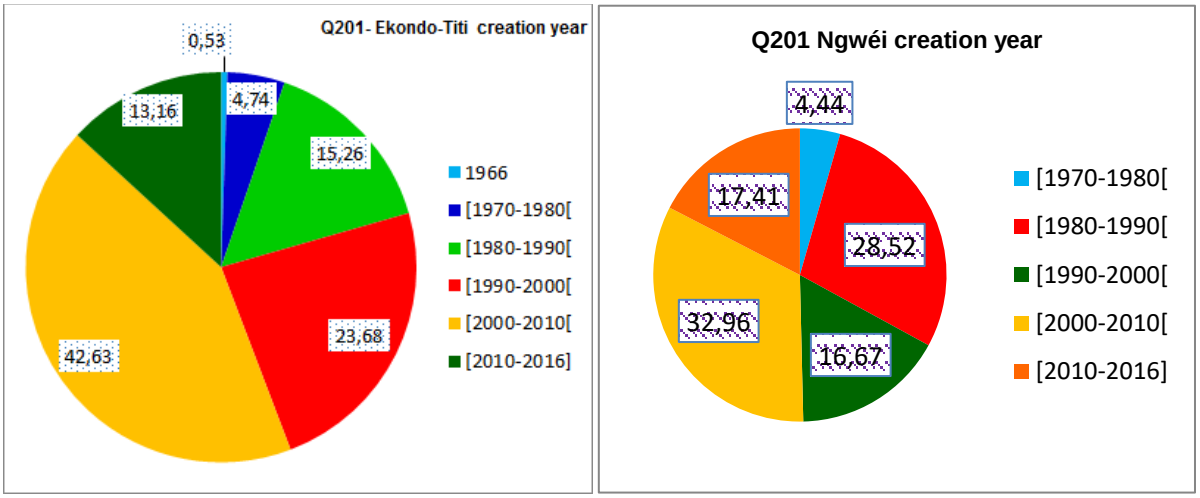


Figure 13 : **Cumulative evolution of production and area of palm plantations in Ngwéi.**

The question of the year of creation of the palm plantation came back in socio-economic surveys (***Q201a – Which year this oil palm plantation was created?***). The answers given made it possible to develop graphs that group together the implementation of palm groves by decade. In both cases, the decade 2000-2010 (Figures 14a and b) is the most important in terms of the creation of palm groves



Figures 14 a &b : Creation of palm plantations per decade in the two municipalities.

If Ekondo-Titi has spent two decades (1990-2000 & 2000-2010) creating palm groves, which account alone for at least 2/3 (i.e. 66.31%) of the total palm plantations created, in the Ngwéi council, the two decades are 1980-1990 & 2000-2010 with an aggregate of 61.48% of total palm groves created.

Moreover, even if all the actors have not declared their oil productions, there is no strong correlation between the palm oil production and the areas allocated. In the Ekondo-Titi district,

four villages (Figures 15 and 16) stand out: Kitta Balue and Bongongo 1 (13-20% of the production and area), Ekwe (over 20% of the area) and Bekora (more than 15% of the area and production).

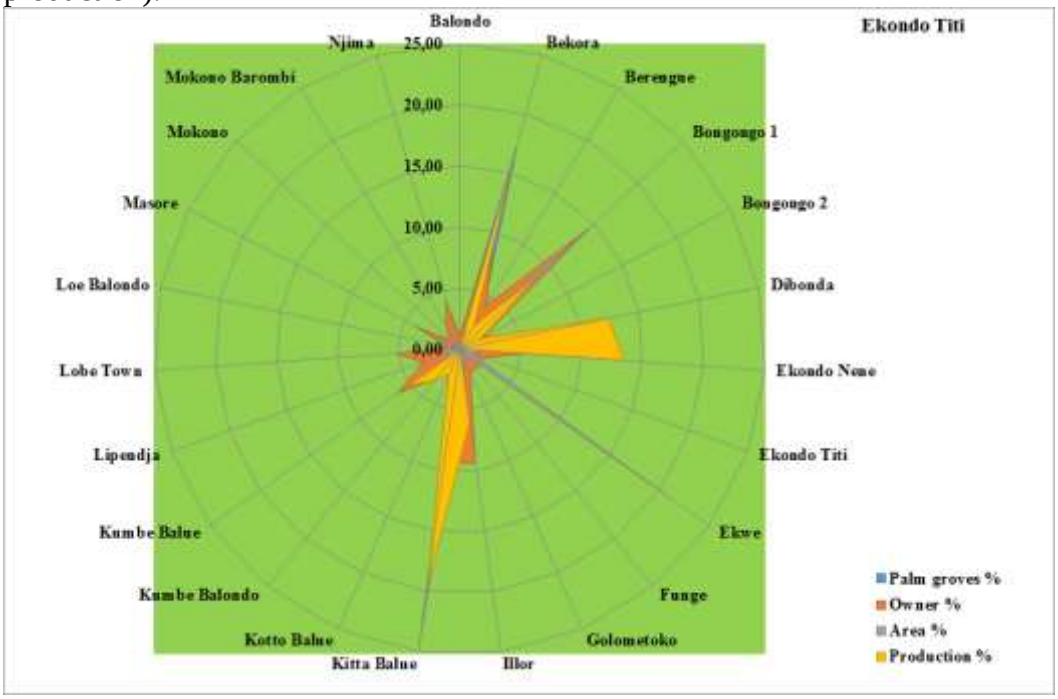


Figure 15: Correlation between area, owner and production in the Ekondo-Titi villages.

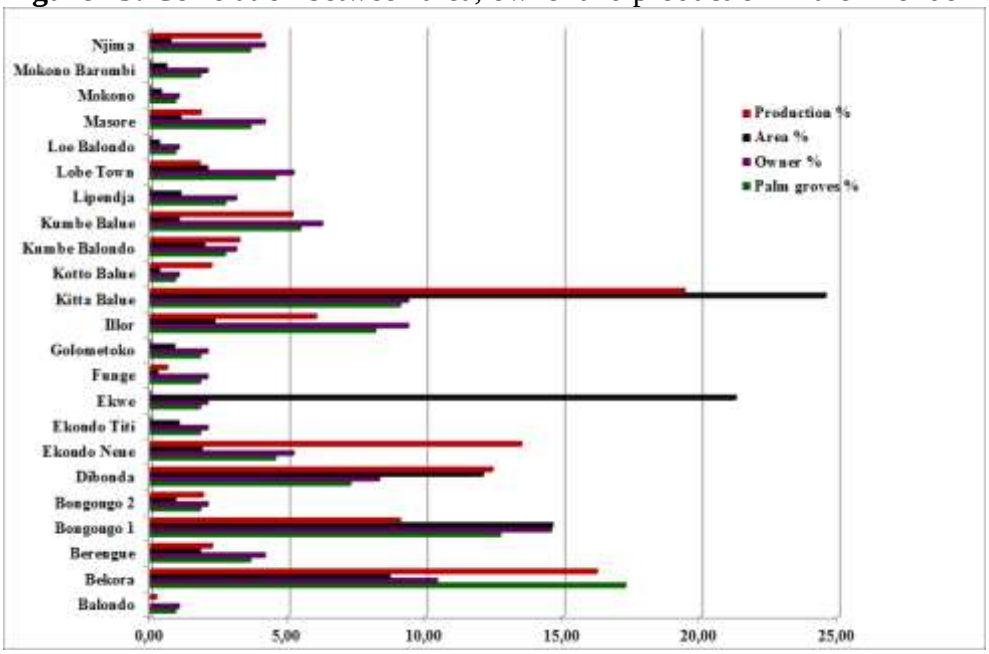


Figure 16: Correlation between area, producers and production in the Ekondo-Titi villages.

The biggest villages in terms of production are Kitta Balue (nearly 20%), Bekora (15 to 17%), Ekondo Nene and Dibonda (more than 13%).

In Ngwéi subdivision, three villages stand out from the rest in terms of area: Njock Loumbe that is Mr Ngué Martial stronghold, which holds 800 ha of palm groves, i.e. more than 30% of the area of elitist and village palm plantations, Makondo II (more than 15%), center and chief town of the district and Ikonde (more than 10%, site of former SOCAPALM plantations).

As far as palm oil production is concerned (Figures 17 and 18), Makek is the leading village with more than 30% of the total production of the area, followed by Mbamblè (17%) and Ngwéi

I (13%). It is true that the mill factory established by M. Ngué Martial at Njock Loumbe ensures a production of at least 5 tons per hour although its own production has not been declared.

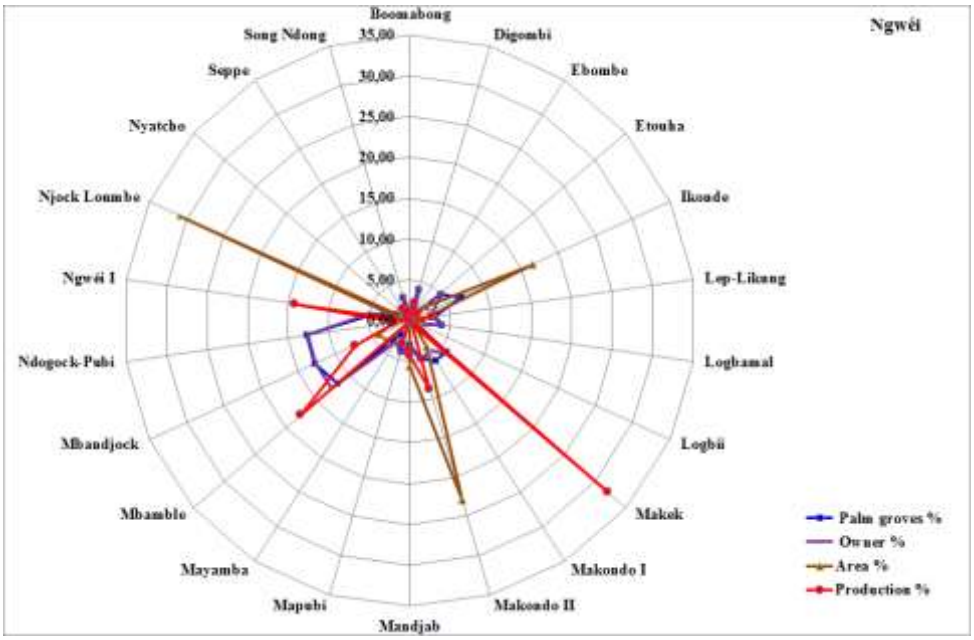


Figure 17 : Correlation between area, producers and production in villages of Ngwéi.

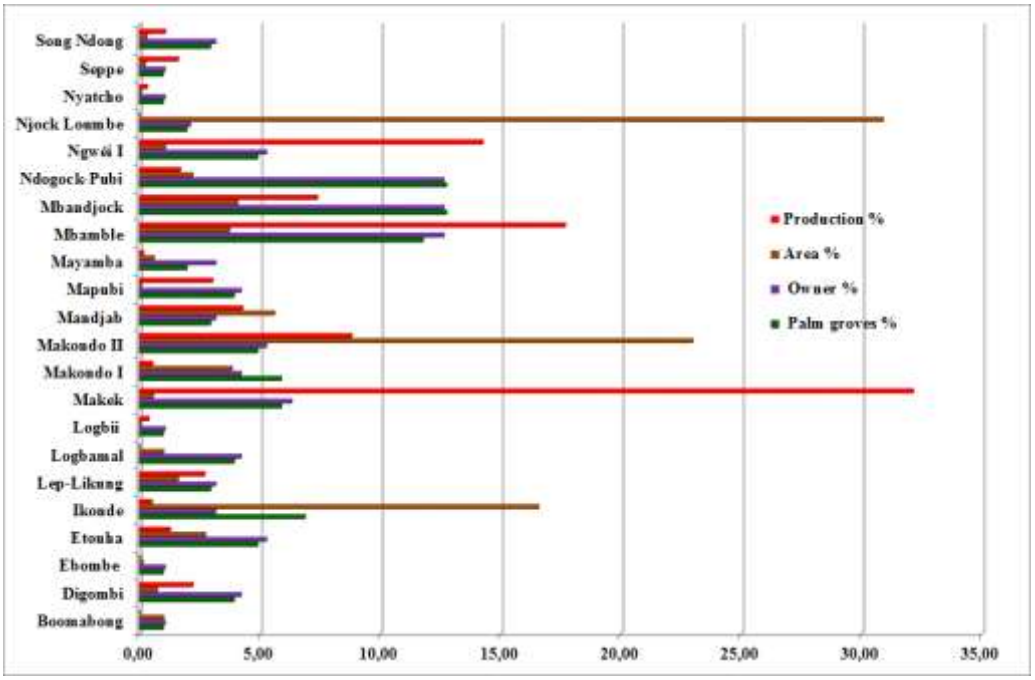


Figure 18: Correlation between area, producers and production in villages of Ngwéi.

The following summarized maps (Figures 19 and 20) give an idea of the situation of *Elaeis guineensis* farming in the two districts. Greater attention should therefore be paid to the evolution of the oil palm areas, which the traditional and administrative authorities should seek to stabilize in order to emphasize production techniques that are less disastrous for the environment and more productive varieties of palm oil. As such, best *Elaeis* agricultural practices should be encouraged.

According to this figure, Kitta Balue, Kotto Balondo, Kombe Balue and Bongongo 1 villages remain particularly to be monitored in terms of increasing areas dedicated to oil palm farming.

The Ekondo-Nene Bongongo II, Barombi and Dibonda villages should be encouraged in order to significantly improve production conditions.

On the Ngwéi side (Figure 20), attention should be focused on Makondo II, Njock Loumbe, Boomabong, Mandjap and Log Bamal villages, where production areas are important because they reduce even the margin available space for other agricultural activities. On the other hand, Seppe, Makek, Mbamble and Ngwéi I are villages that ask for support for an optimal profitability of their palm groves.

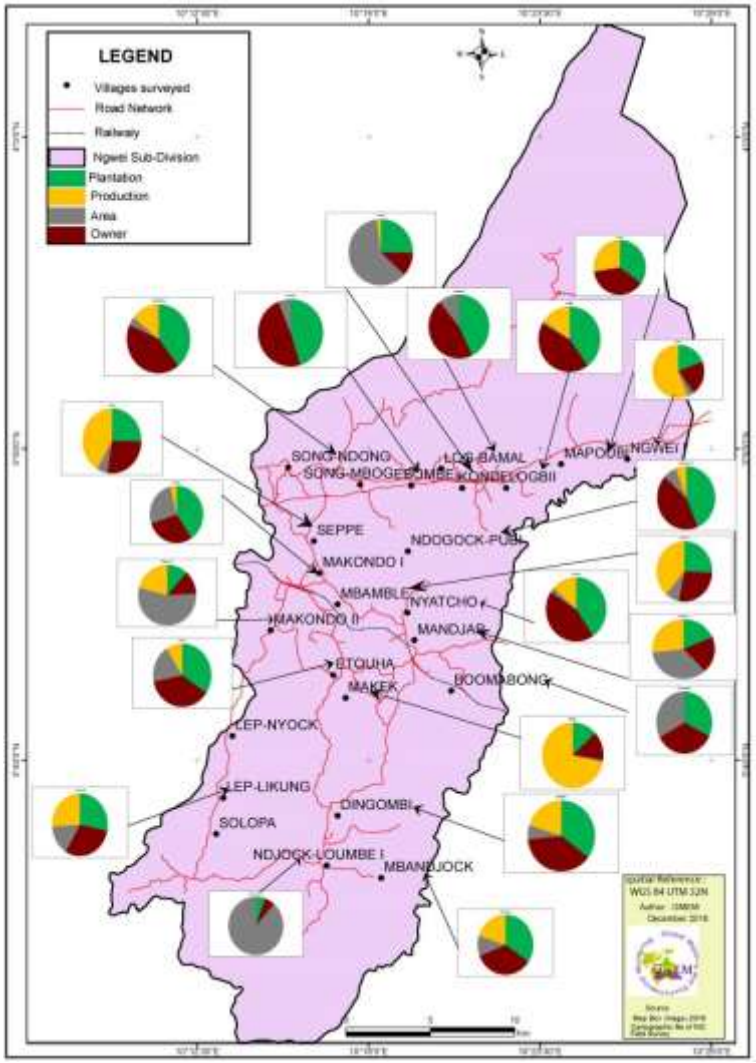


Figure 19 : Synthetic map of the production parameters of *Elaeis* cultivation in Ngwéi

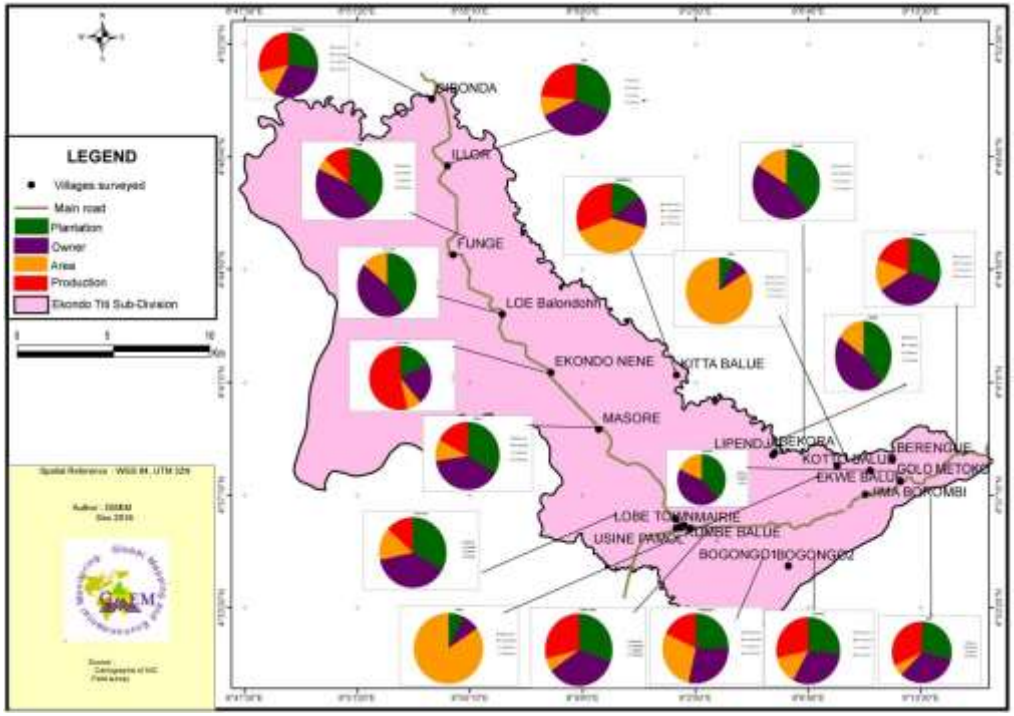
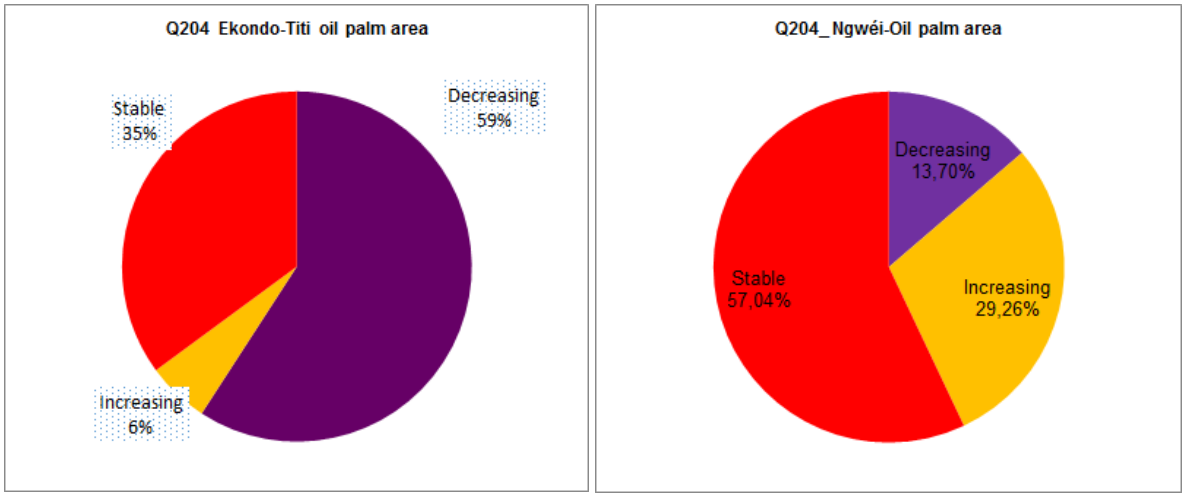


Figure 20: Synthetic map of the production parameters of *Elaeis* cultivation in Ekondo-Titi

This important question of the evolution of *Elaeis* farm areas has raised-up two questions ***Q204- Has the area of your palm plantation evolved? And Q205-1 what are the reasons?*** These questions certainly reveal an inadequate perception of the extent of deforestation caused by oil palm. Indeed, in the Ekondo-Titi villages, only 6.59% of the respondents confirm the evolution of the areas compared with 35% who consider it unchanged and 59% who think that its regress (Figures 21a). In the Ngwéi villages, almost 1/3 of the population (29,28%) acknowledges an increase in area compared with 13,70 who consider it to be decreasing and 57,04% unchanged (Figure 21b).



Figures 21: Perceptions of the dynamics of the Elaeis farms land in Ekondo-Titi and Ngwéi.

In both cases, the reasons for the increase in areas are due to the increase in the oil production which range from 47% in Ekondo-Titi to 30.25% in Ngwéi, and the increase in revenues (33.82% in Ekondo-Titi against 11.76% in Ngwéi), then the fight against the aging of the plants and finally the expansion of the property (palm plantation).

As far as the agro-industries are concerned, it seems to be appropriate to mention them in the following lines.

1.4. The agro-industrial plantations of the two districts.

There are three major industrial estates in the two districts: CDC and PAMOL in Ekondo-Titi, then SOCAPALM in Ngwéi. Since the CDC produces only the rubber tree, we will not make the case, we will present the PAMOL in Ekondo-Titi and the SOCAPALM legacy in Ngwéi. These agro-industries are both multi-site companies.

1.4.1. The PAMOL.

The first mill of the current PAMOL Plantations Plc, was inaugurated on April 14, 1967 in Lobe. At that time, the company was known as "Plantations Pamol of Cameroon" and belonged to the British group Unilever. In the late 1980s, the departure of the British led to the liquidation of PAMOL. However, the company continued its activities until July 1996, when Pamol Plantations Ltd was created by an exchange of claims between the creditors of the defunct Plantations Pamol of Cameroon, which was still a subsidiary of Unilever and shareholders of the new company. The company was kicked off in November 1996. Pamol Plantations Ltd was transformed into Pamol Plantations Public Liability Company in November 2006 to comply with the OHADA treaty. PAMOL is a parastatal company placed

under the supervision of the Ministry of Agriculture and Rural Development (MINADER) and the Ministry of Finance[3].

Pamol Plantations Plc, is renowned throughout the country to be the best producer of palm oil, palm kernel almonds, palm kernel oil, oil palm seeds and palm seedlings. The company also produces soap, mud oil and rubber (Bai).

PAMOL holds three plantations, which are the Lobe (Ekondo-Titi) and Ndian plantations in the Ndian Department and the Bai plantation in the Department of Meme.

The social capital of PAMOL is 4,834 billion FCFA with shareholders like the State of Cameroon (67.16%), the parastatal corporations of Cameroon (17.05%) (Including CNPS, SRC, SPFS, CDC, SOCAPALM, CORLAY, SAFACAM) and private companies (15.79%). It employs nearly 3,000 people, including direct staff (987) and indirect staff (2000).
The main objective of PAMOL is the production and marketing of palm oil, household soap, rubber and palm oil seed. PAMOL is also engaged in an applied research program aimed at the improvement and production of quality seeds. Average production is broken down as follows:

- Fresh fruit bunches – FFB (70,000 t);
- Palm oil (14,000 t);
- Palm kernel (1200 t);
- Oil palm seeds (pre-germinated nuts: 1, 500,000 seeds);
- Rubber (520 t);
- Laundry soap (1,400 t).

Thus, PAMOL sells seeds on the domestic and export markets. It has exported seeds to countries such as Colombia, Congo, Liberia, Nigeria, Thailand, Sierra Leone, Ghana, Indonesia and Malaysia among others. These exports peaked in 1986 and 1987 when 1.2 million and 1.7 million seeds respectively were sold. Nowadays, PAMOL maintains a set of 332 *Dura* and 8 *Pisifera* palms selected parents, and a potential production of about two million seeds of *"tenera"* oil palms a year.

PAMOL has three storage sites for palm oil with a capacity of 6600 tons, distributed as follows:

- Lobe (3,000t)
- Ndian (2,600 t)
- Bota-Limbe (1,000 t)

Plantations are the largest department and the society pillar. This department includes three plantations at Lobe, Ndian and Bai. PAMOL covers a total area of 10 874 ha of which 8 218 ha are cultivated. 575 ha of the cultivated area are occupied by rubber and the rest by oil palm. PAMOL had encouraged the development of village plantations around its plantations. Today, the results are palpable and encouraging. Approximately 6,390 ha of palm plantations belonging to 220 village small holders have been established, with an estimated production potential of 30,000 tons FFB/ per year. This production should normally be transformed by PAMOL. The PAMOL estates are distributed as follows:

[3] These information's come from the Pamol leaflets and flyers as well as from the PMOL website http://www.pamolplantationsplc.cm/html/

- **Lobe Estate (4,126 ha)** in the villages of Ekondo Nene (555 ha), Kokunda (1,456 ha) Ngolometoko (1,440 ha) and Lipenja (675 ha);
- **Ndian (5,098 ha)** in the villages of Makeke (998 ha), Mana (836 ha), Ikassa (675 ha), Mundemba (780 ha), Mongogeseli (144 ha), Center A 760 ha);
- **Bai (1,191 ha)** in the villages of Ekombe Lyongho (51 ha), Soke for hevea (580 ha), Bamboko (560 ha).

PAMOL has two mills for processing fresh fruit bunches (FFB). In addition to running these two mills, the Technical Department maintains carpentry, electrical and general mechanics workshops that ensures proper maintenance of the company's installations and assets. A soap factory was installed in 2003 at Lobe Estate with a production capacity of 1.5 metric tons of liquid soap per hour. This production capacity is bound to increase.

It has two oil mills:

- **The Ndian oil mill (53 years old)** was shut down in 1986 for over 10 years and partly rehabilitated by self-financing in 1999. Its production capacity has been upgraded from 9 tons FFB/hour to 15 tons FFB/hour.
- **The Lobe mill was inaugurated in 1966** and is still operational although at a high maintenance cost. Its production capacity has also been upgraded to 15 tons FFB/hour.

Economically, large investments have recently been made by PAMOL through self-financing:

- The replanting of 1,692 ha and establishment of 60,000 oil palm nursery to complete the Ndian Estate's replanting program.
- Establishment of a 100,000 capacity oil palm nursery to meet with the replanting and extension needs of Lobe Estate.
- Establishment of a 98,000 capacity rubber nursery for replanting and gradual extension of its rubber plantations.

PAMOL has embarked on the implementation of its plantation extension program for 20 billion CFAF as follows:

- Extension of 3,000 ha of oil palm at Ekondo-Nene (Ekondo-Titi);
- Extension of 3,000 ha of oil palm at Bakassi;
- Extension of 3,000 ha of rubber at Kosse.

On the social level:

- PAMOL runs two well-equipped hospitals at Lobe ad Ndian Estates respectively and a clinic at Bai besides many dispensaries in the different camps of the estates;
- Housing and recreational facilities are provided to all PAMOL workers;
- Scholarships are awarded to outstanding students from the villages surrounding PAMOL estates;
- PAMOL offers financial and material assistance to other social activities in the Ndian Division as the need arises.

1.4.2. The SOCAPALM

The *Société Camerounaise des palmeraies* i.e. Cameroonian Company of oil palm (SOCAPALM) represents one of the biggest agro-industrial companies of production of palm oil and its derivatives of Cameroon. Its plantations are spread over 78,529 hectares in the localities of Mbongo, Dibombari, Mbambou, Eséka, Kienke and Edéa. It has 32,500 hectares directly exploited and 18,265 hectares indirectly exploited via family plantations.

SOCAPALM has about 3,626 employees (18% of whom are women), 2,338 subcontractors who would have some 3,000 agricultural workers themselves. In total, nearly 30,000 people would be dependent on SOCAPALM[4].

Thanks to a State program supported by the World Bank in 1963, SOCAPALM was created in 1968. It was privatized in 2000, when it entered the Socfinal group through Intercultures. The French group Bolloré itself controls almost 40% of Socfinal and shares the latter with the two families of the Rivaud group (taken over by Bolloré in 1995), Fabri and de Ribes.

Furthermore, since its privatization in 2000, SOCAPALM has returned more than 21 000 ha to its legitimate owner, the State of Cameroon among which, the 415 ha of Ikonde are managed by the local populations under the control of the Ngwéi administrative authorities (sub-prefect).

SOCAPALM has initiated diversification towards rubber production in recent years, and its rubber production in 2015 reaches 860 tons. Its palm oil production capacity in 2015 was over 100,000 tons, although Cameroon still has a deficit of more than 50% compared to its national needs. The following statistics summarize the current situation:

- 1968: Creation;
- 1968 to 1980: 18,000 ha planted and 4,500 jobs created;
- 1980 - 1990: production evolved from 23,000 tons / year to 57,800 tons in 1990;
- 1986-87: World economic crisis: sharp decline in world palm oil prices and devastating effects on the SOCAPALM;
- 1988: The state takes drastic management measures (adjustment plan) eliminating 11% of jobs with only 37% of the workers in 1993 ;
- 2000: Privatization;
- 2009: Beginning of the partial absorption of the Plantation Ferme Suisse;
- 2009: Beginning of the construction of the new oil mill in Mbambou;
- 2010: Integration of the Edéa plantation with the SOCAPALM plantations;
- November 2013-March 2015: ISO 14001 certification of 3 sites followed later by other sites (Dibombari, Mbongo, Mbambou, Eséka, Edéa and Kienke).
- 6 oil mills certified ISO 14001;
- production: 83, 000 tonnes of crude palm oil per year;
- Area of oil palm plantations: 32,693 ha;
- Area of the SOCAPALM global concession: 56, 000 ha;
- Area of rubber plantations: 2,000 ha;
- Area of the oil palm estimated at 150, 000 ha;
- Area of rubber: estimated at 35, 000 ha (0.07%);
- Area of small holder or village palm oil plantations estimated at 70, 000 ha
- Area of village rubber plantations estimated at 3,500 ha;
- Average annual deficit of crude palm oil in relation to national requirements: 80, 000 tonnes;
- Workers : 5,025 employees (direct and indirect labour)
- 32 villages;
- 7 health centers and dispensaries attended by 5 doctors.

[4] These information's were collected from http://socapalm.com/societe-camerounaise-de-palmeraies/

The presentation of the biophysical environment of the two districts and those of the agro-industries show spatially the continuous expansion of the oil palm plantations in both Ekondo-Titi and Ngwéi. This extension is detrimental to biodiversity even if a relative economic advantage is observed. The second part, focusing on botany, will make it possible to detect and understand the impact of this dynamic on the biodiversity, being the floristic and wildlife richness of these two councils.

2. Floristic inventory within the two districts

Field observations and data analysis clearly show that there is a clear conversion of biodiversity (plant and wildlife, even microbiological) into monospecific biodiversity, which the backdrop is the oil palm. To this end, it is urgent to promote sustainable practices that can reduce greenhouse gas emissions to contribute to the fight against climate change.

2.1. Diversity of the arborescent stratum per diameter class.

In secondary and dense forests, the number of individuals per tree stratum is greater in Ekondo-Titi than in Ngwéi for small diameters. Conversely, large diameters are numerous at Ngwéi (Figure 22)

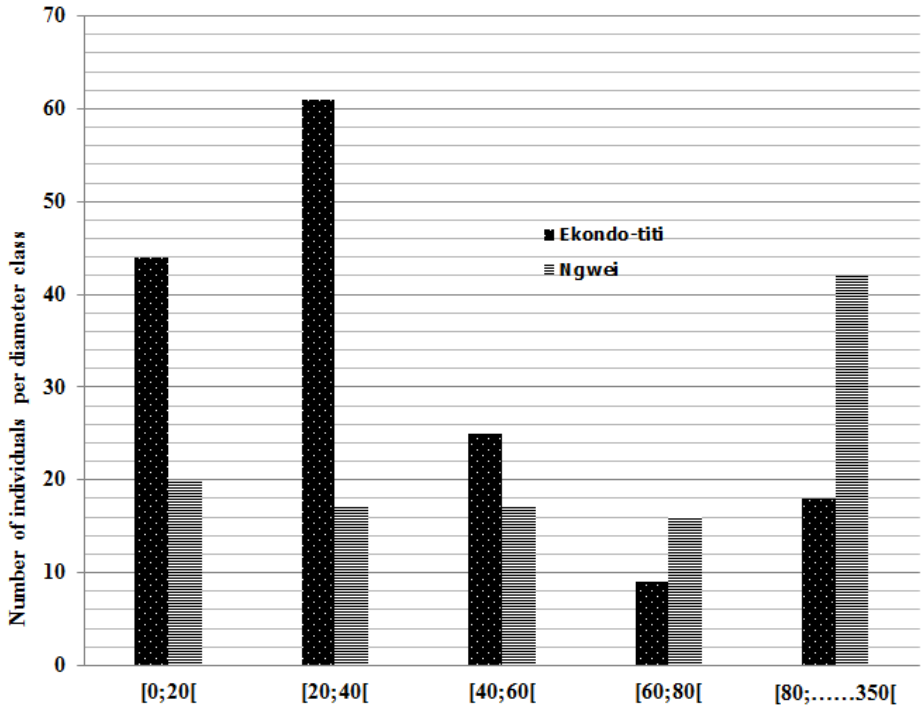


Figure 22: Different trees diameter classes of the study areas

Moreover, the detailed distribution of these diameters appears to be more regular in Ngwéi than in Ekondo-Titi (Figure 23), thus showing two things: the first one concerns the maturity of the Ngwéi forest and the other one the fertile soils of Ekondo-Titi. This soil richness can explain the multiplication of trees less than 40 cm in diameter in Ekondo-Titi against the regular presence of large and very large trees in Ngwéi (Figure 23).

In addition, it is important to recognize that plant communities are dependent on three main mechanisms: interspecific competition (Grime, 1973, Newman, 1973, Grime, 1979), resource availability (Tilman, 1985, 1997; Tilman et al. 1997) and the level of perturbations (Connell, 1978; Grime, 1979; Pickett et al. 1989). These three mechanisms are responsible for the different levels of floristic richness observed (Palmer, 1994). Changes in composition and specific wealth resulting from human activities have become increasingly relevant to questions of community persistence and their productivity (Mooney & Godron, 1983; McNaughton, 1993; Mooney et al. Al., 1996 ; Schulze et al., 1996). Consequently, changes in land use, farming practices and habitat fragmentation, by altering species richness, diversity of functional groups and their composition, have a significant impact on the functioning of ecosystems and the conservation of biodiversity.

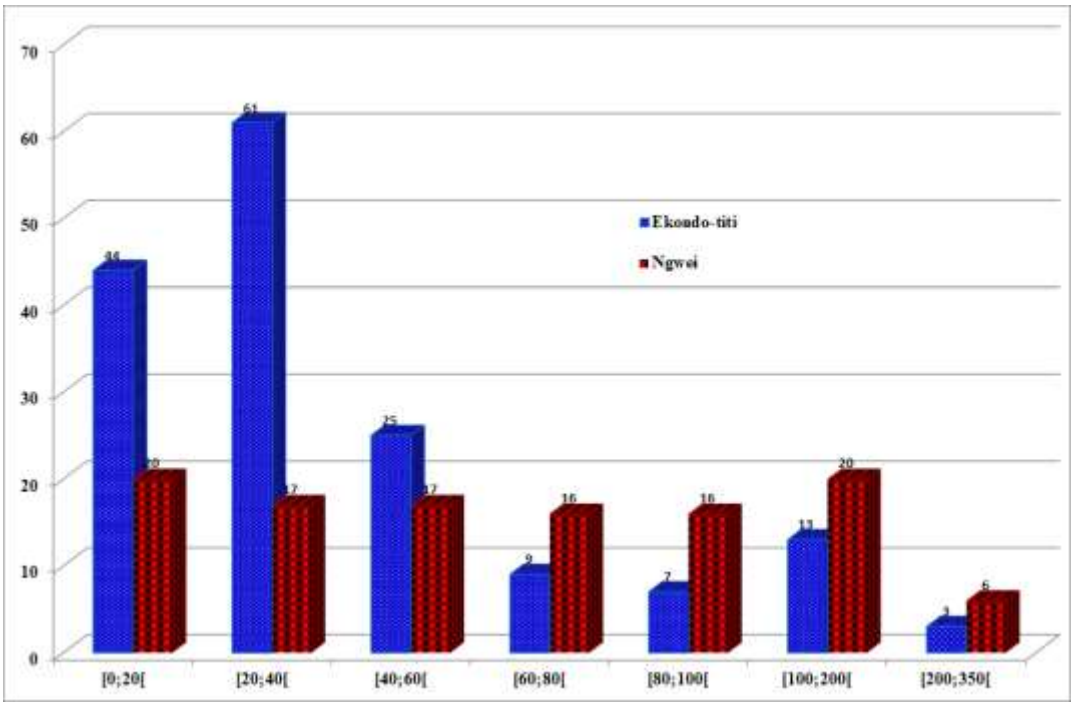


Figure 23: Regular trees diameters classes of the study areas

It is also found that the number of individuals per family in the dense Atlantic forest is greater in Ekondo-Titi (Figure 23) than in Ngwéi (Figure 24). This is an indication of the decline in flora and therefore of the regression of plant and animal biodiversity.

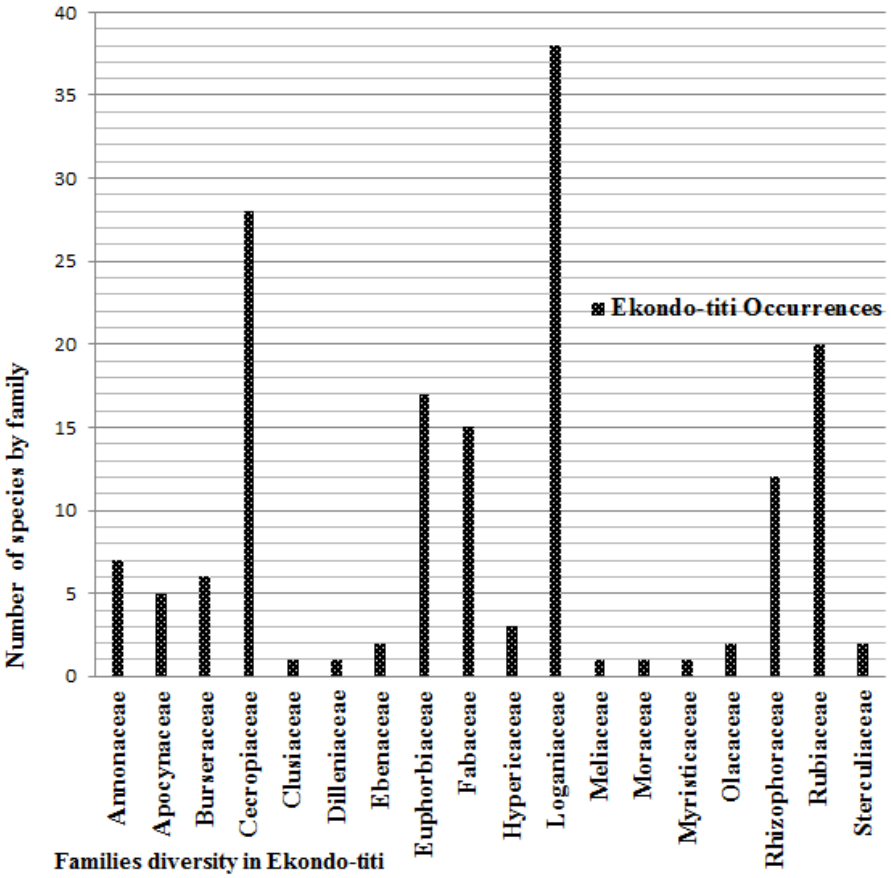


Figure 24 : Families diversity in Ekondo-Titi

In Ekondo-Titi, the families of *Loganiaceae* are dominant followed by *Cecropiaceae*, *Rubiaceae*, *Euphorbiaceae*, *Fabaceae* and *Rhizophoraceae*. In contrast to Ngwéi, only *Myristicaceae* followed by *Cecropiaceae* and *Fabaceae* emerge (Figure 25).

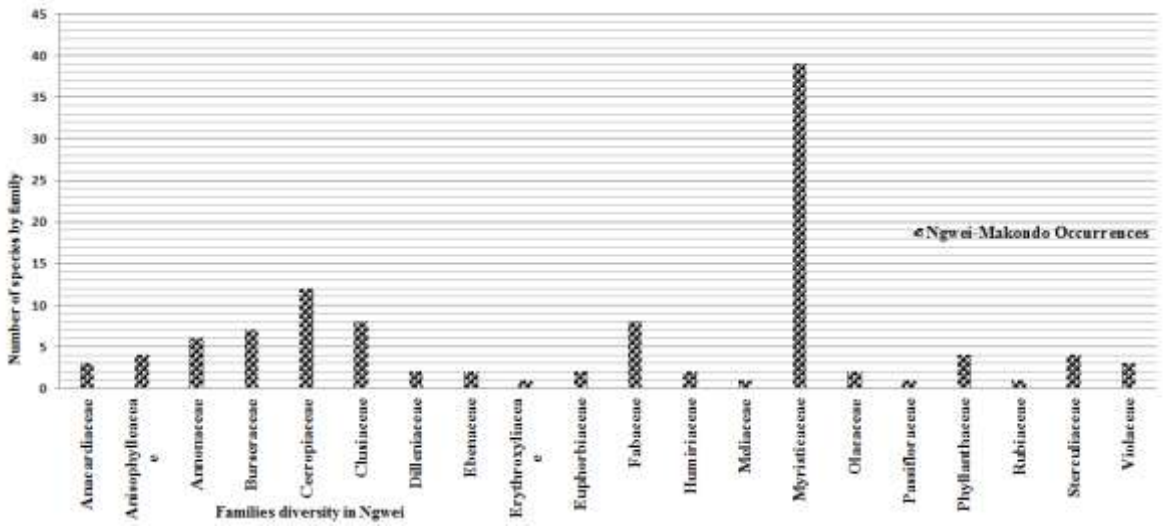


Figure 25: Families diversity in Ngwéi

Nevertheless, in the two dense and wet forest species of Ngwéi and Ekondo-Titi, larger diameter individuals [80-350 [represent 31.11 to 37.5% of the total of Ngwéi sample against 14.19 to 16.19% in Ekondo-Titi (Tables 9 and 10).

In Ekondo-Titi, the Fabaceae *dominate* followed by Burseraceae, *Cecropiaceae* and *Loganiaceae*.

Table 9 : Species of large diameter at Ekondo-Titi [80-350cm]

Scientific name	**Family name**	**Local name**	**DCH**	**Height**
Polyalthia suaveolens	*Annonaceae*	White Moambé	198	22
Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	207	25
Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	125	27
Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	110	17
Dacryodes buttneri Engl.	*Burseraceae*		85	28
Cecropia peltata	*Cecropiaceae*		205	25
Musanga cecropioides	*Cecropiaceae*	Asseng	180	15
Cecropia peltata	*Cecropiaceae*		105	10
Cecropia peltata	*Cecropiaceae*		87	17
Diospyros crassifolia Hiern	*Ebenaceae*		112	18
Diospyros crassifolia Hiern	*Ebenaceae*		110	17
Alchornea cordifolia	*Euphorbiaceae*	Aboé	85	10
Hylodendron mannii	*Fabaceae*		207	30
Tetrapleura tetraptera	*Fabaceae*	Akpa'a	197	35
Hylodendron mannii	*Fabaceae*		110	25
Millettia sanagana	*Fabaceae*		90	8
Albizia gyzia	*Fabaceae*	Sene	85	10

Anthocleista vogelii	*Loganiaceae*	Ayinda	110	25
Anthocleista vogelii	*Loganiaceae*	Ayinda	110	15
Anthocleista vogelii	*Loganiaceae*	Ayinda	90	5
Anthocleista vogelii	*Loganiaceae*	Ayinda	85	7
Gardenia imperialis	*Rubiaceae*		185	18
Morinda lucida	*Rubiaceae*	Akeng	150	15

In Ngwéi, large diameters are dominated by *Myristicaceae* families followed by *Fabaceae* and Clusiaceae (table 10).

Tableau 10 : Species of large diameter at Ngwéi [80-350cm]

Scientific name	**Family name**	**Local name**	**DCH**	**Height**
Sacoglotis gabonensis	*Humiriaceae*	Bidou	350	30
Sacoglotis gabonensis	*Humiriaceae*	Bidou	330	20
Coula edulis	*Olacaceae*	Komé	305	25
Mammea africana	*Clusiaceae*	Abol-Zok	290	35
Symphonia globulifera	*Clusiaceae*		285	32
Coula edulis	*Olacaceae*	Komé	250	35
Diospyros sp.	*Ebenaceae*	Mevini	190	20
Symphonia globulifera	*Clusiaceae*		185	25
Erythroxylon mannii	*Erythroxyliaceae*	Landa	185	28
Dalbergia sp	*Fabaceae*		185	25
Pycnanthus angolensis	*Myristicaceae*		185	37
Antrocaryon klaineanum	*Anacardiaceae*	Akongui	170	35
Piptadeniastrum africanum	*Fabaceae*	Atui	170	12
Staudtia kamerunensis	*Myristicaceae*	Niové	165	32
Antrocaryon klaineanum	*Anacardiaceae*	Akongui	160	35
Antrocaryon klaineanum	*Anacardiaceae*	Akongui	157	27
Poga oleosa	*Anisophylleaceae*	Ovoga	150	35
Dalium sp	*Fabaceae*		150	15
Millettia mannii	*Fabaceae*		150	28
Staudtia kamerunensis	*Myristicaceae*	Niové	150	27
Staudtia kamerunensis	*Myristicaceae*	Niové	147	38
Staudtia kamerunensis	*Myristicaceae*	Niové	145	25
Staudtia kamerunensis	*Myristicaceae*	Niové	145	38
Staudtia kamerunensis	*Myristicaceae*	Niové	130	35
Poga oleosa	*Anisophylleaceae*	Ovoga	110	25
Staudtia kamerunensis	*Myristicaceae*	Niové	108	35
Poga oleosa	*Anisophylleaceae*	Ovoga	100	25
Allanblackia gabonensis	*Clusiaceae*	Kekéné	100	25
Symphonia globulifera	*Clusiaceae*		100	37
Staudtia kamerunensis	*Myristicaceae*	Niové	100	28
Polyalthia suaveolens	*Annonaceae*		95	36
Staudtia kamerunensis	*Myristicaceae*	Niové	95	30

Poga oleosa	*Anisophylleaceae*	Ovoga	90	25
Staudtia kamerunensis	*Myristicaceae*	Niové	90	25
Staudtia kamerunensis	*Myristicaceae*	Niové	90	25
Gilbertiodendron dewevrei	*Fabaceae*	Ebem	87	30
Polyalthia suaveolens	*Annonaceae*		85	30
Musanga cecropioides	*Cecropiaceae*	Asseng	85	22
Diospyros crassifolia	*Ebenaceae*	Mevini	85	10
Gilbertiodendron dewevrei	*Fabaceae*	Ebem	85	20
Staudtia kamerunensis	*Myristicaceae*	Niové	85	25
Uapaca guineensis	*Phyllanthaceae*	Assam	85	25

2.2. Diversity of the tree stratum by height class.

Apart from the diameters, woody heights are another useful parameter for understanding the mechanisms of erosion and conservation of biodiversity. In terms of tree heights, the distribution is more spread out in Ngwéi (with a median height of 21-25 m (Figure 26) than in Ekondo-Titi (where the heights of 1 to 10 m are largely dominant). This also explains the maturity of this Ngwéi forest.

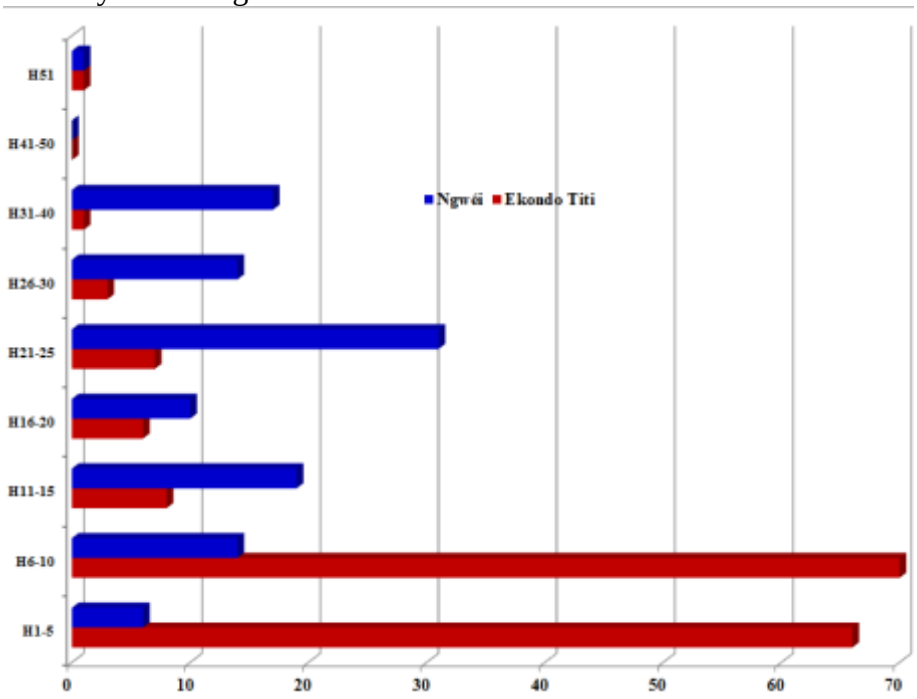


Figure 26: Height of species in the dense and humid forest of Ekondo-Titi and Ngwéi

However, the largest trees (15-60 m [among dense and wet forest trees belong to the families of *Burseraceae, Cecropiaceae and Fabaceae*, followed by *Ebenaceae, Loganiaceae and Rubiaceae* in Ekondo-Titi (Table 11)

Table 11: Species of greater heights in Ekondo-Titi [15-60m]

Scientific name	Family name	Local name	DCH	Height
Julbernardia pellegriniana Troupin	*Fabaceae*		55	55
Tetrapleura tetraptera	*Fabaceae*	Akpa'a	197	35
Hylodendron mannii	*Fabaceae*		207	30
Dacryodes buttneri Engl.	*Burseraceae*	Ozigo	85	28

Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	125	27
Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	207	25
Cecropia peltata	*Cecropiaceae*		205	25
Hylodendron mannii	*Fabaceae*		110	25
Anthocleista vogelii	*Loganiaceae*	Ayinda	110	25
Polyalthia suaveolens	*Annonaceae*	White Moambé	198	22
Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	35	22
Musanga cecropioides	*Cecropiaceae*	Asseng	75	22
Allanblackia floribunda Oliv.	*Clusiaceae*	Kekéné	65	18
Diospyros crassifolia Hiern	*Ebenaceae*		112	18
Gardenia imperialis	*Rubiaceae*		185	18
Santiria trimera (Oliv.) Aubrév	*Burseraceae*	Ebap	110	17
Cecropia peltata	*Cecropiaceae*		87	17
Diospyros crassifolia Hiern	*Ebenaceae*	Mevini	110	17
Musanga cecropioides	*Cecropiaceae*	Asseng	180	15
Anthocleista vogelii	*Loganiaceae*	Ayinda	110	15
Strombosiopsis tetrandra	*Olacaceae*	Mevini	60	15
Morinda lucida	*Rubiaceae*	Akeng	150	15

In the dense humid forest (WDF) of Ngwéi, individuals of greater height come from *Myristicaceae* families (Table 12), followed by *Fabaceae* and *Clusiaceae*; then *Anonaceae*, *Anisophylleaceae*, *Phyllanthaceae*, *Sterculiaceae* and finally *Anacardiaceae*, *Burseraceae* and *Cecropiaceae*.

Table 12: Species of greater heights in Ngwéi [15-60m]

Scientific name	Family name	Local name	DCH	Height
Tetracera macrophylla	*Dilleniaceae*	Ndik	35	60
Staudtia kamerunensis	*Myristicaceae*	Niové	147	38
Staudtia kamerunensis	*Myristicaceae*	Niové	145	38
Symphonia globulifera	*Clusiaceae*		100	37
Pycnanthus angolensis	*Myristicaceae*		185	37
Polyalthia suaveolens	*Annonaceae*		95	36
Antrocaryon klaineanum	*Anacardiaceae*	Akongui	170	35
Antrocaryon klaineanum	*Anacardiaceae*	Akongui	160	35
Poga oleosa	*Anisophylleaceae*		150	35
Mammea africana	*Clusiaceae*	Abol-Zok	290	35
Staudtia kamerunensis	*Myristicaceae*	Niové	130	35
Staudtia kamerunensis	*Myristicaceae*	Niové	108	35
Coula edulis	*Olacaceae*	Komé	250	35
Symphonia globulifera	*Clusiaceae*		285	32
Staudtia kamerunensis	*Myristicaceae*	Niové	165	32
Staudtia kamerunensis	*Myristicaceae*	Niové	65	32
Staudtia kamerunensis	*Myristicaceae*	Niové	55	32
Staudtia kamerunensis	*Myristicaceae*	Niové	53	32
Polyalthia suaveolens	*Annonaceae*		85	30

Gilbertiodendron dewevrei	*Fabaceae*	Ebem	87	30
Sacoglotis gabonensis	*Humiriaceae*	Bidou	350	30
Staudtia kamerunensis	*Myristicaceae*	Niové	95	30
Staudtia kamerunensis	*Myristicaceae*	Niové	67	30
Staudtia kamerunensis	*Myristicaceae*	Niové	28	30
Erythroxylon mannii	*Erythroxyliaceae*	Landa	185	28
Millettia mannii	*Fabaceae*		150	28
Staudtia kamerunensis	*Myristicaceae*	Niové	100	28
Antrocaryon klaineanum	*Anacardiaceae*	Akongui	157	27
Staudtia kamerunensis	*Myristicaceae*	Niové	150	27
Staudtia kamerunensis	*Myristicaceae*	Niové	47	27
Staudtia kamerunensis	*Myristicaceae*	Niové	43	27
Staudtia kamerunensis	*Myristicaceae*	Niové	70	26
Poga oleosa	*Anisophylleaceae*		110	25
Poga oleosa	*Anisophylleaceae*		100	25
Poga oleosa	*Anisophylleaceae*		90	25
Polyalthia suaveolens	*Annonaceae*		55	25
Xylopia rubescens	*Annonaceae*	Odzoabi	27	25
Santiria trimera	*Burseraceae*	Ebap	55	25
Symphonia globulifera	*Clusiaceae*		185	25
Allanblackia gabonensis	*Clusiaceae*	Kekéné	100	25
Garcinia gabonensis	*Clusiaceae*	Ognié	75	25
Tetracera macrophylla	*Dilleniaceae*	Ndik	40	25
Dalbergia sp	*Fabaceae*		185	25
Hymenostedja afzelii	*Fabaceae*		60	25
Staudtia kamerunensis	*Myristicaceae*	Niové	145	25
Staudtia kamerunensis	*Myristicaceae*	Niové	90	25
Staudtia kamerunensis	*Myristicaceae*	Niové	90	25
Staudtia kamerunensis	*Myristicaceae*	Niové	85	25
Staudtia kamerunensis	*Myristicaceae*	Niové	65	25
Staudtia kamerunensis	*Myristicaceae*	Niové	55	25
Staudtia kamerunensis	*Myristicaceae*	Niové	47	25
Staudtia kamerunensis	*Myristicaceae*	Niové	29	25
Staudtia kamerunensis	*Myristicaceae*	Niové	27	25
Staudtia kamerunensis	*Myristicaceae*	Niové	22	25
Coula edulis	*Olacaceae*	Komé	305	25
Barteria fistulosa	*Passifloraceae*	Kekombo	37	25
Uapaca guineensis	*Phyllanthaceae*	Assam	85	25
Sterculia rhinopetala	*Sterculiaceae*	Lotopha	55	25
Santiria trimera	*Burseraceae*	Ebap	65	23
Staudtia kamerunensis	*Myristicaceae*	Niové	60	23
Xylopia aethiopica	*Annonaceae*	Odzoabi	45	22
Musanga cecropioides	*Cecropiaceae*	Asseng	85	22
Mitragyna stipulosa	*Rubiaceae*	Efok bilobi	59	22

Diospyros sp.	*Ebenaceae*	Mevini	190	20
Gilbertiodendron dewevrei	*Fabaceae*	Ebem	85	20
Sacoglotis gabonensis	*Humiriaceae*	Bidou	330	20
Staudtia kamerunensis	*Myristicaceae*	Niové	25	20
Staudtia kamerunensis	*Myristicaceae*	Niové	17	20
Stertulia rhinopetala	*Sterculiaceae*	Lotopha	25	20
Allanblackia gabonensis	*Clusiaceae*	Kekéné	23	18
Staudtia kamerunensis	*Myristicaceae*	Niové	22	18
Uapaca guineensis	*Phyllanthaceae*	Assam	42	18
Staudtia kamerunensis	*Myristicaceae*	Niové	15	16
Santiria trimera	*Burseraceae*	Ebap	10	15
Musanga cecropioides	*Cecropiaceae*	Asseng	52	15
Musanga cecropioides	*Cecropiaceae*	Asseng	48	15
Dalium sp	*Fabaceae*		150	15
Gilbertiodendron dewevrei	*Fabaceae*	Ebem	30	15
Staudtia kamerunensis	*Myristicaceae*	Niové	60	15
Uapaca guineensis	*Phyllanthaceae*	Assam	65	15
Uapaca molle	*Phyllanthaceae*	Assam	60	15
Cola caulicarpa	*Sterculiaceae*	Ekom	50	15
Cola caulicarpa	*Sterculiaceae*	Ekom	17	15

These height classes represent 13.58 to 15.49% of the total sample in Ekondo-Titi, compared with 61.48 to 74.10% in Ngwéi.

The general decrease in species per family is an indicator of the decrease in the epigeal biomass. In addition, land conversion destroys their carbon sink function as shown in Tables 13 and 14 below.

Table 13 : Carbon stock by type of land use

Types of land use	**Epiglotted Biomass**	**Epiglotted carbon [tC/ha]***	**Total GHG [t CO2-e/ha]****
WDF Ekondo-titi	3,9	2,77(7t)	25,67
WDF Ngwéi	22,28	10,47(26,17)	95,96

**One ton of biomass contains 0,475 ton of C_{12}*

*** One ton of C_{12} corresponds to 3,667 tons of CO_2*

Table 14: Carbon leakage related to land conversion

Types of land use	**Epiglotted Biomass**	**Epiglotted carbon [tC/ha]***	**Total GHG [t CO2-e/ha]****
Young palm plantation Ekondo-Titi	26559 t	19068	69922,356t
Young palm plantation Ngwéi	151726,8 t	71287,08	261409,722t

**One ton of biomass contains 0,475 ton of C_{12}*

*** One ton of C_{12} corresponds to 3,667 tons of CO_2*

These carbon leakage from land conversion seem to be less felt at this time because the presence of some animal species hides this dynamics and environmental changes (Tables 15 & 16). Yet on the field, most wildlife species are scarce, either because they are threatened or they have disappeared.

Table 15 : Fauna diversity in Ekondo-Titi

Common name	Scientific name	Status
Avifauna		
African pied hornbill	*Tockus fasciatus or Lophoceros fasciatus*	
Ferruginous duck or Wild duck	*Aythya nyroca*	
Raven or pied crow	*Corvus albus*	
Grey heron	*Ardea cinerea*	
Purple heron	*Ardea purpurea*	
Scops owl	*Otus scops*	
Common house martin	*Delichon urbica*	
Sand martin or bank swallow	*Riparia*	
Black kite	*Milvus migrans*	**Protected**
African grey parrot	*Psittacus erithacus*	**Protected**
Little ringed plover	*Charadrius dubis*	
Tawny pipit	*Anthus campestris*	
Great blue turaco or Giant turaco	*Corythaeola cristata*	**Protected**
Mammals		
Serval or tierboskat or wild cat	*Leptailurus serval*	**Protected**
Malabar large-spotted civet or malabar civet	*Civettictis civetta*	**Protected**
Hyraxes or dassies	*Hyracoidae*	
African clawless otter	*Aonyx capensis*	**Protected**
Common kusimanse, dwarf or brown Mongoose	*Crossarchus obscurus*	
Striped ground squirrel	*Xerus erythropus*	
Greater cane rat	*Thryonomys swinderianus*	
Common or robust chimpanzee	*Pan troglodytes*	
Herpetofauna (reptiles)		
African dwarf crocodile or bony crocodile	*Osteolaemus tetraspis*	
Nile monitor or African small-grain lizard	*Varanus niloticus*	**Protected**
Python	*Phython regius*	**Protected**
Flying snake or gliding snake	*Chrysopelea*	

Yellow mamba	*Dendroaspis angusticeps*	
Green mamba	*Dendroaspis angusticeps*	
Gaboon viper	*Bitis gabonica*	**Protected**

Table 16: Fauna diversity in Ngwéi

Common name	Scientific name	Status
Avifauna		
Crowned eagle or African crowned Eagle or crowned hawk-eagle	*Stephanoaethus coronatus*	**Protected**
Beecroft's flying squirrel or Beecroft's scaly-tailed squirrel *or* Anomalurus beecrofti	*Anomalurops Beecrofti*	
African gray Parrot	*Psittacus erithacus*	**Protected**
Mammals		
Gambian pouched rat or African giant pouched rat	*Cricetomys gambianus*	
African brush-tailed porcupine	*Atherurus africanus*	
Greater cane rat	*Thryonomys swinderianus*	
African clawless otter	*Aonyx capensis*	**Protected**
Malabar large-spotted civet or malabar civet	*Viverra civettina*	**Protected**
Common kusimanse, dwarf or brown Mongoose	*Crossarchus obscurus*	
African Palm civet or two-spotted palm civet	*Nandinia binotata*	
Orycteerop or aardvark	*Orycteropus afer*	**Protected**
Yellow-backed duiker	*Cephalophus silvicultor*	
Blue duiker	*Cephalophus monticola et Philantomba monticola*	
Red duiker or bay duiker	*Cephalophus callipygus; Cephalophus dorsalis*	
Olive baboon or anubis baboon	*Papio anubis*	**Protected**
Common or robust chimpanzee	*Pan troglodytes*	**Fully protected**
moustached guenon or moustached monkey	*Cercopithecus cephus*	**Protected**
Spot-nosed monkey or putty nosed monkey	*Cercopithecus nictitans*	**Protected**
African buffalo	*Syncerus caffer*	**Fully protected**
African forest elephant	*Loxodonta cyclotis*	**Protected**
Bongo	*Boocercus euryceros*	**Fully protected**
Giant forest hog	*Hylochoerus meinertzageni*	**Protected**
Water Chevrotain or fanged deer	*Hyemoschus aquaticus*	**Fully protected**

Sitatunga or marshbuck	*Tragelaphus spekii*	**Protected**
Red river hog or bushpig	*Potamochoerus porcus*	**Protected**
Giant Pangolin	*Manis gigantea*	**Fully protected**
Small Pangolin	*Manis spp*	**Protected**
Herpetofauna and others		
Yellow mamba	*Dendroaspis angusticeps*	
Green mamba	*Dendroaspis angusticeps*	
Nile crocodile	*Crocodylus niloticus*	**Protected**
Python	*Python natalensis*	**Protected**
Gaboon viper	*Bitis gabonica*	**Protected**

2.3. Biodiversity within families

The analysis of biological diversity within families still shows the richness of biodiversity at both sites. However, natural vegetation has about twice as many families than oil palm trees with a higher level of richness in elitic oil palm plantations (Figures 27 and 28).

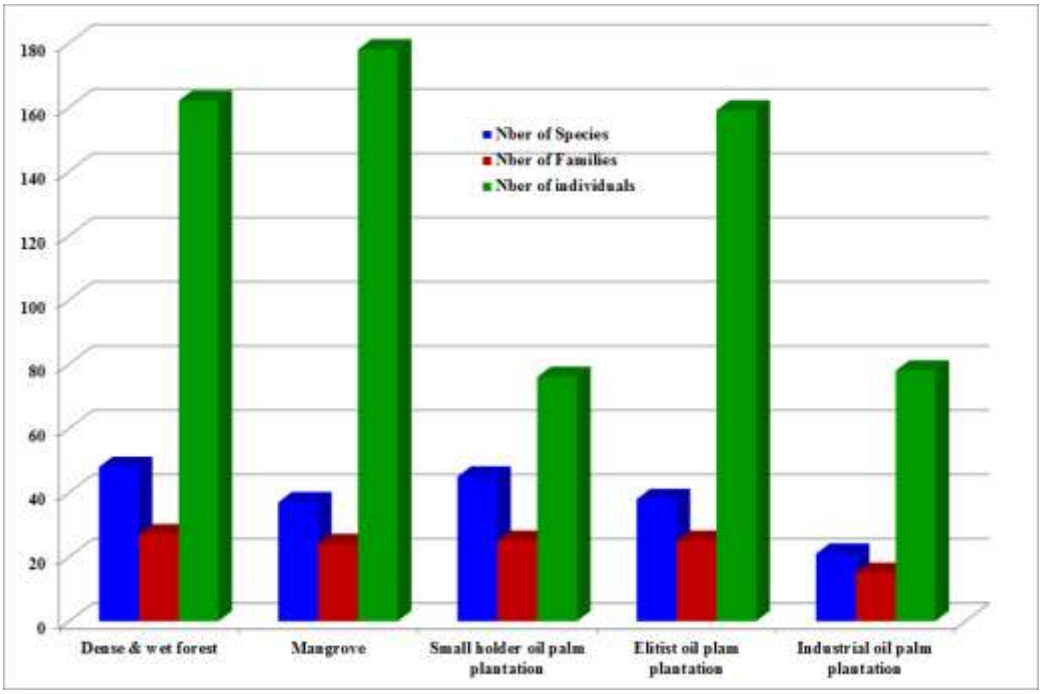


Figure 27: Biological diversity within families in Ekondo-Titi

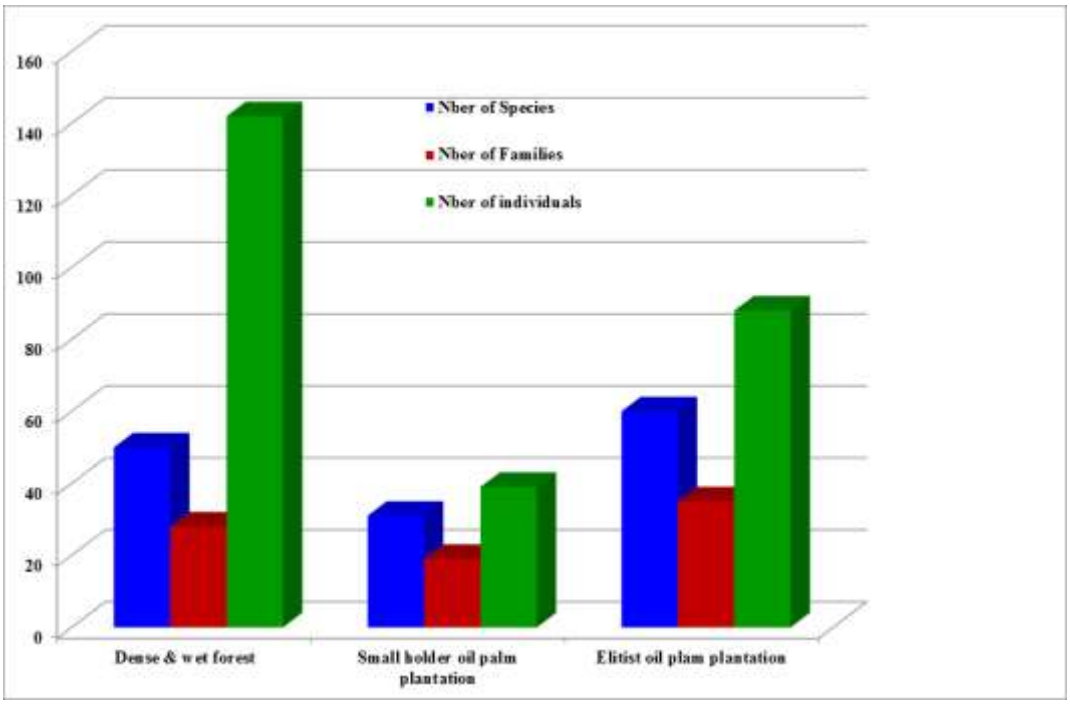


Figure 28: Biological diversity within families in Ngwéi

In Ekondo-Titi, when looking at the number of individuals per family, we find that *Sterculiaceae* (26.76% of the number of individuals) represent the dominant family in dense and wet forest (Table 17) against *Rhizophoraceae* (20.78%) in mangrove forests. In the village oil palm plantations, *Araceae* (10.52%) constitute the dominant family, while the *Fabaceae* emerge in elite (16.98%) and industrial (17.94%) palm plantations.

Table 17: Relative density of the top ten (10) families in Ekondo-Titi

Ekondo Titi wet and dense forest family	Nber Ind	Mangrove family	Nb Ind	Village palm grove family	Nb Ind	Elitist palm groves family	Nb Ind	Industrial alm grove family	Nb Ind
Sterculiaceae	38	***Rhizophoraceae***	37	*Araceae*	8	***Fabaceae***	27	*Fabaceae*	14
Cecropiaceae	12	*Loganiaceae*	34	*Asteraceae*	8	*Rubiaceae*	22	*Loganiaceae*	11
Burseraceae	7	*Arecaceae*	22	*Apocynaceae*	6	*Icacinaceae*	19	*Sellaginellaceae*	10
Clusiaceae	4	*Rubiaceae*	20	*Poaceae*	6	*Apocynaceae*	17	*Asteraceae*	7
Anacardiaceae	3	*Convolvulaceae*	12	*Amaranthaceae*	5	*Hippocrateaceae*	11	*Euphorbiaceae*	6
Anisophylleaceae	3	*Euphorbiaceae*	11	*Commelinaceae*	5	*Dilleniaceae*	8	*Poaceae*	6
Annonaceae	3	*Cecropiaceae*	10	*Euphorbiaceae*	5	*Euphorbiaceae*	7	*Acanthaceae*	5
Commelinaceae	3	*Fabaceae*	10	*Acanthaceae*	4	*Acanthaceae*	5	*Costaceae*	5
Euphorbiaceae	3	*Asteraceae*	7	*Davalliaceaea*	4	*Moraceae*	5	*Commelinaceae*	3
Fabaceae	3	*Araceae*	2	*Fabaceae*	4	*Conaraceae*	4	*Davalliaceaea*	3
Total	**79/142**		**165/ 178**		**55/76**		**125/ 159**		**70/78**

These top ten (10) families account for 55.63% of the total in the wet and dense forest of Ekondo-Titi and 92.69% in the mangrove forest against 73.36%, 78.61% and 89.74% respectively in the village, elitist and industrial palm plantations. *Fabaceae* are the only family present in the five plots followed by *Euphorbiaceae* (4 plots) and *Araceae*, *Asteraceae*, *Acanthaceae* (3 plots).

In Ngwéi, the data changes somewhat and *Myristicaceae* (28.88% of the number of individuals) represent the dominant family in wet and dense forest of Ngwéi against *Fabaceae* (13.63%) in elite palms and *Asteraceae* 15.38%) in village palm plantations (Table 18).

Table 18: Relative density of the top 10 families in Ngwéi

N°	Village palm groves families	Number of individuals	Elitist palm groves families	Number of individuals	Wet and dense forest families	Number of individuals
1	*Asteraceae*	6	*Fabaceae*	12	***Myristicaceae***	39
2	*Fabaceae*	5	*Oxalidaceae*	6	*Cecropiaceae*	12
3	*Moraceae*	5	*Asteraceae*	5	*Fabaceae*	10
4	*Apocynaceae*	4	*Moraceae*	5	*Clusiaceae*	9
5	*Rubiaceae*	3	*Poaceae*	5	*Annonaceae*	8
6	*Amaranthaceae*	2	*Rubiaceae*	5	*Burseraceae*	7
7	*Davalliaceaea*	2	*Acanthaceae*	4	*Marantaceae*	6
8	-----	---	*Ochnaceae*	4	*Phyllanthaceae*	5
9	----	----	*Costaceae*	3	*Anisophylleaceae*	4
10	-----	---	*Davalliaceaea*	3	*Sterculiaceae*	4
	Total	**27/39**		**52/88**	*Total*	**104/135**

In addition, the top ten families accounted for 69.23% of individuals in village oil palm plantations (although there were only 7 major families), 59.09% in elitist palm plantations and 77.03% in wet and dense forest of Ngwéi. Morever, the *Fabaceae* are the only family found in all three plots. Outside this family, four other families are found in all oil palm plantations (*Asteraceae*, *Davalliaceaea*, *Moraceae* and *Rubiaceae*).

Comparing only the non-human vegetation families (wet and dense forest and mangrove) in both districts, the *Fabaceae* and *Cecropiaceae* are the dominant families found in the top 10 families in each plot (Table 19).

Tableau 19: Relative density of the 10 main families in wet and dense forest (WDF) and mangroves in Ekondo-Titi and Ngwéi

N°	Ekondo Titi WDF Family	Number of individuals	Ngwéi WDF Family	Number of individuals	Mangrove Family	Number of individuals
1	***Myristicaceae***	39	***Sterculiaceae***	38	***Rhizophoraceae***	37
2	*Cecropiaceae*	12	*Cecropiaceae*	12	*Loganiaceae*	34
3	*Fabaceae*	10	*Burseraceae*	7	*Arecaceae*	22
4	*Clusiaceae*	9	*Clusiaceae*	4	*Rubiaceae*	20
5	*Annonaceae*	8	*Anacardiaceae*	3	*Convolvulaceae*	12
6	*Burseraceae*	7	*Anisophylleaceae*	3	*Euphorbiaceae*	11
7	*Marantaceae*	6	*Annonaceae*	3	*Cecropiaceae*	10
8	*Phyllanthaceae*	5	*Commelinaceae*	3	*Fabaceae*	10
9	*Anisophylleaceae*	4	*Euphorbiaceae*	3	*Asteraceae*	7
10	*Sterculiaceae*	4	*Fabaceae*	3	*Araceae*	2

For all categories of oil palm plantations (Table 20), the top ten (10) families within the five (5) plots are *Fabaceae* (5 plots) followed by *Asteraceae, Acanthaceae* and *Davalliaceaea* (4 plots) ; then *Apocynaceae, Euphorbiaceae, Morecaeae, Poaceae and Rubiaceae* (3 plots).

Table 20: Relative density of the top ten (10) families in the palm plantation of both districts

Village Palm groves Ngwéi	Nber Ind	Elitist palm groves Ngwéi	Nber Ind	Village Palm Ekondo-Titi	Nb Ind	Elitist palm Ekondo-Titi	Nb Ind	Industrial palm Ekondo-Titi	Nb Ind
Asteraceae	6	*Fabaceae*	12	*Araceae*	8	***Fabaceae***	27	*Fabaceae*	14
Fabaceae	5	*Oxalidaceae*	6	*Asteraceae*	8	*Rubiaceae*	22	*Loganiaceae*	11
Moraceae	5	*Asteraceae*	5	*Apocynaceae*	6	*Icacinaceae*	19	*Sellaginellaceae*	10
Apocynaceae	4	*Moraceae*	5	*Poaceae*	6	*Apocynaceae*	17	*Asteraceae*	7
Rubiaceae	3	*Poaceae*	5	*Amaranthaceae*	5	*Hippocrateaceae*	11	*Euphorbiaceae*	6
Amaranthaceae	2	*Rubiaceae*	5	*Commelinaceae*	5	*Dilleniaceae*	8	*Poaceae*	6
Davalliaceaea	2	*Acanthaceae*	4	*Euphorbiaceae*	5	*Euphorbiaceae*	7	*Acanthaceae*	5
---------	---	*Ochnaceae*	4	*Acanthaceae*	4	*Acanthaceae*	5	*Costaceae*	5
----------	---	*Costaceae*	3	*Davalliaceaea*	4	*Moraceae*	5	*Commelinaceae*	3
----------	---	*Davalliaceaea*	3	*Fabaceae*	4	*Conaraceae*	4	*Davalliaceaea*	3

Therefore, the least diversified plots are the villager palm plantations, followed by industrial and finally elitist palm plantations. This can be explained by the regular maintenance of industrial palm plantations, the mixed food crops grown in some village palm plantations and the irregularity of the maintenance in the elitist oil palm plantations.

2.4. Floristic diversity index

The Shannon index (Table 21) shows significant biological diversity for dense forests and for mangroves (0.28). The Shannon index is also high for the industrial palm plantation of Ekondo-Titi, relatively less for the village palm and elitist palm groves.

The Simpson index is 0.08-0.09 in mangrove, moist and dense forest compared with 0.07 in the industrial and elitist palm plantations of Ekondo-Titi against 0.01 in the villager and elitist palm plantations of Ngwéi. Simpson index shows the degree of land use in the two districts. This is due to the fact that ecosystems are profoundly affected by agricultural practices and especially by oil palm cultivation (and even cocoa farming with exotic species), which reduces density and specific diversity locally.

Table 21 : Biological diversity index

Types of land use	**Shannon index**	**Equitability of Piélou**	**Simpson index**
Ekondo-Titi			
Wet and dense forest	0,27	0,01	0,08
Mangrove	0,28	0,01	0,09
Villager oil palm plantations	0,20	0,00	0,02
Industrial oil palm plantations	0,27	0,01	0,07
Elitist oil palm plantations	0,25	0,01	0,06
Ngwéi (Makondo)			
Wet and dense forest	0,28	0,01	0,09
Villager oil palm plantations	0,21	0,01	0,01
Elitist oil palm plantations	0,18	0,00	0,01

Table 21 shows that of the 18 families in moist and dense forest as well as on 20 mangrove families, only 5 families are found in all palm plantations (village, elitist and industrial). These include *Annonaceae, Apocynaceae, Euphorbiaceae, Fabaceae* and *Loganiaceae*. To this one can add *Moraceae* in wet and dense forests and in the elitist and villager oil palm plantations; then the *Phyllanthaceae* in the mangroves and in the elitist and village palm plantations. This constitutes either a real quantitative and qualitative decrease in biodiversity outside *Fabaceae* families. However, the number of families increased in the elitist (25) and village (24) oil palm plantations of Ekondo-Titi.

2.5. Dynamics of plant biological diversity

Before concluding this chapter, it would be important to highlight the variation in floristic and wildlife biodiversity from natural environments to oil palm plantations. This would give and idea of the real impact of oil palm plantations on the biodiversity decrease within the landscapes studied. Taking the floristic level, Tables 22 and 23 show the biodiversity of the different environments and forms of land use in the landscapes studied.

Table 22 : Evolution of floristic biodiversity in Ekondo-Titi

WDF- Ekondo-Titi		**Mangrove – Ekondo-Titi**		**Elite palm plant. Ekondo-Titi**		**Village palm plant – Ekondo-Titi**		**Industrial palm plant – Ekondo-Titi**	
Family	Nb Ind	Family	Nb Ind	Family	Nb Ind	Family	Nb Ind	Family	Nb Ind
Annonaceae	7	*Amaranthaceae*	1	*Acanthaceae*	4	*Acanthaceae*	4	*Acanthaceae*	4
Apocynaceae	5	*Annonaceae*	1	*Annonaceae*	1	*Amaranthaceae*	5	*Apocynaceae*	1
Burseraceae	6	*Araceae*	2	*Apocynaceae*	17	*Apocynaceae*	6	*Asteraceae*	7
Cecropiaceae	28	*Arecaceae*	21	*Asteraceae*	3	*Araceae*	8	*Combretaceae*	2
Clusiaceae	1	*Asteraceae*	7	*Combretaceae*	2	*Asteraceae*	8	*Commelinaceae*	3
Dilleniaceae	1	*Cecropiaceae*	10	*Conaraceae*	4	*Cecropiaceae*	1	*Convolvulaceae*	2
Ebenaceae	2	*Convolvulaceae*	12	*Davalliaceaea*	4	*Commelinaceae*	5	*Costaceae*	5
Euphorbiaceae	17	*Cyperaceae*	2	*Dilleniaceae*	8	*Costaceae*	1	*Davalliaceaea*	3
Fabaceae	15	*Davaliaceae*	1	*Euphorbiaceae*	7	*Davalliaceaea*	4	*Euphorbiaceae*	6
Hypericaceae	3	*Dilleniaceae*	1	*Fabaceae*	28	*Euphorbiaceae*	5	*Fabaceae*	14
Loganiaceae	38	*Euphorbiaceae*	11	*Hippocrateaceae*	11	*Fabaceae*	4	*Loganiaceae*	12
Meliaceae	1	*Fabaceae*	11	*Hypeicaceae*	2	*Gnetaceae*	1	*Melastomacaceae*	2
Moraceae	1	*Loganiaceae*	34	*Icacinaceae*	19	*Icacinaceae*	1	*Poaceae*	6
Myristicaceae	1	*Malvaceae*	2	*Loganiaceae*	2	*Loganiaceae*	1	*Sellaginellaceae*	10
Olacaceae	2	*Onagraceae*	1	*Moraceae*	5	*Malvaceae*	1	*Verbenaceae*	1
Rhizophoraceae	12	*Phyllanthaceae*	2	*Myrtaceae*	1	*Melastomataceae*	1		78
Rubiaceae	20	*Rhizophoraceae*	37	*Oxalidaceae*	1	*Moraceae*	1		
Sterculiaceae	2	*Rubiaceae*	20	*Phyllanthaceae*	3	*Phyllanthaceae*	2		
		Sapotaceae	1	*Piperaceae*	2	*Piperaceae*	2		
		Sterculiaceae	1	*Polygalaceae*	1	*Poaceae*	6		
				Rubiaceae	23	*Rutaceae*	4		
				Sapindaceae	2	*Smilaceae*	1		
				Sellaginellaceae	2	*Solanaceae*	1		
				Sterculiaceae	3	*Verbenaceae*	3		
				Verbenaceae	4				
18 families	**162**	**20 families**	**178**	**25 families**	**159**	**24 families**	**76**	**15 families**	**78**

Table 22 shows in the Ngwéi council, six (6) families that are found in the dense forest (26) and the village and elitist oil palm plantations. These include *Apocynaceae, Araceae, Asteraceae, Fabaceae, Icacinaceae* and *Rubiaceae*. However, *Marantaceae* and *Sterculiaceae* are found in dense forest and palm plantations.

Table 23 : Evolution of floristic biodiversity in Ngwéi

Wet and dense forest - Ngwéi		**Elite palm plantations- Ngwéi**		**Village palm plantations - Ngwéi**	
Family	**Nber individuals**	**Family**	**Nber individuals**	**Family**	**Nber individuals**
Anacardiaceae	3	*Acanthaceae*	4	*Acanthaceae*	1
Anisophylleaceae	4	*Anacardiaceae*	1	*Amaranthaceae*	2
Apocynaceae	10	*Apocynaceae*	1	*Apocynaceae*	4
Araceae	2	*Araceae*	1	*Araceae*	1
Arecaceae	2	*Asteraceae*	5	*Asteraceae*	6
Asteraceae	2	*Convolvulaceae*	2	*Costaceae*	1
Burseraceae	7	*Costaceae*	3	*Davalliaceaea*	2
Cecropiaceae	12	*Cyperaceae*	2	*Fabaceae*	5
Clusiaceae	9	*Dilleniaceae*	5	*Hippocrateaceae*	1
Commelinaceae	3	*Euphorbiaceae*	2	*Hypericaceae*	1
Dilleniaceae	2	*Fabaceae*	12	*Icacinaceae*	1
Ebenaceae	2	*Gnetaceae*	1	*Lamiaceae*	1
Erythroxyliaceae	1	*Hippocrateaceae*	1	*Marantaceae*	1
Euphorbiaceae	3	*Hypericaceae*	1	*Moraceae*	5
Fabaceae	10	*Icacinaceae*	1	*Piperaceae*	1
Humiriaceae	2	*Irvingiaceae*	1	*Rubiaceae*	3
Icacinaceae	1	*Lamiaceae*	3	*Sapindaceae*	1
Marantaceae	6	*Loganiaceae*	1	*Sterculiaceae*	1
Meliceae	1	*Malvaceae*	2	*Verbenaceae*	1
Myristicaceae	39	*Melastomacaceae*	2		
Olacaceae	2	*Moraceae*	6		
Passifloraceae	6	*Ochnaceae*	4		
Polygalaceae	3	*Oxalidaceae*	6		
Rubiaceae	3	*Phyllanthaceae*	1		
Sterculiaceae	4	*Piperaceae*	3		
Violaceae	3	*Poaceae*	5		
		Polygalaceae	1		
		Rubiaceae	6		
		Sapindaceae	1		
		Sellaginellaceae	1		
		Smilacaceae	1		
		Verbenaceae	2		
26 families	**142**	**32 families**	**88**	**19 families**	**39**

As in Ekondo Titi, the regression of plant biodiversity is quantitative and qualitative for some species. Table 24 summarizes these results.

Table 24: Synthesis of flora dynamics in both landscapes

Ekondo-Titi			
	Number of species	**Number of families**	**Nber of individuals**
Wet and dense forest	48	18	162
Mangrove	37	20	178
Villager oil palm plantations	45	24	76
Elitist oil palm plantations	38	25	159
Industrial oil palm plantations	21	15	78
Ngwéi			
	Number of species	**Number of families**	**Nber of individuals**
Wet and dense forest	50	26	142
Villager oil palm plantations	31	19	39
Elitist oil palm plantations	60	32	88

2.6. Fauna dynamics in the Ekondo-Titi and Ngwéi landscapes

In oil palm plantations, the most commonly encountered animals are rodents (hedgehogs, porcupines, rats, squirrels, etc.). Many animals also live there and build their nests from leaflets. There are also snakes including the green mamba. These snakes settle their habitats within the palms and also consume the ripe nuts.

In fact, when the nuts ripen, oil palm trees attract many large or small birds (crowned eagle, parrot, hornbill and crow) that find food. This birds accretion and other rodents in the palm trees subsequently attracts some antelopes (duikers) who consume the rest of the nuts left by the birds and rodents or those that have fallen on the ground.

Outside the palm plantations, in the food crop farms, there are also many rodents (above mentioned) attracted by the availability of the food that these fields offer. Occasionally, there are herbivores (antelopes) that come for the same reasons. There is often a temporary sedentarization of these rodents in an area depending on the food supply. Traces of their presence are then observed throughout the abandoned fields where they consume the rest of the crops.

In relatively undisturbed forests, for example, north-west of Ngwéi towards Ndjock-Loumbé, on the border with Nyong-Ekelle subdivision, and then to the north-west and west of Ekondo-Titi, the fauna is still quite heterogeneous. It is composed of rodents (porcupine in particular), herbivores (antelopes) and some large mammals (warthogs, hinds, wild boars ...), but also monkeys. There are many more rodents on the edge of streams and swamps (Bongo, Sitatunga) and other mammals that easily find food. It happens regularly in this area of contact with the Nyong-Ekelle district that monkeys, warthogs make inroads into oil palm plantations and food crops farms where they wreak havoc. Warthogs are fond of palm kernel almonds just like monkeys who love palm nuts.

In all cases, the mobility of fauna between oil palm plantations, food crops and forest basins is dictated by the availability of food supply. However, some animals become accustomed to the proximity of human activities, while others prefer to move away and carry out punctual excursions on the farms and palm plantations according to the availability of the food resource.

Finally, the inventory of floristic and faunal biodiversity in the various sites revealed the regime of disturbances of the forest ecosystem in the project area. These disturbances lead to

the fragmentation of habitats of great apes and elephants, as well as other large mammals. The floristic and faunistic richness of the project areas is important from the quantitative and qualitative point of view. However, there is a contrast of floristic richness between the two sites of the project. In the light of the different calculations of biodiversity indicators developed, it appears that the floristic richness is greater in Ngwéi than in Ekondo-Titi. NTFPs (non-timber forest products) are equally abundant and diversified in the project areas. Their exploitation by the local residents contributes to the improvement of their living conditions in general, which is why they are generally conserved in the different natural or modified habitats. The landscape approach will allow us to deepen some of these observations and to propose draft sketch of strategy.

3. Landscape resilience assessment in Ekondo-Titi and Ngwéi

This section will begin with a general overview of the major components of the two landscapes studied in Tables 25 and 26.

Table 25: Major landscapes components and calamities identified in Ekondo-Titi in 2016

Landscape category	Description
Major biophysical elements and landmarks	Plateaux, hills, plains, tall trees, rocks, swamps, creeks, roads, schools, dispensaries, health center, church, rivers, farms, dense forest, palm groves, cocoa trees, mangroves.
Protected landscapes and areas	Afromontane forest, cultural site, church, schools, makets, health centres or dispensary, roads,
Crops and yields	Palm oil, mango, orange, mandarin, grapefruit, papaya, lemon, guava, cocoa, banana, rubber, okra, pepper, cocoyam, vegetables, macabo, corn, groundnut, yam, avocado, plum, coconut, tomato, sugar cane, pineapple, djansang, Prunus africana, palm wine, tapioca (gari), almonds, "*egusi*" melon.
Trees and fruit trees	Trees: iroko, sapelli, mahogany, hevea. Fruit trees: Avocado, mango, guava, lemon tree, orange tree, grapefruit, coconut, plum tree, baobab.
Livestocks	Goats, sheep, poultry, pigs.
Wild animals	Aquatic fauna : Molluscs, crustaceans, fish, manatees, crocodiles, tilapias, sea turtles, shad, etc. Ground fauna : Elephants, chimpanzees, gorillas, monkeys, pangolins, etc.), reptiles (vipers, lizards, pythons, etc.)
Avifauna	Hartlaub duck, hornbills, grey parrots, hawks, etc
Fishing	Catfish (*Silurus glanis*), *Tilapia spp*, Crustaceans, fish, turtles
Population, ethnic groups	Indigenous : clans Balondo, Balue et Barombi. Alien/ Foreign : Bakweri, North-West, West and Littoral Nigerians and Ghanaian immigrants.
Livelihoods	Agriculture, small livestock, artisanal fishing, hunting, income generating activities (IGA), small trade, CIG, transport, employee jobs (PAMOL).
Institutions	Sub-divisioner, town hall, church, gendarmerie, police station, chiefdoms of 2nd and 3rd degree, agro-industry (PAMOL), s decentralized ministerial departments
Climate related calamities and risks	Long rainy season, floods, erosion, gastroenteritis (amoeba), malaria, rheumatism, cutaneous infections, difficult to access
Social calamities, societal risks	Poverty, banditry, underemployment, insecurity in creeks, illiteracy.

Table 26: Major landscapes components and calamities identified in Ngwéi in 2016

Landscape category	Description
Major biophysical elements and landmarks	Plains, low plateaus, hills, swamps, orchards, boreholes, roads, schools, dispensaries, health centers, church, permanent rivers, farms, dense forest, savanna, palm groves, cocoa trees.
Protected landscapes and areas	Church, schools, markets (Dingombi et Makondo1), health centers or dispensary, roads, fantasia
Crops and yields	Palm oil, cocoa, plantain, macabo, maize, peanut, yam, sweet potato, manioc, cocoyam, okra, peper, tomato, vegetables (folon, aubergine), cucumber, lemon, mangoes, orange, mandarin, grapefruit, papaw, guava, avocado, plum, coconut, sugar cane, pineaple, cassimanga, djansang, *Prunus africana*, palm wine
Trees and fruit trees	Trees: moabi, iroko, acajou, ébène, azobé, parassolier, china bamboos, raphia trees. Fruit trees : avocado, mango, guava, lemon tree, orange tree, grapefruit, coconut, plum tree, baobab, moringa,
Livestocks	Goat, sheep, pork, poultry, snails, hedgehogs.
Wild animals	Elephant, monkey, antelope, hare, buffalo, tiger cat, chimpanzee, gorilla, Nile monitor, porcupine, hedgehog, doe, palmist rat, squirrel, pangolin, agouti, snake, goliath frog, Sitatunga,
Avifauna	Owl, hawk, wild duck, partridge, crowned eagle, grey parrot

Fishing	Catfish (*Silurus glanis*), Tilapia *sp*, carpe (*Cyprinus carpio*), viper fish, crabs, shrimp.
Population, ethnic groups	Indigenous: Bakoko (Mpoo), Bassa. Alien/foreign : *Toupouri*, Fulbe traders, North-West foreigners
Livelihoods	Agriculture, small livestock, artisanal fishing, hunting, income generating activities (IGA), small trade, CIG, transport.
Institutions	Sub-divisioner, town hall, church, gendarmerie, 3rd degree chiefdom, head of township, agro-industry (SOCAPALM), decentralized ministerial departments
Climate related calamities and risks	Long rainy season, floods, erosion, bush fires, gastroenteritis (amoebas), endemic malaria, measles (children), rheumatism,
Social calamities, societal risks	Poverty, underemployment, land insecurity and violence, land conflicts, food insecurity, low morality among youth, illiteracy, lack of micro credit.

As part of the baseline assessment and the consultation process on the both landscape, we used a set of indicators for resilience in socio-ecological production landscapes (SEPLs) developed by Biodiversity International and the United Nations University - Institute of Advanced Studies (UNU-IAS), in collaboration with UNDP, to help measure and understand the resilience of the target landscapes. These socio-ecological landscape resilience indicators were measured in its five interrelated dimensions: protection of ecosystems and preservation of biodiversity; agricultural biodiversity; Livelihoods and well-being; knowledge, learning and innovation; social equity and infrastructure.

The baseline study was conducted from the SEPL (Socio Ecological Production Landscape) questionnaire in two villages in each of each district; namely Bongongo I and Masore in the Ekondo-Titi district, then, Makek and Seppe on the Ngwéi side. The SEPL evaluation questionnaire was applied to 115 people including 51 women and 64 men with an average of 25 to 30 people per village. Consultation and evaluation enabled effective, efficient and enhanced participation of women in the process.

At the end of these community consultations, stakeholders decided to support change and participate in the management of natural resources. They are willing to reverse current practices in order to better manage the resources of their territory. However, these good provisions require ongoing support in various forms and formulation of the implementation of effective management plans.

3.1. Landscape perception at Ekondo-Titi

Following the administration of the questionnaire to the population, the following synthesis (Table 25 and Figure 29) shows the results first in women, then in men, finally in both sexes.

Table 27: Synthesis of SEPL performance scores of Ekondo –Titi women

Ekondo-Titi : Women	Ecosystems Protection	Biodiversity	Knowledge and innovation	Governance and social equity	Livelihoods and well being
Lowest third	2.48	3.57	3.86	4.30	2.66
Mean rating	2.74	3.70	3.89	4.33	2.74
Highest third	3.02	3.92	3.96	4.40	2.72
Standard deviation	**0.71**	**0.54**	0.32	**0.56**	**1.20**

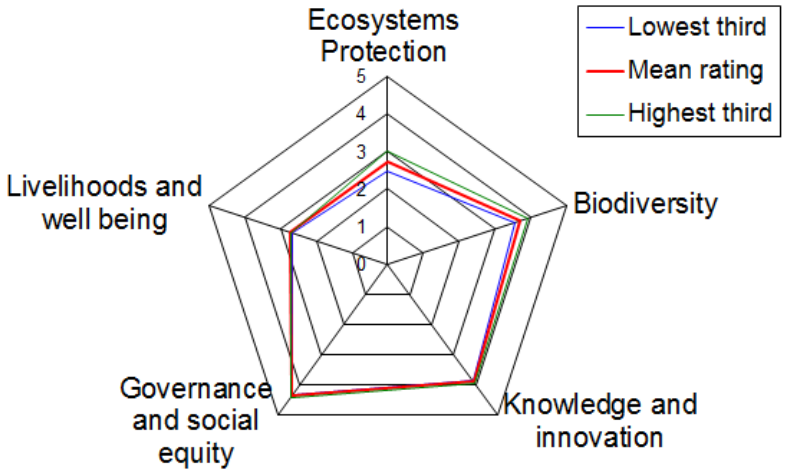


Figure 29: Synthesis radar diagram of SEPL performance indicators of Ekondo –Titi women

For women, the perception of ecosystem protection poses a real consensus problem with a standard deviation of 0.71. The same is true with livelihoods and well-being (1.20). A certain unanimity exists in the learning of knowledge and innovation (0.32), a relative balance of perception in biodiversity, then social equity and infrastructure with relatively low standard deviations (0.54 and 0.56).

On the other hand, the men perception is different with a standard deviation of 0.39 in governance and social equity (Table 28 and Figure 30). Livelihoods show a high score like for biodiversity; then for knowledge, learning and innovation (0.57 & 0.54). The ecosystems protection seems unanimous and relatively better perceived in men (0.50) than in women (0.71) case.

Tableau 28: Synthesis of SEPL performance scores of Ekondo –Titi men

Ekondo-Titi : Men	Ecosystems Protection	Biodiversity	Knowledge and innovation	Governance and social equity	Livelihoods and well being
Lowest third	2.69	3.14	3.43	4.33	2.79
Mean rating	2.74	3.17	3.47	4.34	2.91
Highest third	3.10	3.39	3.70	4.40	3.68
Standard deviation	0.50	**0.57**	**0.54**	0.39	**0.87**

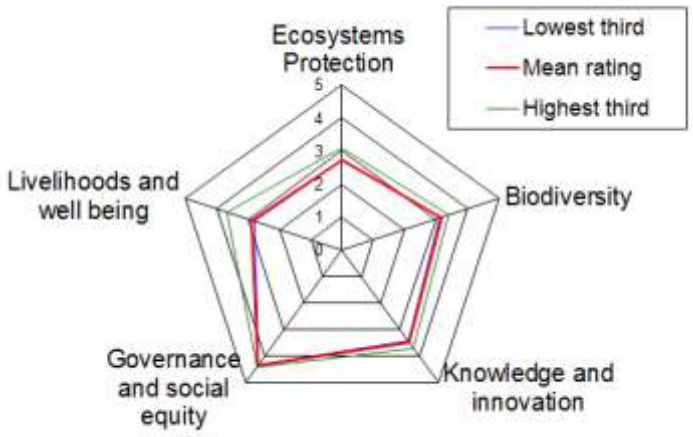


Figure 30 : Synthesis radar diagram of SEPL performance indicators of Ekondo –Titi men

These general disparate results lead to the conclusion that the Ekondo-Titi people still have to work hard to obtain consensus on the ecosystems protection (0.60), agricultural biodiversity (0.62), as well as livelihoods (1.04). Two indicators seem to show a beginning of consensus (Table 29): knowledge and innovation (0.49), then governance and social equity (0.47). However, the governance and social equity indicator remains the bone of contention, including in figure 31.

Tableau 29: Synthesis of SEPL performance scores for Ekondo-Titi both sexes

Ekondo-Titi : male and female	Ecosystems Protection	Biodiversity	Knowledge and innovation	Governance and social equity	Livelihoods and well being
Lowest third	2.72	3.43	3.67	4.33	2.76
Mean rating	2.74	3.42	3.67	4.33	2.83
Highest third	3.10	3.39	3.70	4.40	3.68
Standard deviation	**0.60**	**0.62**	0.49	0.47	**1.04**

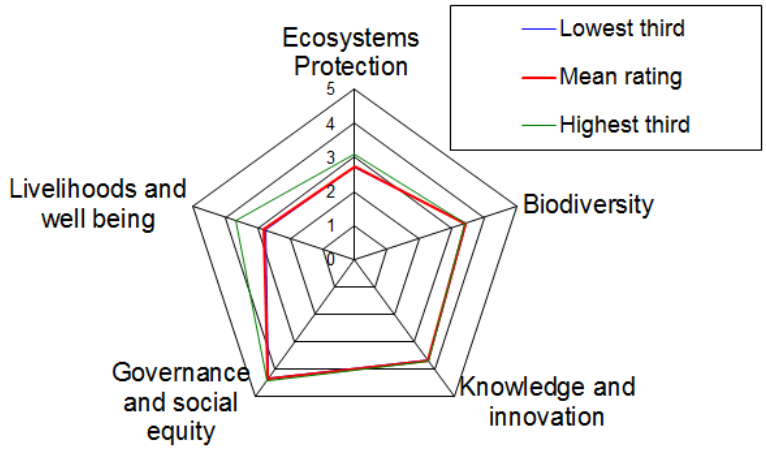


Figure 31 : Synthesis radar diagram of SEPL indicators for Ekondo-Titi both sexes

Based on these findings, it is necessary to sensitize Ekondo-Titi communities to conservative ecological practices without forgetting their provision of livelihoods and infrastructures. Indeed, the poor quality of roads impacted livelihoods in the rainy season. The same is true

with the lack or poor provision of electricity without forgetting access to telecommunications networks.

As for the ecosystems protection, sacred sites do not exist and only a few useful trees for the traditional pharmacopoeia are protected from clearing. Naturally and because of the environment anthropization, we observe a tendency of forest ecosystems reduction, even if there are some land reserves (protected in the expectation of it future use) and rugged Afro-montane forest sites, difficult to access and which remain areas of wildlife refuge in the western part of Ekondo-Titi, bordering the Rumpi Hills.

Agricultural Biodiversity: There is a wide variety of agricultural resources that derive from the opening of Ekondo-Titi to Nigeria. In addition, the use of local varieties of crops and animal species as well as the consumption of local foods (cereals, vegetables, fruits, wild plants, tubers) is favoured. Agricultural biodiversity, well preserved in the oral tradition, is perfectly transmitted to the younger generations of this society through songs and mimes. Agricultural diversity is encouraged and promoted by national programs aimed at self-sufficiency and yield growth in some speculation (maize, cassava, *era* or *Prunus*, etc.). Some local organizations, based on the funding provided by national and international NGOs, experience *Prunus africana* domestication. In 2016, Ekondo-Titi City Council has initiated an agricultural fair for the promotion of agricultural diversification. Such practices must be strengthened, generalized, well managed and extended to the whole district. However, it is necessary to reduce the use of chemical fertilizers, which aggravate the soils degradation already exposed to water erosion and also contaminate running water used for all kinds of needs (dishes, laundry, drinks, bathing and agriculture).

The **knowledge and innovation indicator** is of particular interest because innovations in the agricultural sector aim to improve the population resilience. We found a real consensus on the presence of institutions able of supporting the population efforts (PAMOL and administrative authorities). The relatively low standard deviation shows that institutional development is a priority for Ekondo-Titi.

Governance and social equity indicator is under construction in these communities. Indeed, the chiefdoms are reconstituted in order to try to cope with the challenges of demographic growth and new development challenges. The administrative authorities and PAMOL support these initiatives, as they hope to rely on traditional authorities to govern. The social environment between the PAMOL agro-industry and the local population is very good and looks like as a win-win model that deserves to be encouraged. This indicator obtained the lowest scores in the summary table (0.47). However, perceptions have always stood at inequalities between men (0.39) and women (0.56).

The last indicator on **livelihoods and well-being** measures the impact of the previous ones. It justifies a real consensus on the presence within the landscape of health infrastructures, schools, markets, social and collective facilities for youth, etc. also the inadequate / poor road infrastructure and telecommunications networks. In addition, the hard labour in oil palm plantation encourages the occurrence of diseases such as rheumatism and aches, accidents, snake bites, not to mention the water that causes skin diseases (pruritus, eczema, itching of all kinds), diarrhoea and infectious diseases (malaria). This indicator has achieved the highest scores everywhere because of the enclavement and poor sanitary conditions that can be resorbed with the asphalting of the Kumba-Mundemba road.

3.2. Landscape perception in Ngwéi

The standard questionnaire forwarded in two villages of Ngwéi (Makek and Seppe), gave the following results for both sexes. As far as women are concerned, the radar graph seems to indicate a certain balance in the perception of the different indicators (Figure 32). Governance and social equity alone obtains a high standard deviation (0.74), which reveals disparities in the perception of this theme. In addition, we notice and unanimously perception on the livelihood and well-being indicators (0.51); then, knowledge and innovation (057). However, viewing the high scores (Table 30) in ecosystems protection (0.63) and biodiversity (0.64), women will need to put more effort on this aspect, which among others, is based on the management and conservation of forest resources.

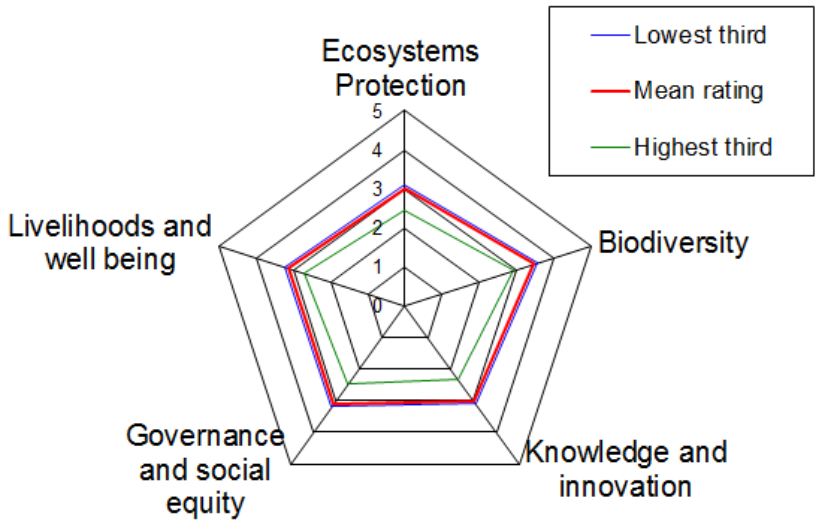


Figure 32 : Synthesis radar diagram of SEPL performance indicators of Ngwéi women

Tableau 30 : **Synthesis of SEPL performance scores of Ngwéi women**

Ngwéi - Women	Ecosystems Protection	Biodiversity	Knowledge and innovation	Governance and social equity	Livelihoods and well being
Lowest third	3.09	3.56	3.09	3.19	3.24
Mean rating	3.02	3.47	3.00	3.10	3.15
Highest third	2.44	2.91	2.31	2.47	2.73
Standard deviation	**0.63**	**0.64**	0.57	**0.74**	0.51

Men scores (Table 31) appear to be very high, particularly in agricultural biodiversity (0.74), knowledge and innovation (0.81), governance and social equity (1.20). Such a situation clearly reflects the lack of unanimity in this landscape and can already underestimate disputes related to land tenure and oil palm.

Tableau 31 : Synthesis of SEPL performance scores of Ngwéi men

Ngwéi - Men	Ecosystems Protection	Biodiversity	Knowledge and innovation	Governance and social equity	Livelihoods and well being
Lowest third	2.57	2.75	2.63	3.37	2.52
Mean rating	2.70	2.81	2.74	3.31	2.61
Highest third	2.88	2.89	2.79	2.67	3.03
Standard deviation	0.67	**0.74**	**0.81**	**1.20**	0.62

Indeed, the resulting radar diagram (Figure 33) clearly shows a considerable working effort of perception in governance and social equity indicator. The absence of infrastructure, the lack

of electricity, roads, drinking water supply, community center for youth, health centers constitute evils that undermine this territory, which, remains largely enclaved despite the Yaoundé-Douala National Road passing through.

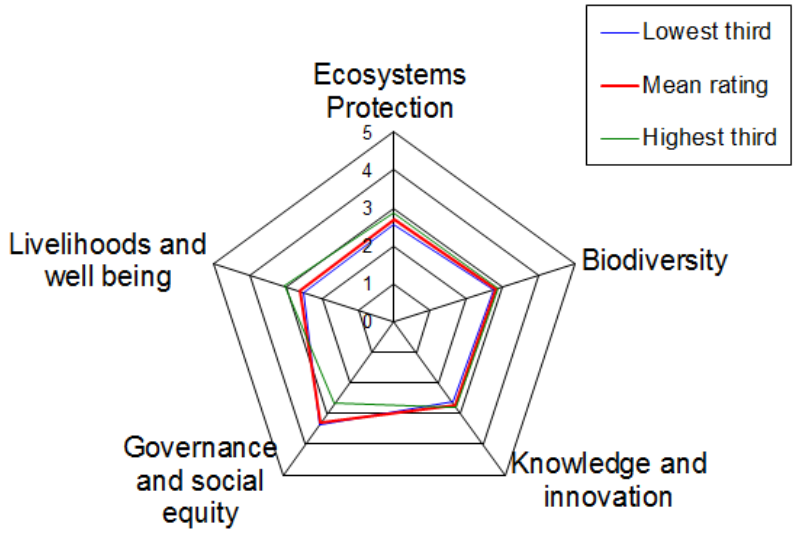


Figure 33: Synthesis radar diagram of SEPL performance indicators of Ngwéi men

In terms of indicators performance synthesis of both sexes in Ngwéi, Table 32 shows that ecosystems protection retains the lowest score (2.80) followed by knowledge and innovation (2.82), then governance and social equity (2.84). It means that these indicators are the main priority axes where the Ngwéi people will put more efforts. This can be explained by the priority currently given to palm oil and cocoa plantations that both nibble the forest.

Tableau 32: **Synthesis of SEPL performance scores for Ngwéi both sexes**

Ngwéi – Male & female	Ecosystems Protection	Biodiversity	Knowledge and innovation	Governance and social equity	Livelihoods and well being
Lowest third	2.80	3.26	2.82	2.84	3.04
Mean rating	2.80	3.06	2.80	3.18	2.82
Highest third	2.96	3.11	2.91	3.54	2.77
Standard deviation	0.66	**0.75**	**0.75**	**1.04**	0.62

High standard deviations in agricultural biodiversity (0.75), knowledge and innovation (0.75), then governance and social equity (1.04) reflect a lack of consensus in these landscape themes, even if the graph (Figure 34) shows a relative equilibrium.

The lack of basic infrastructures (water, energy and road) explains these high standard deviations. The same is true with the difficult access to railway and telecommunication networks.

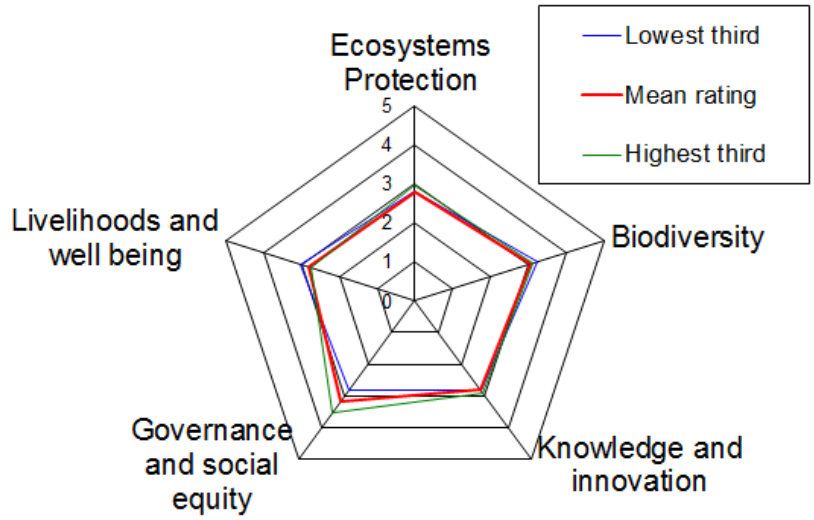


Figure 34 : **Synthesis radar diagram of SEPL indicators for Ngwéi both sexes**

Looking at the **ecosystems protection**, the total absence of sacred sites does not militate in favour of this ecosystems conservation. The forest is getting degraded more and more. Thus, people recognize and confess it with impotence, especially the Seppe village chief.

Agricultural biodiversity indicator shows a quite good variety of agricultural resources (plantain, cocoyam, yam, cassava, sweet potato, coconut, palm oil, cocoa, pineapple, grapefruit, orange and lemon) as well as fauna resources (porcupine, hedgehog, pangolin, elephants in Njock-Loumbe). The use of local varieties of crops and animal species as well as the consumption of local foods (vegetables, corn, fruits, wild plants and tubers) are favoured. Agricultural biodiversity seems to be well preserved in the oral tradition, but it is not transmitted to the young generations of this society for cultural extraversion reasons. This may explain the observed lack of consensus. However since 2015, local language courses have been introduced in primary and secondary schools. Nevertheless, it will be necessary to raise awareness among population on the need of reducing the use of chemical fertilizers, which aggravate soils contamination and degradation and infect running water used for all kinds of needs (dishes, laundry, drinks, bathing and agriculture).

Knowledge and innovation by its score (2.91), seems to indicate that few people are interested in learning about knowledge and especially innovation. Yet this indicator could help improve the living conditions and even the resilience of the local people. The poor resilience situation experienced may be due to recurring land tenure conflicts with SOCAPALM which has ceased to support the populations and to honour its commitments. The high standard deviation (0.75) raises the institutional development problem as well as the respect of traditional (township local authorities) and modern institutions (mayors and sub-prefects).

Looking at the **governance and social equity** indicator, it appears that these communities are suffering from the poor quality of path and roads used in the rainy season. Such a situation increases the cost of motorcycle trips. Electricity is provided in only three (3) villages out of 29, it is insignificant for a region that produces electricity. ALUCAM is the only industry, which, in 2008, based on the findings of its environmental audit, drilled and offered portable water to the population of a dozen villages. The strained social environment between SOCAPALM and local population requires attention if the government was willing to save this landscape and it forest. Because the establishment of elitist oil palm plantations results

from a revenge attitude against the abuses of SOCAPALM. However, the fact that most of the village sons are not employed leads to high pressure on the forest, since the administrative or communal institutions are unable to react.

Livelihoods and well-being still shows inadequacies : one (1) single high school, one (1) CETIC, ten (10) schools, two (2) health centers, one (1) single market in Makondo I for 15,000 inhabitants! In addition, the difficulty of labour in oil palm cultivation is a source of diseases such as rheumatism and aches, accidents, snake bites and endemic malaria. This indicator achieved the highest scores due to landlocked and poor sanitary conditions.

3.3. General synthesis of individual SEPL indicators

The aim of this synthesis is to explain the reasons for high scores or low scores for the 5 indicators used in the two landscape, based on surveys, field observations, interviews and exercises. Problems being almost the same everywhere, the specificities of each district will be italicized within the text. Since the exercises were carried out in four villages (two in each district), we will not fail to mention them.

3.3.1. Ecosystems Protection

For Ngwéi, the mean value of this indicator varies from 1.50 to 4.50 in Makek and Seppe.
As for Ekondo-Titi, it varies from 2.00 in Bongongo I to 4.25 in Masore.

The high perception scores on this indicator in the two districts are due to several reasons:

- ❖ Nurseries of oil palm, cocoa and even *rubber at Ekondo-Titi*;
- ❖ Some of the oil palm waste (raffle) are used as organic fertilizer;
- ❖ Drilling for the supply of drinking water by ALUCAM in Ngwéi and the Town Hall in Ekondo-Titi;
- ❖ Agroforestry of oil palm and cocoa trees has been successfully practiced in the two districts, not to mention the NWFP (*Prunus africana) and the rubber tree in Ekondo-Titi*

The following reasons are suggested **for low scores:**

- ♣ Wood resources are intensively used (fuel wood, timber, space development, plants, fish and game smoking, etc.);
- ♣ Protected areas of traditional or modern establishment are missing in the different villages, this situation has led to a decrease in **animal and plant biodiversity**;
- ♣ Food crop yields appear to have fallen and declined due to demographic growth. Declining of soil fertility and soil erosion as well as land competition linked to oil palm and cocoa pose a serious threat in the villages surveyed;
- ♣ The effects of climate and environmental changes are not controlled by population, their impacts are severely felt by ecosystems and local population (food insecurity, diseases, etc.);
- ♣ Water resources protection and use of organic fertilizers are not widespread;
- ♣ Population are not aware of the nature conservation and knowledge on biodiversity is not documented (both sites). *In addition, land tenure rights are not clearly defined (Ekondo-Titi*);
- ♣ The use by PAMOL of a variety of *Elaeis* seed with large nucleus plays on the spatial extension of the areas allocated to the palm and the various speculations and in turn contributes to the **regression of the dense forest**.

3.3.2. Agricultural biodiversity

This indicator, which has found no consensus, nevertheless addresses an important aspect that affects the survival of people: food security. In all villages, actions have been observed for the survival and maintenance of agricultural biodiversity in all its forms, with priority given to local varieties of crops and animal breeds and the use of local foods such as cereals, vegetables, fruits, wild plants. However, this agricultural biodiversity is well preserved in the oral tradition. Oral tradition in Africa has always been the best means of documentation before writing, and it is relatively well communicated in the villages of these societies.

As for **agricultural biodiversity**, the average value ranges from a minimum of 1.00 in Makek-Seppe to 4.33 in Seppe. Similarly, the standard deviation varies from a minimum of 0.55 to 0.73, reflecting relatively heterogeneous perceptions, despite high overall scores. However, the level of understanding of population requires greater efforts to build consensus, especially between youth and adults, and then between men and women. In Ekondo-Titi, the mean value varies between a minimum of **2.00** in Bongongo I and **5.00** in Massore, with a standard deviation ranging from 0.36 to 0.64 in Bongongo I.

Reasons for these high scores:

- ❖ A wide variety of local crops are used, conserved, consumed, but there is no community seed bank;
- ❖ A relative variety of animals such as goats, sheep, ducks, *hedgehogs* (Ngwéi), poultry, fish and crabs caught;
- ❖ Improved palm and cocoa seeds;
- ❖ Agricultural products are mainly consumed and the surplus is sold on the local and sub-regional market (*Kumba and Nigeria for Ekondo-Titi*, then *Douala-Edéa for Ngwéi*). Different crops (cassava, maize, yam, sweet potato, etc.) are the main source of food, except for a small part that is sold for some basic necessities;
- ❖ Fresh fruits and vegetables are grown and available in all seasons.

Reasons for low scores:

- ♣ Low concern about the sustainable management of cultivated or exploited resources;
- ♣ Low consumption of cultivated products (marketable food in Ngwéi basically);
- ♣ Predominance of palm cultivation to the detriment of food crops (mainly in Ngwéi);
- ♣ Lack of accompaniment of local population by the authorities (mainly in Ngwéi).

3.3.3. Knowledge and innovation

This indicator is of particular interest for the management of biodiversity and innovations in the agricultural sector in order to improve the population resilience. The value varies from **1.00** in the Makek village to **4.75** in the Seppe village (Ngwéi); Then from **2.25 in Bongongo I to 4.25 in Masore** (Ekondo-Titi). The surveyed population gave a relatively high score because the consensus is real. Nevertheless, there is a lack of institutions capable of supporting and enhancing the populations efforts, since the CIGs are less equipped to do so. The relatively high standard deviation (0.75) at Ngwéi shows that institutional development must be a priority in this oil palm district.

Reasons for high scores are as follows:

- ❖ The existence of the local CIGs which supervise the producers in the production and sale. These organizations would benefit from being grouped into cooperatives and strengthened;
- ❖ Women's skills are widely accepted and used;

- *The introduction of the vernacular language into school curricula since 2014 school year in Ngwéi;*
- *The literacy effort is well received among Ngwéi population;*
- *The existence of mimes, tales and songs related to agricultural biodiversity in Ekondo-Titi;*
- *Communities generously use local terminology for resources such as land and water (especially in Oroko and Abo language) in Ekondo-Titi. In addition, the knowledge on cosmology and the protection of natural resources, which are transmitted from generation to generation are practices that would be encouraged despite the very low literacy rate;*
- *Elders transmit conservation knowledge to the younger generations that are aware of it; culture and its rituals are followed and practiced by many generations (Ekondo-Titi).*

Reasons for low scores:

- Practices of agricultural diversity exchanges are carried out only from time to time between villages;
- *Most traditions are lost in Ngwéi and tend to be restored in Ekondo-Titi*;
- Knowledge is not well documented, even if it is mastered in oral tradition;
- There are many difficulties of understanding between generations;
- The malfunctioning of CIGs, most of which are fictitious, if not non-existent.

3.3.4. Governance and social equity

Governance and social equity indicator measures the impact of previous indicators on the position and status of local governance, land autonomy and resource management, women's participation in decision-making and communication with the outside world without forgetting the respect of their knowledge. The average value in this indicator varied from a minimum of **1.25** in the Makek village to **5.00** in Seppe (Ngwéi). On the Ekondo-Titi side, this value increases from **2.25** in Bongongo I to **5.00** in Masore

The reasons for the high scores are as follows:

- Existence of chiefdoms, heads of cantons and closeness to agro-industries (SOCAPALM, SPFS, Ngué Martial in Ngwéi, PAMOL in Ekondo-Titi);
- Free access to land by the indigenous in all villages;
- Women empowement;
- The existence of the drilling provided by ALUCAM at Ngwéi and by the Town Hall at Ekondo-Titi in spite of the sub-floating water table;
- *The retrocession by SOCAPALM of the Ikonde palm plantations managed by the sub-divisional office at Ngwéi;*
- *A peaceful social climate between PAMOL and the populations of the Ekondo-Titi villages.*

For low scores, the following reasons can be provided:

- Local communities have limited access to decision-making, especially in terms of infrastructure and land management;
- *The social climate of insecurity due to poor road conditions and claiming against SOCAPALM which does not respect its commitments in Ngwéi*;
- *The insecurity linked to the opening on the sea in the creeks at Ekondo-Titi*.

3.3.5. Livelihoods and well-being

Accessibility to social services, basic infrastructure such as roads, schools, health centers, etc. logically depend on local development and the population welfare. This indicator has everywhere obtained appreciable scores about the level of the population resilience within the landscape. Elsewhere, we noticed a real consensus on the absence or inadequacy of health infrastructures, roads, schools, markets, social and collective facilities for youth, water and electricity supply, etc. The scores vary between **1.00** and **4.00** in the two villages of Ngwéi while its range from **1.40** to Bongongo I to **4.20** in Massore (Ekondo-Titi)

High scores are explained by:

- *6 health centers for 29 villages, 22 primary and secondary schools (including 5 nursery schools, 15 primary schools, 3 CESs, 1 SAR / SM, 1 secondary high school, 1 CETIC in 15 villages), Ngwéi;*
- *Health is experiencing some significant improvements with the creation of a hospital equipped by PAMOL at Ekondo-Titi*;
- Use of the traditional pharmacopoeia in the two districts;
- Marked improvement of the health supply (significant and qualitative increase in the number of establishments) whose presence is highly appreciated;
- Diversification of IGAs;
- Availability of land;
- Immunization campaigns and distribution of impregnated mosquito nets.

Low scores are due to the following reasons:

- Communities have limited access to infrastructure decisions;
- Infrastructure such as electricity, water and road are insufficient or less accessible. Electricity services do not function satisfactorily (a power shortage can last for weeks), resulting in generators purchasing;
- Health facilities are inadequate in most of the villages. *Malaria is endemic in the Ngwéi district* and *is a threatening plague in Ekondo-Titi where the distribution rate of impregnated mosquito nets is low (14%).* In both districts, there is a health risk due to bathing in water from the contaminated water table, resulting in skin diseases;
- Floods (high vulnerability) are severely felt by people who lose their property and lives;
- Rural roads are difficult to reach in the rainy season and, moreover, are not regularly maintained, especially for remote villages;
- Local crafts and tourism are weakly developed.

3.3.6. Trend arrows

In addition to the scores, it is worth mentioning that the trend indicators computed show that this societies are poorly changing. Indeed, 1/3 of the population (35.88%) think that the situation of the landscape has not changed in 50 years! In addition, 25.19% estimate that there has been a significant improvement in social equity compared to 18.53 who believe in a slight deterioration, particularly in terms of animal health and biodiversity (mammals particularly). Finally, 8.14% choose steep downward trend (abrupt decrease), especially in the field of health and risk exposure as well as the biodiversity degradation; while 12.25% consider that there has been a clear improvement in certain living conditions, especially in Ekondo-Titi (Table 33).

Table 33: **Landscapes trend arrows and scores in Ekondo-Titi and Ngwéi**

Villages	↑ steep upward	↗ slow increase	→ no change	↘ slow decrease	↓steep downward	Total
Bongongo I	38	80	96	45	21	280
Masore	46	100	54	27	13	240
Total 1	***84***	***180***	***150***	***72***	***34***	***520***
% synthesis 1	***16,15***	***34,62***	***28,85***	***13,85***	***6,54***	***100***
Makek	27	49	113	61	30	280
Seppe	14	28	103	56	19	220
Total 2	***41***	***77***	***216***	***117***	***49***	***500***
% synthesis 2	***8,2***	***15,4***	***43,2***	***23,4***	***9,8***	***100***
Total	**125**	**257**	**366**	**189**	**83**	**1020**
%	**12,25**	**25,19**	**35,88**	**18,53**	**8,14**	**100**

In this table, the high score (**34.62**) for the "slow increase" trend in Bongongo I and Masore reflects the illusion of the population's margin for maneuvering the resources of their territory (sea, Atlantic forest, dense forest and mangrove) in Ekondo-Titi. We can also understand the fallacy of the people of Ngwéi villages, of whom 2/5 believe that the landscape has not changed (**43.20**). However, they objectively acknowledge (**23.4%)** that negative changes (landscape degradation, resource depletion, poverty) are more significant than positive changes **(15.4%).**

3.4. Recommendations and conclusion on the SEPLs indicators of both districts

Based on the main challenges facing these landscapes of Ngwéi and Ekondo-Titi, the recommendations go in the direction of its revitalization by promoting the sustainable management of natural resources and especially land resources. In addition, local communities must be actively involved in the sustainable management and use of natural resources to increase agricultural production, restore biodiversity, create wealth to optimize ecosystem services (lack of protected areas, community and council forest, etc.). However, within these communities, the place and contribution of women is significant and improving with generations and education. Nevertheless, the population's lack of control on the landscape leads inexorably to the gradual and unconscious erosion of biodiversity and natural ecosystems.

For the specific case of Ngwéi, it should be pointed out that the community life remains an element to be built in order to reinforce resilience, the participation of populations and the spirit of solidarity in the concerted management of resources. Because everyone is at his head, included in the CIGs. It is also necessary to combat the isolation linked to the poor condition of roads and the absence of an alternative such as railway. The locality does not derive sufficient economic benefits from a single market for the palm oil sale, all of which a cooperative could have solved. Access to improved oil palm seeds remains a headache, for people are attacking the forest in order to increase production areas because of the unavailability of high-yielding selected seeds.

In Ekondo-Titi, the Mayor's concentration of artisanal oil mills that use vehicle engines in one place is beneficial for the landscape, biodiversity, soils and streams. What remains is to carry out an effective and adequate monitoring of the functioning of this site.

Therefore, what recommendations should be made to the populations and institutions of these landscapes in order to improve resilience? Because, the objective of the SEPL exercises is to improve resilience through the basic activities of local communities.

R1: To reduce dependence on oil palm (and even cocoa), diversification of resources and livelihoods is needed to increase welfare through alternative activities and diversification of production types. Implementation and diversification of agroforestry products and ecological agriculture without external inputs of chemical fertilizers for food production. This means improving the management and protection of ecosystems (wildlife habitats, lakes and swamps, creeks, hydrosystems and watersheds) through improved water and soil management (water and soil conservation); erosion control, wetland protection for better visibility in the landscape. Strengthen agricultural management and production, promotion of agroforestry, tiered and multiple agriculture to restore soil and safeguard the integrity of the landscape. The same applies to the installation of hedges around farms to protect crops and increase production.

R2: The conservation of useful trees for firewood without forgetting the manufacture of local materials (clay) and the systematic introduction of improved stoves can slow deforestation. It is also necessary to propose the intensive use of straws from the oil palm, not to mention the use of almond shells for the manufacture of **necklaces, jewellery and other gadgets** (photos 5a & b)

Photos 5a &b: Some gadgets made by a Kribi craftsman based on palm nuts and coconut shells.

R3: Establishment and strengthening of governance structures and institutions as well as basic social infrastructure and facilities (education with agricultural high schools, health institutions and infrastructures, drinking water, roads, electricity including green technologies such as photovoltaic, sports and youth centers), as well as micro-finance and micro-credit facilities. Improve the livelihoods and well-being of social groups through the development and diversification of income-generating activities based on local resources (creation of small seed diversification companies, seed banks, local manufacturing company of cassava flour from manioc tubers, etc.).

R4: Malaria control through the efficient distribution of impregnated mosquito nets and drugs as well as awareness-raising, especially of youth in their behaviour towards the environment. Strengthen institutional capacity at the landscape level and integrate the participation of all stakeholders in decision-making on the landscape, especially women and youth. Finally, the

promotion and empowerment of women through adult literacy and apprenticeship in small trades (crafts, dyeing and making soap, making micro-credits available for the development of IGAs) would enhance the resilience of the landscape while limiting the pressure on the forest.

4. Oil palm plantation dynamics of both districts from remote sensing data

After the empirical tools and indicators used to measure deforestation and changes in the Ekondo-Titi and Ngwéi landscapes, the fourth part of this report will be based on remote sensing and GIS to measure and assess statistically and spatially, the evolution of land use in these two districts. It will deal with Landsat (MSS, TM, ETM + and 8), Geoeye, Ikonos and Google Earth images available.

4.1. Status and land use maps for Ekondo-Titi

The land use maps were performed using Landsat diachronic images (for which we have made a multidate and multitemporal classification of land use) and Google Earth images from 2014 and 2016. Landsat satellite imagery from 1978 to 2015 have been useful for the diachronic analysis of the evolution of agroforestry systems and forests in the Ekondo-Titi district. Using these images and the Google Earth scene in 2016, the impact of oil palm plantation systems on the degradation and conversion of dense forests was quantified and highlighted.

In 1978 (Figure 35), PAMOL is already established in Ekondo-Titi and has set up the essential part of its oil palm exploitation system. On the other hand, the forest and the mangrove are still well preserved and less attacked by the anthropogenic activities. However, some elites hold a few oil palm plantations around Ekondo-Titi centre (Bongongo I, Kumbe Balondo, and Kitta Balue).

In 1986, some pockets of forest degradation and fragmentation were observed. Elitist and villager oil palm plantations have increased significantly (Figure 36), while mangroves appear to be intact. However, the forest is degraded further. It is important to note that before the year 2000, the main drivers of deforestation were food crops and cocoa trees.

In 2000 (Figure 37), forest degradation continues along with mangrove forest degradation. The forest in the southern part of the Ekondo-Titi map is completely degraded. Three-fifths (3/5) of the forest vegetation have disappeared. The plantations extend almost everywhere, especially in the southern and central part of the image.

By 2015 (Figure 38), the regressive dynamics of natural vegetation continues insidiously. Deforestation is increasing in the central part of the image (Ekondo-Nene, Leo Village). More than half of the original forest has disappeared. This severe degradation of the Atlantic forest is linked to the various anthropogenic activities in this territory. Since 2000, even though if there is a diversification of anthropogenic activities, oil palm cultivation become the main deforestation driver because of the multiplication of areas devoted to it spread.

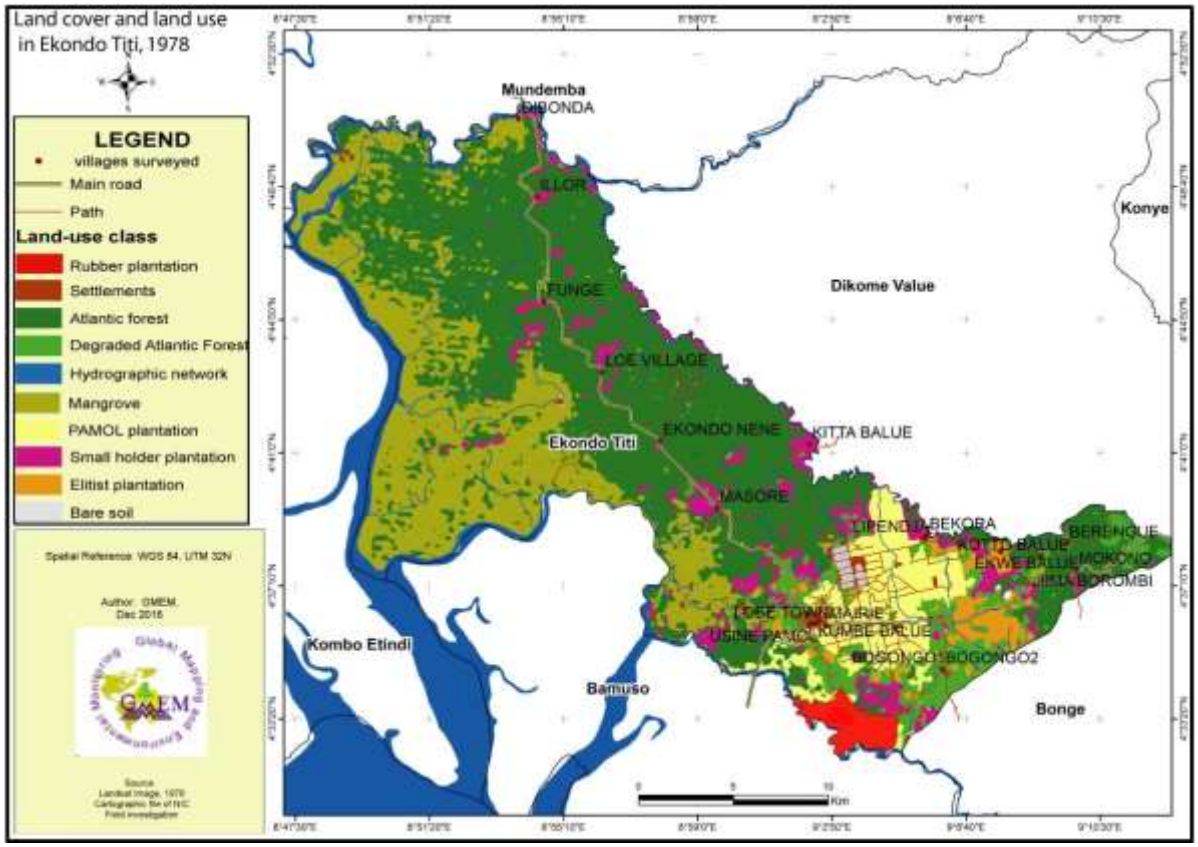


Figure 35 : Land use in Ekondo-Titi in 1978 from Landsat MSS images

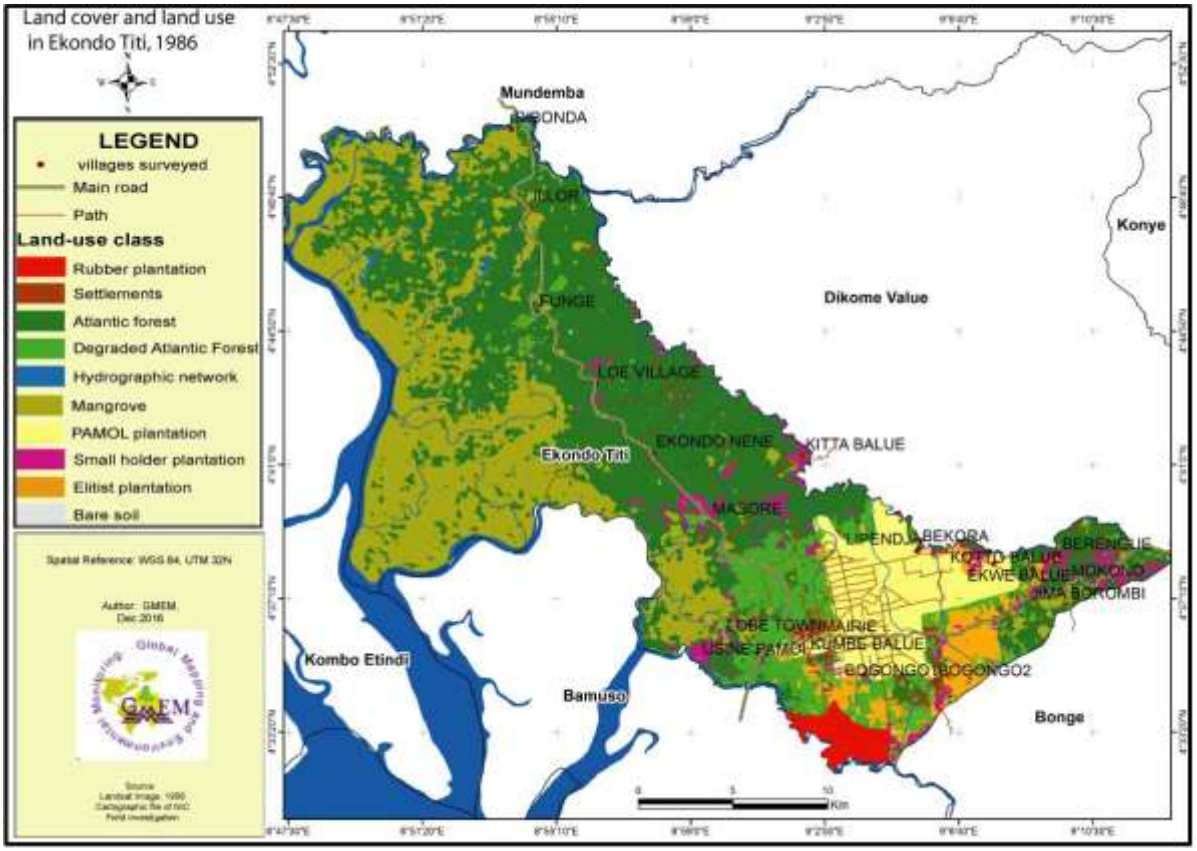


Figure 36 : Land use in Ekondo in 1986 from Landsat TM images.

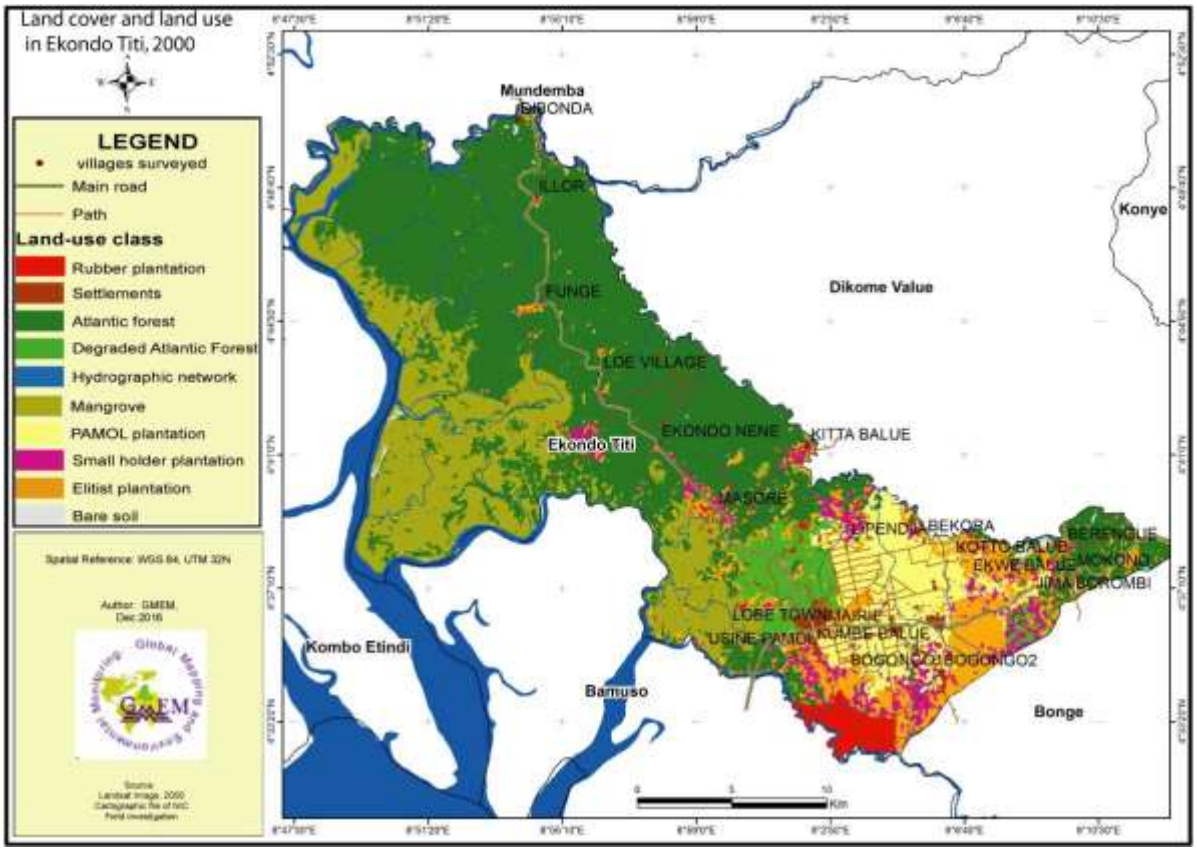


Figure 37 : Land use in Ekondo in 2000 from Landsat ETM+ images.

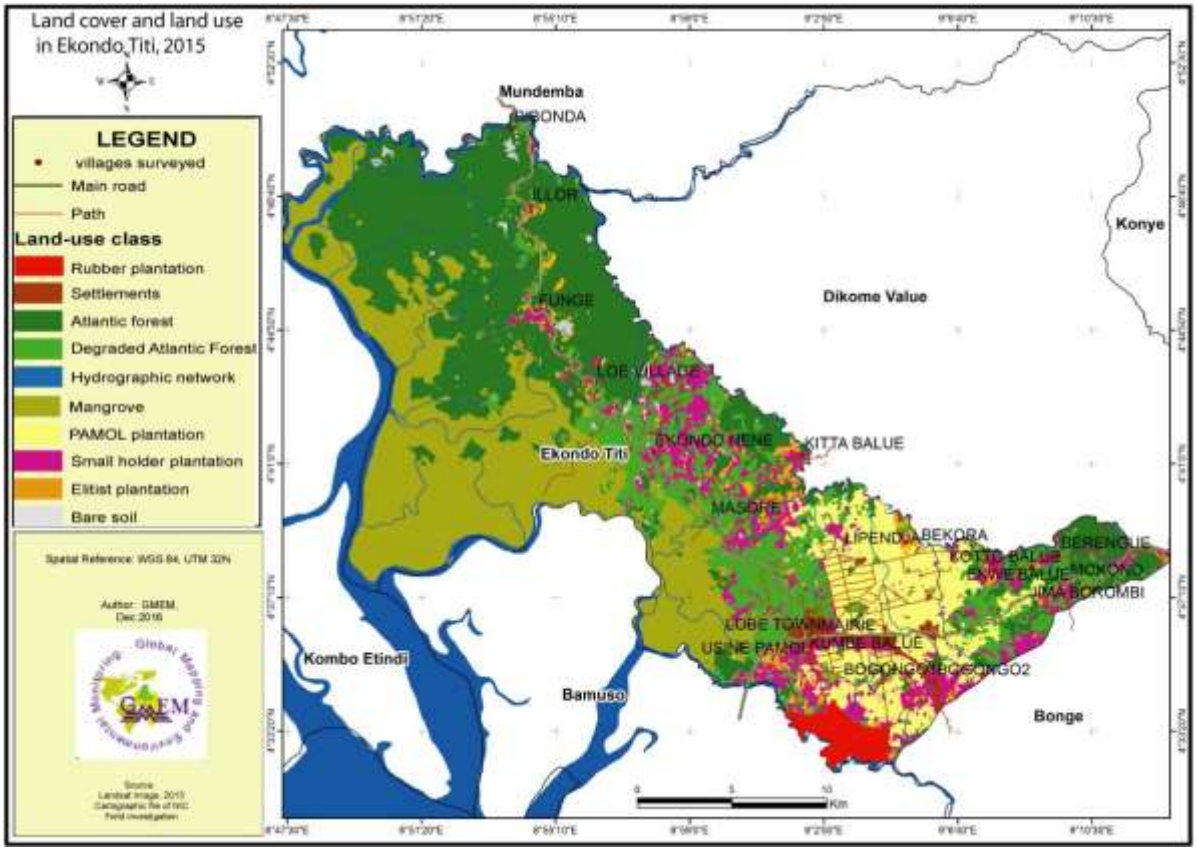


Figure 38 : Land use in Ekondo in 2015 from Landsat 8 images.

The statistics obtained from the processing of the Landsat images allow us to assert that deforestation has evolved in Ekondo-Titi at a rate of 22.74% in 37 years, i.e. 0.61% per year and especially 150.34 ha /year of Atlantic forests against 67.07 ha / year for mangroves. At such a rate (which can accelerate), we can estimate the total disappearance of Atlantic forest in 125 years and 189 years for mangrove. Figures 39 and 40 below illustrate this evolution of the oil palm cultivated areas.

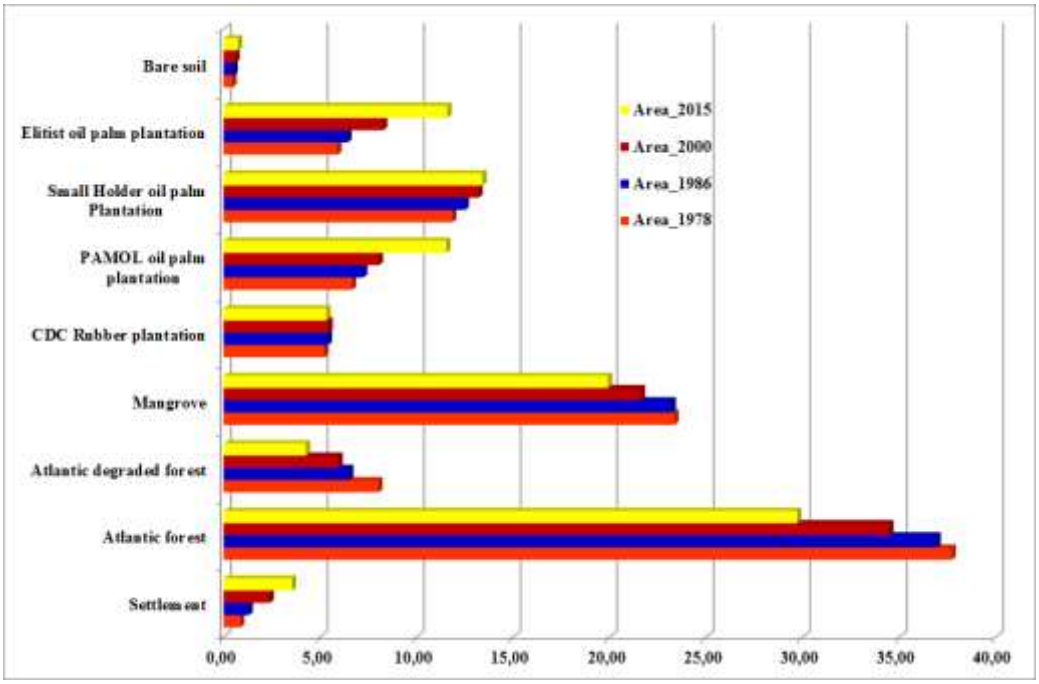


Figure 39: Evolution of the forest and palm plantations in Ekondo-Titi between 1978 and 2015.

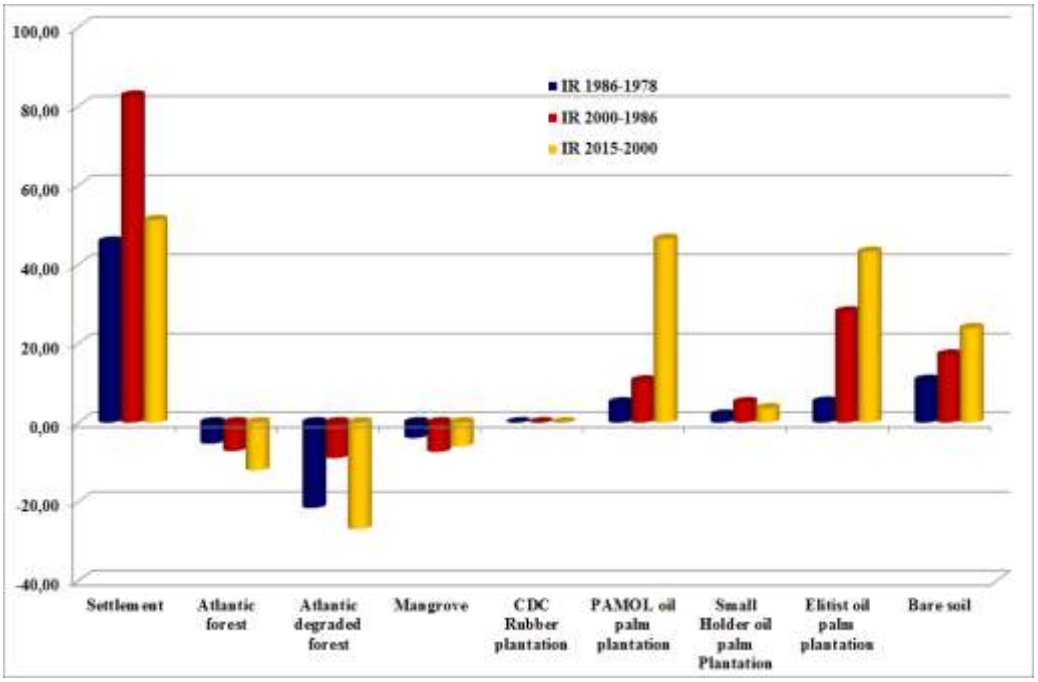


Figure 40 : Increase rate (IR) of the forest and palm plantations in Ekondo-Titi between 1978 and 2015.

Obviously, the increase rate is not the same. One can observe a boom in small holder, elitist and industrial palm plantations, while during the same period, the decline of the forest has been accelerated with a total of 12.09% in 15 years, i.e. a rate of 0.80% per year (which means at least 250 ha of forest loses per year between 2000 and 2015).

However, the spatial resolution (30m) accuracy of these images is relative. For this reason, we processed a final map of the land use with 2016 Google Earth image (0.60 m; Figure 41). It shows an increase of deforestation near roads, a concentration of activities in the southern part of the map around the Ekondo-Titi town and PAMOL plantations. This map, by its level of exactness, should serve as a reference for monitoring the evolution of the ecological activities in the near future. Indeed, it shows that more than half of the area of this district is affected by the deforestation or the degradation of the forests due to oil palm plantations.

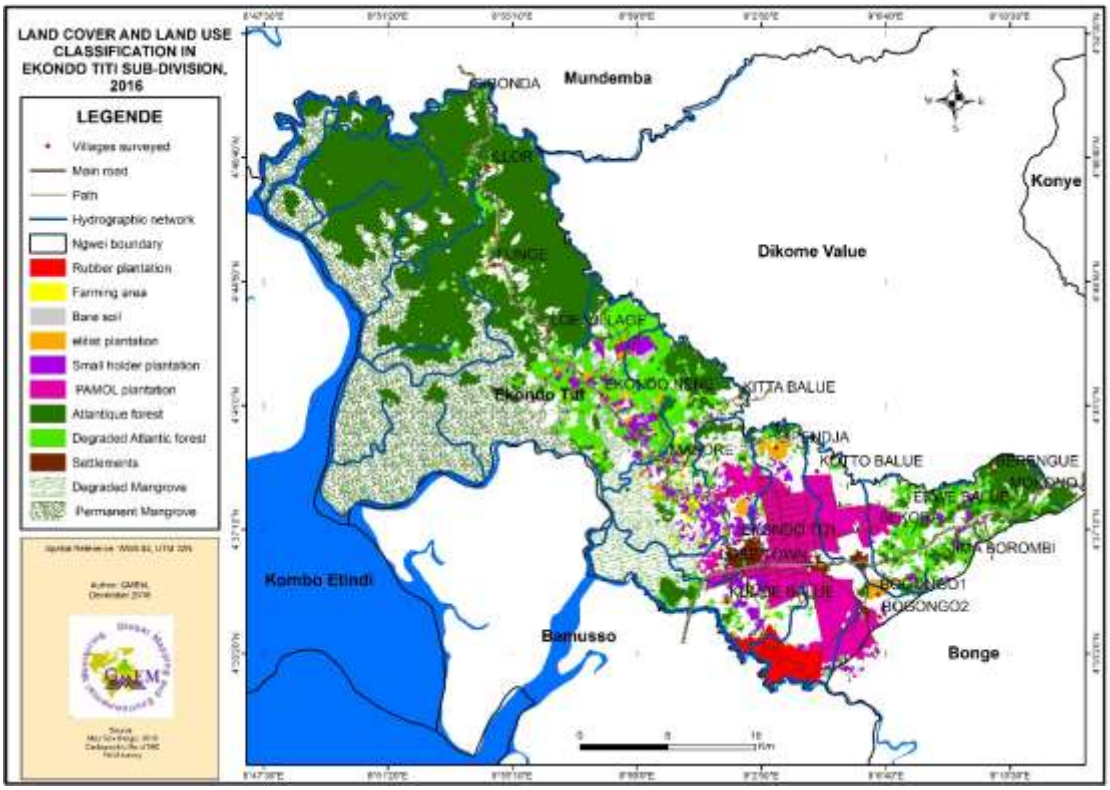


Figure 41: Land use in Ekondo-Titi in 2016 from Google Earth image.

We propose to consider the 2016 Google Earth image statistics as a baseline for future assessments and investigations (Table 34). We observed satisfactorily that the statistics of the degraded forest and the Atlantic forest are about the same as those of the Landsat image of 2015. Deforestation is indeed linked to the increase in the area devoted to the oil palm cultivation, which brought a lot of pressure on space rather than cocoa and other products (multiplication of plots of Elaeis cultivation leading to a reduction of the area once devoted to slash-and-burn agriculture).

Tableau 34: Statistics of the land use in Ekondo-Titi according to 2016 Google Earth image

Land use class	Area (ha)	Percentage
Cultivated area	203,5	0,32
Bare soils	421,33	0,66
Elitist oil palm plantation	**609,86**	**0,96**

Small holders oil palm plantations	**3908,21**	**6,21**
PAMOL oil palm plantations	**5223**	**8,30**
Atlantic degraded forest	6959,45	11,06
Atlantic forest	18872,08	29,99
Degraded forest	10004,66	15,90
Settlements	1009	1,60
Degraded Mangrove	3089	4,91
Unchanged mangrove	12618	20,05
Total	62918,09	100

If one considers the different soils uses in percentage, one could say that with 15.48% of the total, the oil palm cultivation weakly contributes to the deforestation. In fact, as shown in Figure 12a, before 1970, slash-and-burn agriculture, which proceeded through fallow landfall, was the primary driver of deforestation. From 1970 to 1990, food and cocoa farming were the main catalysts for deforestation and forest degradation. The fall in world prices for cocoa and coffee has caused farmers to switch to the market-based food crop, which, since 1990, has been associating with illegal farming to promote deforestation. Since 2000, the intensification of oil palm (smallholder) plots and the multiplication of elite palm plantation (in addition to the agro-industries palm plantations) have made Elaeis cultivation becoming the main driver of deforestation for several reasons:

- There is an "atomization" of space by oil pam cultivation and any residual area between two or more palm plantations remains vulnerable, if not lost, because it is used for other purposes (food production, for example);
- Conversion of former fallows into palm plantations requires population to create new areas for subsistence agriculture in natural or degraded forests, contributing to degradation / deforestation;
- The immediate monetary profitability of the oil palm because of its multiple uses (food and cosmetics) now positions it at the head of the merchant (which has collapsed) and even classical cash crops (coffee and cocoa).

4.2. Situation and land use maps in Ngwéi

This district has the peculiarity of being part of the study carried out in 2014 within the framework of the PALMFORCAM project whose report (Tchindjang et al., 2015) indicates that Ngwéi represents a large palm oil production area both in terms of area than in number of producers (Figure 36).

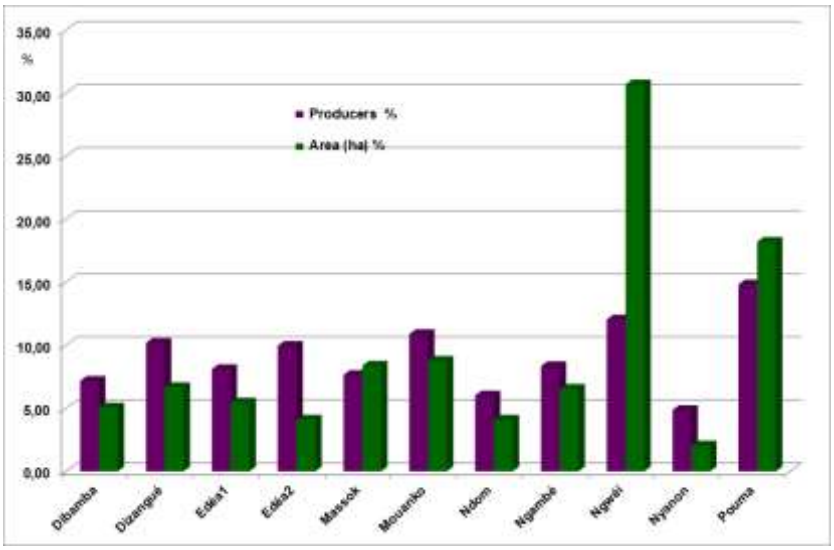


Figure 42: Producers and area by percentage rounding (field surveys, October 2014, Tchindjang et al., 2015).

The percentage of producers exceeds that of the areas in the 2001-2010 decade in the Ngwéi district (Figure 43).

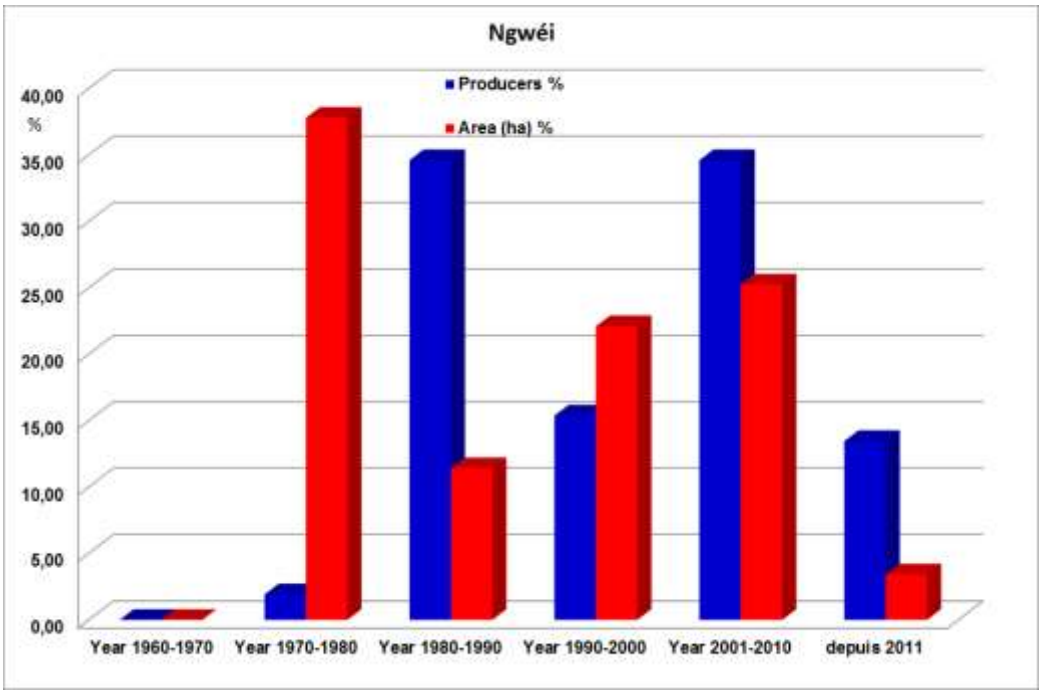


Figure 43: Comparative decadal evolution of producers and area (%) of oil palm plantations in Ngwéi.

Moreover, the percentage of small producers (0-9 ha) is inversely proportional to that of the areas (50-99 ha) in this council (Figure 44).

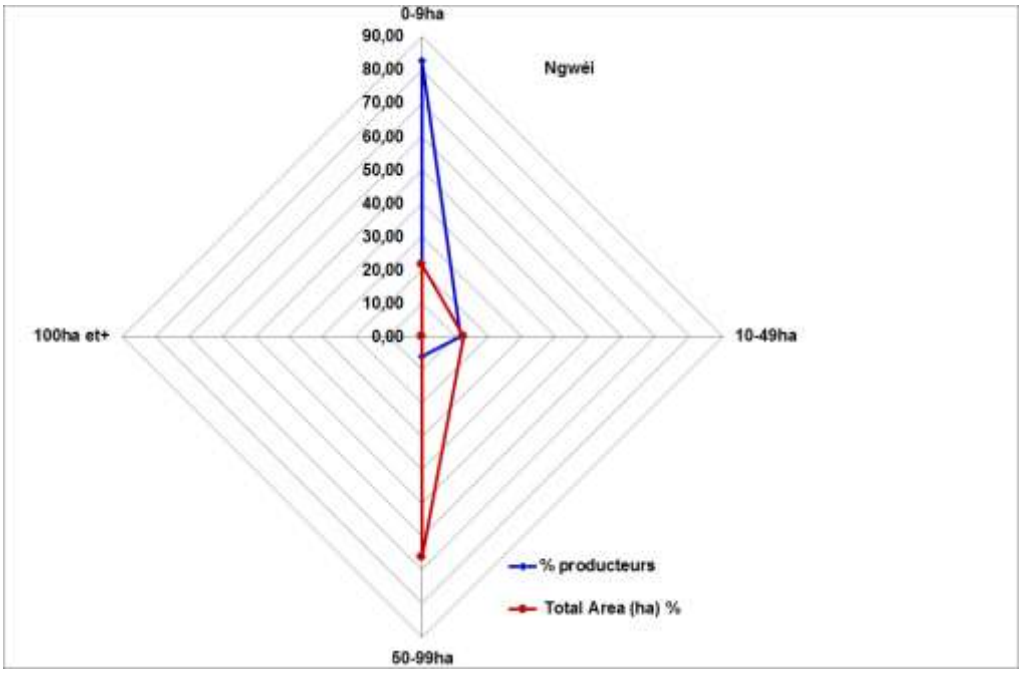


Figure 44: Comparison of the percentage of producers per area class in the Ngwéi district (field surveys, October 2014, Tchindjang et al. 2015).

This initial observation raised up the problem of deforestation by the increase in oil palm plantation. These were made using Landsat diachronic images (for which we have performed a multidate and multi-temporal classification of land use), Ikonos and Geoeye images, and then Google Earth image of 2016.

Landsat satellite images from 1975 to 2013 were used to carry out the diachronic analysis of the evolution of agroforestry systems and forests in the Ngwéi district. They have enabled us to quantify and to highlight the impact of the ecological systems on the degradation of dense forests.

Illustration coming from the 1975 Landsat MSS (Figure 45) shows little investment by indigenous peoples and local elites in the creation of palm plantations. Only SOCAPALM had plantations in the Ikonde village, along the national road No. 3.

In 1984, 10 years later, a change in land use was produced. As early as 1984, a timid development of family plantations began in this large village which still depends on Edéa town. Then there is an extension from the south-west of the map towards the center and the north (Figure 46) in the villages of Solopa, Lep-Likung, Etouha, Boomabong, Song Ndong and Ikonde. On the whole, this development takes place thanks to the national or departmental roads and the paths which criss-cross this council. However, the oil palm cultivation of this period has much more to do with traditional or even quasi-original varieties.

The areas seem to increase largely in 1984. In 1999 (Figure 47), this intense development of the palm plantation continues. Unfortunately, the images we processed have a lot of clouds in 1999, 2000 and 2007. Somehow, we were able to illustrate a certain evolution of these palm plantation.

On the other hand, in 2010, the elites and the populations took a liking to the oil palm plantation and there is a flowering of small holders and elitists plantation around the SOCAPALM former palm plantations (Figure 48).

In 2013, the dynamic begun since 1999 will continue with the intensification of villager and elitist oil palm cultivation. Such a situation accelerates the process of deforestation and is accompanied by significant degradation and fragmentation of the forest and ecosystems (Figure 49).

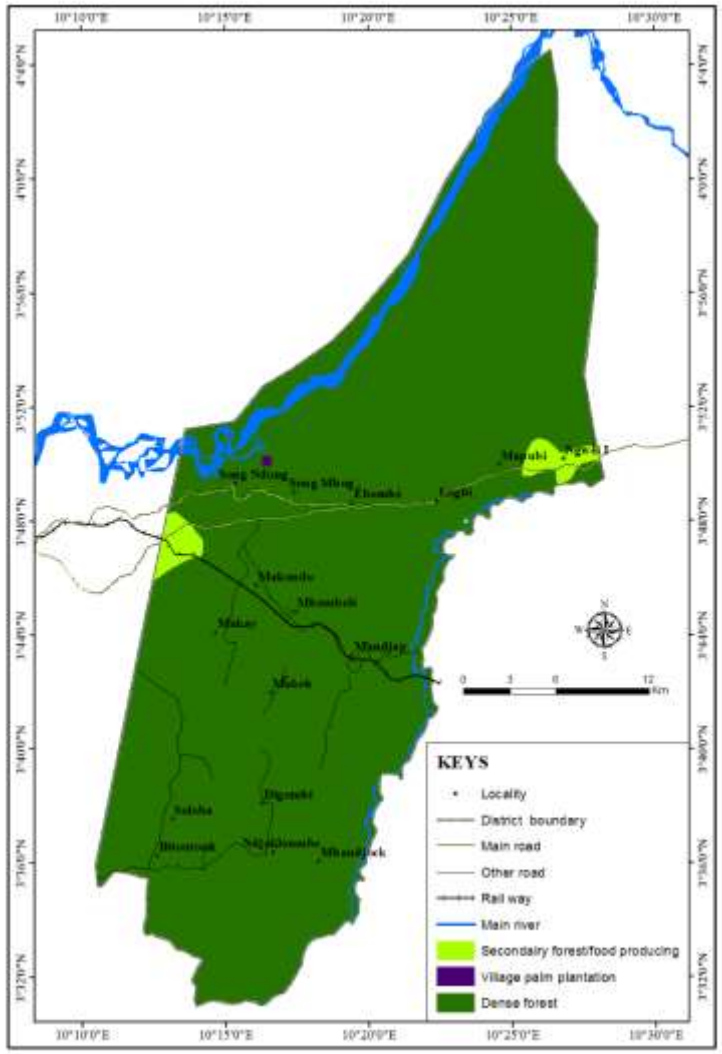


Figure 45 : Land use in Ngwéi in 1975 from Landsat MSS images

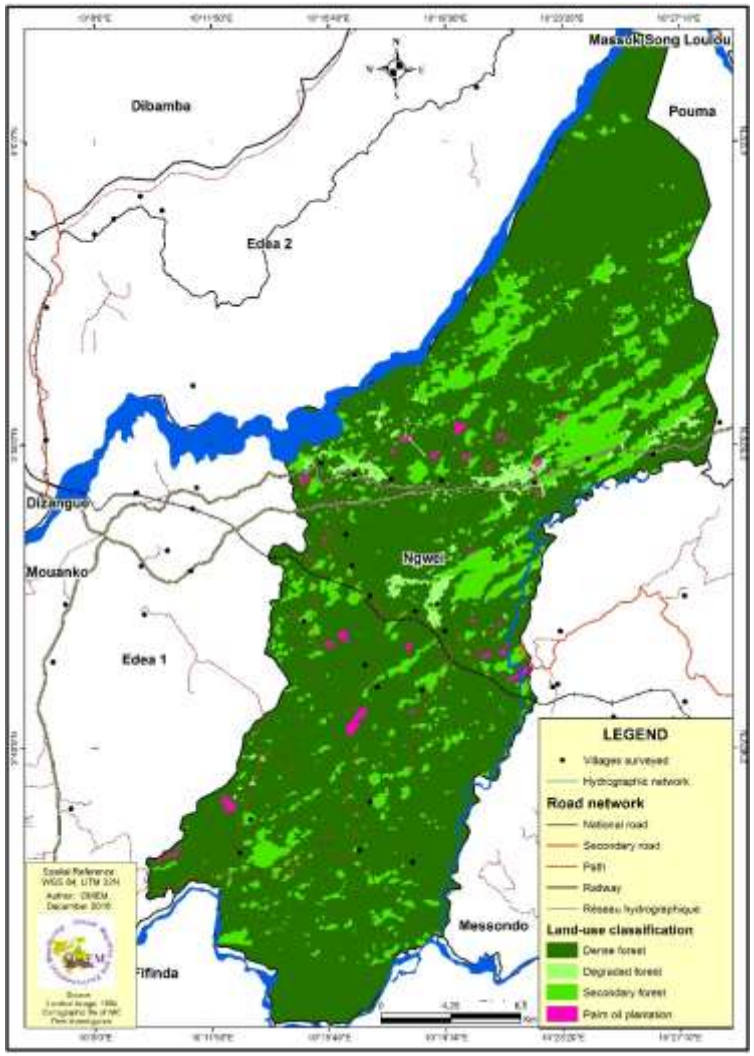


Figure 46 : Land use in Ngwéi in 1984 from Landsat MSS images

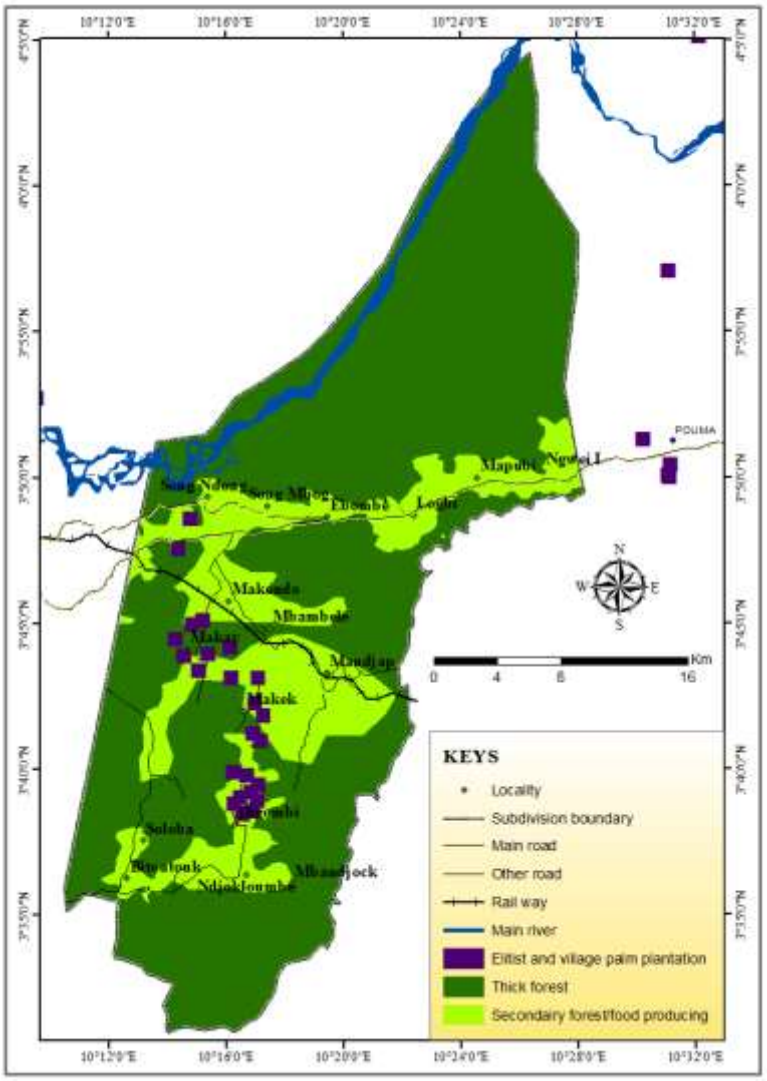


Figure 48 : Land use in Ngwéi in 1999 from Landsat TM images

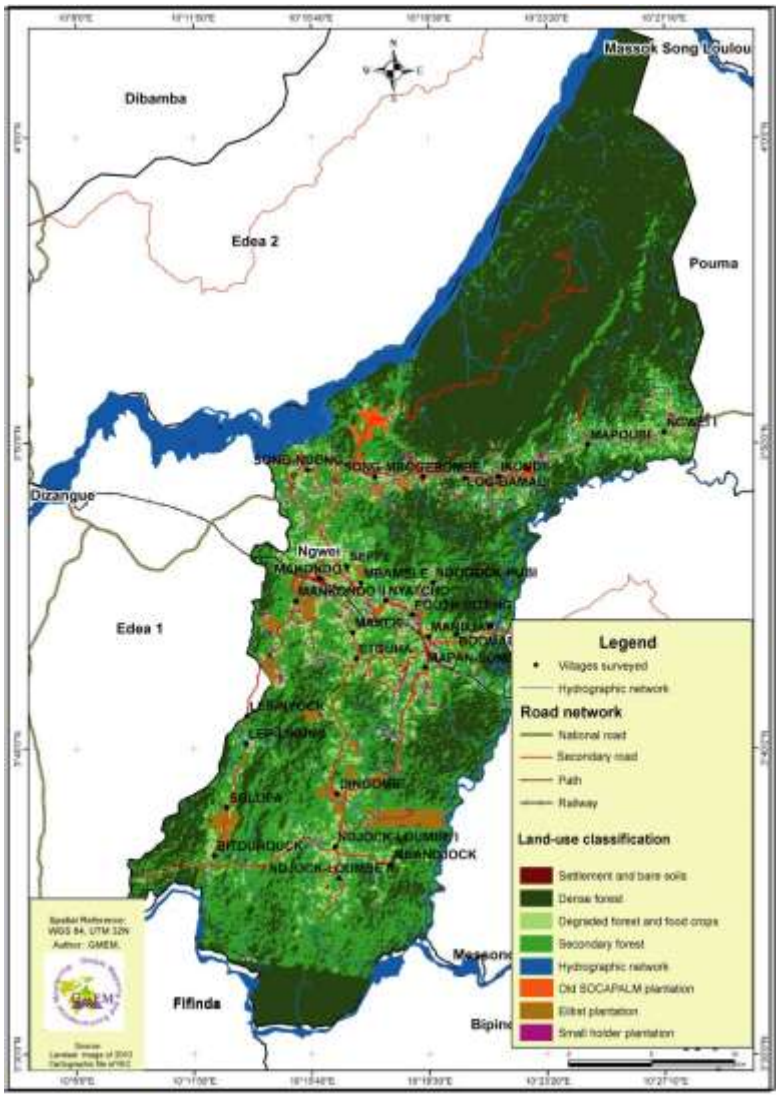


Figure 47 : Land use in Ngwéi in 2010 from the Landsat ETM + images

Looking at Figure 49, it will be seen that in 2013, the entire central part of the Ngwéi council has virtually lost all its forest area to the oil palm and cocoa tree.

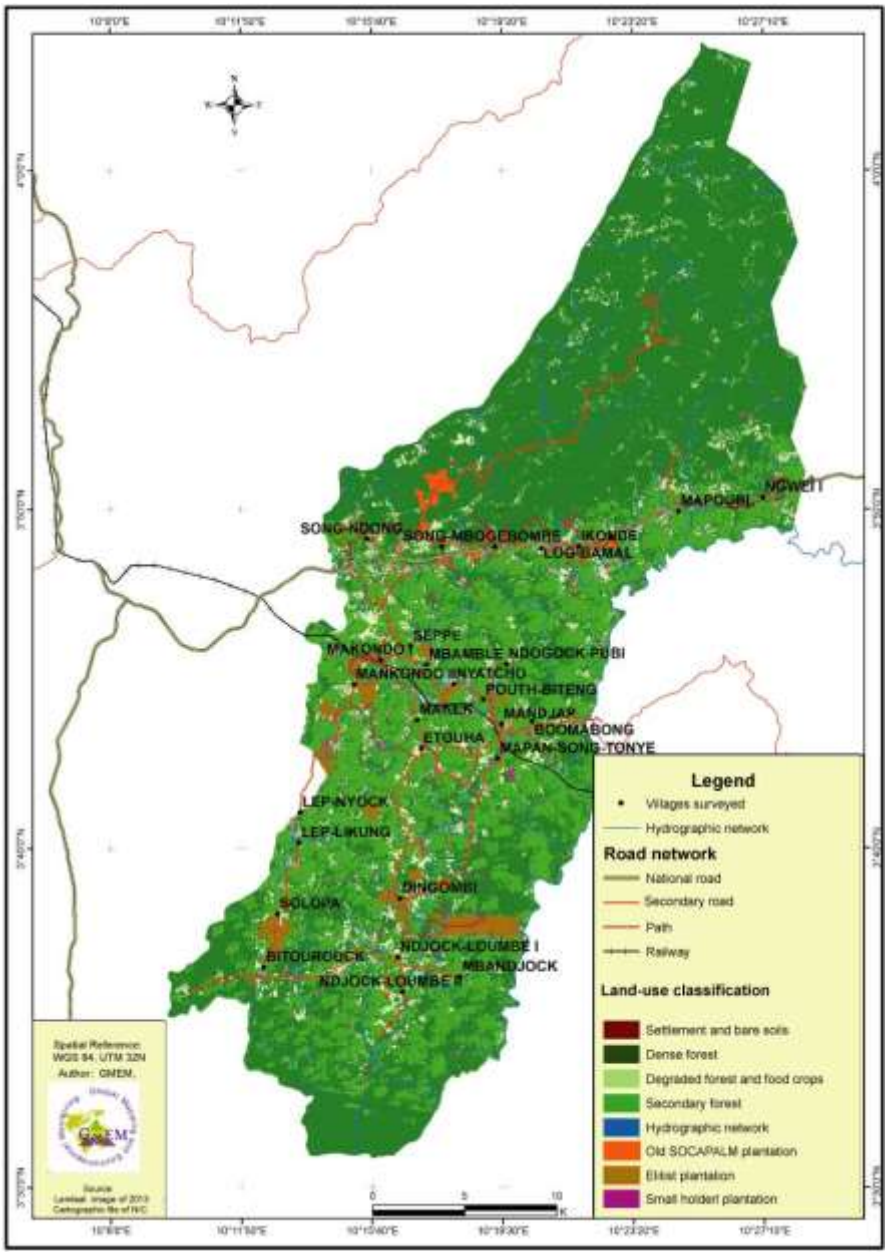


Figure 49: Land use in Ngwéi in 2013 from Landsat 8 images.

However, the cocoa agroforestry system accounts for only 14.53% of the area of elitist palm plantations, according to the information gathered from the District Delegate of MINADER (Table 35). This precisely demonstrates the catalytic role played by forestry in deforestation and forest degradation.

Tableau 35 : The largest areas devoted to oil palm and cocoa plantations in the Ngwéi district.

Oil palm plantations		
Name	**Area (ha)**	**Village**
EPOINER Joseph	75	Makaï dans Makondo II
KANA	**100**	Makaï dans Makondo II
MONGO SOO	**100**	Mbandjock
NDJOCK Augustin	45	Mbandjock

NGOCK Salomon	55	Dingombi
NGUE Martial	**800**	Njock Loumbe
NGUE NGAN	40	Dingombi
NJIKI Robert	**100**	Njock Loumbe
TCHOMB Joseph	**150**	Makaï dans Makondo II
TJEBI André	45	Bitoutouck
Total	**1510**	
Cocoa plantations		
Name	**Area (ha)**	**Localité ou village**
BII Marcial	23	Lep Likoung
BOUMBAI Jean	20	Njock Loumbe
BOUMBE Benoit	07	Ebombe
KANA Antoine	**70**	Lep Likoung
NDJOCK Augustin	12	Mbandjock
NGO BEM Odile Nicole	05	Seppe
NKOU Janvier	07	Seppe
TCHOMB Joseph	**40**	Makaï dans Makondo II
TJEBI André	25	Bitoutouck
----------	05	Mbamblè
----------	05	Bitoutouck
Total	**219**	

In terms of statistics, deforestation is estimated at 45.94% in 38 or 40 years, with an overall rate of 697.22 ha / year between 1975 and 2013. Between 1999 and 2013, in 15 years, Ngwéi loose annually 946 ha of dense forest. At this rate, the Ngwéi dense forest may disappear within 50 years (2067) for the normal scenario or within 37 years (2054) if we take the pace of 946 ha / year. Figures 50 and 51 illustrate this situation.

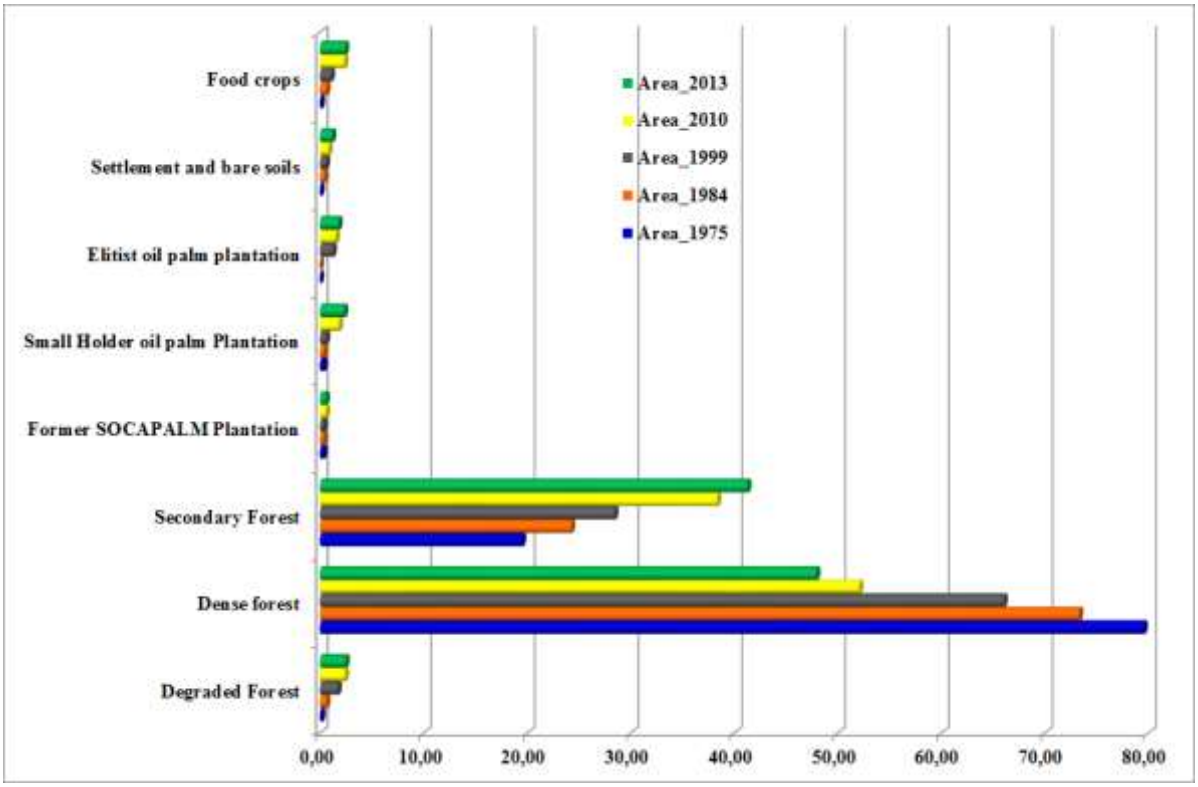


Figure 50 : Evolution of forest and palm plantations in Ngwéi between 1975 and 2013.

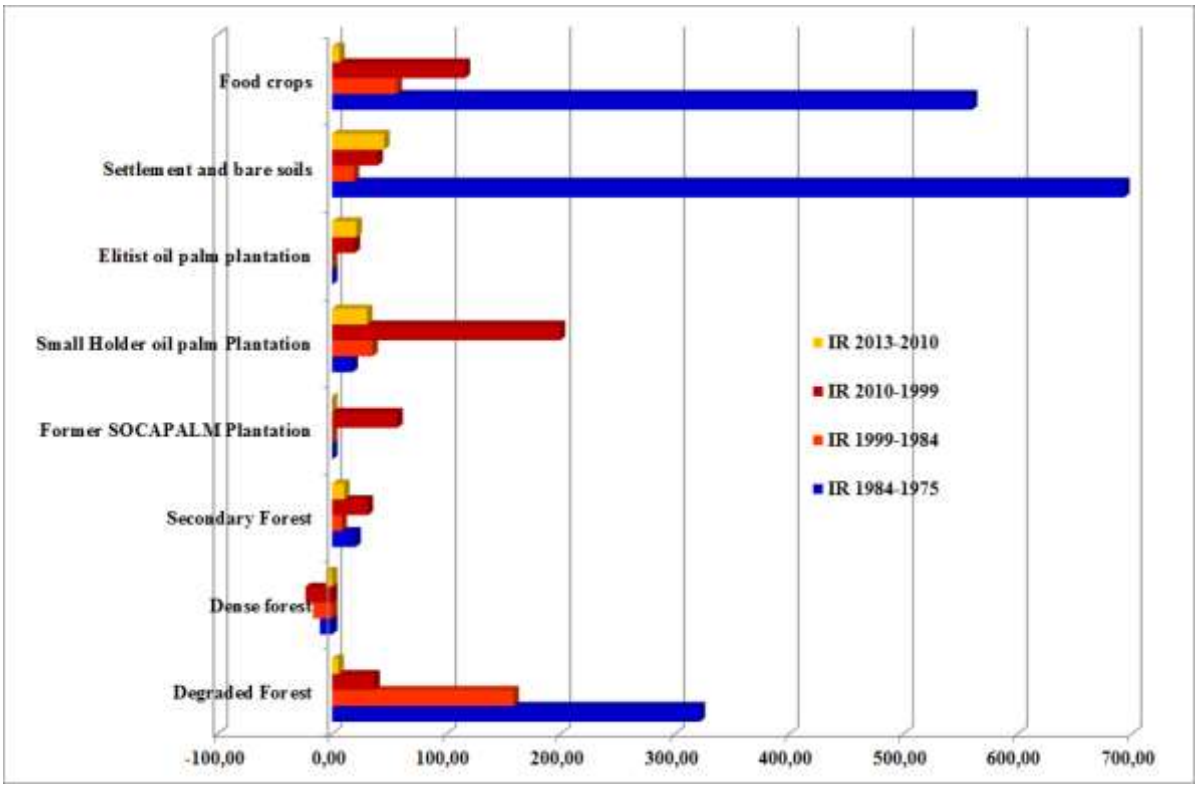
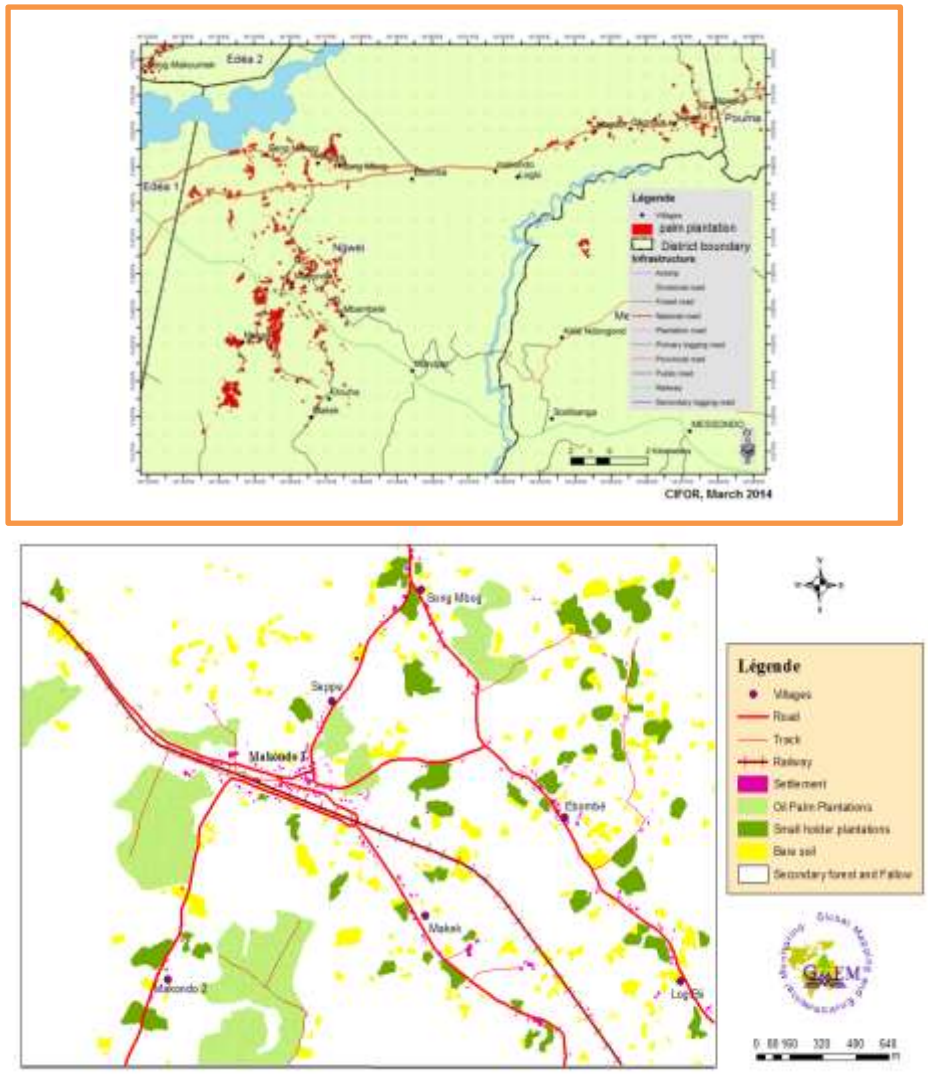


Figure 51: Increase rate of forest and palm plantations in Ngwéi between 1975 and 2013.

Notwithstanding this report on deforestation and degradation of ecosystems by Ngwéi oil palm plantations, the findings for the case of Ekondo-Titi remain valid. Indeed, Landsat images with 30m resolution and sometimes large cloud areas (1999 and 1975) do not always allow accurate account of land use. In addition, the texture of agroforestry landscapes can be confused with low resolutions such as cocoa and palm plantations. For this reason, we tried to use the very high resolution (0.80m) Ikonos and Geoeye images acquired in 2013 as part of the PalmforCam project. These allowed us to better delimit these villager and elitist oil palm plantations.

Thus, the digitization of these images shows a great concentration of villager and elitist oil palm plantations in the Ngwéi council and notably along the roads, the NR3 (Fig. 52 abc). Thus on these high resolution images produced in 2009, we were able to circumscribe ***340 oil palm plantations of which 6 elitists of 340 ha, the rest consisting of villager oil palm plantations accounting for 1130 ha.***



Figures 52 abc : Digitization of the small palm groves on the 2009 Ikonos and Geoeye images of some portions of Ngwéi commune.

There is also a clear trend towards the extension of palm plantations eastwards and north-eastwards as well as to the center of the Ngwéi district. In addition, settlements are mainly concentrated along the roadsides. In any case, with the oil palm and related needs, the population has increased and its uniform distribution throughout the district can raise concerns about future deforestation.

The Google Earth image (0.60 m) of 2016 (Fig. 53) shows land use more accurately and corroborates the trend of deforestation observed with a concentration of activities in the center of the Ngwéi district. This figure may appear also as a baseline for monitoring the evolution of the oil palm activities in the near future.

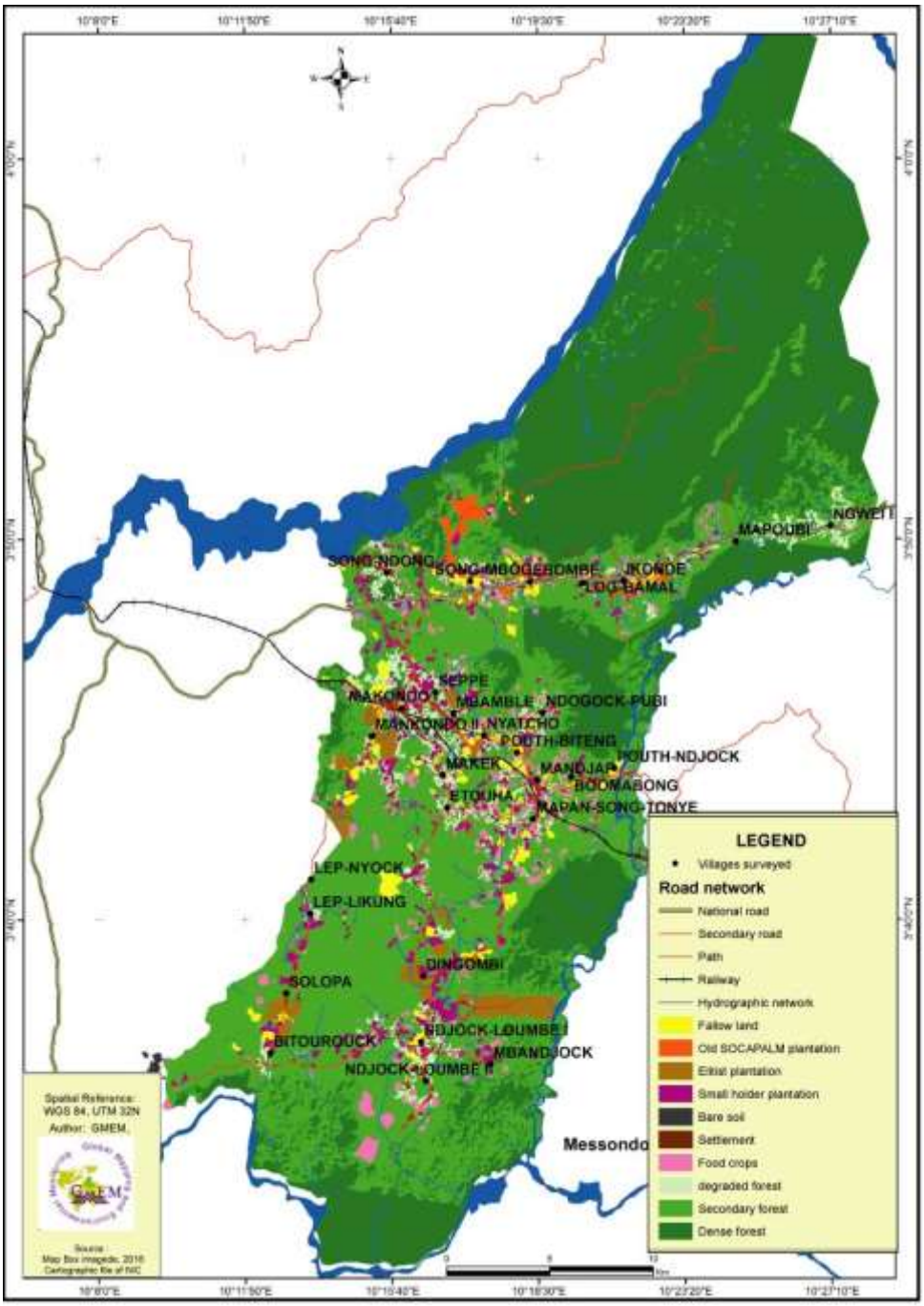


Figure 53 : Land use in Ngwéi in 2016 from the Google Earth image

After this clear evidence of deforestation and forest degradation, the statistics for 2016 are shown in Table 36.

Tableau 36: Statistics of the land use in Ngwéi according to 2016 Google Earth image

Thème	**Area (ha)**	**Percentage**
Managed farms	20,40	0,02
Fallow lands	1186,58	1,39
Former SOCAPALM oil palm plantations	**415**	**0,48**
Elitist oil palm plantations	**2155,75**	**2,53**
Small holders oil palm plantations	**5505, 47**	**6,46**
Bare soils	100,87	0,12
Settlement	456, 20	0,53
Food crops	1667,56	1,95
Degraded forest (cocoa farms)	1262,06	1,48
Secondary forest	31509,33	36,96
Dense forest	40972	48,06
Total	**85251,22**	**100**

In our opinion, as mentioned above with the case of Ekondo-Titi, three deforestation periods are known. But what is important to know is the catalyst. Secondly, the recent period of 2000-2013 corresponds to an intensification of agricultural activities. Of course, oil palm plantations account for about 9% of deforestation in Ngwéi. But we must be convinced by the cumulative impacts in terms of land use, since the extension of arable farming does not go in synergy with food crops.

Consequently, any area between two palm plantations is considered to be lost due to land pressure linked to other land uses (buildings, food crops, etc.), which represent less than 5% of the total. We also observe on some images of Ngwéi that the oil palm cultivation occupies 33% of the image.

In addition, the areas cultivated or not bordering the roads are also lost and will be denuded. Uncultivated areas later become Elaeis cultivation spaces.

The advancement of the settlements along the main roads is impressive and adds cumulatively to the impacts of the plantation. The following illustrations (figures 54 ab and 55) make it possible to apprehend this situation.

Figures 54 ab: ***Oil palm and forest fragmentation in Ngwéi.***
These thumbnails show the impact of the oil palm on the Ngwéi landscape. These impacts are not to be taken in isolation, but must be addressed in a systemic way. Thus, one activity is superimposed on another, since the multiplication of palm plantations is the most visible activity, the Elaeis cultivation becomes the main deforestation driver.
The growth the bare soil and settlements can be observed. A piece of degraded secondary forest exists at the northwest of the image (B). Deforestation appears to have benefited from roads and tracks.

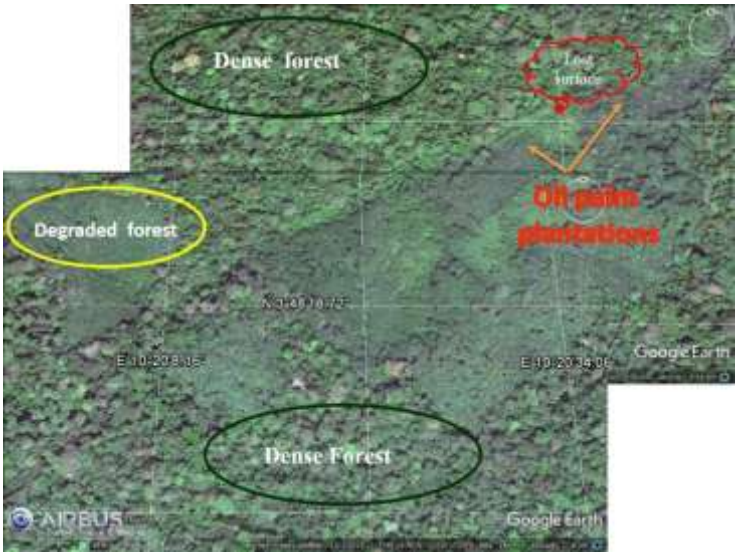


Figure 55 : ***Evolution of forest conversion in Ngwéi***.
From the dense forest, one passes to the degraded forest. As soon as two palm plantations are installed, the space between the two is lost, because it is impacted by the cumulative effects of the latter.

It is clear that the wet and dense forest of Ngwéi is more threatened with extinction than that of Ekondo-Titi if nothing is done. Indeed, the results of the satellite imagery processing confirm the idea of deforestation, whose main driver is oil palm cultivation. Based on this, the environmental assessment that will be presented in the following paragraphs will be based as much on these findings as on those begun since the botanical study and the evaluation of the landscape.

5. Identification and assessment of the oil palm cultivation impacts in both councils.

5.1. Identification, analysis and description of the impacts

Oil palm exploitation produces considerable environmental impacts at the biophysical, economic and social levels. In addition to the interrelation matrix, the Leopold matrix (Table 37) enables us to highlight these different impacts.

Tableau 37: Léopold impact identification matrix

Positive impact = ▲ **Negative impact = ▼**		**ENVIRONMENT COMPONENTS**																
		Biophysical environment								**Human environment**								
		1. Atmosphere	2. Surface water	3. Underground water	4. soil	5. Natural habitat	6. Flora	7. Fauna	8. NTFP	9. Employment	10. Conflicts	11. Local economy	12. Human health	13. Security	14. Noise	15. Odour	16. Cultural heritage	17. Landscape aesthetics
Projects stages	**ACTIVITIES SOURCES of IMPACTS**																	
Preparation stage	**A 1. Nursery**		▼	▼	▼			▼		▲		▲	▼			▼		▲
	A2. Clearing / deforestation	▼	▼	▼	▼	▼	▼	▼	▼	▲	▼	▲	▼	▼	▼	▼	▼	▼
	A3. Picketing /hole digging				▼	▼		▼		▲		▲	▼	▼				▼
	A4. Planting of seedlings		▼	▼	▼					▲		▲	▼	▼				▲
Operation stage	**B1. Plant Care**		▼	▼	▼		▼	▼		▲		▲	▼	▼	▼	▼	▼	▲
	B2. FFB harvest				▼		▼	▼		▲	▼	▲	▼	▼	▼	▼		
	B3. Storage and preparation of nuts	▼	▼	▼	▼					▲	▼		▼	▼		▼		▼
	B4. Extraction of oil	▼	▼	▼	▼					▲	▼	▲	▼	▼	▼	▼		▼
	B5. Packaging and sales										▼	▲					▲	
	B6. Waste management	▼	▼	▼	▼			▲					▼			▼	▲	▼
Plant renewal stage	**C1. New nursery**		▼	▼	▼			▼		▲		▲	▼			▼		▲
	C2. Clearing/ cutting down of old plants	▼	▼	▼	▼	▼	▼	▼	▲	▲		▲	▼	▼	▼	▼	▼	▼
	C3. Picketing /Hole digging, pruning				▼	▼		▼		▲		▲	▼	▼				▼
	C4. Planting of seedlings		▼	▼	▼					▲		▲	▼	▼				▲

5.2. Impacts description

The Leopold matrix above shows that the oil palm cultivation is source of several environmental impacts. It is important to mention that in terms of environmental impacts, ecological aspects (strong sustainability) and social aspects require sustained attention. The economic aspects (low sustainability) are relegated to the last position. What we present below falls within the canons of art and do not in any way represent expert personal positions.

5.2.1. Impacts on the biophysical environment

There are numerous and sometimes cumulative and constitute the main attack on the physical environment in these municipalities. Environmental damages involve the reduction of biological diversity and NTFPs, disturbance of the microclimate and loss of the forest windscreen function, soil erosion and land pressures on natural and local reserves.

5.2.1.1. Atmosphere

Areas where oil extraction and nut preparation are carried out in the countryside of Ngwéi and Ekondo-Titi, often produce a nauseating odour that degrades air quality. During processing and industrial oil extraction, artisanal mills motors emit carbon dioxide and smokes that affect air quality. Increased use of palm oil extraction waste and wood for fresh fruits and nut boiling releases significant quantities of toxic smokes, not only harmful to human health, but also to clean air (photos 6abc).

Photos 6 abc: smoke emission during artisanal (Ngwéi) or industrial (PAMOL de Lobe and artisanal production) refinery of palm oil. Also production equipment's are obsolete and require renewal.

5.2.1.2. Surface and underground water

Water is an essential part of the oil palm production cycle, from nurseries (watering) to oil extraction. Its various uses raise the problem of the resource degradation in terms of both quality and quantity. The use of enormous amounts of water during the preparation of nuts provokes the decrease in the amount of rivers water. Abandonment of nut residues near drinking water sources and waste deposit in watercourses clog their beds, significantly alter and degrade water quality. Infiltration and leaching of chemicals used to fertilize oil palm plantations in watercourses will also affect the quality of running water and groundwater and cause health problems for population that consume it. Lastly, the use of pesticides and chemicals for phytosanitary treatment leads to contamination of groundwater and surface water, if not pollution (Table 38). The same applies to waste from oil extractions, mainly industrial and semi-mechanized, which pollute the rivers that surround the mills. The chemical and bacteriological analyzes carried out on 09 water samples show contamination and pollution, including even groundwater. These water samples were taken upstream, at the spillway and downstream of the palm oil extraction sites in Nkanla (Ngwéi) and Ekondo Titi.

Tableau 38 : Chemical and bacteriological analysis of Ngwéi (Nkanla) and Ekondo-Titi (EKTB and ETP) water samples

Samples	**CND**	**pH**	**NO_3^-**	**NH_4^+**	**SO_4^{2-}**	**COD**	**BOD**	**SM**	**PO_4^{3-}**	**Fecal coliforms UFC/100ml**
Ngwéi river										
Nkanla US	34,9	9,26	9,2	0,29	3	171	90	19	0,09	0
Nkanla SW	33,7	9,38	3,3	0,12	0	84	45	6	0,07	200
Nkanla DS	39,4	9,5	3,7	0,25	0	147	75	7	0,19	15
Ekondo-Titi ETKB= Kumbe Balondo ETP: well of the PAMOL production area										
ETKB1 US	109,7	9,05	5,6	0,36	0	55	30	9	0,09	0
ETKB2 DS	115,1	9,06	0,9	0,2	2	135	75	18	0,17	5
ETKB3 W	54,6	9,58	0,6	0,14	2	57	30	0	0,14	20
ETP1 UP	86	9,2	13,4	0,95	0	49	20	24	0,01	0
ETP2 DS	38,6	9,83	3	0,03	1	63	35	9	0,08	35
ETP3 W	64	9,03	11,7	3,01	0	76	40	3	0,01	28
World Health Organization (WHO) and European Union (UE) standards for drinking water										
	///	6,5-8,5	≤50	≤0,50	400	///	///	absence	5	0

BOD: Biological oxygen demand; COD: Chemical oxygen demand; SM: suspended matter; US: Upstream of the watercourse; SW: Spillway; DS: downstream; W: well;

Overall the surface waters analyzed are basic with pH values all above the recommendations of the WHO standard for drinking water. Chemical oxygen demands are high and reflect pollution. Suspended matters are present in all samples. In addition, Ekondo-Titi ETP1 and ETP3 samples have concentrations of ammonium (NH4 +) ions relatively higher than the recommended value (≤0.50). At the microbiological level, six (06) samples (Nkanla Dv, Nkanla Av, EKTB2Av, EKTB3 Pt, ETP2 Av and ETP3 Pt) showed concentrations of fecal coliforms not complying with guideline values (0UFC / 100ml). As a result, these waters would be under the influence of a major source of

pollution, making them unfit for human consumption without prior treatment. Well water and groundwater are also contaminated (EKTB3 Pt and ETP3 Pt).

If chemical analyzes of the running water around the extraction zones already give these results, still more those of the stagnant waters will pose serious problem. Moreover, these samples were taken in the rainy season, the water being diluted from the spillway towards downstream. There is therefore effective water pollution linked to liquid waste resulting from the palm oil refinery.

At last, field surveys show that waste oils emanating from SOCAPALM and PAMOL oil mills flow into rivers and streams close to village dwellings (photos 7abc). These rivers and streams remain the most fishing and living places estimated by local populations (consumption, bathing, etc.). As a result of these liquid waste, local populations are not only deprived of much of their fishing resources, but they are also exposed to health risks. Pouring of waste oil into watercourses irreparably alter the quality of their environment and present a serious risk to their health. Another negative aspect is the environmental impact of artisanal mill units whose process is polluting because the discharges are not treated.

Photos 7abc: Water pollution around the PAMOL Mill at Lobe and on the artisanal site of Ekondo-Titi

5.2.1.3. Soils

The deposition and abandonment of waste (photos 8abc) resulting from the oil extraction degrade the soil quality. The same applies to the oil storage and the accidental oil discharge on the soil surface. The use of fertilizers, herbicides and other chemicals in palm oil cultivation contaminates and degrades soil quality. Deforestation exposes the soil surface and accentuates its leaching. The oil palm plantation establishment modifies the soil texture as well as its biological characteristics, which is often partly responsible for the degradation of plant diversity in oil palm plantations. This degradation of soil quality is at the origin of the loss / fragmentation of the wildlife natural habitat as well as the destruction of the soil micro-fauna.

Photos 8 abc: Soil pollution related to oil extraction at the Lobe PAMOL Mill.

5.2.1.4. Flora

The clearing of hundreds or thousands of hectares of land for oil palm cultivation is one of the most important factors in the destruction of vegetation cover and consequently of biological diversity. Deforestation and degradation (photos 9 abcd) are the cause of a considerable loss of flora species, fragmentation and disturbance of the natural habitat in these two districts. The

original vegetation on the sites currently occupied by oil palm was mostly an evergreen natural forest (Letouzey, 1985). This natural forest has disappeared in favour of the mono-specific oil palm plantations, which occupy one-tenth of the territory, but it's catalyze deforestation. This allows us once again to attest that this activity is at the root of the degradation and destruction of forest ecosystems. The loss of forest also entails a loss of its windbreak functions as well as soil water erosion restraint (splash) to which must be added the microclimate modification. Aggressions on forests and fallow lands for oil palm establishment create enormous pressure on traditional and modern land reserves and protected areas. Walnuts cooking uses either raffles or crabs and wood (clearing of the forest).

With regard to this forest degradation and deforestation, it is important to note that the PAMOL (Lobe) soap factory (secondary processing industry) uses wood as a source of energy, despite the fact that more than 40% of the forests have been destroyed in favour of oil palm plantations. It means that the remaining forest reserves will be the next target for biomass supply, as the company does not have any forested plots furnishing its soap factory.

Photos 9 abcd: pieces of wood in front of the PAMOL soap factory in Lobe; deforestation and fragmentation of the forest at Ekondo-Nene, and lastly, a board derived from the artisanal sawing linked to the clearing for oil palm plantings.

Neba Shu (2003), based on satellite imagery and field observations, noticed a decline in biodiversity by oil palm plantations. Our conclusions are in line with his own. Although only 10% of the landscapes are affected, the cumulative effects on the flora and the multiplication of smallholders as well as elites explain the deforestation and the decline of biodiversity by palm plantations. It means that cumulative growth of palm plantation areas is one of the main causes of deforestation. Thus, the expansion of plantations is linked to the large immediate economic revenues from plantation products (palm oil and palm kernel oil, soap). Such a situation pushed the existing multinationals (SOCAPALM, PAMOL) to expand their activities, they are follow by a good number of elites, individuals and local groups which engage in this activity, not to mention the flowering of second transformation. Consequently, the huge and increasing number of actors in oil palm value chain is responsible for it spatial spread and it impacts on natural vegetation.

The following extracts from Google Earth image (Fig. 56-57) show the direct impact of the increase in *Elaeis* areas on natural forest degradation and deforestation without a transitional stage in the Ngwéi district.

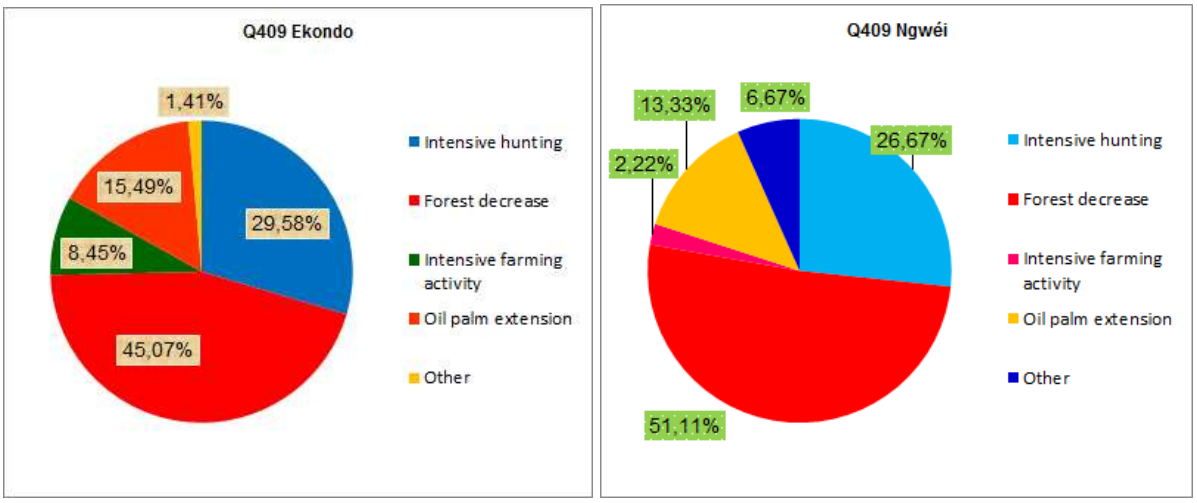
Figure 56 : Deforestation, soil denudation, fragmentation, and forest degradation related to oil palm farming.

Figure 57: Elaeis cultivation and forest fragmentation in Makondo. Forest conversion sometimes uses tracks.

5.2.1.5. Fauna

Forest degradation is one of the major infringements to the loss and decline of wildlife. First of all, the destruction of wildlife habitats and the disappearance of species are caused by the clearing of hectares of forest land. The people of Lobe Town village complain about the total absence of bushmeat in their village. Numerous testimonies in the villages around Ngwéi attest on the drastic reduction of the fauna due to the decrease of the forest massifs areas. They point implicitly an accusing finger on the oil palm development. Moreover, according to Gerber (2008), the disappearance of forests also has consequences on hunting, which is one of the pillars of the traditional Bantu economy. There are almost no game (porcupines, monkeys, antelopes, etc.) and some species have already completely disappeared from the area (such as the elephant that disappeared from Njock-Loumbe, *Njock* meaning the elephant). In addition, the oil plantation guards confiscate the small mammals such as rodents that are caught in these

single-crop farming. Consequently, oil palm husbandry also involves a specification of fauna in a territory. The food supply linked to palm nuts attracts mostly rodents and some birds; it facilitates their expansion at the same time as it favours the dissemination (zoochore seeds dispersion). Thus, the population testimonies attest to the important presence of squirrels, hedgehogs, rats and many birds' species. Also, these populations claim (**Q409**) that the game scarcity has two reasons: deforestation and the extension of oil palm (Fig. 58ab), better, proper intensive hunting and poaching.



Figures 58ab: reasons explaining the decreasing of game in Ekondo-Titi and Ngwéi.

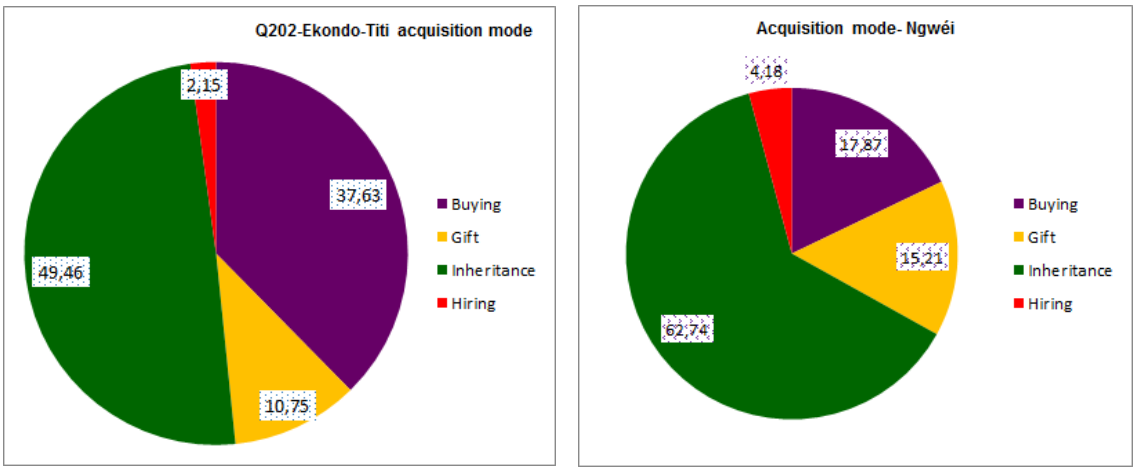
5.2.1.6. Non-Timber Forest Products (NTFPs)

The clearing of hectares of forests in favour of the oil palm establishment become a source of disappearance and lowering of NTFPs as well as the disappearance of certain medicinal plants species. In addition, the clearing of old oil palm trees is responsible for the harvesting of non-timber forest products such as palm wine, mushrooms, cockchafer larvae, etc. The white wine is sometimes fermented and transformed locally into popular whisky (ethanol) that is sold to the villagers. There is nowadays a way of conditioning this wine for its sale on supermarkets.

5.2.2. Impacts on the human environment

The human and socioeconomic impacts of oil palm cultivation are numerous and sometimes contradictory. It may be overshadowed by the employment and income impacts, but the social consequences of this activity remain numerous. It is the case with an increase in the local economy (jobs and incomes), but also for its destructuring (abandoning subsistence crops in favour of oil palm farming). Food insecurity adds to the above impacts with the loss of ancestral values and the violation, usurpation of the territorial rights of local communities to which are added the increased land pressures. The loss of land capital leads to the impossible access to resources and the resulting conflicts. It is partly due to the increase in the price of land, which in most cases remains a legacy (figures 59a & b). There are also many human health risks and risks of accidents (insecurity). These impacts are described below. Nevertheless, at least 87% of men practise oil palm activities in Ngwéi and Ekondo-Titi (Figure 60), resulting in social divisions that extend to the average age of the farmers (Figures 61a and b) and producers who have a low level of education (Figures 62 a & b).

Toutefois c'est une activité exercée par au moins 87% des hommes à Ngwéi et Ekondo-Titi (figure 60) d'où des clivages sociaux qui s'étalent jusqu'à la moyenne d'âge des exploitants (figures 61 a&b) et producteurs dont le niveau scolaire est peu élevé (figures 62 a&b).



Figures 59 a & b : Method of acquiring land for oil palm cultivation in Ekondo-Titi and Ngwéi

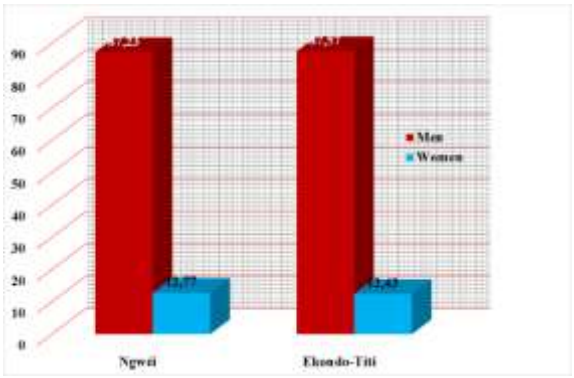
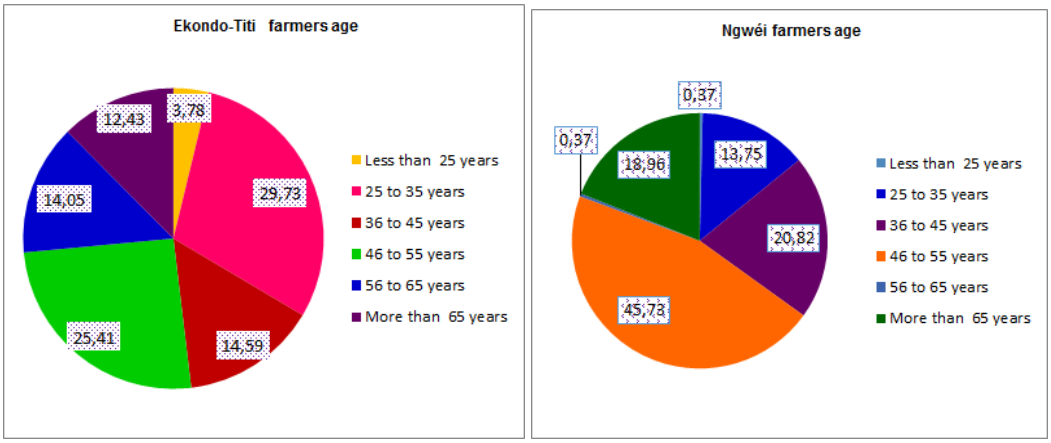
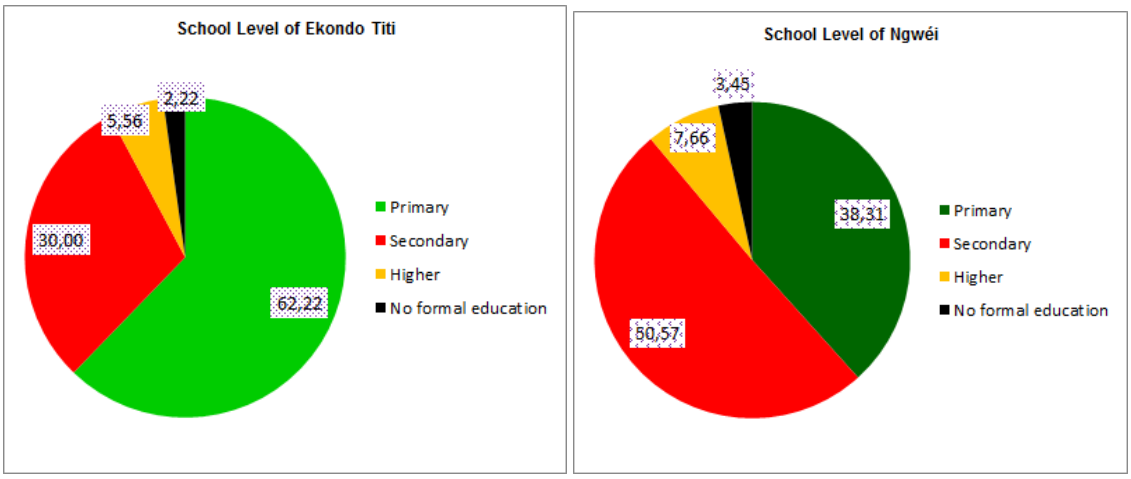


Figure 60: Gender aspect in the labours force of the oil palm cultivation in both councils.



Figures 61a &b : Age of the populations involved in the oil palm cultivation

(25-35 years and 46-55 years dominate in Ekondo-Titi where PAMOL offers 30-year lease and rent opportunities. In the opposite, 36-45 & 46-55 years are recorded in Ngwéi where activity is dominated by elites and retirements).



Figures 62a & b : school level of the population involved in oil palm cultivation

Primary and secondary levels are predominant. The higher education level is that of most elites.

5.2.2.1. Employment

Jobs and revenues generated by the various activities related to the establishment, maintenance and operation of a palm plantation (planting and plant maintenance, transport of FFB and oil extraction) constitute the most visible face of its socio-economic impacts (photos 10abc) able to boost the local economy if the sustainability conditions are fulfilled.

Photos 10 : abc: Transport of FFB and other products from oil palm plantation

5.2.2.2. Local economy

Several aspects of this positive impact are to be noticed:

- The sale of FFB by planters (photo 11) and elites to agro-industries such as PAMOL or SOCAPLAM for oil transformation and sale in Ngwéi or Ekondo-Titi are central activities that enable population increasing incomes while promoting the local economy;
- The establishment of modern mills is another economic facet observed in Ngwéi council (Photo 12), particularly in Njock-Loumbe;
- Significant induced impacts linked to a flowering of secondary processing industries in Cameroon (soap factories, cosmetics). Agro-industries produce only crude palm oil (CPO), with the exception of SPFS, which completely transforms its CPO into refined oil and biofuel. For some years, PAMOL has opted for the transformation of part of its

production into soap, as the current road infrastructure does not permit the evacuation of its production during the rainy season. Several secondary processing industries have been created recently, without taking into account the production capacity of CPO on the national territory. The creation of many secondary processing industries can be explained by the fact that the return on investment is relatively short, the market for refined palm oil and soap remains unsaturated, and export opportunities for neighbouring countries are offered;

- The sale of artisanally or semi-mechanically extracted oil to soap factories, on local and regional markets or at the roadside;
- In addition, the development of income-generating activities, the development of petty trade are also observed in these villages thanks to the oil palm cultivation. The same applies to handicrafts made from palm leaves to produce wickerwork products (making brooms, baskets, sieves ... or for roofs). In addition, palm kernel shells are used in crafts for the manufacture of jewellery (necklaces and others) as well as gadgets for children;
- Lastly, the development of cooperatives based on existing CIGs will constitute the final stage of this economic facet observed in both districts.

Photo 12 : Bags of palm fruits nuts intended for agro-industries in Ekondo-Titi.

Photo 11. Modern oil Mill from Ngué Martial in Njock- Loumbe with a processing capacity of 5 tons of nuts per hour.

5.2.2.3. Social protection and collective bargaining (negotiation)

One can regret the lack of social protection and the weakness of collective bargaining for industrial enterprises. Remuneration and social protection are uncertain at SOCAPALM, which after privatization has set up a subcontracting system consisting of several dozen service providers directly employing growers and other workers on its behalf. It appears that the SOCAPALM subcontractors tend to multiply seasonal contracts so that the labour recruited does not benefit from any social protection. SOCAPALM appears deaf to the demands of the staff representative bodies and their delegates. The social situation is also tense between the owners of the elite palm plantations and the indigenous populations at Ngwéi...

As far as PAMOL is concerned, this social protection seems to be effective. After acquiring 3000 ha in Ekondo-Nene, PAMOL encourages young people to invest in the oil palm by giving them ten hectares of land for 30 years. In addition, it built and equipped a hospital in Lobe Estate for its employees and the whole district population. But, PAMOL employees are exempt from medical consultation and hospitalization expenses. PAMOL plantations are spread over 5 villages (Ngolometocko, Bongongo I & II, Lobe Town and Lipenja) to which it has graciously granted 10 hectares (nursery, plantation and production carried out by PAMOL before the sale) as compensation. Kumbe Balondo also received 25 ha of gratification from PAMOL.

5.2.2.4. Human health

Oil palm negative impacts on human health are direct and have two levels:

- At the artisanal level, local populations working in extraction sites take no measures to protect their health. The nauseating smell absorbed by these workers in extraction sites without the use of personal protective equipment (PPE) could eventually cause disease. Inhalation of chemicals (pesticides, insecticides and herbicides) used to treat palm plants can cause health problems for the populations that handle them. Similarly, the infiltration of chemicals used to destroy weeds and rodents in water bodies could also bring diseases among the surrounding populations. Heat emanating from wood fires and linked to the oil artisanal extraction provokes many health problems for people (anaemia, malaria, dry skin, etc.);
- In agro-industries (PAMOL, SOCAPALM and CDC), the health risk is high because many of the health infrastructures are under-equipped and obsolete. Their housing conditions there are deplorable: overpopulation, dilapidated camps (photo 13), non-functional water pumps, frequency of power cuts, etc.

Photo 13 : The PAMOL worker camp in Lobe Estate

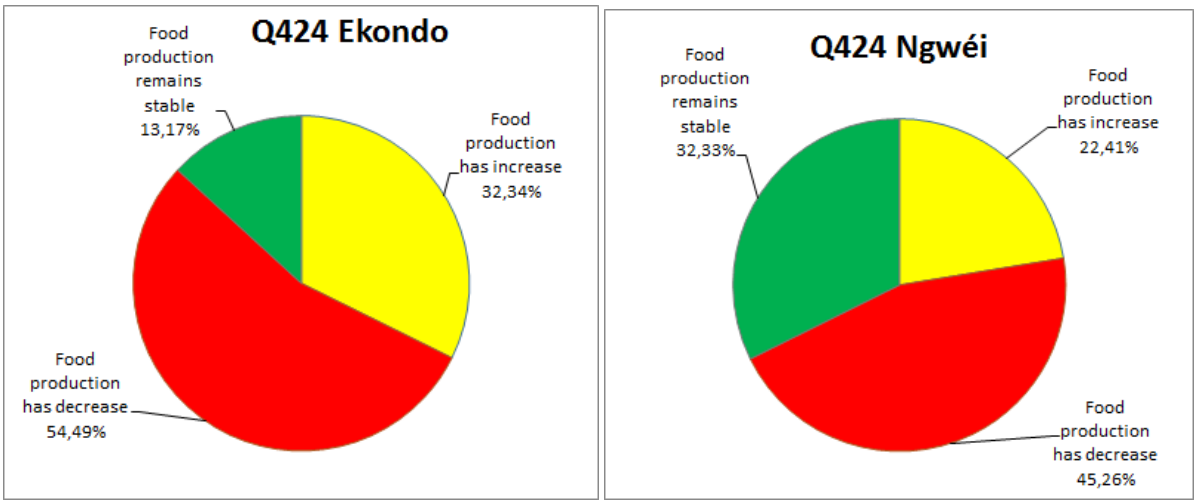
5.2.2.5. Insecurity

Insecurity is a perceived impact from many angles.

Primo, in the local societies and in the elites, oil extraction and artisanal processing usually expose the workers who practice it without safety measures. The risks of injuries and other accidents are incurred during the clearing, hole digging, cleaning and maintenance of the palm plantation; and above all, oil palm harvesting and the pruning of the palm trees.

However, affluent local elites (such as Ngué Martial in Ngwéi) maintain the prohibition of access to their site by security guards recruited not from local populations, but from migrants from the Northern part of Cameroon, which exacerbates social tensions.

Food insecurity is caused by low consideration in subsistence or food crops for the benefit of oil palm. This leads to the specter of famine in a region with such productive lands. Indeed, almost half of the surveyed populations acknowledge that crop yields have declined (Fig. 63a & b).

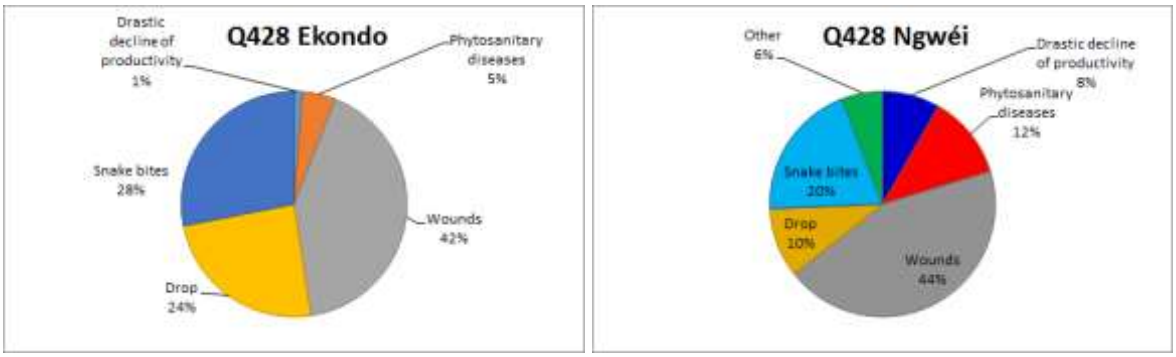


Figures 63a &b : Influence of oil palm cultivation on food production in Ekondo-Titi and Ngwéi.

Secundo, in the agro-industries, a climate of terror seems to be maintained by the local security companies, which for a long time supervised the plantations by means of a contract with SOCAPALM. Recruited and paid by the company to combat palm kernel trafficking, village supervisors conduct patrols on the plantations and privilege contact and dialogue with a population they know. But, since SOCAPALM, like PAMOL, has strengthened its monitoring system by using modern security services such as *Africa Security Cameroon SARL*, which operates as a real private militia, there is growing terror and insecurity.

Tertio: flights of palm fruits in Ngwéi also constitute an insecurity phenomenon. Indeed, the theft of the FFB by the residing population in the vicinity of the industrial plantations is also considered as a negative aspect of the artisanal production of palm oil in Cameroon. However, this theft is carried out either for sale, or it results from poverty instead of being a reaction against the spoliation of the local population lands by elites or agro-industries. However, by not dismissing the moral aspect of the theft, it is necessary to emphasize its negative consequences that affected the industrial or elite as well as the country economy which is in deficit (Cameroon imports oil). Indeed, these stolen bunches will provide half as much oil and therefore increase the need for imports. Apart from this, it should be noted that in a context of tense social climate, the benefits derived by the village population from the presence of agro-industries (SOCAPALM) or elites seem very meagre. This is bitterer when we compare it to the data on the company profitability. On the PAMOL side, this social context seems rather peaceful and there is a harmonious relationship between this society and the neighbouring communities.

Quarto: Risk of accidents and snake bites. Field surveys show that most employees of SOCAPALM and PAMOL do not always benefit from adequate personal protective equipment. Workers are therefore exposed to all natural hazards, chemical or mechanical risks associated with working in industrial plantations (snake bites, risk of poisoning due to the handling of dangerous products, risk of injury; figures 64a and b).



Figures 64 a &b: Bodily and economic risks related to oil palm cultivation in Ekondo-Titi and Ngwéi.

Moreover, the workers transportation conditions from the plantation to the camps are undoubtedly the most glaring illustration of the contempt displayed by certain agro-industries (SOCAPALM, PAMOL), in particular as regards safety rules. To reach the palm plantation in the early morning, workers are parked in trucks or containers designed to carry merchandise; heaped like cattle with their tools and it often happens that the workers injure themselves. In the evening, they have to walk several kilometres to return to their campsites most often located at the heart of the plantations.

5.2.2.6. Noise

The noise produce by motor-driven mills, used during oil processing has a great impact manifested by the exposure of the growers and workers health to the risk of deafness. These noises which constitute sound or phonic pollution can also cause the escape of certain animals. The same is true with noise produced when cleaning fields.

5.2.2.7. Odour

This impact logically follows from the precedents and the different treatments given to palm fruits while conditioning it and extracting oil. Thus, the production process of red oil starts the fermentation of palm nuts that lasts 2 to 3 days, emitting odour. The previously cut bunches are gathered on the ground to let the fruit nuts ripen and easier it dehiscence during destemming. Then come stalking which is the separation of the fruits nuts from the clusters in which they grow with a machete. The odours persist during this stage. The separated nuts are then spread out under the sun for 12 hours to facilitate the elimination by sluicing and sieving of dandruff, impurities and rotten fruits (persistent odour). Waste and effluents from processing and extraction are discharged into the environment and watercourses without prior treatment and generate olfactory pollution. The same is true with the smoke coming from the cobs burning and the water and oil boiling. However, this olfactory water pollution by liquid waste is more important in agro-industries.

5.2.2.8. Cultural heritage (traditional pharmacopoeia)

The forest was originally perceived as inexhaustible by the ancestors. Nowadays, this vision has changed, hence the struggle for industrial plantations to cease to develop, although there are few concrete collective resistance actions and the populations themselves find themselves creating plantations at the expense of the forest for purely economic reasons.

The oil palm provides local communities with many material, social and cultural uses ranging from food to traditional pharmacopoeia through decoration and construction materials, contributing to their well-being and their socio-cultural development. For the traditional pharmacopoeia, palm oil is an antidote to poisons, palm kernel oil (photo 14) is useful for skin

care in both new-borns and adults. Lastly, palm wine appears inescapable in all traditional ceremonies and rites concerning enthronement, weddings, deaths and funerals.

Photo 14 : Handmade palm kernel oil for the traditional pharmacopoeia in Ngwéi.

However, as Plédran points out (2012), village plantations also lead to "individualisation of land tenure and contractual responsibilities (debts) that destabilize traditional lineage institutions. Its further marginalize the most disadvantaged social groups (such as young people and women). At last, it's widen inequalities and allow the elites to stand out even more from the rest of the community ". Elites accede to the land in their village like all the other villagers, but, they possess the means to buy larger areas. Sometimes colossal, they buy land from their neighbours in need and this mechanism leads to land scarcity phenomenon and consequently rising land prices (Ndjogui and Levang, 2013). In Ekondo-Titi district, the land problem is not really the case, may be because the social policy of PAMOL softens the situation out of urban Ekondo-Titi and Lobe Town. In these two urban areas, high population density leads to the occupation of land reserves, resulting in land conflicts that seem to be badly perceived but remain real (figures 65 and 66 ab). For example, in ***Q426 Did the development of palm plantations generate conflicts in your locality***? The affirmative response is not strong (25%, Figure 59a).

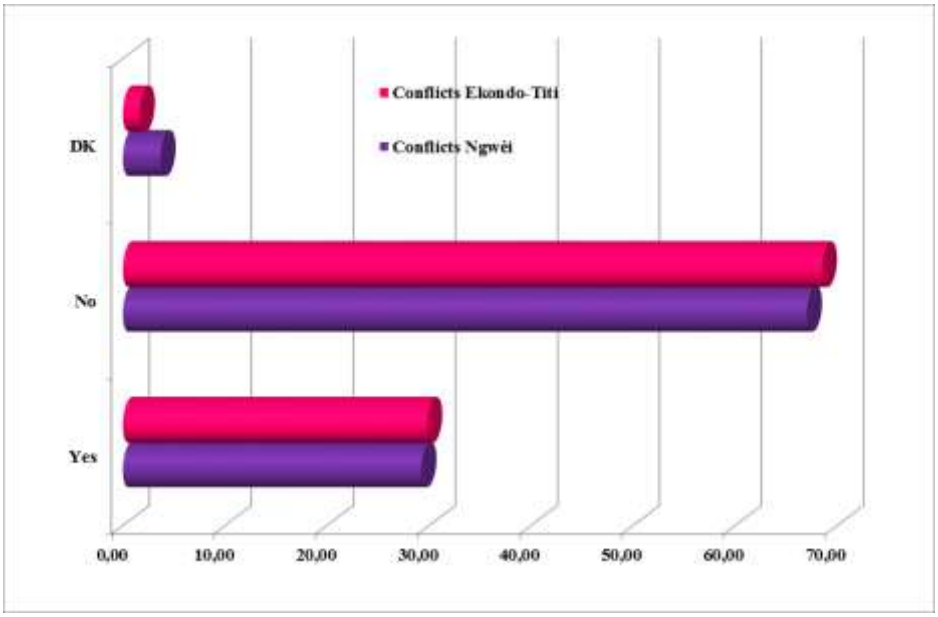


Figure 65 : Recognition of the conflicts emergence by population

Question **Q427** forces them to specify the type of conflict; the answers show that at least 3/4 of the conflicts are landed in the two municipalities (figures 66 ab) with a special emphasis in Ngwéi.

Figures 66 ab: Types of conflicts related to oil palm cultivation in Ekondo-Titi and Ngwéi.

Thus, in the Cameroonian context of Ngwéi in Sanaga Maritime, the social position of the elites often creates an unequal power balance between these actors and local peasants (Sevestre, 2013). The power of intimidation that the elites have and their potential assimilation to a defender of their interests outside widens the framework of bargaining, which then no longer takes into account only the land issue. The financial capacities of these elites are also clearly higher than those of the "average" peasants, allowing them not only all the imaginable corruptive drifts (towards the administration, the traditional chiefs) but, above all, giving them an advantage in negotiation; Sevestre, 2013). Moreover, the educational level of these elites (mostly higher education) is generally significantly higher than that of the majority of the villagers. They can more easily manipulate the latter during negotiations, either orally or in writing (knowledge of contracts, administrative machinery, etc.).

At the end, village plantations represent an ambiguous and complex phenomenon, as they are still at an embryonic stage and at the same time involve a contractual commitment that benefits to agro-industries and binds farmers to them (PAMOL, SOCAPALM). The so-called supervised village plantations have always been the subject of many problems. According to the World Bank, the benefits of village palm plantations are multiple: its guarantee stable incomes for farmers. It’s encourage land tenure. It’s reinforce the monetization of the rural environment, thus generating "development". Some studies, on the contrary, arrive at different conclusions: smallholders’ plantations induce an individualisation of land and contractual responsibilities (debts) that destabilize the traditional lineage institutions. It further marginalizes the most disadvantaged social groups (such as youth and women); finally, it widens inequalities and allows elites to differentiate themselves more from the rest of the community.

5.2.2.9. Landscape aesthetics

The clearing of many hectares of forest for the oil palm cultivation changes the landscape. Contrary to the beautification of the landscape which is observed thanks to the presence of the new palm nurseries (photo 15) and the implanted palm plantations (agro-tourism), the degradation of the aesthetic and the disfigurement of the landscape are observed by the abandonment of waste (photo 16) from the oil processing and effluent discharges into the water, not to mention the dirt and ugliness that typically characterize the artisanal milling units. However, it is important to notice that in Ekondo-Titi, the City Council forced small producers and elites to install their artisanal presses on the outskirts of the city to fight against the anarchic

establishment of these mills and social nuisances. Such a decision helps preserving the aesthetics of the local landscape.

Photo : 16 : Nursery in gestation in Ekondo-Titi.

Photo 15 : Incineration of oil palm wastes at Ngwéi.

3.2.2.10. Waste

Wastes from various activities related to oil palm contribute to soil degradation, air quality, olfactory pollution, degradation of landscape aesthetics, water pollution and it elimination is not always easy, hence an opportunity for pig breeding (photos 17a & b).

Photos 17 ab: Pigs consuming waste from the oil extraction in Ngwéi. Pigsty near an artisanal mill and a river in Ngwéi.

Overall, this analysis led us to recognize direct, indirect and cumulative impacts.

The direct impacts on the biophysical environment are: air contamination, foul odours (olfactory pollution), contamination / pollution of ground and surface water, soil contamination and pollution, flora and fauna destruction, biodiversity degradation, deforestation and forest conversion, reduction of NTFPs and landscape aesthetics**.**

The direct impacts on the human environment can be summarized as: employment and income, local economy, human health, insecurity and conflict, noise, odours, cultural heritage and waste.

Indirect impacts (physical and human) include habitat fragmentation, degradation and loss of biodiversity, food insecurity, cultural heritage, social protection, collective bargaining and local crafts.

To end, cumulative impacts (physical and human environment) affect habitat fragmentation, degradation and loss of biodiversity, deforestation coupled with the rubber and cocoa single-crop farming or the merchant crop including plantain; food insecurity; social conflicts; social protection and collective bargaining.

5.3. Evaluation of the impacts of oil palm cultivation

After identifying and describing different impacts in the previous paragraphs, we will proceed via the Leopold matrix to the evaluation of these impacts by rating as shown in table 39. The aim is to determine the most significant and less significant impacts of oil palm cultivation in Ngwéi and Ekondo-Titi municipalities.

Table 39: Absolute impact assessment matrix

Component of the affected environment	Impacts - sources activities	Impacts	N°	Characterization parameters						Evaluation
				Nature	Occurrence	Intensity	Spatial extension	Duration	Reversibility	Importance
Air	**Clearing / Deforestation** **Storage and preparation of palm nuts** **Oil extraction**	Degradation of air quality		▼	3	2	1	1	2	1.8
Surface water	**Clearing / Deforestation** **Oil extraction** **Waste management**	Degradation of water quality / contamination		▼	3	3	4	4	4	3.6
Underground water	**Clearing / Deforestation** **Oil extraction** **Storage and preparation of palm nuts**	Contamination, of groundwater		▼	3	2	1	3	3	2.4
Sol	**Clearing / Deforestation** **Picketing, Hole digging** **Planting of seedlings** **Storage and preparation of palm nuts** **Oil extraction**	Soil quality degradation and contamination		▼	4	4	2	3	4	3.8
Natural habitat	**Clearing / Deforestation** **Picketing, Hole digging**	Fragmentation, destruction of natural habitats		▼	3	3	4	5	5	4
Flora	**Clearing / Deforestation** **Plant Care** **Fruit bunches harvest** **Clearing of old plants**	Deforestation		▼	5	5	4	5	4	4.6
Fauna	**Clearing / Deforestation** **Picketing, Hole digging** **Plant Care**	Disruption of wildlife and wildlife habitat Migrations and loss of wildlife		▼	4	3	3	5	5	4
Non timber forest products (NTFPs)	**Clearing of old plants**	Increase / decrease in non-timber forest products Loss of medicinal species		▲	3	2	2	5	5	3.4
Employment	**Clearing / Deforestation** **Picketing, Hole digging** **Planting of seedlings** **Plant Care** **Storage and preparation of palm nuts** **Extraction de l'huile** **Conditionnement et vente**	Jobs creation		▲	4	4	5	4	3	4
Conflicts	**Plant Care** **Storage and preparation of palm nuts** **Fruit bunches harvest** **Packaging and sales**	Source of conflicts		▼	4	4	1	4	2	3

Local economy	**Fruit bunches harvest Packaging and sales**	Development of economic activities Increase in revenues		▲	3	3	3	5	4	3.6
Human health	**Plant Care Storage and preparation of palm nuts**	Degradation of workers human health of injury		▼	4	3	2	4	2	3
Insecurity	**Plant Care Storage and preparation of palm nuts**	Injury			3	3	2	3	3	2.8
Noise	**Storage and preparation of palm nuts**	Noise		▼	3	2	2	2	1	2
Odour	**Storage and preparation of palm nuts Waste management**	Degradation of air quality		▼	3	2	2	1	1	1.8
Cultural heritage	**Craft production of palm kernel oil**	Traditional Pharmacopoeia			3	3	5	4	3	3.6
Landscape aesthetics	**Creation of new nurseries**	Landscape embellishing		▲	2	2	1	1	1	1.4

Legend: (1-1.2) = Very low or negligible impact; (2-2.9) = low impact; (3-3.9) = Significant impact; (4.1-5) = very significant impact.

There are a total of 17 impacts with 14 of major and significant importance, two minors but not insignificant impacts requiring mitigation or improvement measures, 1 impact of minor importance, therefore not significant and negligible. Measures to mitigate and improve these impacts are presented in table 40.

Table 40: Proposed mitigation or enhancement measures

Impacts	Mitigation or enhancement measures
Degradation of air quality	Use of filters in industrial oil mills and regular technical checking of those mills in order to replace the worn-out filter elements in time. Work to acquire community-operated artisanal mills to avoid burning wood or cobs
Degradation of water quality	For agro-industries, treat the water before releasing it to the environment, if necessary, recycling it. Use complementary mud as food for pigs (porks) Drilling in extraction areas *Interpreting and utilizing RSPO principles as the relevant best practices by producers and millers*
Soil quality degradation	Cementing palm nuts storage areas and oil extraction Use as much as possible fallows, degraded areas and leave the forest intact Using cobs as natural fertilizer Using almonds and mud as pigs food Using fibers to produce energy Using plants that restore soil
Destruction of natural habitats	Stabilize or reduce the area allocated to the oil palm Keeping the optimum of 143 feet / ha to avoid the spatial extension of oil palm plantations Extending the most productive varieties of oil (PAMOL) Avoid tackling forest ecosystems using poor fallow land Use plants that restore soil Exploiting any economic opportunities offered by the oil palm to not limit itself to the production of oil alone. *Interpreting and utilizing RSPO principles for environmental responsibility and conservation of natural resources and biodiversity.*
Clearing/ Deforestation	Reducing the area allocated to oil palm Exploiting any economic opportunities offered by the oil palm to not limit itself to the production of oil alone Land zoning, land-use planning and creation of conservation areas for tourism Raise awareness and educate people about the value of forests and their conservation

	Replanting species cut down *Interpreting and utilizing RSPO principles for environmental responsibility and conservation of natural resources and biodiversity.*
Disruption of wildlife and wildlife habitat Migrations and loss of wildlife	Avoid multiplying large oil palm plantations to the detriment of forests that harbour wildlife. Regulating hunting Fighting against poaching and illegal logging Encourage the breeding of hedgehog and fish farming *Interpreting and utilizing RSPO principles for environmental responsibility and conservation of natural resources and biodiversity.*
Diminution des Decrease in non-timber forest products Loss of medicinal species	Domestication of certain non-timber forest products such as mushrooms, *Prunus*. Conditioning palm wine for sale Reduction of area allocated to oil palm Encourage the creation of local cooperatives for the management of resources and land Replanting species cut down Land zoning and land use plan
Job creation	Recruiting local labour as a priority Sensitizing and training people in the oil palm trades Formalizing jobs in agro-industries (CNPS) Equipping workers Encouraging win-win partnership *Interpretating and utilizing the RSPO's principles for commitment to long-term economic and financial viability*
Local economy : Development of economic activities Increase in revenues	Raising awareness of the diversification of IGAs Encouraging groupings in production cooperatives Institutionalize markets for oil sales and standardize prices Capacity building on IGAs. Evolving from tontines to microfinance and community funds Encouraging palm kernel shell crafts Working towards an ecological (green) economy *Interpretating and utilizing the RSPO's principles for commitment to long-term economic and financial viability*
Degradation of workers human health	Port of Protective Equipment (PPE) to rally farms Multiplication of health centers *Interpretation and utilization the RSPO principles for responsible consideration of employees, individuals and communities affected by producers and millers*
Insecurity	Establishment of local vigilance committees Improving rural electrification Managing Conflicts Protecting victims of agro-industries Strengthen the mobility and security forces Encourage diversification and effective consumption of local food production (food insecurity). *Interpretation and utilization the RSPO principles for responsible consideration of employees, individuals and communities affected by producers and millers*
Noise	Port of Protective Equipment (PPE) to rally farms and oil processing sectors
Conflicts	Securing land ownership Land zoning and land use plan Encourage social negotiation and win-win partnership between farmers and agro-industries Avoiding individualist capitalist accumulation and developing social capitalism Better pay for workers and take into account their rights Banning subcontracting (SOCAPALM) Sustainably compensate populations whose land has been occupied by agro-industries in the expected standards (compensation). *Interpretation and utilization the RSPO principles for responsible consideration of employees, individuals and communities affected by producers and millers*
Cultural heritage	Transmission of ancestral practices to the younger generation and involve them

	Capacity building on the virtues of the palm as well as its components and forms of use Documenting Intangible Heritage
Social protection and collective negotiation	Establish schools and health centers in villages to compensate land conceded to oil palm cultivation Promoting social dialogue between agro-industries and farmers Increase the capacity of traditional chiefs in the performance of their interface functions Strengthen the capacity of civil society and trade unions Creating community radio stations Better Governance in oil palm cultivation territories *Interpretation and utilization the RSPO principles for responsible consideration of employees, individuals and communities affected by producers and millers*
Aesthetics and landscape degradation	Waste treatment and valorization (compost) Waste valorization (pigs) *Interpretation and utilization of the RSPO principles as the relevant best practices by oil producers and millers*

Although change is peculiar to human nature, it is important to notice that in the palm oil sector, some changes that seem minor and positive may in the long term have a strong impact on the traditional system and , in particular, the women who depend on them. It is therefore crucial to involve traditional palm oil producers if the changes were to improve their living standard.

5.4. Proposal for an Environmental and Social Management Plan

The Environmental and Social Management Plan (table 41) is an action plan that defines how, when, why, by whom, and what actions are taken and incorporated into the environmental assessment process of a given project in order to ensure it environmental and social acceptability. It summarizes all activities and measures that must be taken in order to monitor, and comply with the prescribed measures with a view to reducing the related impacts of oil palm cultivation. It must allow environmental monitoring as well as environmental and social monitoring for effective environmental protection. Although oil palm cultivation is an income and employment generating activity in both Ekondo-Titi and Ngwéi districts, these jobs are not of quality and this income benefits mostly affluent people. This explain why, in the ESMP implementation, social measures and the fight against poverty and all forms of exploitation or land grabbing should be encouraged.

Table 41 : Environmental and social management plan

Component of affected environment	Impact identified	Environmental action	Objective of the action	Actors in charge of implementation	Implementation Period	Implementation cost XAF	Indicator for monitoring the effectiveness of the action	Effectiveness monitoring actors
Air	Air quality degradation	Using filters in industrial oil mills Regular technical inspection of the mills. Acquiring motorized artisanal mills by community to avoid burning wood or cobs	Reduce the emission rate of toxic gases in order to preserve the biophysical environment and the farmers health	PAMOL, SOCAPALM and Elites Responsible for processing and extraction of palm oil.	Before, during, and after oil extraction activities	2,000,000	Medical report on the prevalence rate of respiratory diseases at extraction sites Technical maintenance report on tools	The state through local elected representatives MINEPDED MINADER
Water	Water quality degradation Depletion of water resources	Water treatment by agro-industries prior to release to the environment Recycling of water Recovering of mud in addition to pig feed Installing boreholes	Preserving water quality	PAMOL, SOCAPALM and Elites Responsible for processing and extraction of palm oil.	During palm oil extraction activities.	5,000,000	Report on the follow-up of activities drafted by MINEE	MINEE MINEPDED MINADER PAMOL SOCAPALM
Soil	Soils quality degradation	Cementing palm fruit /nuts storage and oil extraction areas Using of poor fallow land and degraded vegetation areas Using of cobs as a natural fertilizer Using of almonds and mud as feed for pigs Using fibers to produce energy Using of soil-restoring plants	Preserving soil quality	PAMOL, SOCAPALM and Elites Responsible for processing and extraction of palm oil.	During palm oil extraction and processing activities.	2,500,000	Environmental activity monitoring report Number of plants planted	MINEPDED
Natural habitat	Natural habitats loss	Reducing the area allocated to oil palm Increasing the density of palm trees per hectare	Safeguarding natural habitats Preserving biodiversity	Council Responsible for land issues	Before the clearing of the plot for the setting up of the palm plantation	2,000,000	Report of local elected representatives Visual observation	The state through local elected representatives

		Extending the most oil productive varieties (PAMOL) Zoning the territory Reforestation of local species destroyed Using of plants that restore soil Developing crafts from the palm tree			The entire life of the palm groves			MINEPDED MINDCAF
Flora	Deforestation	Reducing the area allocated to oil palm Developing crafts from the palm tree Land zoning and creation of conservation areas for tourism Creation of nurseries Raising awareness and educating people about the value of forests and their conservation Reforesting the destroyed local species Defending and creating land reserves	Reducing deforestation rate Forest conservation	Councils Responsible for the old palm plantations	The entire life of the palm plantations	2,000,000	Number of nurseries created Number of local reforested species Reforestation success rate	The state through local elected representatives MINFOF MINEPDED
Fauna	Disruption of wildlife and wildlife habitat Migrations and loss of wildlife	Reducing the area allocated to oil palm Regulating the hunting Fighting against poaching and illegal logging Encouraging the breeding of hedgehog and fish farming	Safeguarding Wildlife Preserving biodiversity Protecting ecosystems	Responsible for palm plantations Agro-industries	Before oil plantation establishment	2,500,000	Report of local elected representatives Visual observation	Implementation of a Wildlife Protection Plan MINFOF MINDCAF MINEPIA
Non timber forest products	Loss of medicinal species Decrease in non-timber forest products	Domesticating certain NTFPs such as mushrooms and Prunus. Conditioning palm wine for sale Reducing the area allocated to oil palm	Valuing natural resources	Responsible for palm plantations Council	Before and after oil plantation establishment	3,500,000	Number of planting	MINEPDED MINDCAF

		Encouraging the transfer of CIGs to local cooperatives Reforestating the destroyed local species Zoning of the territory						
Employment	Jobs creation	Recruiting local labour (agro-industries) as a priority Formalizing jobs in agro-industries (CNPS) Sensitizing and train people in the oil palm trades Equipping workers Encouraging a win-win partnership	Reducing unemployment and poverty Reducing land pressure	Both councils	Before oil plam plantation implementation	5,000,000	Number of people recruited	MINPROFF
Local economy	Development of economic activities Increase in revenues	Raising awareness of the diversification of IGAs Encouraging groupings in production cooperatives Institutionalizing markets for oil sales and standardizing prices Capacity building on IGAs. Evolution of tontines towards microfinance and community funds Encouraging palm kernel shell crafts Working towards an ecological (green) economy	Encourage local development Provide microfinance	Both councils	Before, during, and after oil plantation implementation	5,000,000	Number of activities created	MIMPMEESA
Health	Degradation of workers human health	Port of protective equipment (PPE) to rally plantations Multiplication of health centers Distribution of impregnated mosquito nets	Preserve the workers health on sites	Responsible for palm plantations and agro-industries	As soon as the palm plantations implementation	5,000,000	Individual health record	MINSANTE MINFOPRA
Noise	Noise	Port of protective equipment (PPE) to rally plantations and oil processing sectors	Preserve the works health on sites	Responsible for palm plantations and agro-industries	During extraction and processing	2,500,000	Individual health record	MINSANTE

Insecurity	Food deficit Social Conflicts Aggression	Establishing local vigilance committees Improving rural electrification Managing Conflicts Protecting victims of agro-industries Strengthening the mobility law enforcement and security forces Encouraging diversification and effective consumption of local food production (food insecurity)	Working for the protection of local populations and their food	The two councils, the vigilance committees, the guarding companies	During the work, harvesting, extraction	5,000,000	Follow-up report Number of security stations created Rural electrification rate	MINDEF MINEPDED MINATD MINSANTE MINADER MINEPAT
Conflicts	Aggression, violence Intimidation threat	Securing land ownership Zoning of the territory Encouraging social negotiation and win-win partnership between farmers and agro-industries Avoiding individualist capitalist accumulation and developing social capitalism Better paying the workers and taking into account their rights Banning subcontracting (SOCAPALM) Sustainably compensating populations whose land has been occupied by agro-industries in the expected standards (compensation)	Protection of local populations and their property (palm plantations) Improving the social climate	Agro-industries PAMOL et SOCAPALM, Elites and smallholders	Before, during, and after oil extraction activities	10, 000,000	Monitoring Report Number of employees affiliated with the CNPS Payslip	CNPS MINTSS MINDCAF
Cultural heritage	Development of traditional pharmacopoeia	Transmission of ancestral practices to the younger generation Involvement of the younger generation in current practices	Promote the socio-cultural benefits of plants including oil palm Promoting conventional medicine	PAMOL, SOCAPALM, Elites, local population	Before, during, and after oil extraction activities	1,000,000	Activity Monitoring Report	MINFOPRA, MINSANTE SOCAPALM PAMOL Councils MINCULTURE

		Capacity building on the virtues of palm and other plants Documenting Intangible Heritage						
Social protection and collective negotiation	Lack of social protection Tense social climate	Establishing schools and health centers in villages to compensate land conceded to oil plam plantings Promoting social dialogue agro-industries vs peasants Granting increased resources to traditional chiefs in their interface functions Strengthening the capacity of civil society and trade unions Creating community radios	Management of populations working in agro-industrial palm plantations	Agro industries Elites and large growers	The entire life of the palm plantation	20, 000,000	Number of schools created Number of health centers created Record of transfer	MINEDUB MINESEC MINSANTE MINCULTURE
Landscape aesthetics	Landscape degradation	Waste treatment and valorization (compost) Waste valorization (pigs) Fostering landscape resilience	To protect the nature	Responsible for oil extraction and processing zones	After the oil extraction activities	500,000	Number of clean sites	MINEPDED MINDCAF MINATD MINEPAT

5.5. Environmental and Monitoring Plans

Environmental monitoring by project initiators is intended to ensure compliance and enforcement of the mitigation or compensation measures prescribed in ESMP, of which it is an essential component. In addition to the legal obligations and requirements relating to the relevant laws and regulations, it incorporates the commitments of the initiators.

NB: The monitoring program may, however, be subject to periodic review in the light of the performance of the mitigation measures envisaged during the implementation of the project. In this case, this revision will make it possible, if necessary, to redirect the continuation of this work and to improve the progress of the project in order to achieve the expected objectives.

Monitoring is the systematic collection and analysis of information as a project progresses. The goal is to improve the profitability and efficiency of a project or organization. It is based on established objectives and activities planned during the planning stage of the work. The role of monitoring is to ensure continuous and systematic control of project activities and results through monitoring, verification and control of the implementation process throughout its establishment.

The purpose of environmental monitoring by the project proponent is to verify, through field experience, the adequacy of the assessment of certain impacts and the effectiveness of certain mitigation or compensation measures and for which there is uncertainty. Beyond the evaluation, the purpose of environmental monitoring is to learn from past experiences. The role of environmental monitoring is therefore crucial, as it increases knowledge, reduces uncertainty, improves analytical tools and ultimately protects the environment.

Environmental monitoring makes it possible to monitor the assessment of the various environment components that will be affected by the implementation of the activity. Thus, at the end of the proposed environmental management plan, certain environmental elements such as flora, water, employment and the economy, require environmental monitoring and follow-up which are proposed in tables 41 & 42.

Table 42: Environnemental monitoring plan

Component of affected environment	**Environmental action**	**Objective of the action**	**Actors in charge of implementation**	**Implementation Period**	**Indicator for monitoring the effectiveness of the action**	**Planning for implementation**
Water	Using of pipelines for drainage of wastewater	Preserving water quality	Responsible for processing and extraction of palm oil	During and after oil extraction activities	Follow-up of the water path	Weekly inspection of the premises by the sanitation service
Flora	Creation of nurseries and reforestation in local species Reduction of area allocated to forestry Zoning and preserving forest land Constitution of land reserves	Reducing the rate of deforestation Stabilizing the forest areas	Councils authorities Head of the palm plantations MINFOF Forest Station	At any time	Number of nurseries of local species created Number of seedlings	Plant monitoring and maintenance
Fauna	Stabilizing the areas allocated to oil palm farming Fighting against wildlife poaching Breeding hedgehog	Safeguarding wildlife	MINFOF Forest Station	During the life of the palm plantations	Inspection report Visual observation	Implementation of the Wildlife Protection Plan
Employment	Sensitizing and training populations on recruitment conditions. Recruiting the local workforce	Reducing unemployment and poverty rates	Municipal authorities Local Authorities	Before the establishment of the palm plantations	Number of local employees of elite plantations and agro-industries	Consultation of reports of field inspection activities by the Social Affairs Department
Economy	Sensitizing and training of populations on the creation of IGAs Establishing Microfinance and micro-credit	Increasing the rate of savings	Municipal authorities Local Authorities	Before and after the establishment of the palm groves	Number of income-generating activities created	Consultation of reports of field inspection activities by the Social Affairs Department

Table 43: Environnemental follow-up plan

Component of affected environment	Environmental action	Objective of the action	Task envisaged or monitoring measure	Indicator for monitoring the effectiveness of the action	Inspection means	Frequency of the follow-up	Implementation period or calendar	Actors to monitor effectiveness
Water	Water treatment before releases to the environment Use of pipelines for drainage of wastewater	Preserving water quality	Wastewater Orientation Water analysis	Bi-monthly report of the follow-up of the activities drafted by MINEE	Direct observation Physico-chemical analyzes results	Quarterly based on the detected parameters	During extraction activities	MINEE MINEPDED
Flora	Creation of nurseries and reforestation of local species Reduction of area allocated to oil palm farming Zoning and preserving the forest territory Constitution of land reserves	Reducing the deforestation rate	Purchase, planting and maintenance of seedlings	Assessment of the reforestation success rate Number of reforested species	Direct observation Reports MINEPDED and MINFOF	half-yearly	The entire life of the oil palm plantation	The State through local elected representatives MINFOF MINEPDED
Fauna	Stabilizing the areas allocated to oil palm farming Fighting against wildlife poaching Breeding hedgehog	Safeguarding Wildlife	Multiplication of controls Forest Station Patrols	Report of local elected representatives Visual observation	Reports of the MINEPDED MINFOF MINADER MINEPIA	Quarterly	The entire life of the oil palm plantation	MINFOF MINDAF
Emploment	Raising awareness of recruitment conditions. Recruiting the local workforce	Reducing unemployment and poverty rate	Use local labour as much as possible	Number of people recruited	Identification of workers CNPS reports	Quarterly	The entire life of the oil palm plantation	Local elected representatives
Economy	Sensitizing and training of populations on the creation of IGAs Establishing microfinance and micro-credit	Increase the savings rate	Schedule training sessions on income IGAs.	Number of activities created	Identification of activities created	Quarterly	The entire life of the oil palm plantation	MINPMEESA

Broadly speaking, the analysis of the oil palm cultivation impacts shows that this monoculture has considerable impacts on receiving environments and leads to floristic and wildlife species loss, fragmentation of ecosystems and habitats, the disappearance of products NTFPs, water and soil pollution, conflicts. Even if one can console oneself for the jobs that it provides, the diversification of income sources remains inescapable. It is essential that NGOs, CSOs, CIGs, the State, traditional authorities and others work for the interpretation of the RSPO criteria for the production of certified and ecologically profitable certified palm oil. Compliance with the various measures prescribed in the ESMP and the implementation of the proposed monitoring plan below will make it possible to reduce or even control these impacts. In Indonesia and Malaysia, where the development of palm oil has been dazzling, massive deforestation is unfortunately, a situation that these countries are finding difficult to control today. It is to be feared that Cameroon, notably Ngwéi, which is the Sanaga Maritime pilot district of oil palm belt, suffers the same fate to the detriment of its forests intrinsic value.

6. Recommendations and conclusion

6.1. RSPO and certification

The Roundtable on Sustainable Palm Oil (RSPO) is a global, multi-stakeholder initiative on sustainable palm oil. This process was developed and launch in 2003 by WWF and OXFAM which were later joined by *Les Amis de la Terre* (Friends of the Earth) and Greenpeace. The principal objective of RSPO is "to promote the growth and use of sustainable palm oil through cooperation within the supply chain and open dialogue between its stakeholders". The RSPO Principles and Criteria for Sustainable Palm Oil Production were adopted in November 2005, revised in 2007 on the basis of the criticisms made, and validated in 2013 by the General Assembly. RSPO is summarized in a set of 8 principles and 39 criteria (table 43) for certification proposed to producers. It is a thinking basis useful to African producers and managers, especially Cameroonians. **These principles must be presented to any new operator before the starting of his activity. In addition, it must be accompanied by a preliminary impact assessment and a certificate of conformity**.

Table 44 : Principles, criteria and possible benefits of RSPO.

N°	Principles	Criteria	Possible Benefits
1	Commitment to transparency	Oil palm growers and millers provide adequate information to other stakeholders on environmental, social and legal issues relevant to RSPO Criteria, in appropriate languages & forms to allow for effective participation in decision making. management documents are publicly available, Code of ethical conduct in operations and transactions	Mutual respect, Commitment of the parties, Availability of the documentation, Building trust between stakeholders
2	Compliance with applicable laws and regulations	Compliance with all applicable local, national and ratified international laws and regulations. The right to use the land can be demonstrated, and is not legitimately contested by local communities with demonstrable rights. Use of the land for oil palm does not diminish the legal rights, or customary rights, of other users, without their free, prior and informed consent.	Law reinforcement, Prior and informed consent Lack of significant land conflicts or conflicts restriction
3	Commitment to long-term economic and financial viability	management plan that aims to achieve long-term economic and financial viability.	*Social and economic sustainability*
4	Use of appropriate best practices by growers and millers	Operating procedures are appropriately documented and consistently implemented and monitored.	Practices minimise and control erosion and degradation of soils.

		Practices maintain soil fertility at, or where possible improve soil fertility to, a level that ensures optimal and sustained yield. Pests, diseases, weeds and invasive introduced species are effectively managed using appropriate Integrated Pest Management (IPM) techniques. Agrochemicals are used in a way that does not endanger health or the environment An occupational health and safety plan is documented, effectively communicated and implemented. All staff, workers, smallholders and contractors are appropriately trained.	Practices maintain the quality and availability of surface and ground water. Good ecological footprints Reducing casualties
5	Environmental responsibility and conservation of natural resources and biodiversity	Plans to mitigate the negative impacts and promote the positive ones are made, implemented and monitored, to demonstrate continuous improvement. The status of rare, threatened or endangered species and high conservation value habitats, if any, that exist in the plantation or that could be affected by plantation or mill management, shall be identified and their conservation taken into account in management plans and operations. Environmental management system : Waste is reduced, recycled, re-used and disposed of in an environmentally and socially responsible manner Efficiency of energy use and use of renewable energy is maximised. Use of fire for waste disposal and for preparing land for replanting is avoided. Plans to reduce pollution and emissions, including greenhouse gases, are developed, implemented and monitored.	Protection of hot spots Protection of forest with high conservation value Reducing GHG
6	Responsible consideration of employees and of individuals and communities affected by growers and mills	Plans to mitigate the negative impacts and promote the positive ones are made, implemented and monitored, to demonstrate continuous improvement. There are open and transparent methods for communication and consultation between growers and/or millers, local communities and other affected or interested parties. Mutually agreed and documented system for dealing with complaints and grievances, which is implemented and accepted by all parties. Pay and conditions for employees and for employees of contractors always meet at least legal or industry minimum standards and are sufficient to provide decent living wages. The employer respects the right of all personnel to form and join trade unions of their choice and to bargain collectively. Children are not employed or exploited. Children are not exposed to hazardous working conditions. Any form of discrimination based on race, caste, national origin, religion, disability, gender, sexual orientation, union membership, political affiliation, or age, is prohibited. Policy to prevent sexual harassment and all other forms of violence against women and to protect their reproductive rights is developed and applied.	Best local communities resilience Partnership opportunity Restoration of better social conditions Local development Social security guarantee

		Growers and millers contribute to local sustainable development wherever appropriate. Growers and mills deal fairly and transparently with smallholders and other local businesses.	
7	Responsible development of new plantings	comprehensive and participatory independent social and environmental impact assessment is undertaken prior to establishing new plantings or operations, or expanding existing ones New plantings does not replaced primary forest or any area required to maintain or enhance one or more High Conservation Values. Extensive planting on steep terrain, and/or on marginal and fragile soils, is avoided. No new plantings are established on local peoples' land without their free, prior and informed consent, Local people are compensated for any agreed land acquisitions and relinquishment of rights, subject to their free, prior and informed consent and negotiated agreements. Use of fire in the preparation of new plantings is avoided minimising GHG in all new plantings	Best yields of plantations Funding /finance access Reducing of GHG
8	Commitment to continuous improvement in key areas of activity	Growers and millers regularly monitor and review their activities and develop and implement action plans that allow demonstrable Continuous improvement in key operations.	Best yields of plantations

In addition, Southeast Asian (SIVA, Sime Darby, Good Hope and GMG), Western Europe (SOCAPALM of the French Bolloré Group) and American (Cargill and Herakles of the USA) enterprises based in Africa (Eldorado of the red gold), are the subject of much criticism: poor wage treatment of employees, poor waste management, disregard for local communities, plunder of forest resources, failure to comply with concession contracts, etc.). All these observations call for the standardization of this activity by equally binding principles negotiated over-the-counter in a participatory approach.

Indeed, the main criticism made with regard to the RSPO is its voluntary nature and therefore not very restrictive. Critics of this "green" palm oil cried foul, alleging green wash and weak certification standards. It was almost a moot point: Most of that oil has languished on the global market. On the other hand, NGOs that do not support the initiative insist on the low standards and the lack of guarantees on several major points: deforestation (notably High Conservation Value Forests - HCVF), conversion of peatlands and GHG emissions. Faced with these criticisms, the RSPO has strengthened its governance system, notably by setting up a complaint system and a supervisory committee which has led to the suspension of the certifications of certain members. What can environmental and social certification bring to the peasants and agro-industries of Ekondo-Titi and Ngwéi?

6.2. Impact of environmental and social certification

According to the FAO, there are more and more corporate codes of conduct, some of which concern the entire food chain to producers. In addition, consumer concerns have led to a number of certification and / or labelling initiatives, some implemented by NGOs and others by the business sector or government institutions. They often refer to treaties and conventions at international level, sometimes translating them into verifiable standards for direct implementation by producers and / or traders.

A large number of voluntary environmental and social standards and certification schemes in agriculture have emerged over the past two decades. Governments have become involved or involved in some of them, most clearly in biological farming and labelling. Most social and environmental standards such as the fair trade system, the SA8000 social responsibility standard and the SAN / Rainforest Alliance sustainable agriculture program have been developed by non-governmental organizations (NGOs). Markets for certified but unlabelled products, such as Sustainable Agriculture Network (SAN), SA8000 and EurepGap certified products, are only differentiated at the wholesale and purchaser level but not at the consumer level.

Implementation of standards and market penetration of certified and / or labelled products have complex impacts on the economic performance of the farm. Production costs, yields and producer prices can be positively or negatively affected and must be analyzed together. In addition, the initial investment costs are likely to be very farm specific. New crops or activities can be introduced into the system, further complicating the analysis of profitability.

No systematic study is available, which assesses the impact of certification programs on a wide range of farms, crops and locations. However, the number of case studies that have examined - more or less exhaustively - the impacts on various costs and aspects of profitability, is increasing. Studies therefore concentrate on returns, others on profitability, and others on the factors of success and the role of support organizations. A brief synthesis is given for each type of certification and its standards.

The Round Table has established certification systems based on the RSPO Principles and Criteria: one is to ensure that palm oil is produced in a sustainable manner and the other aims to ensure the integrity of the trade in palm oil, that is to say that the palm oil sold as sustainable is actually palm oil produced in certified plantations. Both systems involve external certification bodies.

Palm oil or palm oil derivatives certified by the Roundtable on Sustainable Palm Oil (RSPO) can be purchased through three supply chain systems: ‘Segregated’, ‘Mass Balance’ and ‘Book and Claim’. Each of these systems comes with its own advantages, requirements and pre-approved consumer claim. The three systems ensure that market claims about the production and use of sustainable palm oil remain transparent and accurate.

6.2.1. Palm oil certified segregated and « Identity preserved [5]» (IP)

Segregated palm oil is traced throughout the supply chain, but allows mixing from multiple certified plantations. CSPO is collected from certified plantations in dedicated tanks and kept separate from noncertified oil all the way to the end user. The end user therefore receives 100% certified palm oil. Fully traceable palm oil (Identity Preserved) is an even stricter variation on this system whereby the palm oil is segregated but is also traceable back to an individual plantation. It is not mixed with palm oil from other certified plantations. This type of CSPO is associated with the highest level of traceability.

Identity Preserved (IP) supply chain model assures that the RSPO certified oil palm products delivered to the end user, is uniquely identifiable to a single mill and its supply base and is kept physically isolated from all other oil palm sources throughout the supply chain (including

[5] http://awsassets.wwfffr.panda.org/downloads/wwf___enquete_huile_de_palme_bd.pdf

other segregated RSPO-CSPO sources). Fully certified and traceable to the source. The consumer is assured that the physical palm oil received came from a uniquely identifiable, RSPO-certified plantation. Identity Preserved is the most costly of the four supply chain systems because of the extensive need for documentation and verification. This complexity is further magnified if the palm oil fractions (different types of refined palm oil) are converted to derivatives for use in other industries (such as health and beauty) as the number and complexity of handling and storage increases exponentially. It is important that there is a balanced market demand for all fractions of segregated CSPO in order to maximize the benefit and minimize costs to end users.

The value of these two options lies in the greater involvement of firms throughout the supply chain (they must have a relatively fine view of their supply). These options also ensure that the oil used contains 100% CSPO and therefore does not contribute to deforestation. However, these modes of supply are expensive because the flow of certified and non-certified palm oil must be separated along the supply chain (production, transport, refining, etc.).

6.2.2. Mass balance CSPO (Certified sustainable palm oil)

In the Mass Balance system, certified palm oil is mixed with noncertified, but a record is kept of the amount of certified palm oil in the tank. When the palm oil is sold to the end user, the same volume that was certified at the start can be sold as certified; the rest is sold as noncertified. This allows for the mixing that takes place in the supply chain without affecting the total volume of palm oil that is ultimately sold as certified. It is cheaper to implement than segregated because certified oil does not have to be kept separate. This supply chain option is relatively inexpensive compared to Identity Preserved and Segregated, but it has a lower level of traceability and market claims are not as strong. However, as final volumes do not contain 100% certified palm oil, users can not be certain of the sustainability of their supplies, therefore traceability is not guaranteed.

6.2.3. Book and claim (Green palm certificate or certificates purchase)

Book and Claim system is very different from the other models as there is no requirement for physical traceability (CSPO does not have to be segregated or tracked) through the palm oil supply chain. In the Book and Claim system, the sale of CSPO Certificates is separate from the sale of the physical palm oil. For example, a certified plantation may face a situation where its buyers are not interested in purchasing CSPO. In this case, the plantation sells its product as normal, uncertified palm oil. By recording the volumes, however, the plantation can then can sell Book and Claim certificates to other downstream entities in the supply chain (e.g., consumer goods brands or retailers) who wish to “offset” nonsustainable palm oil purchases with these certificates. Book and Claim was designed to help generate rapid uptake of the RSPO certification system. Book and Claim is very cheap to monitor as it is purely a paper-based process. It simply requires that auditors check the volume of certified palm oil that the plantation has produced and that the oil was not already sold as certified. The Book and Claim certificates trading platform is managed by Green Palm. GreenPalm is a very cheap option for brands to purchase RSPO endorsed palm oil with a claim stating it supports the production of sustainable palm oil. It is important to underline that the physical oil itself is neither certified nor sustainable.

This method is often used by businesses that do not yet have the necessary RSPO certification or supply chains required for physical CSPO, and so is often a viable option for businesses using fractions and derivatives of palm oil, for whom a certified segregated physical supply might not be available, or for those importing finished goods containing palm oil. The RSPO

PalmTrace system also enables palm oil smallholders (and land locked producers without export routes) to sell their sustainable production, covering the costs of RSPO certification and encouraging future investment.

Nevertheless, a company using this option can still use palm oil from plantations involved in deforestation and allows supply chain players to continue to source unsustainably. Most companies now use this system as a first step, not an end in itself, with the risk of exposing themselves to green-washing charges. Since the system does not guarantee the traceability of the palm oil used, it is intended to encourage production of CSPO at a lower cost.

6.2.4. Segregated (mixture of palm oils CSPO)

The Segregation supply chain model (SG) assures that 100% RSPO certified oil palm products delivered to the end user comes only from RSPO certified sources. It permits the mixing of RSPO certified palm oil from a variety of certified sources. Segregated is fully certified palm oil however still not traceable to plantation. Certified palm oil is kept separate from non-certified palm oil, but is blended with other batches of CSPO and therefore cannot be traced back to a specific plantation. This option requires that fruit bunches and oil from RSPO certified sources are kept physically apart from other non-certified palm oil by growers, mills, transport and storage providers, refiners, and manufacturers. The end-user is assured that the physical palm oil received came from one or more RSPO-certified plantations, but unlike the Identity Preserved system, the oil cannot be traced back to individual plantations.

6.2.5. Rainforest Alliance certification

The good news is that consumer demand for “deforestation-free” palm oil has led to the creation of certification bodies, primarily the Roundtable on Sustainable Palm Oil (RSPO) in 2003, to provide products with better traceability. Unfortunately, many people have found the RSPO’s efforts to be inadequate, which is why the Rainforest Alliance got involved. As an organization with long experience in applying agricultural standards, and a member of the RSPO, the Rainforest Alliance has developed its own plan for certifying palm oil farms as sustainable and allowing them the use of their distinct green frog seal.

Rainforest Alliance[6] shares the concerns of many on the destructive impact of the expansion of oil palm plantations in tropical forests, particularly in Southeast Asia and especially on the Borneo and Sumatra islands. By supporting RSPO's efforts, Rainforest Alliance has created its own complementary and rigorous certification system for palm oil, based on the Sustainable Agriculture Network (SAN) standards. Operations that meet the demanding SAN standards for palm oil can get the Rainforest Alliance certificate. SAN standards were created in tropical countries more than 15 years ago through a long process of research, experimentation and consultation involving farmers, scientists, NGOs, universities, government agencies and Agricultural enterprises. The process was led by biologists as the protection of wildlife, tropical rainforests and other tropical ecosystems was and remains the main objective

In other words, the environmental certification of agricultural holdings can be applied to all farms, irrespective of their size and production. It is voluntary and follows a progressive logic on three levels, whose requirements are articulated around four themes:

- Biodiversity

[6] http://www.rainforest-alliance.org/lang/fr/work/agriculture/palm-oil

- Phytosanitary strategy
- Fertilizer management
- Water resources management

Certification should lead to the establishment of the conditions to be respected by any new and former oil palm farmer. It presents itself as one of the strong recommendations that Cameroon must adopt and adapt to its environmental standards for a palm oil that respects the environment and rural production companies.

N.B. Certification can be individual for the elites and collective for the small village farmers organized in cooperative.

6.3. Food insecurity

Hunger, which is still very present in rural and even urban areas in many developing countries, especially in Africa, is closely linked to poverty. Lack of sufficient income to buy food is a major contributor to household food insecurity. With oil palm, there is a tendency to forget about other speculation and this can lead to starvation which itself contributes to poverty by lowering labour productivity, reducing disease resistance and reducing the impact of education (FAO[7], 2001: 6). It is clear that development based largely on agriculture is an effective way to reduce poverty and accelerate economic growth. This result is normally achieved not only by increased incomes for agricultural producers and labourers, but also by creating demand for non-marketable goods - mainly local services and products. The challenge for developing countries is to identify specific needs and opportunities for agricultural and rural development and to focus investment in areas where the impact on food security and poverty will be significant. The functioning of any individual production system is strongly influenced by the external rural environment (policies, institutions, markets and links to information).

According to FAO (2001: 14), there are five main household strategies to improve their subsistence level:

- Intensification of existing production models;
- Diversification of production and processing;
- Increase in farm size;
- Increased off-farm income, both agricultural and non-farm;
- Complete exit of the agricultural sector from a particular farming system.

We do not think that oil palm farmers in Ngwéi or Ekondo-Titi are there. Therefore, the value chain of the oil palm must be explored to enable them to diversify incomes.

6.4. Evolution of CIG to cooperatives.

Producer associations or cooperatives may be formed respecting diversity and complementarity. The organization of producers' cooperatives would also make it possible to curb the sales problem at the same time as that of artisan mills. Moreover, in Ngwéi, it is realized that most of the CIGs (table 44) are run by elites owning large oil palm estates or cocoa farms, this situation does not militate in favour of the village producer's interests.

Table 45: list of the CIG and their delegates

Name of the CIG	Name of the Delegate	Locality or village	Sector
GIC REFERENCE	SEH François	Ebombè	Oil palm
GIC JAY	DIKANDA Paul	Solopa	

[7] ftp://ftp.fao.org/docrep/fao/003/y1860f/y1860f.pdf

GIC PPS	DIALBOO Manfred	Sombock	
GIC CAMAT	BELLA Irène	Njock Loumbe	
GIC JAEM	NDJOCK Augustin	Mbandjock	
GIC SOCOOPADOMCOOPCA	NGUIMBOUS Jean Jacques	Ngwéi I	
GIC PROTOCAM	SEPPE Blaise	Seppe	
GIC PROAM	NGWET Marthe	Makek	Cocoa
GIC LUMIERE	BINGONG Augustin	Makaï dans Makondo II	
GIC JAEMAK	BIYIHA Joseph	Makondo I	
GIC AGROVITAL	BOUMBAI Jean	Njock Loumbe	
GIC SOVIEM	NLEP Simon Pierre	Mbamblè	
GIC PROCACUL	NKOMA Thérèse	Lep Likoung	
SCOOP-CAN	EPOUNER Monique	Makondo	
SCOOP CACAN	BOUMBAI Jean	Ngwéi	

This move towards a cooperative system is also aimed at the renovation of means and equipment for the oil production (extraction) for poor villager palm plantations. If this is not realized, we fall into the trap of agricultural extractivism or pure productivism which is already the prerogative of agro-industries

6.5. Integration oil palm plantings and pig breeding.

It is imperative to encourage pig farming, which is the best complement to and allied of oil palm cultivation in terms of waste management and farms organic fertilization. This makes it possible to carry out an integrated production by combining piggery and oil palm so that all the oilcakes and other waste are consumed by the pigs.

6.6. REDD+ and PES as a means of combating deforestation

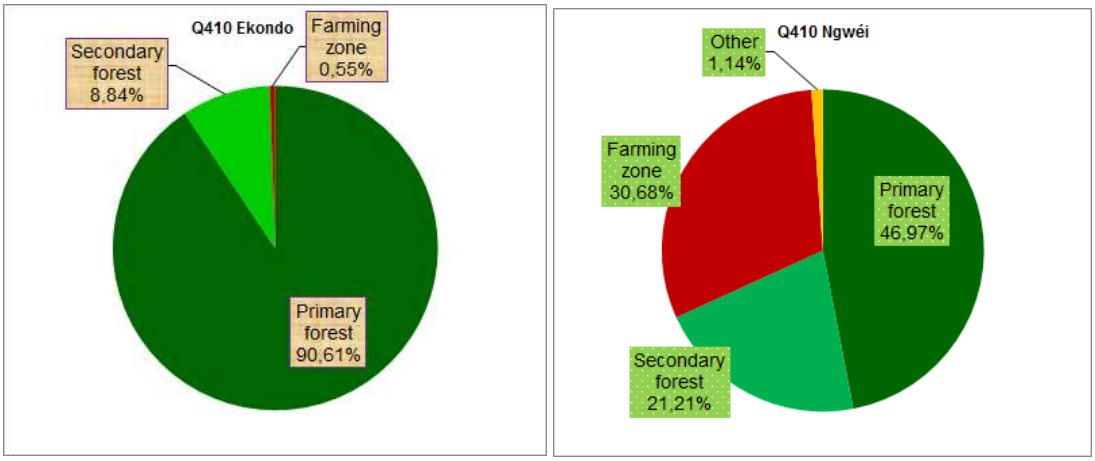
According to the FAO (2010), oil palm growing is today the main cause of deforestation and greenhouse gas emissions. The increase in dedicated areas is therefore a dilemma and a disaster. We also recommend **encouraging reforestation in order to avoid the unfortunate situation of these two producer's basins**, which will make the oil palm an economic opportunity, an engine of deforestation and unfortunately an ecological disaster. It is a challenge and at the same time a dilemma that comes at the right time with the REDD + process as well as payments for environmental services.

These measures can be implemented in different communities to promote sustainable use of the forest. The idea of payments for environmental services or payments for ecosystem services, although of recent concern in the context of climate change and REDD +, fits well with the RSPO HCVF concept. Nlom and Sonwa (2013), in a report sponsored by MINFOF (www.minfof.cm/documentation/Etude_MINFOF_2013.pdf, pp.211-236, report retrieved [15 June 2014] from) state that PES «are effective where regulatory approaches have failed; because it's create a system that encourages conservation rather than a set of obligations. Its will enable the transfer of income to local communities ". Therefore, all the initiatives involved in carbon sequestration, watershed protection and water management, soil fertility protection and the biodiversity conservation are based on PES and REDD +. Furthermore, it is better to develop new plantations on marginal land, fallow land or abandoned fallow land (as is the case for some villagers in Ngwéi and which should be emulated by the elites) than elsewhere in dense forest and mangrove. The REDD process in the Ngwéi council, which is more threatened by oil palm deforestation, needs to be quickly implemented.

Ekondo-Titi hosts in its western fringe, a good part of the Gulf of Guinea mangroves. Degradation pockets have already been observed, it is essential to ensure it conservation. However, PAMOL intends to develop 3000 ha of palm plantations in Bakassi at the expense of mangroves. It is not superfluous to recall that the populations recognize that they have cleared the forest to install the palm plantation (Fig. 67b).

Q410 For the setting up of your palm plantation, what type of vegetation have you transformed?

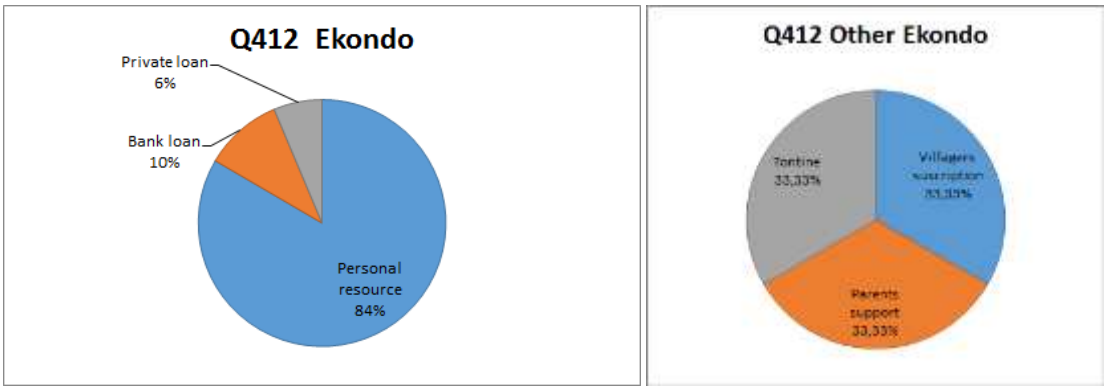
The primary forest is destroyed for the benefit of elaeis plantation for 90.61% of respondents in Ekondo-Titi against 46.97% in Ngwéi. Secondary forest is equally strongly sought in Ngwéi (21.21%) against 8.84% in Ekondo-Titi. The Ngwéi disorder stems from the fact that the food crop areas (30.68%) are continuously converted into palm plantations, which considerably reduces the space devoted to subsistence agriculture.



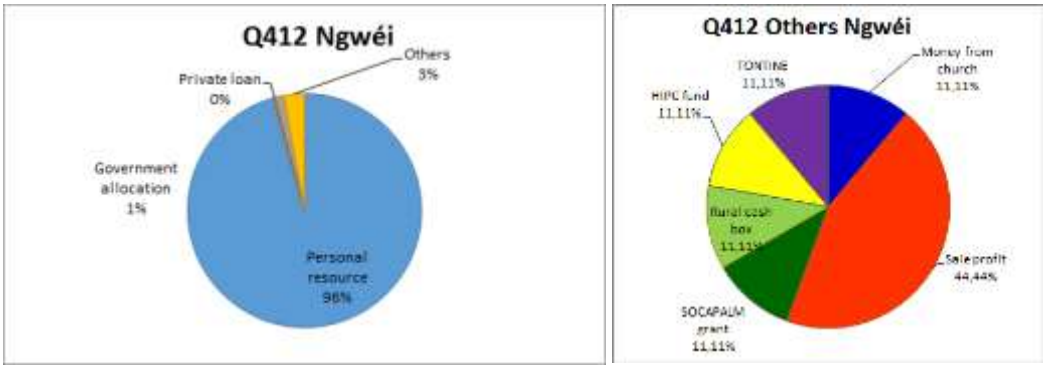
Figures 67 ab: vegetation type preceding oil palm plantings

6.7. An embryo of local development to be pursued

The Sanaga Maritime different territorial units tax the agricultural plantations. Thus, palm oil producers are registered and pay taxes for the implementation of local community development projects. Industrial production units in the form of private companies (SOCAPALM) or parastatals (PAMOL-CDC) pay other forms of taxes (corporate tax, additional centimes ...). This embryo of development suffers from the weakness of the State accompaniment. **How to supplement the weakness of the State accompaniment? Capital is needed, also microfinance and credit mechanisms are to be implement in place in agricultural communities**. Indeed, the sources of financing activities exclude the poorest as shown in the following figures 61 abcd. To the question ***Q412 what are the sources of funding for your activities?*** *Responses focus on personal resources to 84% in Ekondo-Titi and 96% in Ngwéi, which is the responsibility of the more affluent elites.* Indeed, the land pressure would be better regulated if the poorest had a certain financial autonomy in the beginning of their activities.



Figures 68 ab: Financing sources of the oil palm cultivation at Ekondo-Titi



Figures 69 ab: Financing sources of the oil palm cultivation at Ngwéi (*HIPC: heavily indebted poor countries*)

6.8. Social Equity and Oil Palm

We have seen in the landscape resilience approach that social equity was a plague for the two municipalities of Ekondo-Titi and Ngwéi. However, a sustainable activity shares its benefits to the various actors entering the production chain (Tsayem, 2011). The investment of smallholder farmers in the oil palm would enable them to take advantage of agro-industries if and only if a win-win partnership was established. The creation of large palm plantations must necessarily take into account the desires and needs of local populations who are often expropriated from their land by force. Such a situation distorts their lives and undermines their dignity (Gerber, 2008). More attention must also be given to subsistence agriculture to ensure food security for the population. Incentive programs such as maize or intensified production of edible tubers must penetrate the two councils; thus ending the concept of exclusive zone for a single agricultural speculation. A great attention should also be paid on jobs salaries in agro-industries (Pigeaud, 2008; Retrieved 15 October 2013) from: http://www.liberation.fr/economie/010176109-les-camerounais-exploites-des-palmeraies-de-bollore). At the level of village farms, the system of remuneration deserves a framework of the authorities to ensure the attractiveness of these jobs. More attention needs to be paid to the poor. In addition, there is a need to provide women with a stronger foundation and clearly determine their tasks in the production chain of oil palm plantings.

6.9. Water pollution control

We found high biological oxygen demands in the running water. To limit these impacts on water resources, it is necessary to invite the actors to solidarity in an integrated management. Operators using the same water resource must agree on a system that ensures the overall demand and its renewal. The discharge of liquid waste (photos 18 a & b) into the rivers

constitutes a mess not only because of the organic matter (oilcake) loss (resulting in high pH), but, also for the water contamination or pollution. It would also be useful to discriminate between the sources of water reserved for the domestic consumption needs of the populations and those devoted to agricultural activities in general. This would avoid not only conflicts in sharing, but also ensure a good quality of water resources. **At the rate at which artisanal mills are growing and agro-industries are multiplying, there is a wager that most of the waters of these environments will in some ten years become unfit for consumption and domestic needs**.

Photos 18 a&b : Pouring of palm oil refinery waste from the PAMOL mill in the Mana River (Ndian basin).

6.10. Implementation of land-use plans, land reparcelling and agricultural zoning

Agricultural land consolidation consists of grouping small parcels into a larger land. Often, this technique increases crop profitability. Zoning is a tool for protecting agricultural land. These two notions deserve to be mentioned in the context of provisional or compensatory measures, for example in the context of consolidations being municipal or departmental planning initiative or decision aimed at limiting peri-urbanization or urbanization pressures also, to protect the forest (Ngwéi and Ekondo-Titi), mangrove or afro montane forests (Ekondo-Titi) and the ecosystem services they provide. The zoning defines precisely the vocation of each of the municipal territory areas, with short and long term deadlines, and must imperatively fit into the local development plans. In addition to the quantitative aspects of sampling, zoning will ensure that these harvests are reasoned based on their qualitative impacts on the basis of a well-established agricultural diagnosis in each council. Each zoning must be associated with a regulation that specifies the permissible land uses and outlines the priorities and opportunities for sustainable development of the municipal territory and especially of the agricultural activities provided for in this framework.

Taking into account these elements, we established in the Ekondo-Titi district that the villages and urban localities of Bekora (13.59%), Dibonda (12.15), Bongongo I (31.37), Ekondo Kitta Balue (25.86) and Ekwe (27.30) are to be monitored because their land spaces are saturated in terms of the oil palm plantation surface area ratio. In the Ngwéi district, Ikonde (21.20%), Makondo II (24.19 and chief town) and Njock Loumbe (34.81) villages constitute the most saturated territories. We believe it would be useful to propose 22,300 ha to the north of the map and 5,400 ha to the south of the Ngwéi landscape, while in Ekondo-Titi the entire northern part (18,872 ha) and Coastal fringe (15, 707 ha) with its creeks to be protected (figures 70 a & b). We insist on this by invoking the uniform distribution of the population in the two territories (Fig. 63a & b). Such a distribution can already create pressures on saturated territories and forced migrations over others. The chief towns, by virtue of their function and

the institutions they inhabit, will experience these difficulties. The same applies to the sites of industrial extraction facilities such as Lobe Town (Ekondo-Titi) and Njock-Loumbe (Ngwéi).

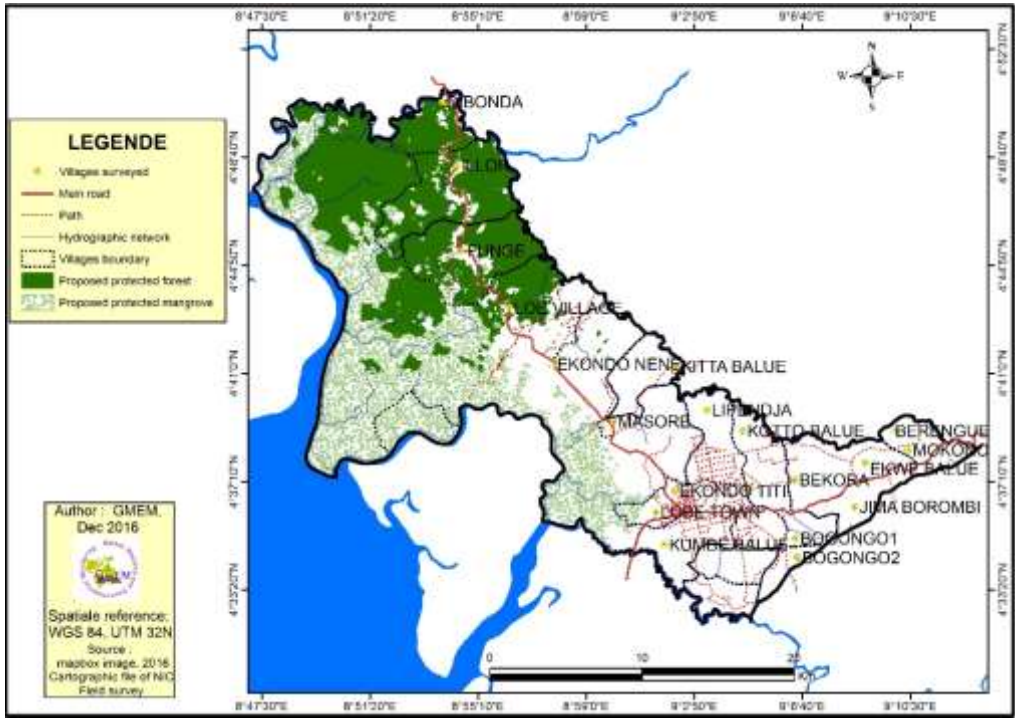
6.11. For an integrated and sustainable ecological system

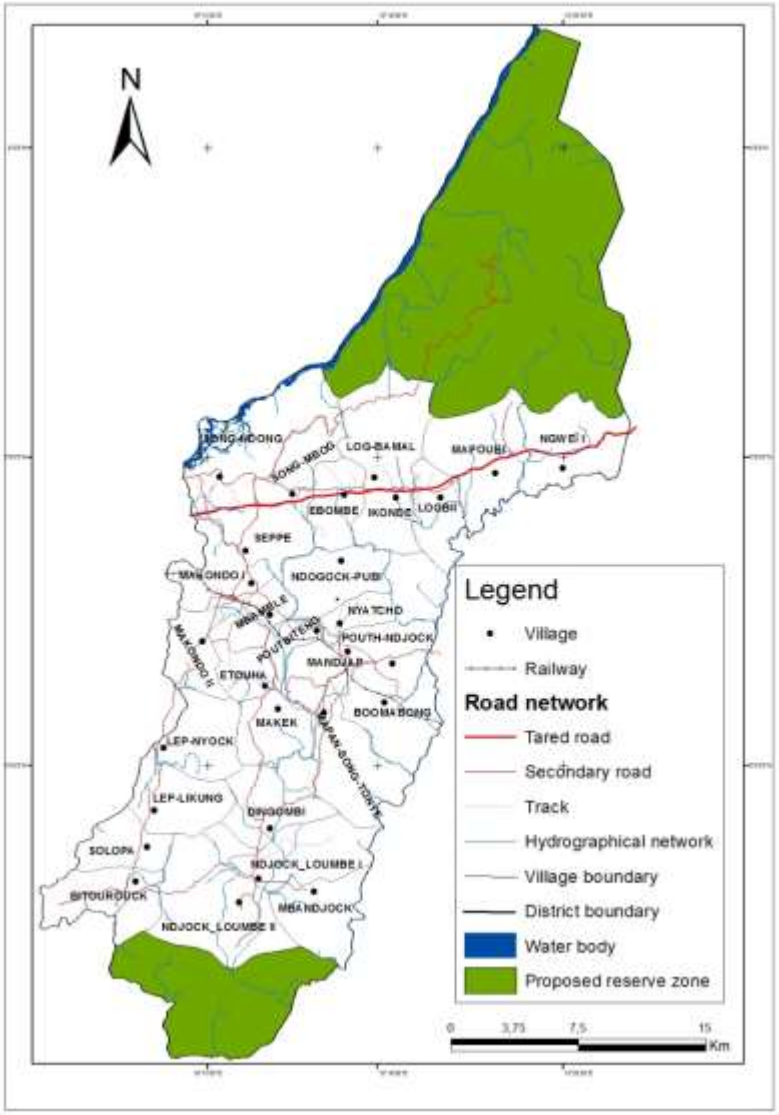
Given that the government wants to make Cameroon self-sufficient in palm oil, we thought it would be opportune to propose an evolution towards an integrated and sustainable ecolabelling system. Several aspects should be taken into account:

- Initially, the establishment of community mills for smallholders' plantations which will contribute to improving yields at the same time as this reduces the extent of pollution while allowing for environmental monitoring. Thereafter, the evolution of these small planters towards a cooperative system is desired;
- Access of small farmers to more productive seeds is advised. This involves reducing prices and training nurserymen at the local level. The same applies to the approval of palm oil sales prices.
- Valuation of the *Elaeis* value chain
- Strengthening partnership and cooperation between agro-industries and elites on the one hand and populations on the other hand is an asset.
- However, land zoning and the preliminary environmental assessment (EIA or impact notice depending on the size of the oil palm plantation) are essential for the forest ecosystems conservation. Zoning leads to a better control of the land and thus to the rate of spatial expansion of the palm plantation groves.

Figures 70 ab : Sketch of the proposed development plan of the two councils, Ekondo-Titi and Ngwéi.

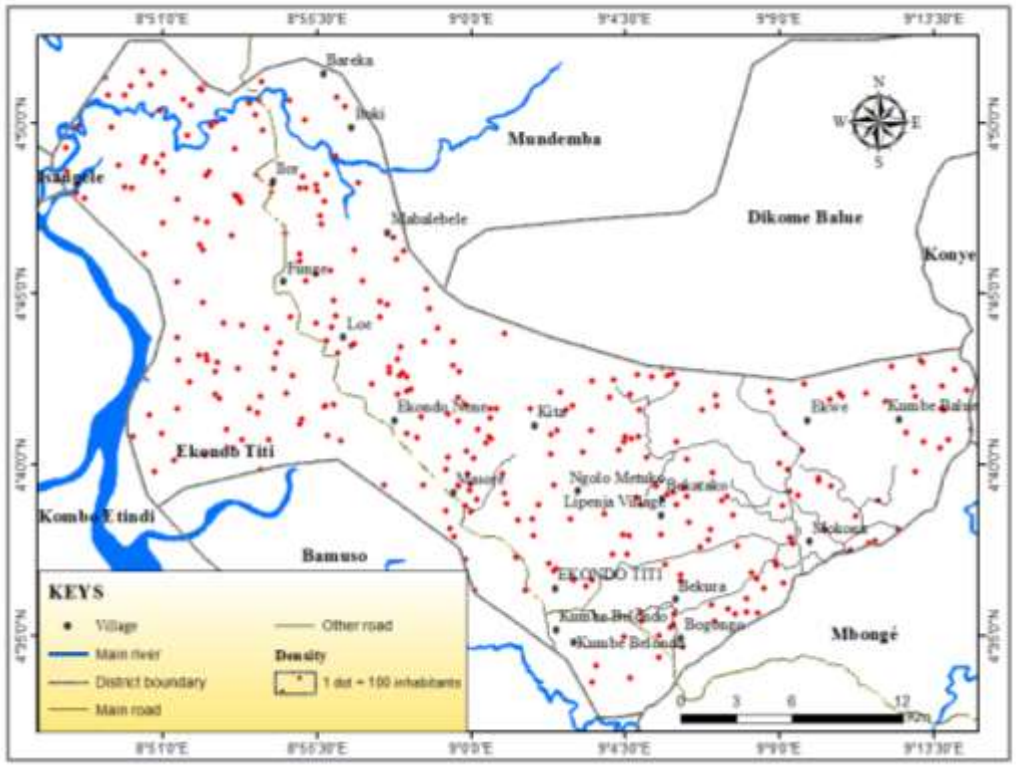
The northern fringe and the coastal strip of Ekondo-Titi should be protected against the expansion of smallholders, elite or industrial palm groves. In the Ngwéi case, the southern or northern fringe would be transformed into land reserves, communal forests, etc.

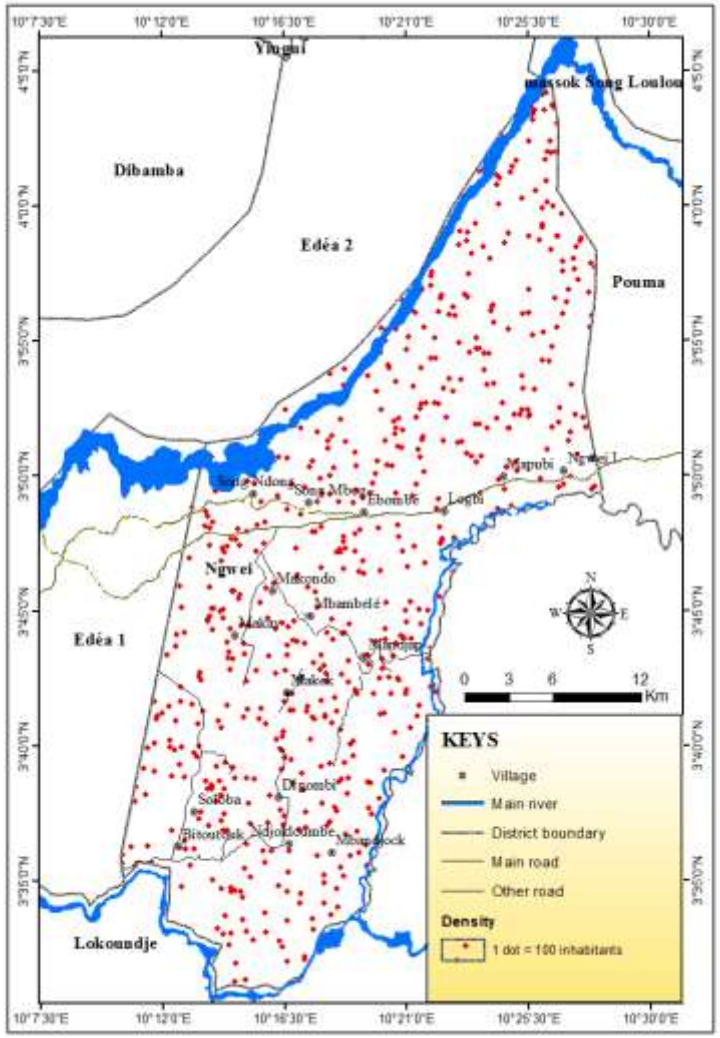




Figures 71 ab : **Population distribution in the d'Ekondo Titi et de Ngwéi subdivisions.**

There is a spread of population in Ekondo Titi. This spreading doubles with a densification at Ngwéi. This is an obvious sign of the saturation of the territory that calls for an agricultural zoning and reparcelling.





6.12. General conclusion

The main objective of this work was to evaluate the environmental impacts of the extension of the oil palm surfaces on deforestation and the biodiversity degradation in the Ngwéi and Ekondo-Titi districts.

The methods used in addition to the surveys are transects and plots, landscape resilience, remote sensing and GIS as well as environmental assessment. We have come to the conclusion that the main driver of the biodiversity degradation in the two municipalities since 2000 has been the boom in oil palm production, which is compounded by the cumulative impacts of other activities (farming, cocoa, and commercial food).

Botanical methods using field observations and index calculations highlight deforestation and clearly show that there is an effective conversion of biodiversity (plant and wildlife, even microbiological) into monospecific biodiversity, whose backdrop is the oil palm. To this end, there is an urgent need to promote sustainable oil palm agricultural practices.

The assessment of the landscape resilience shows that the populations of these two landscapes are not resilient in terms of governance and social equity as well as livelihoods and well-being. It emerges that the protection of ecosystems is not the best shared thing in these landscapes where the perception of a theme is different from one sex to another. Reduction and fragmentation of forest ecosystems due to the anthropization of the environment is evident while the social climate does not always favour this biodiversity conservation.

The remote sensing images processing gives an overall rate of deforestation of 22.74% in 37 years, with 0.61% per year corresponding to 150.34 ha of Atlantic forest loss per year, compared to 67.07 ha / year for the mangrove in Ekondo-Titi. This amounts allow us to predict a total disappearance of the forest within 125 years and 189 years for the mangrove.

In Ngwéi, we recorded an overall deforestation rate of 45.94% in 38 years, with an overall rate of 697.22 ha / year between 1975 and 2013. Between 1999 and 2013, in 15 years, Ngwéi lost 946 ha of it forest per year. At this rate, the Ngwéi dense forest will disappear within 50 years (2067) for the normal scenario or within 37 years (2054) if we take the pace of 946 ha / year.

The environmental assessment confirms this deforestation impelled by oil palm cultivation and indicates the important impacts on the plant and animal biodiversity without forgetting the local economy and the social climate. All these elements contribute to the degradation of the forest. To this end, it seems useful to propose, in addition to other measures, land reparcelling and agricultural zoning in favour of forests and it conservation, without forgetting a progressive establishment of integrated production system which will lead to certification on the basis of the RSPO proposed criteria.

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APPENDICES
Environmental impacts of small holders and elites palm oil plantations on deforestation in the Sanaga Maritime and Ndian Basin landscapes: case studies of Ngwéi and Ekondo-Titi Subdivisions

Appendices 1-5: methodological tools

1. Impacts sheet

2. Flora and fauna record sheets

3. Palm groves sheet

4. SEPL indicators sheet

5. Questionnaire

A1. Impacts Sheet

Environmental impacts of small holders and elites palm oil plantations on deforestation in the Sanaga Maritime and Ndian Basin landscapes: case studies of Ngwéi and Ekondo-Titi Subdivisions
Author : Date : 2016

Activity – Action of impact source:	**Affected environmental component** :
Correspondence in the matrix N°. Réf . :	**spatial Location (with GPS coordinates)** :
Qualitative or quantitative description of the impact :	
Magnitude **Duration :** Long____ Medium____ Short _____ **Intensity :** High____ __ Medium _____ Low_____ **Scope/Extent :** Regional_____ Local_____ Punctual_____ **Justification :**	
Importance **Permanence of the impact** : Permanent_____ Temporary_____ **Rarity or uniqueness of the element of the milieu :** High____ Medium____ Low_____ Nil_____ **Level of protection granted:** High ____ Medium ___ __ Low _____ **Sensitivity of the receiving environment:** High ____ Medium ____ Low ____ **Reversibility of the impact:** Irreversible_____ Reversible_____ **Onset Time:** Critical :_____ _____ Non critical _____ **Criterion or standard of existence:** Local___ National ____ International ____ No___ **Justification :**	
Signification **Level of Valuation:** High____ Medium____ Low_____ **Social consensus on the valuation:** High____ Medium____ Low_____ Nil_____ **Justification :**	
Summary of the impact **Magnitude** High _____ Medium _____ Low_____ **Importance** High _____ Medium _____ Low_____ **Signification** High _____ Medium _____ Low_____ **potential Impact** Major_____ Medium _____ Minor____ Not Significant __ **Justification :**	
Avoidance, mitigation, compensation or maximization measures, responsibilities and supervisory or monitoring measures to join the ESMP	
Residual impact: Major_____ Medium _____ Minor_____ Insignificant__ _ __	
Final Comments :	

A.2 Flora record sheet

N°……H N C

Data recorder ……N°……
Record date……
Place of record……
Description……
……
……
……
……
……
……
Ecological information ……
Observations……
……

Local name ……
DCH of individuals……
Size (s) of individuals……
Number of individuals of the species……

Identification of the species :
Family name……
Scientific name……
Determinative of the species……Date……

GLOBAL MAPPING AND ENVIRONMENTAL MONITORING

Fauna record sheet

Data recorder :……
Record date ……
Place of record ……
Description of fauna index……
……
……
……

Identification of the species :
Family name……
Scientific name……
Determinative of the species……Date……

GLOBAL MAPPING AND ENVIRONMENTAL MONITORING

A3. Palm grove sheet

Subdivision village	Name of the oil palm holder	GPS coordinates	Year of creation	Area	Annual production
		x y			
		x y			
		x y			
		x y			
		x y			
		x y			
		x y			
		x y			

A4. SATOYAMA INDICATOR SHEET : RESILIENCE INDICATORS IN SOCIO ECOLOGICAL PRODUCTION LANDSCAPES / SEASCAPES (SEPLS)

WHAT TO ASSESS	***SCORES***			***AVERAGE SCORES***
Landscape/seascape diversity and ecosystem protection		***Trend in the last 50 years***	***Total Score for the section***	***TOTAL / 4 =***
(1) Landscape/seascape diversity The landscape or seascape is composed of a diversity/mosaic of natural ecosystems (terrestrial and aquatic) and land uses. **Examples:** **Natural ecosystems**: mountains, forests, grasslands, wetlands, lakes, rivers, coastal, lagoons, estuaries, coral reefs, sea grass, meadows and mangrove forests**.** **Land uses**: home gardens, cultivated fields, orchards, (seasonal) pastures, haymaking lands, aquaculture, forestry and agro-forestry, irrigation canals, water wells. **Note**: Landscape/seascape diversity and land uses can be demonstrated through a mapping exercise. ***Is the landscape/seascape composed of diverse natural Ecosystems (terrestrial and aquatic) and land uses?***	**(5) Very high** **(There is a large number of natural ecosystems and land uses)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low** **(There is only one or a very small number of natural ecosystems and land uses)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(2) Ecosystem protection Areas within the landscape or seascape are protected for their ecological and/or cultural importance. Note: Protection may be formal or informal and include traditional forms of protection such as sacred sites**.** **Examples:** Strict nature reserves, national parks, wilderness areas, heritage sites, community conserved areas, marine protected areas, limited-use areas, sacred sites, grazing reserve areas, rules and regulations to exclude outsiders from the (seasonal) use of natural resources, etc. ***Are there areas in the landscape or seascape where ecosystems are protected under formal or informal forms of protection?*** ***Which ecosystems are protected and what is the form of protection?***	**(5) Very high** **(Key resources are under some form of protection)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low** **(There are no areas under protection)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		

(3) Ecological interactions between different components of the landscape/seascape Ecological interactions between different components of landscape or seascape are taken into consideration in natural resource management. **Examples of ecological interactions**: Areas slated for conservation or restoration benefit other areas through pollination, pest control, nutrient cycling and increase of animal population. Forests protect water sources and provide fodder, medicine and food. Agricultural activities can affect other parts of the landscape. Marine protected areas may increase marine populations also in other in fishing areas (spillover effects). ***Are ecological interactions between different components of the landscape or seascape considered while managing natural resources?***	**(5) Very high (Ecological interactions are considered while managing natural resources)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Ecological interactions are not considered while managing natural resources)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(4) Recovery and regeneration of the landscape/seascape The landscape or seascape has the ability to recover and regenerate from environmental shocks and stresses. **Examples of environmental shocks and stresses:** Pest and disease outbreaks; Extreme weather events such as storms, extreme cold, flooding and droughts; Earthquakes and tsunamis; Forest fires. **Note**: If a timeline is created during the workshop introduction, in which recent shocks and stresses are listed, it can be a helpful reference for scoring this indicator. ***Does the landscape or seascape have the ability to recover and regenerate after extreme environmental shocks? What was the community's response to recent shocks and stresses?***	(5) Very High **(Very high ability to recover and regenerate)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Very low ability to recover and regenerate)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
Biodiversity (including agricultural biodiversity)		***Trend in the last 50 years***	***Total Score for the section***	***TOTAL /3 =***

(5) **diversity of local food system** Foods consumed in the landscape or seascape include food locally grown gathered from local forests and/or fished from local waters. **Examples:** Cereals, vegetables, fruits, nuts, wild plants, mushrooms, berries, livestock, milk, dairy products, wildlife/insects, fish, seaweeds, etc. ***Does the community consume a diversity of locally-produced food?***	**(5) Very high (Diversity of locally-sourced foods is very high and these foods are widely consumed)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (There are very few or no locally-sourced foods)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(6) Maintenance and use of local crop varieties and animal breeds Households and/or community groups maintain a diversity of local crop varieties and animal breeds. **Examples:** Seed guardians, expert animal breeders, animal breeding groups, home gardens, community seed banks. ***Are different local crops, varieties and animal breeds conserved and used in the community?*** ***Is the quality of seeds and breeds maintained?*** ***Do invasive species replace local ones or is this not taking place?***	(5) **Very high (Local crop varieties and animal breeds are widely conserved and used).** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (There are few or no local crop varieties and animal breeds)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(7) Sustainable management of common resources Common resources are managed sustainably in order to avoid overexploitation and depletion. **Examples**: Grazing regulations; Fishing quotas; Sustainable tourism; Control of wildlife poaching and illegal logging; or harvesting of forest products**.** ***Are common resources managed sustainably? What is the status of exploitation of common resources (forests, fisheries, grasslands)?***	**(5) Very high (Common resources are managed sustainably)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Common resources are overexploited or depleted)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
Knowledge and innovation		***Trend in the last 50 years***	***Total Score for the section***	***TOTAL / 4 =***

(8) Innovation in agriculture and conservation practices New practices in agriculture, fisheries and forestry are developed, adopted and improved and/or traditional practices are revitalized. **Examples:** Adoption of water conservation measures such as drip irrigation or water harvesting; Diversification of farming systems; Introduction or re-introduction of drought- or saline-tolerant crops; Organic agriculture; Terracing; Reintroduction of native species; Shifting and rotation of grasslands; Reforestation; Replanting of corals, sea grass and mangroves; Fish houses; Selective fishing gear. ***Does the community develop, improve and adopt new agricultural, fisheries, forestry, and conservation practices and/or revitalize traditional ones to adapt to changing conditions, including climate change?*** ***Which innovative practices are used in managing agriculture, fisheries and forestry?***	**(5) Very high (The community is receptive to change and adjusts its practices)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (The community is not receptive to change and makes few innovations)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(9) traditional knowledge related to biodiversity Local knowledge and cultural traditions related to biodiversity are transmitted from elders and parents to the youth in the community. **Examples:** Songs, dances, rituals, festivals, stories, local terminology related to land and biodiversity; Specific knowledge about fishing, crop planting and harvesting, and the processing and cooking of food; Knowledge included in school curricula. ***Are local knowledge and cultural traditions related to biodiversity transmitted from elders and parents to young people in the community?***	**(5) Very high (Local knowledge and cultural traditions are transmitted to young people)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Local knowledge and cultural traditions are lost)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		

(10) Documentation of biodiversity-associated knowledge. The biodiversity in the landscape or seascape, including agricultural biodiversity, and knowledge associated with it is documented, stored and made available to community members. Examples: Traditional knowledge registers; Resource classification systems; Community biodiversity registers; Farmers' field schools; Animal breeding groups; Pasture co-management groups; Seed exchange networks (animal and seed fairs); Seasonal calendars. ***Is agricultural biodiversity, and associated knowledge documented and exchanged?***	**(5) Very high (Documentation is robust)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (There is little or no documentation in the community)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(11) Women's knowledge Women's knowledge, experiences and skills are recognized and respected in the community. Women often have specific knowledge, experience and skills about biodiversity, its use and management, which are different from those of men. **Examples of women specific knowledge**: Know-how about the production of particular crops; Collection and use of medicinal plants; Caring for animals. ***Are women's knowledge, experiences and skills recognized and respected at household, community and landscape levels?***	**(5) Very high (Women's knowledge, experiences and skills recognized and respected at all levels)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Women's knowledge, experiences and skills are not recognized and respected)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
Governance and social equity		***Trend in the last 50 years***	***Total Score for the section***	***TOTAL / 4 =***
(12) Rights in relation to land/water and other natural resources management Rights over land/water and other natural resources are clearly defined and recognized by relevant groups and institutions, for example governments and development agencies. Recognition can be formalized by policy, law and/or through customary practices. **Examples:** Land-use groups; Community forestry committees; Co-management groups or communities. ***Does the community have customary and/or formally recognized rights over land, (seasonal) pastures, water and natural resources?*** ***Do these rights give security in terms of access and use?***	**(5) Very high (Rights are fully recognized and not disputed)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Rights are not recognized and heavily disputed)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		

(13) community-based landscape/seascape governance The landscape or seascape has capable, accountable and transparent local institutions in place for the effective governance of its resources and the local biodiversity. **Examples of institutions:** Organizations, rules, policies, regulations and enforcement aimed at resource management; Traditional authorities and customary rules; Co-management arrangements, for example joint forest management, between local people and government. ***Is there a multistakeholder landscape/ seascape platform or institution able to effectively plan and manage landscape resources?*** ***Does agreement exist about the boundaries of natural resources in terms of access and use?*** ***Is the policy and legal environment supportive or not?***	**(5) Very high (Platform or institution is capable of transparent, participatory and effective decision making)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (There is no multistakeholder platform or institution)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(14) Social capital in the form of cooperation across the landscape/seascape Individuals within and between communities are connected and coordinated through networks that manage resources and exchange materials, skills and knowledge. **Examples:** Self-help groups; Community clubs and groups (women's and youth groups); Intercommunity networks; Associations of federations with a focus on natural resource management. ***Is there connection, coordination and cooperation within and between communities for the management of natural resources?*** ***Is the level of out-migration low?***	(5) **Very high (There is a very high level of cooperation and coordination in natural resource management)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (There is little or no cooperation and coordination in natural resources management)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		

15) Social equity (including gender equity) Rights and access to resources and opportunities for education, information and decision-making are fair and equitable for all community members, including women, at household, community and landscape levels. **Examples:** Upland and lowland communities; Community members belonging to different social or ethnic groups; Women's voices and choices are taken into consideration in household decision-making and at community meetings where decisions about collective actions are made. ***Is access to opportunities and resources fair and equitable for all community members, including women, at household, community and landscape level?*** ***Is decision-making fair and equitable for all community members, including women, at all levels?***	**(5) Very high (Access to resources and opportunities is fair and equitable at all levels)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low (Access to resources and opportunities is not fair and equitable)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
Livelihoods and well-being		***Trend in the last 50 years***	***Total Score for the section***	***TOTAL /5 =***
(16) Socio-economic infrastructure Socio-economic infrastructure is adequate for community needs. **Examples of socio-economic infrastructure:** Schools, hospitals, roads and transport; Safe drinking water; Markets; Electricity and communication infrastructure**.** ***Is the socioeconomic Infrastructure adequate for the needs of the community?***	**(5) Very high (Socio-economic infrastructure meets all community needs).** **4) High** **(3) Medium** **(2) Low** **(1) Very low** **(1) Very Low (Socio-economic infrastructure does not meet community needs)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(17) Human health and environmental conditions **The overall state of human health in the community is satisfactory, also considering the prevailing environmental conditions.** Examples: Absence or regular occurrence of diseases; Frequency of disease outbreaks that affect a large number of people; Absence/presence of environmental stresses like pollution, lack of clean water, exposure to extreme weather events. ***What is the general health situation***	**(5) Very high (The health situation and the environmental conditions are good)** **4) High** **(3) Medium** **(2) Low** **(1) Very low (The health and the environmental conditions are bad)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		

of local people also considering the prevailing environmental conditions? What are the main risks? What types of medicine are used? (i.e. traditional healing methods, modern medicine)				
(18) Income diversity People in the landscape or seascape are involved in a variety of sustainable income generating activities. **Note:** Diversity in economic activities can help households in case of unexpected downturns, disasters, changes in environmental conditions, etc. ***Are households in the community involved in a variety of sustainable, income-generating activities?*** ***What activities generate income in the landscape or seascape?***	**(5) Very high** **(Households are involved in a variety of sustainable, income generating activities)** **4) High** **(3) Medium** **(2) Low** **(1) Very low** **(1) Very low** **(Households have no alternative economic activities)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(19) Biodiversity-based livelihoods Livelihood improvements in the landscape or seascape are concerned with innovative use of local biodiversity. **Examples:** Handicrafts using local materials, e.g. wood carving, basketry, painting, weaving etc.; Eco-tourism; Processing of local foods, bee-keeping etc. ***Does the community develop innovative use of the local biodiversity for its livelihoods?***	**Very high** **(Livelihoods are being improved by innovative use of local biodiversity)** **4) High** **(3) Medium** **(2) Low** **(1) Very low** **(Livelihood improvements are not related to local biodiversity)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		
(20) Socio-ecological mobility Households and communities are able to move around to take advantage of shifts in production opportunities and avoid land degradation and overexploitation. **Examples of mobility:** Shifting cultivation and crop rotation practices; Shifting between agriculture and herding/fishing; Seasonal migration of herders; Shifting fishing grounds; Maintaining reserve areas for periods of hardship. ***Are households and communities able to move around between different production activities and locations as necessary?*** ***Are there agreed rules and regulations for effectively doing so?***	**(5) Very high** **(There are sufficient opportunities for mobility)** **(4) High** **(3) Medium** **(2) Low** **(1) Very low** **(There are no opportunities for mobility)**	↑steep upward trend ↗slow/some increase → No change ↘slow/some decrease ↓steep downward		

A5 . INDIVIDUAL SET OF QUESTIONS

Environmental impact of small holders and elites palm oil plantation on deforestation in the Sanaga Maritime and Ndian Basin landscapes: case studies of Ngwéi and Ekondo-Titi subdivisions.

This questionnaire is exclusively for scientific purposes. Information collected in this survey is strictly confidential in accordance with Law No. 91/023 of 16 December 1991 on censuses and statistical surveys in Cameroon. Thank you for your contribution and your understanding.

GENERAL INFORMATION

IDENTIFICATION AND LOCATION OF THE PRODUCTION UNIT

REGION _____

DIVISION _____

SUBDIVISION_____

CANTON _____

VILLAGE_____

NUMBER OF THE QUESTIONNAIRE _____

SURVEY AND CONTROL REPORT

INVESTIGATOR_____

DATE_____

BEGINNING TIME_____

END TIME _____

SUPERVISOR _____

DATE OF CONTROL _____

DATA ENTRY REPORT

DATA ENTRY AGENT : _____
DATE : _____
SUPERVISOR : _____

SECTION 1: IDENTIFICATION OF THE PALM GROVE PLANTATION

Q101	Name and surname	……
Q102	Sex	1 Male 2 Female
Q103	Region of origin	…….
Q104	How old are you?	a- Less than 25 years b- 25 à 35 years c- 36 - 45 years d- 46 à 55 years e- 56 - 65 years f- More than 65 years
Q105	What is your highest level of education?	1 Primary 2 Secondary 3 higher 4 No instruction
Q106	Are you the owner of this palm plantation?	1 Yes 2 No ***NB : if Q106=1, go to à Q201***
Q107	Where does the owner live (Town/village)?	……

SECTION 2: CHARACTERISTICS OF THE OIL PALM PLANTATIONS

Q201	When (year) was created this palm plantation?	……
	What is the area of this palm plantation?	…… ha
Q202	How did you acquire the plot of land bearing this palm plantation?	1 Buying (Give the year ……..) 2 Donation 3 inheritance 4 Location (Specify the annual rent ……)
Q203	How many palm plants do you have in your plantation?	…….
Q204	Did the area of this palm plantation changed?	1 Increasing 2 Decreasing 3 Stable
Q205	Name the reasons of these changes?	1_____ 2_____ 3_____ 5 Don't know
Q206	Do you plant many varieties of palm trees?	1 Yes 2 No 3 Don't know
Q207	Name those varieties	1_____ 2_____ 3_____
Q208	Give the reasons for the choice of those varieties**?** ***QCM : Give as many reasons as possible***	1 High yield 2 Adaptation to the climate 3 Adaptation to the type of soil 4 Résistance to rodents /insects 5 Other (s) …… …….
Q209	What are the regular treats/attacks on the culture of palm trees? Specify the stage of evolution for any treat.	1 Attacks of caterpillars…….. 2 Attacks of insects…… 3 Attacks of rats et other rodents…… 4 others(s)……
Q210	How do you fight against these threats?	1 Use of insecticides and pesticides

		2 Use of trap to catch rats/rodents 3 Nothing is done 4 Other(s)……...

SECTION 3: PRODUCTION

Q301	How many harvests do you have in a year?	……yield(s)/year
Q302	How many litters of oil do you extracts from the exploitation of and hectare of palm plantation?	1) Plantation of less than 8 years……. 2) Plantation 08 to 15 years…… 3) Plantation more than 15 years …….
Q303	What do you do with you production	1 Direct consumption 2 Sold in the market 3 Sold to retailers 4 Exportation 5 deliver to big enterprises 6 Other(s) ……
Q304	Except of oil do you exploit any other resource from palm trees?	1 Yes 2 No ***= go to Q306***
Q305	Name them?	1…… 2…… 3…… 4……
Q306	Do you have your personal unit to extract oil?	1 Yes 2 No
Q307	What is the tool used?	1 Community oil press 2 Private oil press 4 Other(s) ……
Q308	What is the general orientation of your production year to year?	1 Yield increasing 2 Yield decreasing 3 Yield stable
Q309	What do you think of the development of this activity in your locality?	1 For industrial plantations *a) good b) uncertain* 2 For elitist plantations *a) good b) uncertain* 3 For small scale plantations own by villagers *a) good b) uncertain*
Q310	What can be done to improve the development of palm plantation in this locality?	1 Public subvention 2 Donation of materials 3 Technical support 4 other (s)……. …….

SECTION 4: SOCIOECONOMIC AND ECOLOGICAL IMPACTS

A- Ecological impacts

Q401	Do you think the climate has any impact on the production of palm oil?	1 Yes 2 No 3 Don't know ***If Q401=2 or 3 go to Q403***
Q402	Explain how? ***QRO : Give as many results as possible***	…… …… ……

Q403	Do you have any problem of soil conservation?	1 Yes 2 No= go to 405
Q404	Name them?	1 Erosion 2 Decrease of soil fertility 3 Other(s) …….
Q405	Where do you collect water for different activities (extraction of oil for instance)?	1 Rain fall water 2 Water from rivers 3 Water from wells 4 Irrigation 5 Other(s)…….
Q406	Do you think palm exploitation impacts the availability of water for households in term of quantity and quality?	1 Yes 2 No 3 Don't know
Q407	Explain how?	1 Pollution of river water 2 excessive consumption of water by palm trees 3 Other(s)……
Q408	Do you have a lot of bush meat here?	1 Yes= ***go to Q410*** 2 No
Q409	What explain the present scarcity of bush meat in this area?	1 excessive hunting 2 Decrease of forest surface 3 Intensive agriculture activity 4 Extension of palm plantation 5 Other(s)……
Q410	Before the put in place of this palm oil farm; what was the natural vegetation in place?	1 a thick forest 2 a degraded forest 3 Culture zone 4 Other(s)…….
Q411	How do you manage the waste from your palm oil plantation?	1 Incineration 2 Discharge in a river 3 Transformation into compost 4 Transformation into kernel oil 5 Other(s)……

B- Economic impacts

Q412	What are the sources of funding for the putting in place of this palm oil farm?	1 Personal resources 2 Bank loan 3 Loan from private donors 4 Allocation from the government 6 Other ……
Q413	Do the benefits drawn from the exploitation of your palm oil farm allow you to satisfy your needs?	1 Yes 2 No
Q414	How much money does you gain per hectare exploited when you proceed to:	1 Personal extraction? ..... 2 Collective extraction? ..... 3 Sold to a big enterprise? …….
Q415	Is the exploitation of palm oils plantation your only source of incomes?	1 Yes 2 No 3 Don't know ***NB : If Q415= 1 go to Q417***
Q416	Name the other activities?	1…… 2…… 3……

C- Social impacts

Q417	Do you the exploitation of palm oil plantation has decrease the level of poverty in the village?	1 Yes 2 No 3 Don't know
Q418	How many people work in this plantation?	…… men……. ……women
Q419	What is the origin of these workers?	1- Family members 2- people from this village 3- migrants from other regions of the Cameroon 4- strangers
Q420	Do this workers registered in CNPS?	1 Yes 2 No
Q421	Are you member of any CIG? If yes give the name	1 Yes 2 No
Q422	Have the palm plantation activities divert people from other village activities?	1 Yes 2 No 3 Don't know ***NB : if Q422= 2 or 3 go to Q424***
Q423	Name some activities that are nearly abandoned?	1…… 2…… 3…… 4……..
Q424	How has the palm oil activities impacts food producing in the village?	1 Food producing has increase 2 Food producing has decrease 3 Food production is stable
Q425	In case of dropping of food production; How do you supply your needs?	…… …… ……
Q426	Does the development of oil palm plantation in the village generate any sort of conflicts?	1 Yes 2 No 3 Don't know ***NB : if Q426= 2 or 3 go to Q428***
Q427	Name these conflicts?	1 Land tenure conflicts 2 Conflicts related to water management 3 Conflicts with hunters 4- Other(s)…….
Q428	What are the threats of oil palm activities on health of population?	1 Drop of productivity 2 herbal diseases 3 Injuries 4 Falls 5 Snake bites 6 Other(s) diseases(s)/threat(s) …… …… …… … ……

Consultation and survey teams on the field

Ekondo-Titi team

- ✓ SAHA Frédéric, MSC in Geography, (PhD student), assistant to the main consultant, The University of Yaoundé I.
- ✓ TENE TAYO Jean Lawrence, MSC in forestry & agronomy, EIA specialist ; The University of Dschang
- ✓ MBEVO FENDOUNG Philippe; MSC in GIS and remote sensing; (PhD student) The University of Yaoundé I.
- ✓ ABASOMBE Donald, MSC student in Geography & botanist working on palm oil; The University of Yaoundé I.
- ✓ KONTELEDJO Serge Merlin, MSC student in Geography, The University of Yaoundé I.
- ✓ FEUDJIO FOKEM Danielle Michèle, MSC in EIA (CRESA-FASA), the University of Dschang.
- ✓ GHASARAH Gloria LUM, MSC student (FASA), The University of Dschang.
- ✓ MATANG Gertrude, MSC student in Geography, The University of Yaoundé I.

Ngwéi team

- ✓ VOUNDI Eric: MSC in Geography, (PhD student), assistant to the main consultant, The University of Yaoundé I.
- ✓ NGO MAKAK Rose: MSC in GIS and remote sensing specialist (Burkina Faso).
- ✓ DJOUKOUO Félicité : MSC in Sociology, (PhD student), The University of Yaoundé I.
- ✓ SEUTCHUENG TCHUENGA Thierry: MSC in Geography, PhD student (IRAD).
- ✓ UMM Jean Jules: MSC in GIS and remote sensing, The University of Yaoundé I.
- ✓ ESSONO Damien Marie: MSC in Biology (Botanist), (PhD student), The University of Yaoundé I.
- ✓ MOKAM SIMO Aurelie Bertille: MSC in EIA, (HIES-Yaoundé).

Appendix 6- TERMS OF REFERENCE

Environmental impact of small holders and elites palm oil plantation on deforestation in the Sanaga Maritime and Ndian Basin landscapes: case studies of Ngwéi and Ekondo-Titi subdivisions.

1. Context and rationale

The oil palm (Elaeis guineensis) is native of West Africa and the Congo Basin. It has become the main source of edible oil in the world. Outside the two Asian giants (Malaysia and Indonesia), the remarkable progression of African productions results from various factors including the improvement of cultivation techniques and machining techniques; research and dissemination of high-yielding crosses, research and fight against diseases and pests, considerable reduction of production costs, in particular through the use of by-products; finally, the involvement of the local elites in the productive apparatus and the extension of the area of this speculation to the whole tropical zone.

In Cameroon, one of the most recent initiatives in favour of plantations is the Program for the Development of Village oil Palm (PDPV) launched in 2005 by MINADER. The second phase was launched in 2011 after a study of the oil palm sector considered as a job provider in 2009 by the Ministry of Employment and Vocational Training. This program is therefore considered a "national priority" because this project was launched as part of a "proactive policy of modernization of agriculture". It aims in particular at promoting a system of subcontracting favourable to privatized agro-industries and supposed to embody the "new era" of the expansion of the oil palm in the country.

Cameroon is one of the major oil palm production areas in Africa (4th place in Africa). Traditional palm production is relatively old in Cameroon. Historically, the first palm groves were established in the Sanaga Maritime and bear the seal of Western missionaries in the 1870s. Then, followed the southwest in the Ndian basin with the Germans, then the English (PAMOL and CDC) between 1910 and 1947. The economic crisis of the 1990s will have contributed to the increased development of the Palm tree in Cameroon in both Sanaga Maritime and the Ndian basin. The direct effect of this was the return to farmland of the urban (elite) populations encouraged by the government to participate in the rehabilitation of the country through agriculture. If in the Sanaga Maritime, to the existing industrial plantations, elitist and village plantations have been added and multiplied; in the Ndian basin, in addition to the existing industrial and village plantations, new industrial plantations (Herakles) were added. All this has contributed to the drastic increase in cultivated areas that have progressed at the expense of primary, secondary and mangrove forest ecosystems.

The oil palm is part of the landscape of WWF's current activities in Cameroon as part of the Oil Palm Adaptive Landscape (OPAL) project jointly implemented by CIFOR, PDPV and WWF. WWF is paying close attention to deforestation activities and loss of biodiversity related to oil palm in Cameroon, particularly those in Sanaga Maritime and the Ndian Basin, which are still areas of forests of high value for Conservation.

The present terms of reference aim at the recruitment of a consultant to conduct and carry out a study on the environmental impacts of the oil palm plantations on the deforestation and, consequently, the degradation of biodiversity in the Ngwéi and Ekondo-Titi districts. Land clearing for production could lead to the loss of areas of high value for conservation and the emission of greenhouse gases from deforestation and forests degradation. The aim is to propose effective strategies that can help minimizing the negative impacts of oil palm farming while maximizing socioeconomic profits.

In terms of environmental issues, the development of palm groves is accompanied by the fragmentation of forest ecosystems and the conversion of forests with high conservation value, while the preservation of forest ecosystems is a challenge in this region of Cameroon, within a context of fighting against poverty and dealing with harmonious and sustainable development. In addition, the other environmental problem posed by the development of village, semi-industrial and industrial palm plantations is that of sustainable exploitation, in particular the management of waste resulting from the extraction of palm oil.

However, the oil palm cultivation dilemma for economic growth lies between its socio-economic benefits (direct benefits) and its various environmental degradations. It is also necessary to know whether these advantages are not to be relativized in the face of the losses and harms caused by the cultivation and exploitation of the oil palm. In a context where global concerns are oriented towards the preservation of ecosystems and biodiversity, the fight against climate change through the significant reduction of anthropogenic impacts on the natural environment, modes of exploitation of the palm oil that prevail remain in fact problematic. They therefore constitute a somewhat impediment to the achievement of Cameroon's REDD + objectives and further raises the

problem of the coherence of the government sectoral policies. The aim of this study is therefore a necessity and must respond to the imperative aim of reconciling agriculture with the concern for environmental preservation in a spirit of sustainable development.

2. Aim and objective of the study.

2.1. Aim of the study

This study is part of the research on the ecological sustainability of the development activities of oil palm plantations in the framework of the OPAL project in Cameroon. It aims at the evaluation of the environmental impacts of the extension of the oil palm surfaces on deforestation and biodiversity degradation in the Ngwéi and Ekondo-Titi districts.

2.2. Objective of the study

The aim is to evaluate the environmental impacts of village, semi-industrial and industrial palm plantations on the continuity of forest cover in the Ngwéi and Ekondo-Titi districts within the framework of the OPAL project in Cameroon.

Specifically, the study will focus on:

- The impact of the development of village, semi-industrial and industrial palm plantations on ecosystem fragmentation, forest degradation and deforestation. To do this, it requires a map of land use and changes in these territories following the development of palm groves;
- Identifying, determining and quantifying the environmental impacts of palm groves and it consequences on the Ngwéi and Ekondo-Titi landscape at the triple scale of the village, the conservation areas and the district;
- Analysis of the negative and positive impacts of small holder, semi-industrial and industrial palm oil plantations on ecosystems, habitat fragmentation, biodiversity conservation and local communities;
- Proposal for mitigation measures and also improvement of the current system of palm oil cultivation in this landscape.

3. Mandate and mission of the consultant

The successful consultant will have to produce, within the specified deadlines, data relating to all the objectives assigned to this study. He should refer to the institutional framework of the agricultural sector in Cameroon. The strategic plan for the development of the oil palm sector should be taken into account. Moreover, in recent years various national and international institutions have been interested in the cultivation of oil palm in the World in general and in Cameroon in particular. The consultant should make an important review of existing work in order to situate this study in its scientific and spatial context.

4. Expected results

1. The identification of the environmental impacts related to palm oil cultivation and its consequences on the forest landscape of Ngwéi and Ekondo-Titi are determined, identified and quantified.
2. The comparative analysis of the environmental impacts of small holder, semi-industrial and industrial palm oil cultivation in Ngwéi and Ekondo-Titi shows a correlation with ecosystem dynamics and impacts on habitat fragmentation, biodiversity conservation and the rights of local communities.
3. Effective measures to mitigate the adverse environmental impacts of elaeis farming and to improve the current Ngwéi and Ekondo-Titi system are proposed.
4. The organization of a half-day workshop to present the initial findings of the study in order to gather contributions and inputs from resource persons.

5. Expected deliverables

The study should lead to the following results:

- A report on the impact of palm groves development on land-use and land cover characteristics, ecosystem fragmentation and deforestation should be established;
- This report will be complemented by maps of the diachronic evolution of the palm oil and the land use landscapes in Ngwéi and Ekondo-Titi, making it possible to assess the changes in forest cover in each subdivision.

6. Methodology

The Sanaga Maritime is the largest division of the Littoral administrative Region with an area of 925,393 ha for a population of 162,315 inhabitants (18 inhab / km²). The Sanaga Maritime appears to be a preferred environment for arable farming as well as optimum palm oil development conditions (topography, climate, etc.). It has 11

subdivisions including Ngwéi. The study targets the oil palm plantations of the Ngwéi district in the Sanaga Maritime Division.

The Ndian Divisin is the largest in the South-West administrative Region with an area of 630,690.7 ha for a population of 161,511 inhabitants (19 inhab/ km²). The South-West Region is a large agricultural development zone (the cradle of the green revolution), notably with the PAMOL plantations that ripple throughout the Ndian basin and occupy more than 75% of the land use and agricultural area of the division. The Ndian Division is maritime and it appears as an area of predilection for the oil palm cultivation because the conditions of it development are optimal (topography, climate, labour, etc.). It has 9 districts including the one of Mundemba which houses the chief-town. The study will target the Ekondo-Titi elaeis plantations in which 3/4 of the useful agricultural surface is occupied by large industrial plantations of PAMOL and CDC.

Thus, the study will concentrate mainly in the Ngwéi and Ekondo-Titi subdivisions. It must be based on a coherent methodological approach that integrates all the value chain in oil palm production. It therefore requires a participatory approach and requires the tender to set up a multidisciplinary team to conduct consultations and fieldwork.

However, it is left to the tender to propose a working methodology that is consistent with the objectives and results of the study and, in line with the work plan. This methodology will have to be discussed beforehand and if necessary, amended and validated by the coordination of the project.

In addition, the consultant should provide a draft study methodology, including questionnaires and other tools as well as a work plan and schedule for field visits. The methodology must therefore demonstrate how the specific objectives will be achieved during this study.

6. Required expertise and qualifications

This consultation is open to, Environmentalists, Geographers, Foresters, Botanists and Agronomists.
The mission will be carried out by a local consultant with a multidisciplinary team. The consultant profile is as follows:

- Be a senior geographer, forester, botanist, agronomist or environmentalist (GCE +5) with at least 5 years of professional experience.
- Have proven experience in environmental impact assessment (at least 10 years)
- Have experience in carrying out similar studies on the landscape of the region or elsewhere
- Have a good knowledge on the landscape and the region concerned;
- Mastering Geospatial, GIS and Remote Sensing Tools

The consultant team must have a geographer, a sociologist, an environmentalist, an agronomist, a botanist / forester.

NB. Applicants will be specified in the technical offer the composition of the team that will carry out the study, including the CVs of the team members and the methodology to be used.

7. Composition and submission of the application file.

- A technical offer explaining the understanding of the TOR, the methodology of the work and incorporating a chronogram of the study's progress;
- An updated curriculum vitae signed in 2016;
- Photocopies of diplomas;
- At least 3 references indicating that the tender has already rendered similar services;
- A detailed financial offer, mentioning the unit prices and quantities proposed and the half-day cost of the workshop to be organized in Yaoundé;

NB: the methodology proposed by the selected recipient will be subsequently amended in the light of the documentary review and the WWF's requirements in this matter for validation by the coordination team.

8. Duration and indicative timetable of the study

The study will begin as soon as the Consultant is identified and will take place over a period of 3 months (90 days) covering data collection, processing, analysis and reporting.
The Consultant is free to propose a timetable that will enable the expected results of the study to be achieved within the time constraints. The following indicative procedure is proposed:

- Consultation meeting with the WWF team for a review of the terms of reference, a better clarification of expectations and a briefing on the methodology and techniques used to carry out the study;
- Review and analysis of available and relevant documentation on the company and the study area;
- Consultation and interviews with community members and local authorities;
- Participatory identification of landscape impact indicators with communities;
- Analysis and synthesis of the results in relation to the expectations of the study;
- Provisional report to be submitted to WWF for amendment;
- Production and submission of the final report taking into account the various amendments.

9. Confidentiality Clause
The Consultant shall not use or disclose information received from WWF or other sources obtained in the course of his assignment without prior written authorization from WWF.

10. Submission
Application files must be sent no later than August 31, 2016 at 4:30 PM.
The folders will be sent to the following address:

WWF Regional Office for Africa (ROA), Yaoundé Hub
Immeuble Panda, Bastos
Rue la Citronnelle
P.O BOX. 6776 Yaoundé
Republic Of Cameroon
Phone: (+237) 222 21 70 84 /83
Fax.: (+237) 222 21 70 85
Website: www.panda.org

Or at the e-mail address: recruit-cam@wwfcam.org with copy to LMiaro@wwfafrica.org and DHalleson@wwfcam.org

With the mention:
Tender to carry out a study on the environmental impacts of small holders and elitist palm groves on deforestation in Sanaga Maritime and Ndian Basin landscapes: case studies of the Ngwéi and Ekondo-Titi subdivisions.

Building a future in which humans live in harmony with nature