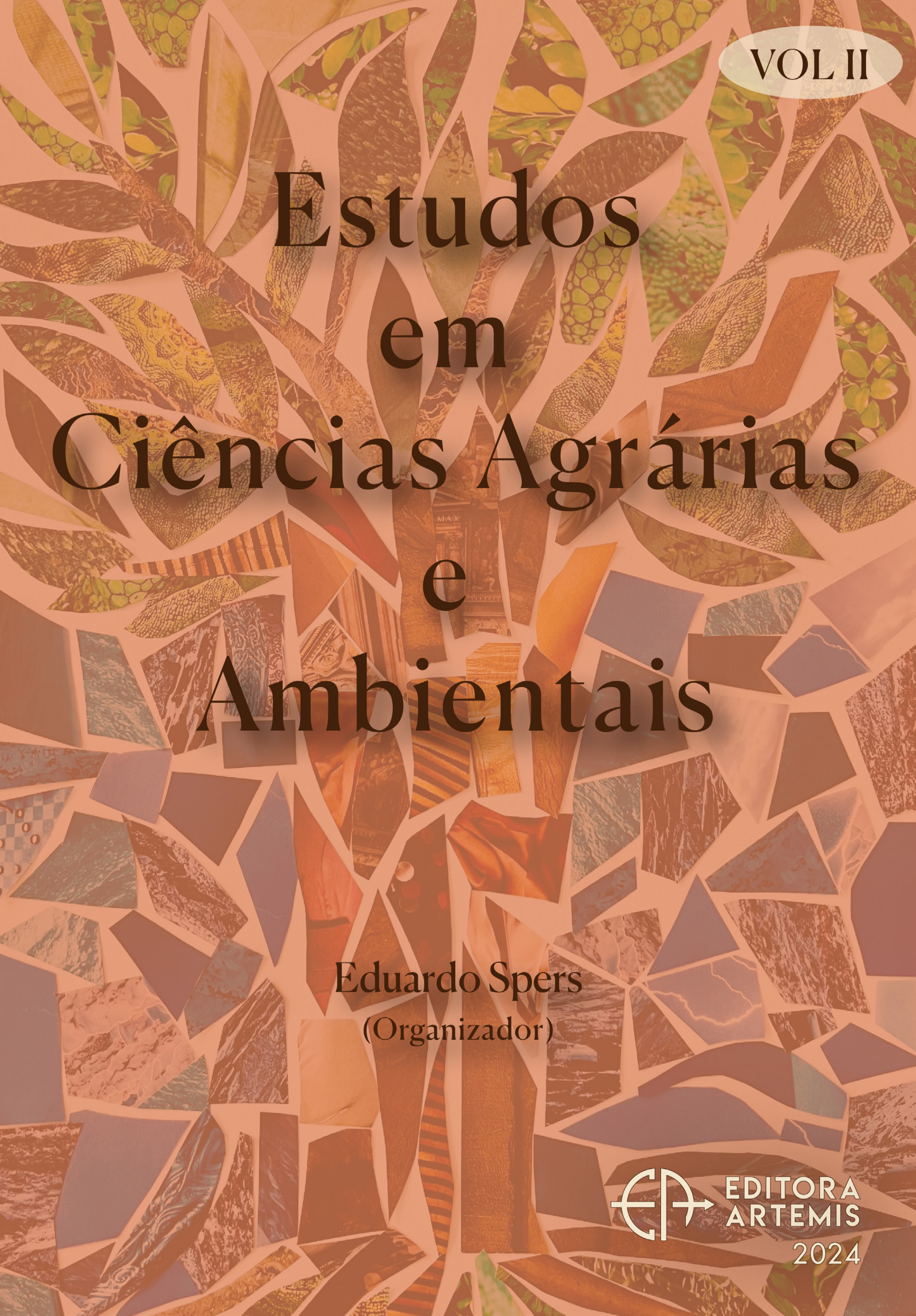

VOL II

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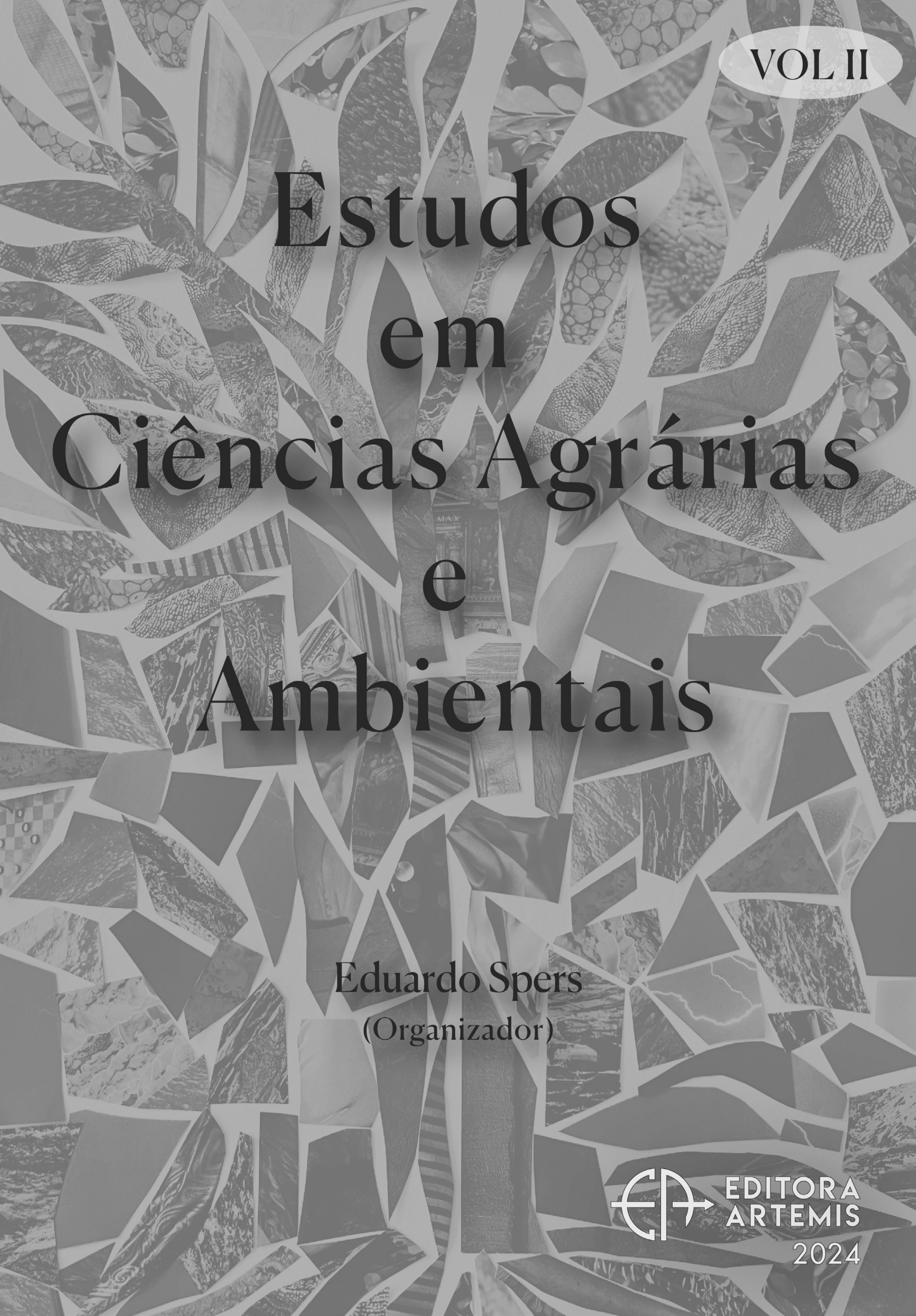

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APRESENTAÇÃO

O campo das Ciências Agrárias e Ambientais desempenha um papel fundamental na compreensão e solução dos desafios contemporâneos relacionados à produção de alimentos, à conservação ambiental e ao bem-estar animal. Em um mundo em constante transformação, questões como a sustentabilidade dos agroecossistemas, o manejo eficiente dos recursos naturais e a saúde pública se tornam cada vez mais relevantes. É com este espírito que apresentamos o volume II da coletânea "Estudos em Ciências Agrárias e Ambientais", que reúne pesquisas de autores de diversas partes do mundo, cada um contribuindo com sua perspectiva e expertise únicos.

Os quinze artigos que compõem este volume abordam uma variedade de tópicos, refletindo a riqueza e a diversidade das Ciências Agrárias. Desde práticas conservacionistas que buscam melhorar e manter agroecossistemas, até investigações sobre o uso de fitohormonas e fertilização na produção vegetal, o uso de tecnologias de processamento de madeira e a promoção do bagre armado - cada estudo traz à tona questões cruciais que impactam tanto a produção agrícola quanto a saúde ambiental.

Neste volume, também exploramos a crescente relevância dos produtos agrícolas locais, especialmente em tempos desafiadores como os que vivemos, marcados pela pandemia da COVID-19. A importância de circuitos curtos de proximidade se torna evidente, promovendo não apenas a segurança alimentar, mas também a resiliência das comunidades.

Além disso, as contribuições da veterinária destacam a importância do cuidado animal e da saúde pública, ilustrando a interconexão entre os seres humanos, os animais e o meio ambiente.

Esperamos que esta coletânea não apenas informe, mas também inspire debates e colaborações futuras entre pesquisadores, profissionais e estudantes da área. Juntos, podemos avançar em direção a um futuro mais sustentável e equilibrado, em que conhecimento pesquisa sejam os pilares para soluções efetivas.

Agradecemos a todos os autores e colaboradores que tornaram este trabalho possível. É nossa esperança que os estudos aqui apresentados contribuam para um entendimento mais profundo das questões agrárias e ambientais, e que possam servir de base para novas investigações e práticas inovadoras.

Eduardo Eugênio Spers

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SUSTENTABILIDADE E PRÁTICAS CONSERVACIONISTAS

CAPÍTULO 10

THE DILEMMA OF THE DEVELOPMENT OF OIL PALM PLANTATIONS AGAINST FOREST CONSERVATION IN CAMEROON

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ABSTRACT: The economic crisis of the 1980s coupled with the devaluation of the CFA franc in 1994 led to significant impoverishment of rural populations with a significant drop in purchasing power. Such a phenomenon has driven to the emergence of new income-generating activities. This is how the rural and elite populations of some administrative divisions or subdivisions (Ngwéi, Ekondo Titi) rushed to the production of palm oil since 1990, both for food needs and for cash income. The cultivation of oil palm leads to the clearing of large areas of dense forest each year in Cameroon. As such, oil palm cultivation becomes the main driver of deforestation leading to the loss of plant and animal biodiversity as well as soil and water pollution, which raises questions about its sustainability. The oil palm sector is progressing in Cameroon with around 360,000 ha of palm plantation shared between agro-industries, elites and small farmers. Annual palm oil production increased from 270,000 tons in 2013 to 413,000 tons in 2018 against a demand that peaked at 1,179 million tons in 2018. As methodology is concerned, we use geospatial tools through multi-temporal and multi sensor satellite images like Landsat from 1976 to 2015, IKONOS, GEOEYE, Google Earth from 2009 to 2016 to map the dynamic of different forms of land use and land cover within those areas. Secondly field investigations allow us to collect field data on the number producers, the areas per producer, the production itself

as well as the validation of the results of images processing. The results show that oil palm cultivation has both positive and negative impacts, however the negative impacts are numerous and difficult to correct, hence the dilemma. Indeed, in terms of positive impacts we can mention employment and income then the improvement of the living conditions of certain households and elites in particular; while in terms of negative impacts, we will readily cite deforestation, the intensive use of fertilizers and pesticides which lead to the pollution of waterways, and the difficult disposal of waste from presses. Also a double analysis by the impacts and by political ecology makes it possible to better analyze the causes of such a phenomenon while highlighting the essential consequences of the management and transformation of the environment. Also, with more than 820ha of forest lost per year, oil palm become the main and pernicious driver of deforestation. The negative effects degradation obviously relate to the fragmentation of ecosystems and habitats; pollution or contamination of river water used for food and body needs in the absence of drilling, impoverishment of soils and their erosion (sloping soils), conversion of degraded lands and reduction of carbon stocks through the attack on marshy and malaria areas, the social divisions and injustices born from the purchases and dispossession of land by the elites and the recruitment of foreign labor, the loss of biodiversity and food security (lack of time and land) of rural populations, return migrations and local migrations towards areas of high production. However, it is necessary to maximize the positive impacts and minimize the negative impacts and here too the dilemma arises, because what type of governance can lead to a win-win oil production system. Should we not identify degraded lands and allocate them to oil palm then identify those still intact for protection; tourism and municipal forestry? Furthermore, how can we remain indifferent to the conversion of forests of very high conservation value where much sought-after primates nest? This paper aim at analyzing the dilemma and the controversy of elaeisfarming following the massive destruction of dense forest and high conservation value forest in Cameroun. The most suitable areas of elaeisfarming is main center of endemism in Cameroon (another dilemma) and as such, it threat destruction of biodiversity while compromising conservation. It raises up a problem of governance which implies a better articulation of the tensions between development and environmental issues.
KEYWORDS: Conservation. Deforestation. Dilemma. Elaeisfarming. Impacts.

O DILEMA DO DESENVOLVIMENTO DAS PLANTAÇÕES DE PALMA DE ÓLEO VERSUS A CONSERVAÇÃO FLORESTAL NOS CAMARÕES

RESUMO: A crise económica dos anos 80, juntamente com a desvalorização do franco CFA em 1994, conduziu a um empobrecimento significativo das populações rurais, com uma queda significativa do poder de compra. Este fenómeno levou ao aparecimento de novas actividades geradoras de rendimento. Isto é como as populações rurais e de elite de algumas divisões ou subdivisões administrativas (Ngwéi, Ekondo Titi) correram para a produção de óleo de palma desde 1990, tanto para necessidades alimentares como para rendimentos monetários. O cultivo do dendezeiro leva à desflorestação de grandes áreas de floresta densa todos os anos nos Camarões. Como tal, o cultivo de palma torna-se o principal motor da desflorestação, levando à perda de biodiversidade vegetal e animal, bem como à poluição do solo e da água, o que levanta questões sobre

a sua sustentabilidade. O sector do óleo de palma está a progredir nos Camarões, com cerca de 360.000 hectares de plantação de palma partilhados entre agro-indústrias, elites e pequenos agricultores. A produção anual de óleo de palma aumentou de 270 mil toneladas em 2013 para 413 mil toneladas em 2018, contra uma procura que atingiu o pico de 1,179 milhões de toneladas em 2018. No que diz respeito à metodologia, utilizámos ferramentas geoespaciais através de imagens de satélite multitemporais e multisensoriais como o Landsat de 1976 a 2015, IKONOS, GEOEYE, Google Earth de 2009 a 2016 para mapear a dinâmica das diferentes formas de uso e cobertura do solo dentro destes áreas. Em segundo lugar, as investigações de campo permitem-nos recolher dados de campo sobre o número de produtores, as áreas por produtor, a produção em si, bem como a validação dos resultados do processamento de imagem. Os resultados mostram que o cultivo do dendezeiro tem impactos positivos e negativos, no entanto os impactos negativos são numerosos e difíceis de corrigir, daí o dilema. Com efeito, em termos de impactos positivos podemos referir o emprego e o rendimento, depois a melhoria das condições de vida de certos agregados familiares e das elites em particular; enquanto que em termos de impactos negativos citaremos prontamente a desflorestação, o uso intensivo de fertilizantes e pesticidas que levam à poluição dos cursos de água e a difícil eliminação dos resíduos das prensas. Também uma dupla análise pelos impactos e pela ecologia política permite analisar melhor as causas de tal fenómeno, ao mesmo tempo que destaca as consequências essenciais da gestão e transformação do ambiente. Além disso, com mais de 820 hectares de floresta perdidos por ano, o dendezeiro tornou-se o principal e pernicioso motor da desflorestação. Os efeitos negativos da degradação estão obviamente relacionados com a fragmentação dos ecossistemas e dos habitats; poluição ou contaminação das águas dos rios utilizadas para alimentação e necessidades corporais na ausência de perfuração, empobrecimento dos solos e sua erosão (solos inclinados), conversão de terras degradadas e redução dos stocks de carbono através do ataque a zonas pantanosas e de malária, as divisões sociais e as injustiças nascidas das compras e expropriação de terras pelas elites e do recrutamento de mão-de-obra estrangeira, da perda de biodiversidade e de segurança alimentar (falta de tempo e de terras) das populações rurais, das migrações de retorno e das migrações locais para áreas de elevada produção. Contudo, é necessário maximizar os impactos positivos e minimizar os impactos negativos e também aqui surge o dilema, porque que tipo de governança pode levar a um sistema de produção petrolífera ganha-ganha. Não devemos identificar as terras degradadas e alocá-las ao dendezeiro e depois identificar aquelas que ainda estão intactas para proteção; turismo e silvicultura municipal? Além disso, como podemos permanecer indiferentes à conversão de florestas de altíssimo valor de conservação, onde nidificam primatas muito procurados? Este artigo tem como objetivo analisar o dilema e a controvérsia da elaeisfarming após a destruição maciça de florestas densas e de elevado valor de conservação nos Camarões. As áreas mais adequadas para a agricultura elaeis são o principal centro de endemismo nos Camarões (outro dilema) e, como tal, ameaçam a destruição da biodiversidade, ao mesmo tempo que comprometem a conservação. Levanta um problema de governança que implica uma melhor articulação das tensões entre o desenvolvimento e as questões ambientais.
PALAVRAS-CHAVE: Conservação. Desflorestação. Dilema. Elaeisfarming. Impactos.

1 INTRODUCTION

1.1 CONTEXT AND PROBLEM

Agriculture is one of the main causes of the degradation of natural ecosystems (Bahuchet. & Betsch 2012). It accounts for 24% of global greenhouse gas emissions Carlson et al; (2013). The resulting climate changes affect the whole humanity IPCC (2007). Agriculture is also the primary anthropogenic cause of deforestation and desertification. It largely participates in the degradation of water resources with the increased use of chemical inputs (Tchindjang et al, 2016; Tchindjang, 2017). These negative impacts are mainly imputable to industrial agriculture, practiced over large areas and without taking into account the basic principles of sustainability. Artisanal agriculture also presents unsustainable practices such as shifting slash-and-burn agriculture (Bahuchet. & Betsch 2012; Zhang et al, 2002).

On a global scale, palm oil is the leading vegetable oil for consumption since 2015, and its demand continues to grow. The processed food industry consumes approximately 72% of all palm oil production, the personal care and cleaning products industry consumes 18%, and the biofuel industry consumes the balance at 10%. The largest exporting countries of crude palm oil and its fractions (whether or not refined) in 2017 were Indonesia (USD 18.7 billion), Malaysia (USD 9.8 billion), and the Netherlands (re-export) (USD 1.2 billion), while the largest importing countries that year were India (USD 6.5 billion), China (USD 3 billion), and Pakistan (USD 2.2 billion) Brack et al. 2016, Workman, 2019a&b). The multiplication of uses of palm oil in cosmetics, energy (biofuels), agri-food, etc. amplifies global and national demand.

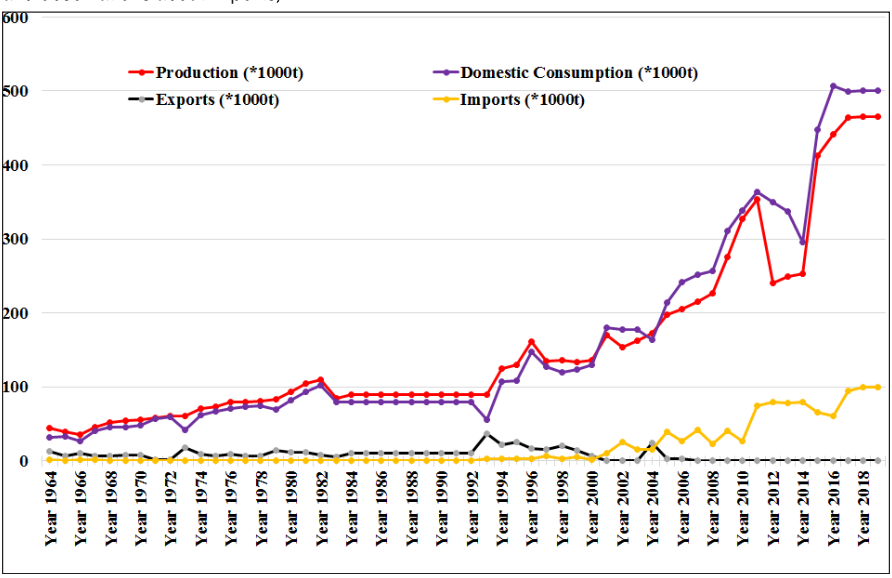
In Africa, Cernansky (2019) thought that an estimated 3.03 million ha of land “traditionally used or inhabited by local communities,” covering both forest and farmland, have been acquired by palm oil companies. Cameroon is a middle income country with about 70% to 75% of its population dependent on the agricultural sector for livelihood and employment. Agricultural sector provides about 30% of the country’s GDP (Bassel, 2014; Bassel and Sisak, 2014) Cameroon is a cradle for palm oil production and being amongst the main producers of palm oil in Africa has attracted much attention recently from private companies worldwide.

Palm oil is not new to Cameroon with the first commercial plantations being established in 1907 under the German colonial administration in the coastal plains, around Mt. Cameroon and Edéa (Ndjogui et al, 2014, Ngom et al, 2014). The crop was further developed under the Franco-British regime until 1960 when it had reached an estimated production of 42,500 tons (Carrere, 2013). After Independence, the government of

Cameroon took over palm oil production with the creation of public sector companies like “SOCAPALM, PAMOL and CDC. The Cameroonian production level positioned the country as the 13th producer of palm oil in the world and the leading producer in the Central African sub region (USDA, 2020). This considerable increase palm oil production was mainly due to the dropping prices of cocoa and coffee which were then the major cash crops. The economic crisis in the late 1980s and early 1990s, including the devaluation of the CFA franc impacted many smallholders in the ecologically suitable areas driving a shift to the development of oil palm plantations (Ngando et al, 2011).

Cameroon’s palm oil production is growing fast since 1993 and was estimated to 465,000 tons of palm oil in 2019 (USDA, 2020) while consumption and import grew to reach respectively 500,000 tons and 100, 000 tons (Figure 1).

Figure 1: Palm oil production, consumption and export/import in Cameroon (Source, USDA, 2020 complete by field work and observations about imports).



Cameroon ranks 10th among palm oil producing countries in the world and 3rd in Africa behind Nigeria (940,000 tons) and Ivory Coast (417,000 tons). Its production is estimated reach more than 650 000 tons in 2022 for a national demand estimated at more than 1,179, 000 tons (Miaro et al, 2020). The sector functions with a structural deficit of 160, 000 tons.

Unfortunately, the increase in cultivated areas comes at the expense of natural forest ecosystems with high conservation value and plots allocated to other activities such as agriculture. Elaeis farming raises a lot of controversy. It induces unprecedented degradation and deforestation. The losses of biodiversity are inestimable in a context where concerns on a global scale are oriented towards the conservation and preservation of ecosystems useful for mitigating climate change, and therefore, for the sustainability of life on earth. Also, it contributes to the decline or at least the stagnation of other economic activities in prone cultivated areas i.e. Ngwéi, Ekondodo Titi, Sanaga Maritime. With the scarcity of land, the decline in food production and the emergence of social conflicts (particularly linked to land). Soil degradation, pollution and contamination of river water, etc. are so many other problems that the cultivation and processing of this plant generate. The dilemma is therefore obvious and lies between the socio-economic benefits and the environmental problems generated by the development of palm oil production. The ultimate concern is how to reconcile elaeisculture with the imperative need for preservation and sustainable management of ecosystems in this department. This dilemma leads the oil palm to tackle the conservation by eating away at the areas of the protected areas of the territories concerned or by downgrading them in favor of granting industrial plantations.

In Cameroon, the oil palm production is stratified in three sectors: an agro-industrial sector, smallholder's scheme and medium holder's scheme (semi-industrial) in contract with agro-industries and independent small and medium scale producers (Bakoume et al 2002). We estimates today that more than 600,000ha are used for palm oil farming in Cameroun in five types of plantations.

- Family planters (type1) with an area ranging from 1 to 15 ha.
- Rural investors (type 2) with an area around 15 to 50 ha.
- Urban investors (type 3) that are still called elites, with an area ranging from 50 to more than 200 ha.
- Private investors (type 4) from 800-5, 000ha.
- Agro industrial (type 5) plantations with more than 10,000 ha.

But this view seems too simplistic and we need to organize the production around (table 1)

Table 1: Organization of oil palm production in Cameroon.

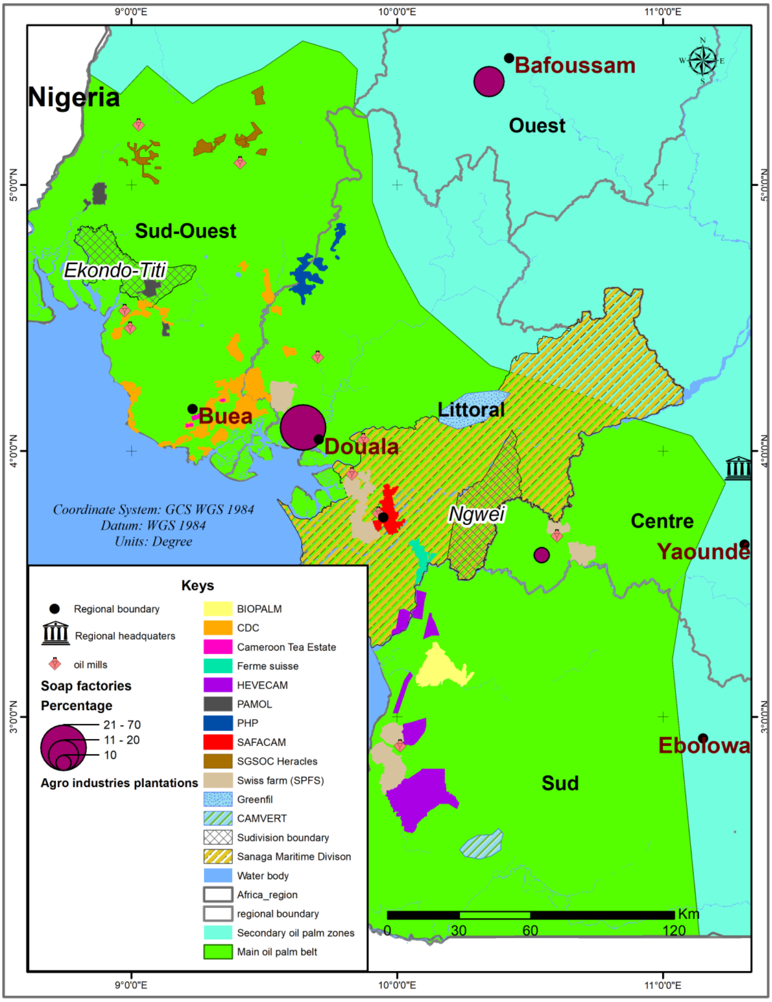
Scale	**Size of the farms ha**	**Type of mills**	**Destination of the products**
Smallholders & families	1-5h	Hand and foot	Family consumption and sales
Smallholders	5-15	Hands	Local consumption and sold
Motorized Smallholders	15-50	Mechanical, motorized	Wholesale, to small scale retailer /individuals
Independent holdings	50-250ha	Motorized, semi industrial	Great retailer, second transformation
Private investors	More 800-5000ha	Industrial	second transformation industries
Agro industries	More than 10000ha	Industrial	second transformation industries

1.2 BACKGROUND AND STUDY FRAMEWORK

This study focuses on Cameroon, a country in Central Africa located between 2°-13°N and 8°-16°E (Figure 2). This "Africa in miniature" had an estimated population of 27 million in 2020. It is a predominantly young population; the 0-15 age group representing nearly 43% of the total workforce (BUCREP, 2010). Physically, Cameroon has a dry tropical climate in the north and a humid equatorial climate in the south. The relief is very diverse, ranging from landscapes of coastal plains to high plateaus and mountain ranges scattered across the territory, not to mention a long opening (400 km) to the Atlantic Ocean. In terms of water resources, Cameroon is the second wettest country in Africa after the Democratic Republic of Congo. Economically, Cameroon is one of the middle-income countries with a human development index (HDI) of 0.563 in 2018. Economic activity is dominated by the primary sector (45% of GDP) (MINEPAT, 2009). Agriculture employs 45.3% of the working population. The diversity of the conditions of the biophysical environment is favorable to the development of a large number of crops, both food (cassava, maize, millet, macabo, rice, etc.), and cash (sugar cane, cotton, palm oil, rubber, cocoa, etc.). Regarding the oil palm, it develops preferentially in the coastal area qualified as the "elaeisfarming" belt of Cameroon (figure 2). Administratively, oil palm plantations and concessions are set up in the maritime facades of the southern, coastal and southwestern regions.

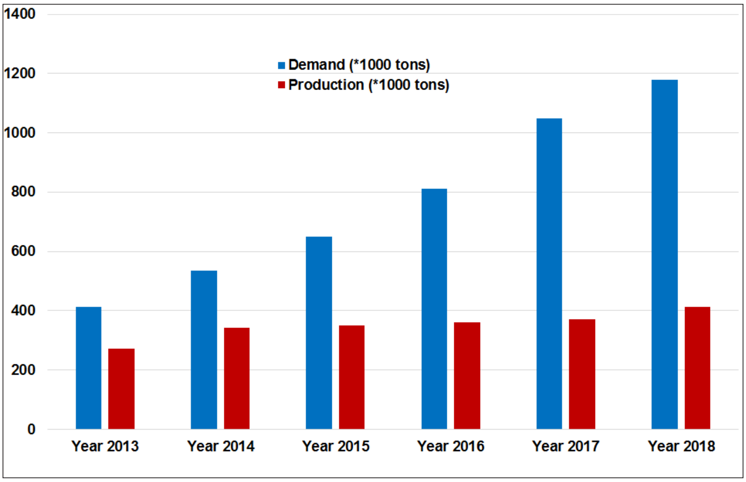
As drawn in the map, this belt offers suitable conditions for the development of oil palm: low altitude (less than 500 m); sufficient rainfall (more than 1800 mm / year); favorable temperature between 22 and 30°C; low thermal amplitude; rich and deep soils; etc. It is in this area that one can find agro-industries, the major producers of palm oil. At the edge of this "elaeisfarming" belt, there are a few small marginal farms both on the vast southern Cameroonian plateau and in the Western Highlands where oil palm could be sown with lukewarm success.

Figure 2: “elaeisfarming” areas, oil palm farms and industries of Cameroon.



Cameroon’s oil palm production has grown at a rate of 2.8% yearly that is from 100,000 tons of CPO in 1990 to about 270,000 tons in 2014 (www. indexmundus .com), 372,000 tons in 2017 (Mbodiam, 2019) and 413,000tons in 2018 (SA, 2019). Despite this increase production and the efforts put in place by the government through different programs, projects and partnership with NGOs, the problem of palm oil demand (figure 3) and its related products has not been solved within the country. Palm oil is regularly imported to fill the gap, with the country registering import of about 80,000 tons in 2012, 78,000 tons in 2013 and 80,000 tons in 2014 (USDA 2020) 95000 tons in 2017, 100,000 tons in 2018. This deficit in the supply of palm oil is mainly due to aging plantations mostly made up of the wild variety (*dura*), poor management of the plantations and poor mills performance (artisanal mills). The transformation of palm fruits is done by two sectors being industrial or artisanal, but their mills are very old with a reduced efficiency as equipment is outdated. The increasing al mil demand has gone from 100,000tons in 2010 to reach more than 1,000,000 000 tons[1] nowadays due to colossal investments and demand from second transformation industries like SCR Maya, SODECOTON, Refinery PACIFIC, AZUR, SAAGRYS, SOC, etc.

Figure 3: Demand and production of palm oil in Cameroon sine 2013.



2 METHODOLOGY

The study began with documentary research in various libraries of institutions in Yaoundé to gain an overall understanding of the oil palm sector in Cameroon and particularly in the production basin. The emphasis is placed on the history of the sector in Cameroon and the factors and reasons for the development of this speculation in Cameroon. The second phase was developed around field surveys using questionnaires. To this end, 334 questionnaires were administered over a week to village and industrial oil producers in the eleven (11) districts of Sanaga Maritime. Further 290 and 260 questionnaires were administered in Ngwéi and Ekondo-Titi Sub-divisions respectively. These surveys placed particular emphasis on, among other things: production mechanisms, the ecological and socio-economic impacts of palm groves and the prospects for the sector in the department. Field observations, interviews and focus groups carried out with populations, local authorities and industrialists completed the approach.

The surveys carried out among palm plantation owners focused on the characteristics of the palm groves: size, varieties planted, age, production per hectare,

1 EcoMatin, https://ecomatin.net/huile-de-palme-le-deficit-de-production-du-cameroun-se-creuse-a-700-000-tonnes/accessed on 03/08/2020

varieties cultivated, yields, evacuation of production etc., perception by the local populations of the ecological and socio-economic impacts or mutations of elaeisculture, the future of this speculation in their department... GPS surveys of palm plantations and field photographs of different issues were also carried out during the surveys.

Geopastical tools were mobilized. The processing and analysis of satellite images of Sanaga Maritime were carried out diachronically and based on Landsat, GEOEYE, IKONOS and Spot images.

Using ArcGIS and Envi and Erdas remote sensing software, the various maps were generated. The processing of multi-date images, subsequent analyzes and interpretations made it possible to understand the dynamics of land use in a relevant manner. Particular emphasis will have been placed on the evolution of the forest cover in the department in relation to the dynamics of development of elaeisculture. These analyzes and interpretations of satellite images and the resulting maps provided a global overview of the changes induced over time by the development of olive growing, housing, and other agricultural activities.

The processing of the survey questionnaires was carried out using Microsoft Excel 2007 and made it possible to generate various diagrams, providing information on numerous aspects linked to the evolution of oil palm cultivation, such as: different categories of planters, the distribution by gender of oil growers, the method of land acquisition, the origin of financing for the creation of a palm grove, the evolution of yields and income, the destination of the production, the type of vegetation welcoming palm plantations, etc.

This study, carried out between 2013 and March 2020 by an interdisciplinary team (geographers, botanists, environmentalists and geomatician specialists), highlighted the impact of oil palm cultivation on the landscape and the range of tools used during this study are resumed in Table 2.

Table 2: Methods used in assessing the impact of oil palm plantation in the environment.

Methods	Operational work
Satellite image processing	LANDSAT image processing (MSS, TM, ETM+ & 8 de 1975 à 2015)
Botanical Survey on quadra and transects	Two quadras and two transects in each type of palm plantation visited on field (village, elitist et industrial); a quadra in the dense forest.
Environmental impacts assessment	Interaction matrix and impact sheet per receiving environment
Questionnaire Survey	290 and 260 questionnaires respectively in Ngwéi and Ekondo-Titi subdivisions

Landscape method	Application of the SEPL exercises in 4 villages (two per subdivision) which involves a total of 60 participants.
Carbon stock estimation method	Assessment of carbon stock in aboveground biomass by allometric equation

In this paper, we did not take into account the carbon stock assessment.

As impact assessment is concerned, the combination of characterization criteria such as the nature, probability of occurrence, scope or extent, magnitude or intensity, reversibility and duration of the identified impacts is necessary in the classification of these impacts. The assessment of the identified impacts was done by rating (Tchindjang, 2017). Ratings from 1 to 5 were assigned to the indicators (table 3) depending on the degree of impact. The absolute importance represents the average of the impact ratings over the total number of rated indicators. Nature is the way of being of an impact which can be positive (○) or negative (●) in the concerned environment.

Table 3: Impact assessment indicators and rating de l'évaluation des impacts.

Value	Occurrence of the impacts	Territorial scope (extent) of the impacts	Duration of the impacts	Intensity of the impacts	Reversibility of the impacts	Final rafting
1	Very unlikely	Very reduce space (10%)	Very short	Very weak	Immediately reversible	1-2 non significant or negligible
2	Unlikely	Reduce space 15-20%	Temporary	Low	Quickly reversible	
3	Likely	Fairly extensive 25-40%	Long enough	Way	Reversible	2.1-2.9 insignificant
4	Certain	Extended 50%	Long	High	Little reversible	3-4 significant
5	Very certain	Very extensive 60-100%	Very long	Very high	Irreversible	4.1-5 very significant

The absolute importance or significance of the impacts is determined by calculation by taking the product of all the ratings assigned to each indicator over the total number of indicators. This is illustrated by the following equation:

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

Equation 1

After rating the impacts were qualified according to the results obtained.

- The rating [1- 2] represents the insignificant or negligible impacts;
- The rating [2.1 - 2.9] represents the insignificant impacts;
- The rating [3- 4] represents the significant impacts;
- The rating [4.1 - 5] represents very significant impacts.

The impact criticality threshold is established as the rating value greater than or equal to the average of the grid: 3.

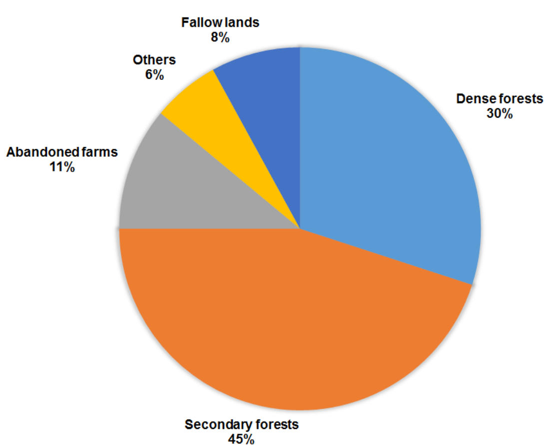
3 RESULTS AND INTERPRETATION

Paragraphs below allow us to address the main axes of sustainability into the oil palm sector: economic viability, social inclusion, environmental preservation and governance. We observe on field that Most of the components of the biophysical environment are affected by this activity. Globally, we notice the clearing of the forest for the establishment of new plots, the erosion of the land during exploitation, the pollution of air and water during processing as well as relative poverty and inequality among peasants. We can include grievances related to the distribution of benefits and the development of neighboring communities.

3.1 OIL PALM BETWEEN DEFORESTATION AND ECOLOGICAL SUSTAINABILITY IN CAMEROON

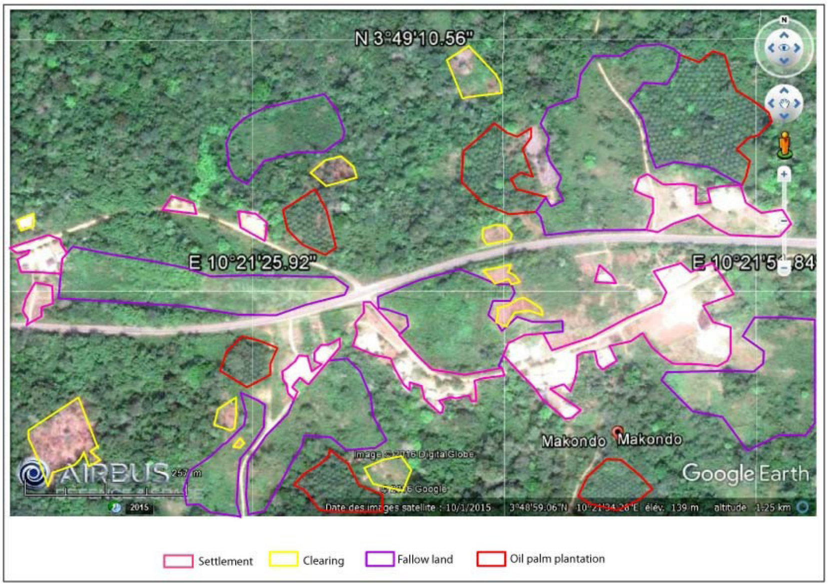
For a mean deforestation of 0.138%/yr (i.e. a loss of 150,000ha of forests/yr), 74% of this deforestation concern areas particularly areas where oil palm agro-industries and small farms are located. Thus, ecology of the oil palm shows that the forest area has the suitable conditions (soil, rainfall, temperature, relief and insolation) for its development. It is in this vein that all old and new palm plantations (from all actors being agro-industries, small farmers and elites) are located in forest areas. This is because forest milieu guarantees them a sustained production over a long period while others areas like fallows and abandoned farms do not bring the expected results (figure 4).

Figure 4: Type of land use chosen for the creation of the oil palm plantations in the main production basins (Source: field survey 2013-2020).



It is worth notice that agro industrial palm plantations / concessions and properties are 100% created on forests. The areas of industrial oil palm producers increased from 46,850 ha in 2009 to 63,200 ha in 2014 and more than 176,600ha in 2019. It means 35% increase in about 5 years and 73% in 10 years. Nevertheless, remote sensing in the Ngwéi and Ekondo-Titi subdivisions as well as Sanaga Maritime Division show that more than 83% of smallholders palm plantations were created to the detriment of primary and secondary forests. The increase is estimated at more than 50% in 10 years between 2000 and 2010. The latter do no longer used fallow land and other abandoned fields. Because there are so many smallholder actors more than 90% for only 15% of area, the accelerated deforestation process by atomizing the forest (figure 5).

Figure 5: Atomization of the forest by unsustainable oil palm worsen practices (construction or building, clearing, palm plantations and wasteland) contributes enormously to the decline of the forest which is suffocated. Any parcel of forest located between two of these plots is doomed to disappearance (*Source: map from Google Earth Airbus images*).



The threat of palm plantations on the original forest is all the more serious as certain industrial concessions granted in recent years are adjacent to protected areas. This is the case of Sithe Global Sustainable Oils Cameroon (SGSOC); a subsidiary of the American multinational Herakles Farms (Figure 2). The concession acquired by the latter is located in the Kupe-Manenguba division, whose protected areas (namely Korup and Monts Bakossi national parks as well as Rumpi hill reserve and Banyang-Mbo fauna sanctuary) are recognized as High conservation value forests (HCV) and also endemic for its biodiversity. The same situation was observed in the Greenfil case whose palm plantations are located very close to the Ebo forest which houses wide variety of wild animals, especially the western gorilla, the chimpanzee of Nigeria-Cameroon, the drills and several other primates as well as many endemic plant species. It is the same with the recent de-gazettement in 2019 of 09-025 Forest Management Unit (FMU) to the profit of the installation of new oil palm (60,000 ha) plantation by CAMVERT (Figure 2) at Campo, near the famous Campo Ma'an National park recognized as Model forest and biosphere reserve. The proposed declassified area encompasses two blocks covering 40,000 ha to the north and 20,000 ha to the south bordering Dipikar Island (Campo Ma'an National Park) where there is a gorilla habituation project ongoing.

Deforestation caused through palm planting also breaks up the habitat of endangered species and disturbs wildlife corridors usually used by forest elephants. Such a situation bring confusion and we recorded on fields more and more anger, disappointment and land conflicts due to ambiguous governance of the forest.

3.2 THE CHALLENGE OF ECOLOGICAL SUSTAINABILITY

The main biophysical components of environment are exposed to the most worrying negative externalities from the palm oil sector. Based on this ecological pillar, the nature protection organizations continually invite producers and State to put more effort and to pay attention to the following summarized points.

Better integration of oil palm cultivation and pig / poultry farming (plate 1). Pig breeding and poultry farming must be encouraged, because they constitute a better complement and ally of palm farming in terms of waste management and organic fertilization of the fields at the same time as it allows integrated production;

- Integrated management of waste which becomes a source of fertilization and cooking for artisanal oil extraction;
- Avoidance of deforestation and forest degradation by zoning and securing preserved forest areas considered as a land reserve;
- Installation of palm plantations on fallow land (plate 1) and not detrimental to the forest.

Avoidance of the reproduction of cumulative impacts linked to the layering of several activities (construction, artisanal sawing, logging, land clearing, subsistence farming and oil palm cultivation). Finally, the cumulative impacts (physical and human environment) affect the fragmentation of habitats, the loss of biodiversity (see figure 3 above), deforestation coupled with the monoculture of rubber and cocoa or the market food crop including plantain; food insecurity; social conflicts; and finally, social protection and collective bargaining.

Plate 1: illustrations of some observed oil palm practices. On the to from left to right: biological fertilization at Bogso; Oil palm plantation on fallow land at Ngwéi; House construction at the entrance to the forest and the palm plantation at Pouma. Bottom from left to right: Last step of oil extraction by artisanal cooking using kernel waste pigs consuming palm nut waste and cake.

As mentioned above, the oil palm is an emerging driver of deforestation since 1990 in Cameroon. Its integration into the process of reducing emissions due to deforestation and forest degradation (REDD +) is a necessity. The resources mobilized by this mechanism can be used to:

- Optimize the use of existing plantations / concessions before considering any form of extension and promote agricultural intensification at the same time with the rehabilitation of old plantations;
- Promote the development of oil palm plantations as a priority in old plantations, abandoned plantations and areas with degraded forest cover.
- Promote sharecropping in the palm oil sector and correctly assess the impacts of investments in the palm oil sector;
- Monitor compliance with land use plans, protection and management of forests in accordance with approved zoning;
- Develop a policy and legal framework for environmental mitigation / carbon offsets of investment projects in forested areas;
- Promote the identification, management and monitoring of areas of high conservation value (HCV) during plantation development.

Equipped with all these assets, the palm oil sector will then present itself as a real opportunity for Cameroon to achieve good performance in REDD +. Rather than creating new plots, it is necessary to favor the restoration of old plantations to limit the deforestation front. Oil palm, being a forest plantation, can become an asset for the restoration of forests and degraded lands; which would significantly increase the sequestration of greenhouse gases in Cameroon. Once again, the remunerations collected will go into financing the sustainability of this sector.

3.3 ELAEISFARMING, EROSION OF BIODIVERSITY AND SOILS CONTAMINATION

The establishment of palm plantations generally involves the almost total clearing of the forest. This leads to the loss of species, including those that are endogenous in certain areas of high conservation value. Oil palm is generally grown in pure culture. It does not tolerate association with other speculation. The other species found in palm plantations are generally the ombrophilous grasses. From our observations, we can affirm that smallholders palm plantations relatively conserve their biodiversity better than industrial ones. This is explained by the solicitation of other ecosystem services such as traditional pharmacopoeia and the harvesting of non-timber forest products by populations.

Oil palm plantations bordered protected areas which is dangerous. Hence the advantage of avoiding installing oil palm plantations next to protected areas or in dense forests because they considerably reduce biodiversity. Better still, in this area, the Government should seek to restore the portions of protected areas eaten away by the palm plantations of agro-industries or elites and other unscrupulous investors.

It is clear that oil palm becomes the source of deforestation and land degradation. Clearing plots during establishment exposes the land to runoff erosion. Certain palm plantations areas such as the district of Ndom and Nyanon have steep slopes, causing the leaching of their soils. The increased use of chemical fertilizers by agro-industries also deteriorates the soil in the long run. In terms of statistics computed since 2013 from processed satellite images, 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. In Sanaga Maritime, from 1986 to 2013, deforestation rate is estimated at 23.61%. Figures 6-8 illustrate the smallholders growing scattered and atomize farms in 2013 (Sanaga Maritime division) and 2016 (Ngwéi and Ekondo-Titi Subdivisions) in the studied areas.

Figure 6: Land cover and land use in Sanaga Maritime in 2013 from Landsat ETM+ (P186/r057 & P186/r58) validated with Kappa Coefficient of 95% and after fieldwork. Smallholders' farms are distributed and scattered mostly along the road network.

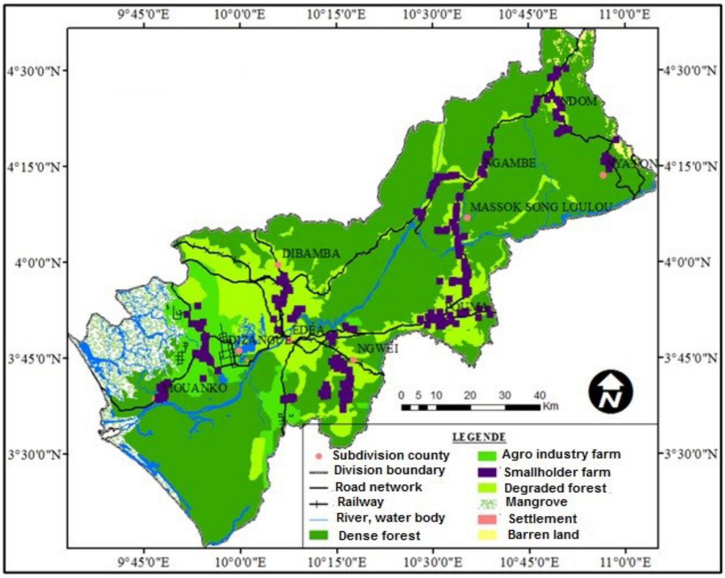


Figure 7: Land cover and land use in Ekondo-Titi in 2016 thanks to Google Earth images (1.5m resolution). We can observe that original forest and mangrove have disappeared everywhere apart from the Northwestern part of the map. Smallholders' farms are spreading northwestern wards.

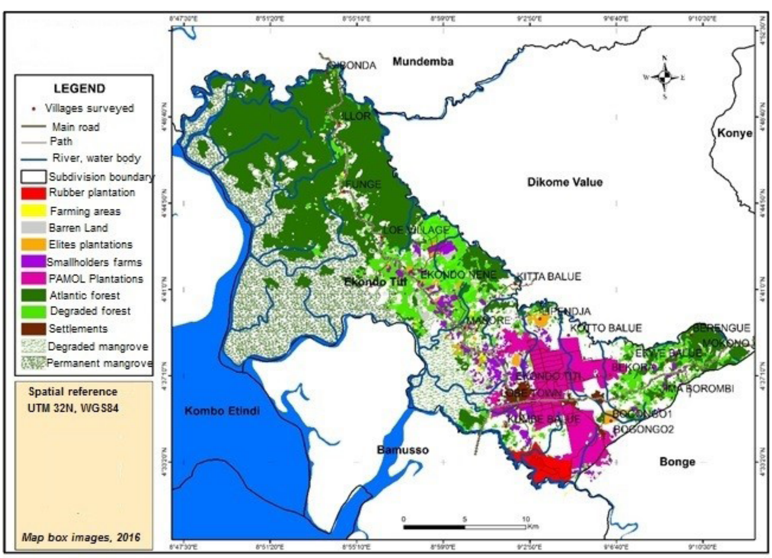
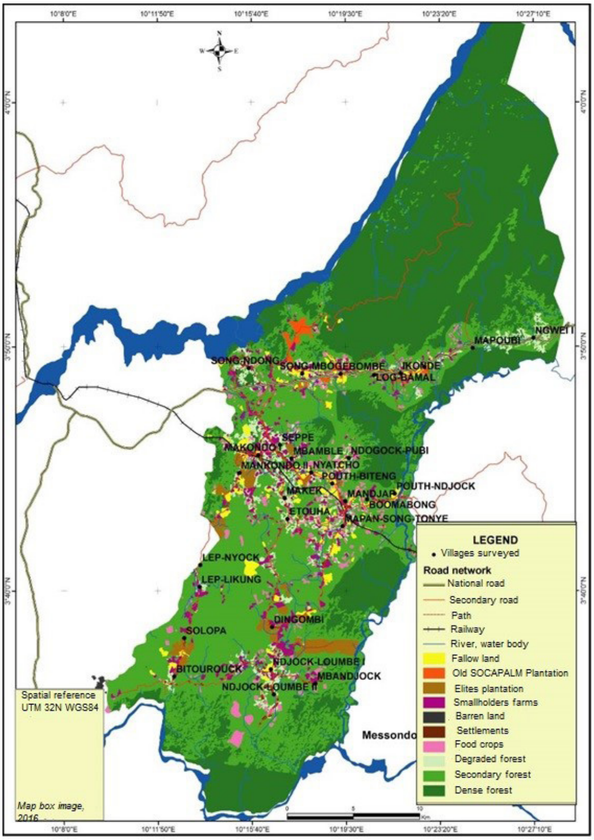


Figure 8: Land cover and land use in Ngwéi District in 2016 from Google Earth images. A small portion southward and a great area northward of the images remain intact and need to be preserved. Numerous smallholders' farms oil palm widespread and scattered in the central part of the image show that the Ngwéi District is the stronghold with almost more than 30% of the areas producing red oil within the Sanaga Maritime Division.



3.4 IMPACTS OF ELAEISFARMING IN BIOPHYSICAL MILIEU

Agriculture is the second leading cause of greenhouse gas emissions in Cameroon. It is also the primary driver of changes in land use patterns. Industrial speculations such as cocoa, rubber, sugar cane and oil palm use processes that also damage water causing water pollution. In the context of oil palm, the following stages: clearing for the establishment of new plots, storage of nuts, oil extraction, packaging and waste management are particularly formidable for both air and water. The above table only shows two positive impacts (3.5%) on fauna and NTFPs over 55 negative impacts (96.5%), meaning that oil palm cultivation is disastrous on natural environment. Those impacts are significant for surface water, flora and fauna (biodiversity), soils, natural habitats and NTFPs (Table 5). However, these areas are the most concerned by the safeguard policies of the World Bank and the African Development Bank (ADB), because they are elements of the natural heritage of a country.

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Table 5: Absolute importance of the impacts of the oil palm cultivation on the biophysical milieu.

Component of the affected environment	Activities sources of impacts	Impacts	Characterization parameters and rafting						Final assessment
			Nature	Occurrence	Intensity	Spatial extent	Duration	Reversibility	Importance
Air	Land clearing / deforestation Storage & preparation of nut Oil extraction	Degradation of air quality	•	3	2	1	1	2	1,8
Surface water	Land clearing / deforestation Oil extraction Waste management	Degradation of water quality / contamination, pollution	•	3	3	4	4	4	3,6
Underground water	Land clearing / deforestation Oil extraction Storage & preparation of nut	Contamination, water table attack, pollution	•	3	2	1	3	3	2,4
Soil	Land clearing / deforestation Staking, hole punching Planting Storage & preparation of nut Oil extraction	Degradation of soil quality Contamination, pollution	•	4	4	2	3	4	3,8
Naturel habitat	Land clearing / deforestation Staking, hole punching	Fragmentation, destruction of natural habitats	•	3	3	4	5	5	4
Flora	Land clearing / deforestation Plant maintenance Harvesting bunch Felling old palm plants	Deforestation, fragmentation	•	5	5	4	5	4	4,6
Fauna	Land clearing / deforestation Staking, hole punching Plant maintenance	Fauna habitat disturbance Migration and loss of fauna species	•	4	3	3	5	5	4
Non-timber forest products (NTFPs)	Felling old palm plants	Increase /decrease in NTFPs Loss of medicinal species	•○	3	2	2	5	5	3,4

Source: fieldwork, 2013-2020.

3.5 ELAEISFARMING AND ECONOMIC SUSTAINABILITY

Overall, agriculture contributes 22% of Cameroon's GDP and employs nearly 62% of the workforce. The oil palm represents 30,000 jobs in the formal sector and at least 50,000 in the informal sector, to which must be added hundreds of thousands of peasants working on their own without being registered (Tchindjang et al, 2016)[23]. Shellfish farming is considered to be a highly intensive labor activity (HILA). In Sanaga Maritime, 51% of the population admits that the oil palm allows them to validly meet their existential needs Ngom et al, 2014[5]. For the elite, this is an area where people invest to earn extra income or prepare for retirement. In the elaeisfarming villages of Cameroon, an abundance of direct or indirect activities linked to this sector makes it possible to more or less effectively rule out the specter of unemployment and poverty. In terms of employment and the local economy, the oil palm despite the importance of negative biophysical impacts keeps the employment side as a positive impact with scores ranking from 3.6 to 4 (Table 6).

Table 6: Absolute importance of impacts of the oil palm on the economy.

Component of the affected environment	Activities sources of impacts	Impacts	Characterization parameters and rafting						Final assessment
			Nature	Occurrence	Intensity	Spatial extent	Duration	Reversibility	Importance
Local economy	Harvesting bunch Packaging and sale	Development of economic activities Increase in income	o	3	3	3	5	4	3,6
Employment	Land clearing / deforestation Staking, hole punching Planting Plants maintenance Storage & preparation of nut Oil extraction Packaging and sale	Job creation	o	4	4	5	4	3	4

Source: fieldwork, 2016-2020.

From an economic standpoint, the benefits of oil palm cultivation are undeniable. This profitability explains the rapid development of the "red gold". Nevertheless, the contribution of the palm plantation to the local economy and to the well-being of neighboring populations does not always meet expectations. However, in order to strengthen this asset and ensure economic viability, it is necessary to organize and orient the sector in such a way as to ensure a decent income for all stakeholders. The benefits for the national economy must also be optimized. Palm oil being a source of financial evasion, it is necessary to ensure the autonomy of Cameroon in order, as much as possible, to avoid imports. In practical terms, achieving this goal involves:

- The establishment of an inter-profession between the various actors (agro-industries, elites and smallholders) of the sector to ensure its sustainability and viability.
- Facilitating access to the main inputs / infrastructure (plant material, fertilizers, technical support, roads, etc.) for the benefit of all actors of the palm oil sector.
- Promotion of good management practices for plantations (economic valuation of by-products / by-products, research and use of cheap energy, etc.)
- Promotion of a model of association of agro-industries and surrounding private palm plantations.
- In addition, the development of income-generating activities as petty trade is 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). Moreover, 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.

Table 7 gathered the perception recorded from farmers and plantations owners about the economic impacts.

Table 7: Perception of livelihood economic impacts through questionnaire and landscape methods.

Area	**Sanaga Maritime (n =335)**			**Ngwéi (n=290)**			**Ekondo-Titi (n=260)**		
Variable	N	No change	P	N	No change	P	N	No change	P
Income level	15	10	75	13	8	79	10	9	81
Quality of social network	25	10	65	27	5	68	15	10	75
Job creation	5	15	85	7	5	88	5	5	90
Social infrastructure	45	35	20	55	25	20	55	30	25
Welfare	10	10	80	5	5	90	4	6	90

N: is Negative P: is Positive.

Better economic results for the oil palm sector in Cameroon also require the establishment of appropriate mechanisms to mobilize resources to finance its development. In terms of economic sustainability, the practice of intercropping (plate 2) is an asset. It is also desirable to diversify economic activities and promote geotopes in elaeisfarming environments with a view to tourism. Finally, improving farmers' incomes and household subsistence is an essential necessity.

Plate 2: Intercropping and oil palm value chain. At the top from left to right is intercropping with banana plantain and maize. Some of the peasants associated also fruits like papaw or coconuts.

Bottom: Oil palm value chain. After cleared old plantations, farmers can extract palm wine (from the trunk) which could be conditioned and sold. Palm wine has also medicinal effect and is used in traditional pharmacopeia and sometimes basket or fly hunting. Palm veins can also be used as brooms after clearing old farms. The last image at the right shows waste packaging from oil extraction to be used as fertilizer or sold.

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

3.6 SOCIAL ASPECTS OF THE SUSTAINABILITY OF THE OIL PALM SECTOR IN CAMEROON

Social sustainability is quite complex to develop. As we observed on field, it must include social protection, collective bargaining, inclusive dialogue, conflict resolution, corporate social responsibility and environmental justice. These questions variably challenge the agro-industrial and artisanal sub-sectors. In the wake of agro-industrial activities (SOCAPALM, SAFACAM, CDC, PAMOL), we can, more or less, be satisfied with the social protection of employees even if controversies regularly emerge such as the level of wages. The fact remains that the latter are regularly paid and for the most part benefit from some social security. Conversely, almost all of these agro-industrial companies do not adapt well to union activities, especially when they tackle economically sensitive issues such as salary increase, health care, paid leave, security, social benefits of family members of employees, etc. One can add the dictatorship of dismissal which is fashionable and annihilates all prospects for inclusive dialogue and concerted negotiation within companies. It is worth mentioning that the social situation is also tense between the owners of the elite palm plantations and the indigenous populations at Ngwéi. Because the impacts are so important, it is necessary to give sustainable compensation to populations whose land has been occupied by agro-industries in the expected standards.

Over the 83 impacts identified in social environment, 37.35% are positive while 62.65% are negative, signifying that on social domain, oil palm can be seen as a threat. Thus, the social and economic 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.

In the field of the artisanal sub-sector, the face of the sustainability of the elaeisfarming draws a gloomy observation: disorganization of the sector and the market, lack of social security for smallholders, land disputes, conflicts with agro-industries (Table 8), etc. The question is that of a sector that will be fully organized, where the players remain scattered and whose activities sufficiently demonstrate a collective lack of consideration of social sustainability.

Table 8: Absolute importance of impacts of the oil palm on the social environment.

Component of the affected environment	Activities sources of impacts -	Impacts	Characterization parameters						Final assessment
			Nature	Occurrence	Intensity	Spatial extent	Duration	Reversibility	Importance
Conflicts	Plant Care Storage and preparation of palm nuts Fruit bunches harvest Packaging and sales	Land dispute, Aggression, violence Intimidation, threat Tense social climate	•	4	4	1	4	2	3
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	Injuries Food deficit, social conflicts	•	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 the 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

Source: fieldwork, 2013-2020.

Elaeisfarming provides local communities with many materials, 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 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.

Finally, 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. Table 9 shows the recorded perception of the social impacts by elaeisfarmers.

Table 9: Perception of livelihood social impacts through questionnaire and landscape methods.

Area	Sanaga Maritime (n =335)			Ngwéi (n=290)			Ekondo-Titi (n=260)		
Variable	N	No change	P	N	No change	P	N	No change	P
Access to food	45	20	35	50	20	30	60	15	25
Quality of Housing	12	18	70	10	15	75	20	15	65
Access to land	22	10	68	12	16	72	5	15	80
Access to social infrastructure	50	10	40	50	15	35	40	15	45
Access to drinking water	20	8	72	12	10	78	38	12	50
Water pollution	68	20	12	72	18	10	70	15	15
Insecurity and conflicts	75	10	15	83	10	7	85	5	10

At the socioeconomic level, there are enormous disparities depending on the category of actor; the oil palm value chain seems in fact to benefit more to agro-industrial actors and operators of second and third palm oil transformations. On the contrary, smallholders, because they are not sufficiently taken into account in sectorial policies, are poorly organized, which does not allow them to take the best advantage of the still artisanal oil palm exploitation. The quantitative economic numbers therefore drown the realities.

3.7 GOVERNANCE OR POLITICAL SUSTAINABILITY

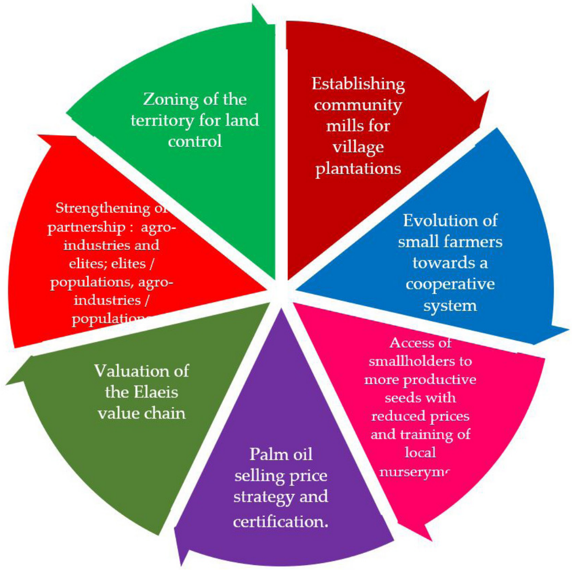
Governance requires having at least a national oil palm strategy, then fighting against deforestation, approving selling prices, rationalizing production and reducing imports. The definition of a strategy and better governance are prerequisites for the sustainability of any economic activity. Cameroon has a national strategy for sustainable development of the palm oil sector which validation is pending. This strategy identifies a set of actors and hierarchical decision-making bodies for the governance of the sector. The national steering committee is responsible for monitoring the implementation of the strategy. To this body, we add programs and projects, professional organizations (inter-professional organizations, cooperatives and unions), consular chambers and national and regional consultation frameworks. Operationally, it becomes urgent to:

- Make a temporal halt in the issue of large concessions for oil palm cultivation and other speculations;
- Prioritize smallholders schemes instead of large scale plantations;

- Apply the same land management requirements to all operators (agro-industry, SMEs) in the land allocation process in order to avoid injustice and deforestation,
- Set up a system for assiduous and regular monitoring of land concessions at the local level;
- Organize and conduct participatory mapping activities of areas and resources (forest) of high conservation value;
- Negotiate, develop and sign the specifications then implement them and make them public;
- Finalize and popularize the zoning plan being developed at MINEPAT for better ownership by stakeholders;
- Develop and set up a system for the redistribution of land royalties in accordance with the regulations in force.

Governance and strategic management are among the axes defined by the Employment Growth Strategy Document (MINEPAT 2009) aiming to make Cameroon an emerging country by 2035. Outside the national framework, good governance must be applied to any economic sector including the oil palm. In addition, securing the elaeisfarming basins prey to attacks by armed groups is seen as a necessity for Cameroon. Figure 9 summarizes the main axes useful for the mainstreaming of sustainability in the oil palm. An integrated and sustainable management approach in the oil palm sector takes into account all stakeholders.

Figure 9: strategy for an integrated and sustainable palm oil farming system.



4 DISCUSSION:

4.1 ENVIRONMENTAL AND ECOLOGICAL DILEMMA RELATED TO ELAEISCULTURE DEVELOPEMENT

The dilemma arises from the paralleling of the socio-economic advantages and the plural disadvantages that the development of elaeisculture generates in the areas where it is cultivated. In a space with multiple resources and assets, the issues, all of them important, clash and denote the need to delimit the fields of deployment of the different activities. The Sanaga Maritime, Ngwéi and Ekondo Titi are full of very rich forest ecosystems with high conservation value (Table 10). Rainforests sheltering plant and animal biodiversity occupy a large part of the space. The high altitude sectors of the north of the department (Nyanon, Ndom, Ngambé) are home to unique species (endemic and rare). Just like the mangroves of the coastal zone (Mouanko, Dizangué) which constitute the landmark of many animal species in terms of habitat and procreation space. This involves the numerous streams and rivers which structure the very dense hydrographic network of the department.

The issues linked to the preservation of these ecosystems are important, taken in parallel with the pursuit of sustainable development objectives. Better still, this conservation, beyond preserving resources for future generations, contributes to the prospect of developing other economically profitable and ecologically clean activities such as tourism. Political awareness of conservation issues has led to the demarcation of numerous protected areas listed in Table 10 below. By adding up all the categories of protected areas, approximately 25% of natural spaces in these prone areas are classified as protected areas. But, beyond these boundaries, there is a real problem of developing these spaces. Most are abandoned. They have thus increasingly suffered in recent years from attacks by populations who are eating into the outskirts by happily establishing their activities there, particularly palm plantations.

4.2 ELAEISCULTURE AND CONSERVATION : AREAS OF ENDEMISM IN CAMEROON

This first diagnosis nevertheless allows us to get an idea of HCV 1 in these territories, particularly around conservation zones and protected areas (PMK, PNDE, PNCM, PNMC) which correspond to the HCV1 category. However, the presence of fresh water and wetlands around Limbe, in the coves of Ndian, Ekondo Titi and especially at Lake Tissongo in the Douala-Edéa National Park allows them to be attributed to HCV4. The threats observed around the PNDE and PNCM make them areas identifiable as HCV3, because we observe a considerable reduction in the surface areas of the ecosystems.

It should be noted that most of these protected areas adjoin UFAs. This is the case of PNCM which surrounds UFA09-020, 09-021, 09-022, 09-023, 09-024 & 09-025 which are all HCV certified forest units. This is also the case for PN Ebo with UFA 07-002. The same applies to PN Korup (UFA 11-002-11-006) PN Bakossi (UFA 11-002) Banyang Mbo (UFA 11-022) etc. Naturally, wetlands recognized as such or associated offer immeasurable ecosystem services. Some are visualized in the images (figures 12 and 13) and may well fit into the components of HCV1.4 and HCV4.

Table 10 :Elæisculture against conservation: Conservation areas of HCV 1 and HCV 4.

HCV identified	Potential or real threats	Objectives	Proposed management measures
HCV 1.1.			
Campo Ma'an NP **Kribi Marine Park** **Douala-Edéa NP** **Mt Cameroon NP** **Ndongere NP** **Korup NP** **Bakossi NP** **Banyang Mbo Sanctuary** **Ebo NP** **Forest Reserves of Njambo, Yingui, etc**	Overlapping and nibbling of areas linked to agricultural activities and agro-industries (HEVECAM, SOCAPALM, CDC, PAMOL) Reduction of plant and animal densities on the outskirts Presence of forest concessions Decommissioning of UFA 09-025 next to PNCM Poaching via forest trails or that of agro industries Mangrove degradation	Stabilization or increase in animal and/or plant densities. Adequate and operational zoning of Protected Areas.	Forum or platform for consultation with agro-industries Raising awareness among managers of protected areas and agro-industries Restitution to the conservators of protected areas of areas eaten away by agro-industries Development of corridors for wildlife (especially elephants Establishment of a regular territorial surveillance system to combat poaching. Blocking and monitoring of access roads and dismantling of bridges after operation. Continue mangrove regeneration activities Restoring forest landscapes
HVC 1.4 et HCV 4			
Kribi Marine Park **Douala-Edéa National Park with Tissongo and Ossa lakes** Places of seasonal concentration of species (marine turtles, manatees, etc.): due to its location or the habitats found there, the concession presents areas of periodic concentration of animals	Deterioration of the state of habitats due to exploitation or other anthropogenic activities Deterioration of the banks of bodies and watercourses Degradation of the habitat bordering the Lakes (Ossa) bodies and watercourses and siltation of water points – Deterioration of junction sites between rivers, bodies of water and roads Exposure of soil on steep slopes and erosion, creating landslides and corollary harmful effects	Safeguard the integrity of these sensitive sites Prevent slopes from being exposed – Avoid obstructing waterways at points	Registration of sensitive sites in the protection series – Materialization of the limits of the most sensitive sites – Implementation of an information and awareness program for local populations on these sensitive sites – Development and implementation of operating procedures avoiding disruption and degradation of identified and recognized sensitive sites stabilization of banks disturbed by engineering structures (anti-erosion devices), compliance with standards regarding slope slopes

Figure 10: Distribution of threatened amphibian species in Cameroon and West Africa (Source: MINEPDED, 2014: 14 and IUCN, 2018: 36).

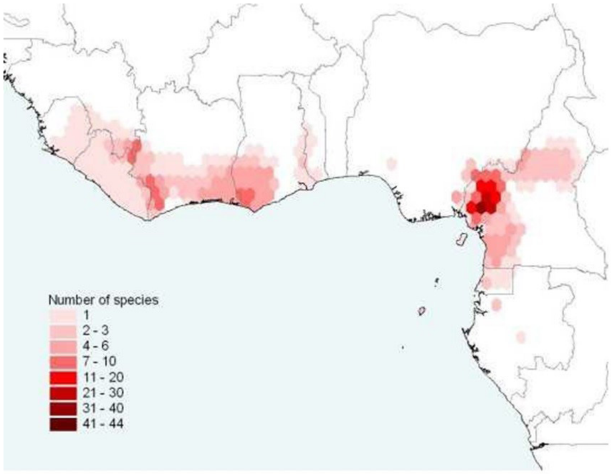
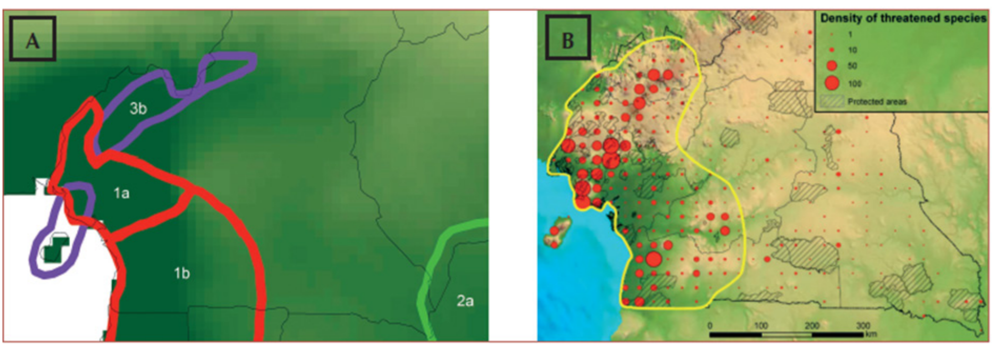


Figure 11: Distribution of threatened amphibian species in Cameroon and West Africa. 2. (Source: MINEPDED, 2014: 14 and IUCN, 2018: 36). 3. Main areas of mammalian endemism, according to OFAC (adapted from http://www.observatoire-comifac.net): (1a) West Cameroon region, (1b) Rio Muni region, (2a) West Congo region, and (3b) West Cameroon region. 4. In (B), Density of plant species.



4.3 STRONG DEMAND FOR PALM OIL

As shown before, global demand for palm oil is growing very quickly and supply is struggling to keep pace. Cameroon's national production is also in deficit. Demand is growing rapidly, stimulated by the multiplication of uses of palm oil. Apart from food needs which are growing very quickly, there are those of manufacturers in the field of cosmetics (oil and soap). Also their proximity of the city of Douala (economic capital of Cameroon) reinforces the demand for oil, constantly stimulating the development of elaeisculture. The cosmetics, food and beverage industries and refineries have multiplied, stimulating producers every day to produce a little more. Table 11 below lists the cosmetic industries established on the national territory.

Table 11: Consumption capacities of the cosmetics industries of Cameroon.

Company name		Locatio	Total processing capacity (in ton)	Products	
				Refined oil	Soap
1	AZUR	Douala	15 264	9 994	5 270
2	CCC	Douala	6 552	0	6 552
3	CCO	Bafoussam	3 206	1 690	1 516
4	HACC	Douala	2 496	0	2 496
5	NOSA	Yaoundé	1 197	0	1 197
6	SAAGRY	Douala	2 256	1 632	624
7	SANET	Douala	749	0	749
8	SAS	Douala	1 248	0	1 248
9	SCR MAYA	Douala	15 264	9 994	5 270
10	SCS	Bafoussam	7 264	2 735	4 529
11	SHC	Douala	800	0	800
12	SICT	Douala	En arrêt	/	/
13	SMC	Douala	1 248	0	1 248
14	SMS	Douala	1 089	0	1 089
15	SOC	Bafoussam	1 089	0	1 089
16	SOPROICAM	Douala	1 664	1 664	0
TOTAL			**54 242**	**20 865**	**33 017**

Source: Ngom et al, 2014.

For the moment, public and private initiatives in the oil palm sector have not yet succeeded in curbing needs. At the rate at which the palm oil deficit is evolving in Cameroon, for example, it is clear that oil production has great prospects ahead of it and that the efforts of public and private actors (mainly producers) will have to be doubled in the medium term to satisfy national demand and thus limit imports.

4.4 GOVERNANCE ISSUES

The attitude of the Cameroonian government remains to be questioned in the context of the pursuit of the objectives of sustainable management of natural ecosystems and the development of olive oil production in Cameroon. The government has limited its interventions in the agricultural sector since the economic crisis of the 1990s. This disengagement has contributed greatly to the development of elite palm plantations elsewhere. In the meantime, the population has increased significantly and so has the need for agricultural products. ". Since then, the government project has targeted a growth of 5000ha of planted area per year. In addition, priority was given to foreign private investors to strengthen production and make the country self-sufficient in palm oil production. In

2009, the concession of 73,083 ha of mountain forest with high conservation value to the Herakles Farms group in the South-West region sparked political scandal, provoking the anger of environmental defenders. Increasingly, the government is implementing a land concession policy that is very favorable to industrialists and preferably in sparsely populated areas to limit protests from the population. Which relegates the issues and objectives of conservation of natural ecosystems to second place.

4.5 LESSONS TO LEARN

The ever-increasing development of elaeisculture in the areas studied goes hand in hand with multiple environmental problems. They reveal in space the reverse side of speculation erected as a model of socio-economic development. No! Active elaeisculture here, the underlying levers of an activity which deconstructs existing natural assets and weakens, so to speak, the prospects for sustainable development. In the shadow of its much-touted socioeconomic advantages, it insidiously combines a series of misdeeds that are difficult to repair at the current rate of its growth.

Deforestation and disappearance of biodiversity

The development of elastomer production is driving unprecedented deforestation in the Sanaga Maritime, Ngwéi and Ekondo Titi. The illusion of large available land reserves leads elaeisgrowers (industrialists, elitists and villagers) to constantly increase the planted areas. The rich forests of those areas are also subject to competition between oil production and subsistence agriculture and logging. They are therefore declining at a very rapid rate (table 12). Since the 2000s, the oil boom has relegated subsistence agriculture and logging far behind and has positioned itself as the main activity driving the deforestation dynamic. Palm groves are created indiscriminately in virgin and secondary forests as well as in fallows left by subsistence agriculture (figure 8a). The losses of biodiversity and multiple resources useful to populations are inestimable.

Table 12: Projected rate of the forest disappearance linked to oil palm cultivation.

Parameters	Sanaga Maritime	Ngwéi	Ekondo-Titi
Area in sq km	9311	848	652
Total deforestation rate	28% in 40 years	45,94% in 40 years	22,74% in 37 years
Mean annual rate	0,7% per year	1.15% per year	0,61% per year
Net deforestation (ha)	121,043ha	11,872	7,882
Deforestation due to oil palm (ha)	65,177	7,632	3,977
Time span projected for the disappearance of the forest	50-70 years	37-50 years	125-189 years
% Oil palm expansion occurring at the expense of the forest	70%	90%	80%

Remote sensing studies of a subset of plantations in 20 countries suggest that about 45% of oil palm plantations in Southeast Asia came from areas that were forests in 1989. Estimates vary by region to the other being 31% in South America, 7% in Africa and 2% in Central America. For Indonesia and Malaysia, the estimates were 54% and 40%, respectively (Meijaard & Sheil, 2019; Meijaard et al, 2020, Sheil et al, 2018). Another estimate gave over the last 40 years, 47% and 16% of total deforestation by oil palm in Malaysia and Indonesia, respectively (Meijaard & al, 2018; Qaim et al, 2020). These statistics can be compared to what we observed in the productive basins of Ngwéi (45.94%) and Ekondo Titi (22.74%) as well as Sanaga maritime (23.61%). According to Ordway et al, (2019), the dynamics of oil palm expansion in sub-Saharan Africa have been neglected. They proved that 67% of oil palm expansion from 2000 to 2015 occurred at the expense of forests in the southwest region of Cameroon.

The replacement of virgin forests by palm monoculture reduces the natural capabilities and capacities of these spaces. Their numerous environmental, social, cultural and economic services are reduced or even disappear.

All around the protected areas, palm groves are taking root and insidiously eating away at the space. The districts of Pouma, Ngwéi and Edéa 1, Ekondo Titi have lost almost all of their virgin forests to the creation of palm groves and more or less subsistence agriculture. The other districts are unfortunately starting this dynamic. Which ultimately questions the proponents of Cameroonian policy in terms of environmental preservation and sustainable development. The increasing deforestation inevitably increases greenhouse gas emissions because it reduces the CO2 sequestration capacity. The Indonesian example is very illustrative in this regard. The country is home to 3% of the world's forests and ranks 3rd among countries emitting greenhouse gases with a deforestation rate of more than 15%, the highest in the world and mainly due to olive growing. However, Cameroon has joined numerous international initiatives and conventions in this direction: UNFCCC, REDD+, convention on biological diversity, etc.

Soil erosion and impoverishment

Soil degradation is another major aspect of the development of oil palm growing. The establishment of a palm grove leads to the almost clear cutting of all the trees on the plot. The resulting wood is used for energy purposes. At the very young stage, the surface occupied by the palm grove is at the mercy of erosion. The abundant rainfall in the region makes the phenomenon almost permanent. Despite everything, erosion tends to decrease as the palm trees grow. The widening of the leaflets and their lateral stretching allows the creation of a fairly compact canopy (or roof) which limits the impact of raindrops on the soil. The palm tree is also a monoculture. Which reflects the fact that it hardly tolerates the presence of other plants. The fact is above all that, the elaeis is very voracious in terms of consumption of organic matter, water and other nutrients from the soil.

Pollution

It is mainly due to artisanal and archaic palm nut processing techniques and the problem of waste management. If manufacturers argue loudly and to anyone who will listen that their waste is subject to rigorous and ecologically responsible treatment (which at least remains to be verified), village planters who transform their own production with presses craftsmen cannot say the same. The notable fact of this artisanal processing of palm nuts in the is that the artisanal mills are most often located near a watercourse (photo plate 2). Because the palm oil extraction process requires a lot of water.

Poverty of disadvantaged groups

It is known that there are many socio-economic advantages of elaeisculture: (i) the increase in planters' income; (ii) their Financial autonomy and independence; (iii) the extend of Palm exploitation throughout the year; (iv) the easier managing of the oil stocks; (v) the Self-consumption and marketing; (vi) the exploitation of Many other derivative products; (vii) an embryo of local development.

But, not everyone has the financial means necessary to create a palm plantations. With the development of palm cultivation, it created social classes at the local (village) scale. The owners of palm groves appear more or less as the "well-off" class. Also, people who have not succeeded in olive growing or who live in other activities, particularly subsistence farming, struggle to live decently. In fact, the illusion of "wealth" guaranteed by oil production does not always correspond to the reality on the ground. The cultivation, maintenance and exploitation of palm trees require a lot of financial resources. Very quickly for many people, the plantations are abandoned due to lack of means. In addition, oil production leads to fierce competition for land with subsistence agriculture.

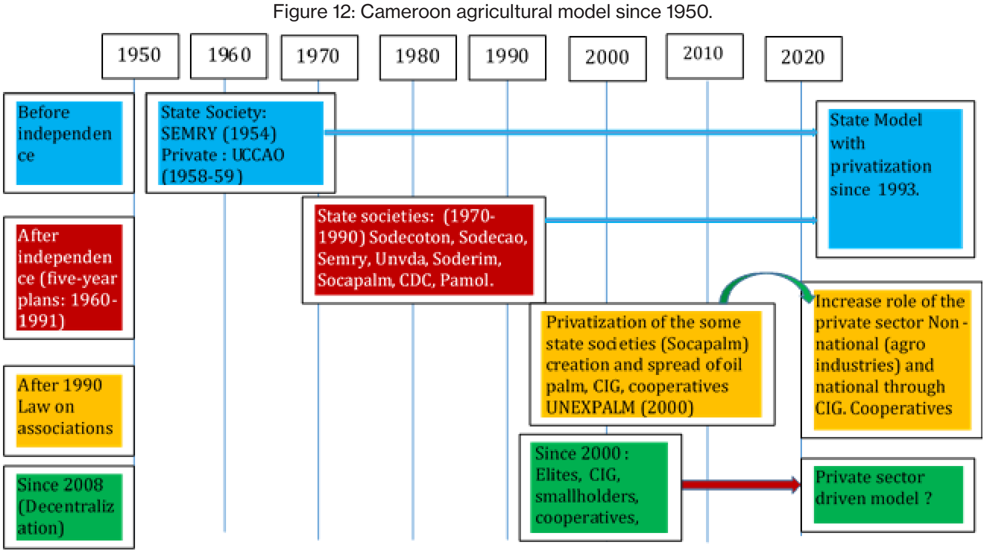
4.6 ANY MODEL?

What can be the best model for small holder in Cameroun to boast the red oil production? Is it necessary to gather smallholders in cooperatives or just to provide micro mill per smallholder's community?

The state supports the organization of the sector through production models, which allow small growers to group into cooperatives to benefit from the expertise of the agro-industry. It is a partnership established between cooperatives of smallholder's farmers, a bank and an agro-industry, all under the supervision of the State. These small planters play an important role in the production of crude palm oil (CPO) because they are more and more numerous and occupy large areas. The total area controlled by small growers increased from 27% in 2007 to 38% in 2011 with 86 million tons of CPO produced (Jan Willem et al, 2013). These models have often been designed to promote rural development, reduce the expenditure of smallholders in transport and fertilizer costs, and provide additional benefits to local communities and migrants. The income is generated by the sale of bunches of fresh nuts (Fresh Fruit Bunches) to the mills, by cooperatives or networks of traders neighboring the plantation (Beekmans et al, 2014).

In Cameroon, agricultural cooperatives have had varying success since the independence era (1960-1970) (figure 12) depending on the crop. The best organized cooperative sector is cocoa and coffee. Cameroon's concern is to strengthen palm oil production in order to meet the country's edible oil demand as well as secondary processing industries. The disorganization between the growers, the non-control of production and the areas of small growers, the import of large quantities of palm oil each year from South-East Asia. The low local production which fails to meet the needs of the populations, as well as the lack of monitoring and orientation of the local activities of small producers which disorganizes the groups, etc.

Figure 12: Cameroon agricultural model since 1950.



5 CONCLUSION

The objective of this article was to tackle the dilemma of oil palm cultivation and conservation development in three administrative area Sanaga Maritime Ngwéi and Ekondo

Titi. The results show that this activity is not sustainable and drive deforestation while threating biodiversity and conservation. It emerges that the oil palm has many negative consequences on the environment such as deforestation and various forms of pollution. Economically, the sector is still dominated by small producers whose methods do not allow satisfactory profitability. In addition, tax collection is lacking, hence the low participation in the national economy. At the social level, wage employment in the field is not well organized and corporate social responsibility is not applied among agro-industries and other large farmers (elites) who nevertheless deserve to be encouraged in this direction if we want to give the local riparian populations the opportunity to benefit from it.

Thus, four levers have been identified to promote sustainability in the palm oil sector in Cameroon: (1) boosting productivity (intensification, best practices and replanting oil farms) to ensure economic profitability; (2) promoting better sharing of benefits; (3) limiting the sector's impact on deforestation and (4) setting up an appropriate framework for good governance in the oil palm sector. This article highlights the actions for each of these objectives for different actors to achieve results. In the economic field, it is necessary to set up self-financing mechanisms for the smallholders' sector and achieve self-sufficiency to avoid imports. In the social field, consultation frameworks must be put in place to promote the consideration of the concerns of all stakeholders, in particular small growers who are harmed and remain the biggest losers in this system. Indeed, already poorly organized, they are not sufficiently taken into account in sectorial policies. With regard to the environment or more specifically ecology, it is necessary to limit deforestation and the pollution induced by the palm oil sector through energetic measures, because we are witnessing a permanent granting of concessions (Greenfil SA in 2014 and CAMVERT in 2019) for oil palm despite warnings and actions from environmental organizations like WWF and Rainforest. Thus, four levers have been identified to promote sustainability in the palm oil sector in Cameroon: (1) boosting productivity (intensification, best practices and replanting oil farms) to ensure economic profitability; (2) promoting better sharing of benefits; (3) limiting the sector's impact on deforestation and (4) setting up an appropriate framework for good governance in the oil palm sector.

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