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1987a,b; Tijani, 1993,1995), (Kumasi et al., 2001)
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Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing *Escherichia coli* in the Calgary Health Region: emergence of CTX-M-15-producing isolates. *Antimicrob. Agents Chemother.* 51: 1281-1286.

Pelczar JR, Harley JP, Klein DA (1993). *Microbiology: Concepts and Applications.* McGraw-Hill Inc., New York, pp. 591-603.

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Journal of Ecology and the Natural Environment

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Review

The impacts of climate change on African continent and the way forward

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This paper reviews several studies on the impacts of climate change on developing countries in Africa, one of the most vulnerable continents due to lack of financial, technical and institutional capacity to cope with the impacts of climate change. Due to various anthropogenic activities, greenhouse gases are increasing in the atmosphere at an alarming rate which leads to extreme temperature and flooding, loss of soil fertility, low agricultural productions (both crops and livestock's), biodiversity loss, risk of water stress, and prevalence of various diseases. It is predicted that the temperature in Africa continent will rise by 2 to 6°C over the next 100 years. In terms of economic, the Sub-Saharan Africa will lose a total of US\$26 million by 2060 due to climate change. The increasing occurrence of flooding and drought is also another predicted problem for Africa. Climate change can set back development of nations. Even though African countries are working on adaptation and mitigation options to minimize the adverse effects, climate change is expected to cause large damage to their economy. Thus, climate change adaptation and mitigation options require greater attention to ensure future food security and well-being of African peoples.

Key words: Adaptations, Africa, Climate Change, Impacts, Mitigations, Vulnerable.

INTRODUCTION

The global temperature and precipitation have changed rapidly over the last century due to anthropogenic increases of greenhouse gases (GHGs) in the atmosphere (for example, burning of fossil fuels, like coal, petroleum and natural gasses and widespread deforestation). The Intergovernmental Panel on Climate Change (IPCC) has predicts that the global surface temperature will increase by 1.4 - 5.8°C by 2100 years due to increasing concentration of GHGs specifically

carbon dioxide.

Temperature across Africa continent are predicted to rise by 2 - 6°C over the next 100 years and rainfall variability is predicted to increase, resulting in frequent flooding and drought (Hulme et al., 2001). According to IPCC report on Regional Climate projections of 2007, by 2050 the average temperatures in Africa are predicted to increase by 1.5 - 3°C, and the warming of Africa continent is very likely to be larger than the globe. The

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Table 1. Major African drought over 1980-2008 as reported on EM-DAT, 2009, (Adopted from Anne Bourke, 2011).

Country names	Years	Affected nearest (0.1 mn)
Kenya	2008	1.4
	2005-06	3.5
	2004	2.3
	1999-02	23.0
	1997-98	1.6
	1994-95	1.2
Ethiopia	1991-92	2.7
	2008	6.4
	2003-04	12.6
	1997	1.0
	1989-94	6.5
	1987	7.0
Sudan	1983-84	7.8
	2000-01	2.0
	1991-92	8.6
	1987	3.5
Eritrea	1983-85	8.4
	2008	1.7
	1999-03	2.3
Somalia	1993	1.6
	2008	3.3
	2000-01	1.2
	1987	0.5

increasing of the global temperature can be minimized if mitigation strategies are implemented in all regions of the world. Temperatures in all African countries are projected to rise faster than the global average increase during 21st century (James and Washington, 2013). Rainfall variability has also become more significant over the last century. For instance, precipitations in Eastern Africa show a high degree of spatial and temporal variability dominated by a variety of physical processes. Report by Williams and Funk (2011) described that over the last 3 decades rainfall has decreased over eastern Africa.

Climate change affects the biodiversity, food security, water availability, and productivity levels in Africa (Hope, 2009). The Least Developed Countries (LDCs) are dependent on agriculture, climate sensitive economic sectors, which makes more vulnerable to the impacts of climate change because of its less resilient to negative external events and low capacity to adapt than other developing countries (Bruckner, 2012). Africa continent is one of the most vulnerable continents due to its high exposure and low adaptive capacity. The vulnerability of Africa continent is only due to low level of economic development that makes less and low capacity to adapt the impacts of climate changes (Bruckner, 2012). Higher

temperatures and rainfall variability reduce crop productivity in low income and agriculture-based economies. For the majority of Sahelian countries (that is, Senegal, Mauritania, the Gambia, Guinea Bissau, Mali, Burkina Faso, Niger, Chad, Sudan and Eritrea) which depend mainly on subsistence and small-scale farming, climate change, such as increasing temperature and declining rainfall, pose considerable risks to their livelihoods (Hummel, 2015). People who are poor and marginalized usually have the least buffer to face even modest climate hazardous and suffer most from successive events with little time for recovery (Olsson et al., 2014).

African countries are more affected by climate change because of their reliance on agriculture as well as their lower financial, technical, and institutional capacity to adapt (Nordhaus, 2006; Rose, 2015; Signgh and Purohit, 2014; Huq et al., 2004). The African continent is expected to be the most affected by climate change, land degradation, and desertification (Hummel, 2015). Though Africa is the lowest source of GHG emissions from inhabited continents (due to low levels of industrial development), it is the most vulnerable to the effects of climate change (Beg et al., 2011, Huq et al., 2004 and Bewket, 2012).

THE MAIN IMPACTS OF CLIMATE CHANGE

Drought and flooding

Drought

Drought has had significant impacts on food insecurity and affects the life of African people and its trend is increasing in 21th century (IPCC, 2007b). According to Emergency Events Database (EM-DAT) more than 100 million people were affected by drought in Africa. Kenya was affected by drought seven times over 1991-2008, which affects about 35 million people. Ethiopia also experienced six drought times over 1983-2008. Other African countries were also affected by drought several times (Table 1).

From Africa continent, Eastern African countries (that is, Burundi, Eritrea, Ethiopia, Kenya, Uganda, Tanzania, Rwanda, and Somalia) were among the vulnerable countries to the effects of drought due to its dependency on rain-fed agriculture. Feyssa and Gemedo (2015) also justify that climate change mainly affect the rain-fed agricultural sectors in technological and economically less developed countries in Africa. Due to drought, by 2100, arid and semi-arid regions of Africa are expected to expand by 5-8%, or 60-90 million hectares, resulting in agricultural losses of between 0.4-7% of gross domestic product (GDP) in Northern, Western Central and Southern Africa (IPCC, 2007).

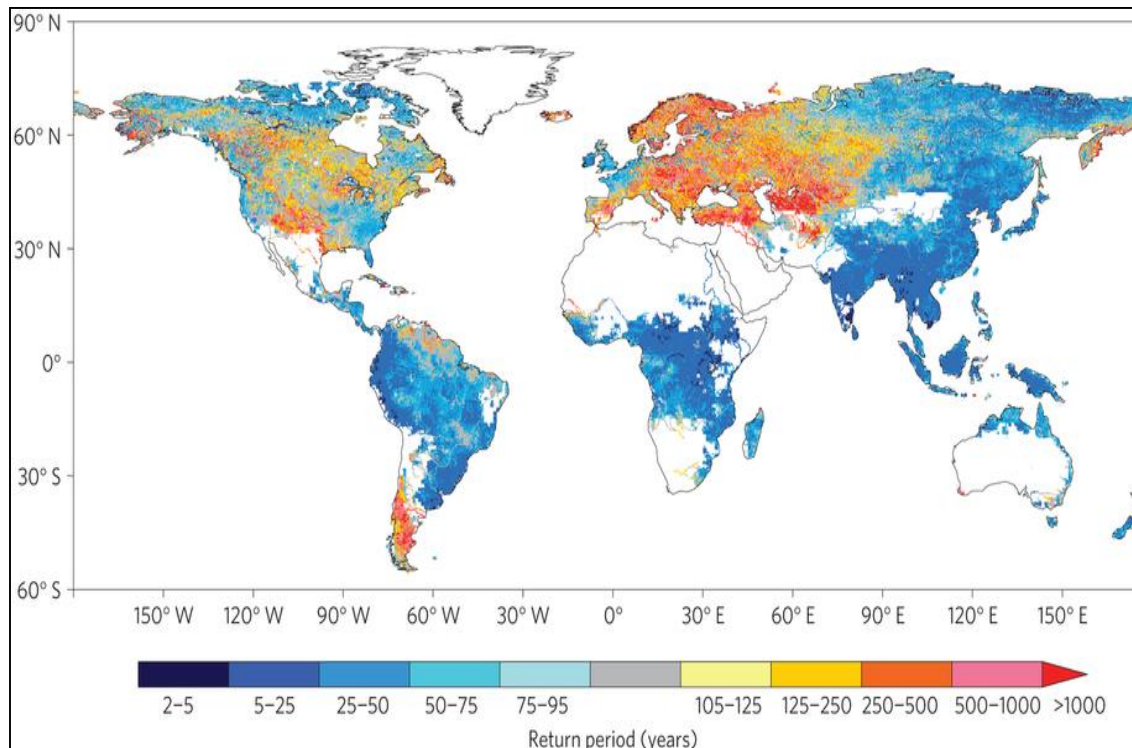


Figure 1. Multi-model median return period (years in 21c for discharge corresponding to the 20c 100-year flood (Adopted from Hirabayashi et al., 2013).

Extreme events like flooding and droughts are not similar across the continent, some regions will experience higher rainfall (the equatorial belt regions), even in drier areas there is a possibility of higher frequency of more intense downpours, which may bring flooding (Conway, 2009). Contrary to the equatorial belt regions, the northern, southern and horn of Africa are typically arid or semi-arid regions.

Flooding

Flooding leads to immediate deaths and injuries of people, infectious diseases like malaria and exposure of people to toxic substances. According to the flood portal of European Commissions Joint Research Center, Institute for Environment and Sustainability (2010), more than 1 million people were affected in over 20 African countries and approximately about 500 lives were lost and over 1.2 million people were displaced from their homes. The LDCs more suffer from climate change related disasters like floods. They lack institutional, economic, and financial capacity to cope with the impacts of climate change and to rebuild the infrastructure damaged by natural disasters (Sokona and Danton, 2001). Flooding is occurring everywhere in the world (Figure 1), however, the

degree of its impacts depends on the adaptive capacity of a country, that is, developed countries have high adaptive capacity while poor countries suffer more from the impacts of flooding. The frequency of flooding across the world varies from 2 to more than 1000 years (Figure 1).

Impact on food security/ food productions

Climate change will affect the production of crops. Climate is a primary factor for agriculture productivity, such that any environmental change affects plant and animal production (Shongwe et al., 2014). With increasing frequency of droughts and floods associated with climate change, agricultural production will decline and the state of food insecurity and malnutrition will increase (Kumsa, and Jones, 2010). It is estimated that African farmers are losing about US\$28 per hectare per year for each 1°C rise in global temperature (Kumsa and Jones, 2010). The African Partnership Forum (APF, 2007), described that, climate change can no longer be considered as an environmental problem only, as it also becomes a major threat to sustainable development and poverty reduction. Climate change can hinder sustainable development of nations by minimizing yield production,

which leads to food insecurity.

All crops are not affected equally by climate change. Crops such as rice, wheat, beans, maize and potatoes are highly affected and other crops like millet, which resist high temperature and low levels of water may be less affected (Huq et al., 2004). Sub-Saharan Africa (SSA) is the most susceptible and vulnerable places to climate change and variability anywhere in the world (Barr et al., 2010; Hummel, 2015). It is also estimated to be the most food-insecure region in the future (Thomton et al., 2011).

According to the report of the Economic Intelligence unit of 2014, food affordability in SSA is undermined by low average incomes, widespread poverty and heavy reliance on costly food imports. This report also justified that highly fragmented farming system, little use of modern farming system and low application of productivity-enhancing techniques undermines agricultural output and makes the SSA a net food importer.

The impacts of climate change on smallholder farmers, who depends only on rain-fed agriculture are among the most disadvantageous and vulnerable groups (Tetteh et al., 2014). Similar to crop productions, climate change also adversely affects livestock's productions. According to (Getu, 2015) agriculture and livestock keeping are amongst the climate sensitive sectors. The negative impacts of climate change are more severely felt by poor people in developing countries who mainly depend on the natural resources base for the livelihoods.

Climate change affects agricultural productions and exacerbates the problem of food security in Africa (Kumssa and Jones, 2010 and Mendelsohn and Tiwani, 2000). According to Food and Agriculture Organization (FAO, 2003), over 60% of Africans depends on agricultural activities for their livelihoods. Low yields of agricultural production leads to losses of economic development that hinder efforts to meet the Millennium Development Goals (MDGs) of African countries. The SSA predicted to loss a total of US\$26 billion by 2060 due to climate change (United Nations Development Programme (UNDP), 2011). The (IPCC, 2007b), estimate that climate change will reduce the yields of rain-fed agriculture up to 50% by 2020. According to (Thornton et al., 2007) in the tropics and subtropical regions, crop yields may fall by 10 to 20% to 2050 because of warming and drying, but there are places where yield losses may be more severe.

Impact on development

Africa faces the biggest development challenges of any continent because of an increase in the number of people at risk of water stress, exposure to malaria, and a drop in agricultural yields (Frankhauser and Schmidt-Traub, 2011). Climate change has the potential to undermine sustainable

development, increase poverty, and prevent the realization of the MDGs (IPCC, 2009). Failure of achieving the MDGs correlates with areas where high climate vulnerability is expected to occur (Yohe et al., 2007). It is obvious that climate change and variability will seriously hinder future development of a nation. The biophysical effects of climate change on agriculture induce changes in production and prices, which play out through the economic system as farmers and other market participants adjust autonomously, altering crop mix, input use, production, food demand, food consumption, and trade (Oxfam, 2009).

Impact on human health

Climate change also causes scarcity of water resources and severe floods that leads to outbreaks of waterborne diseases. African countries suffer serious health problems because of climate change United Nations Economic Commission for Africa (UNECA, 2011). UNECA justified that, Africa is the most susceptible continent to climate change related health problems due to the existing poverty and weak institutions to deal with health challenges posed by climate change. Change in rainfall will affect the presence and absence of vector and water borne pathogens (IPCC, 2001). Any changes in temperature and precipitation will boost the number of disease-carrying mosquitoes that leads to malaria epidemics (Lindsay and Martens, 1998). The problem of Malaria is associated to climate change. According to World Health Organization (WHO, 2003) malaria epidemics in Zimbabwe have been closely linked to climate variability caused by El Nino. Figure 2, demonstrates how climate change disturb human health. Climate change can affect the well-being of human beings either directly or indirectly. For instance, changing the quality of air, water and food can disturb human health indirectly. Climate change will likely discomfort the environmental and social conditions which might leads to social and economic disruptions.

THE WAY FORWARD

We have a number of alternatives to minimize the negative impacts of climate change in Africa continent. The possible alternatives which compact the impact of climate change on Africa continent include communication and outreach, adaptation and mitigation options and climate change related research which supports decision making.

Communication and outreach

The first and the basic one are public environmental

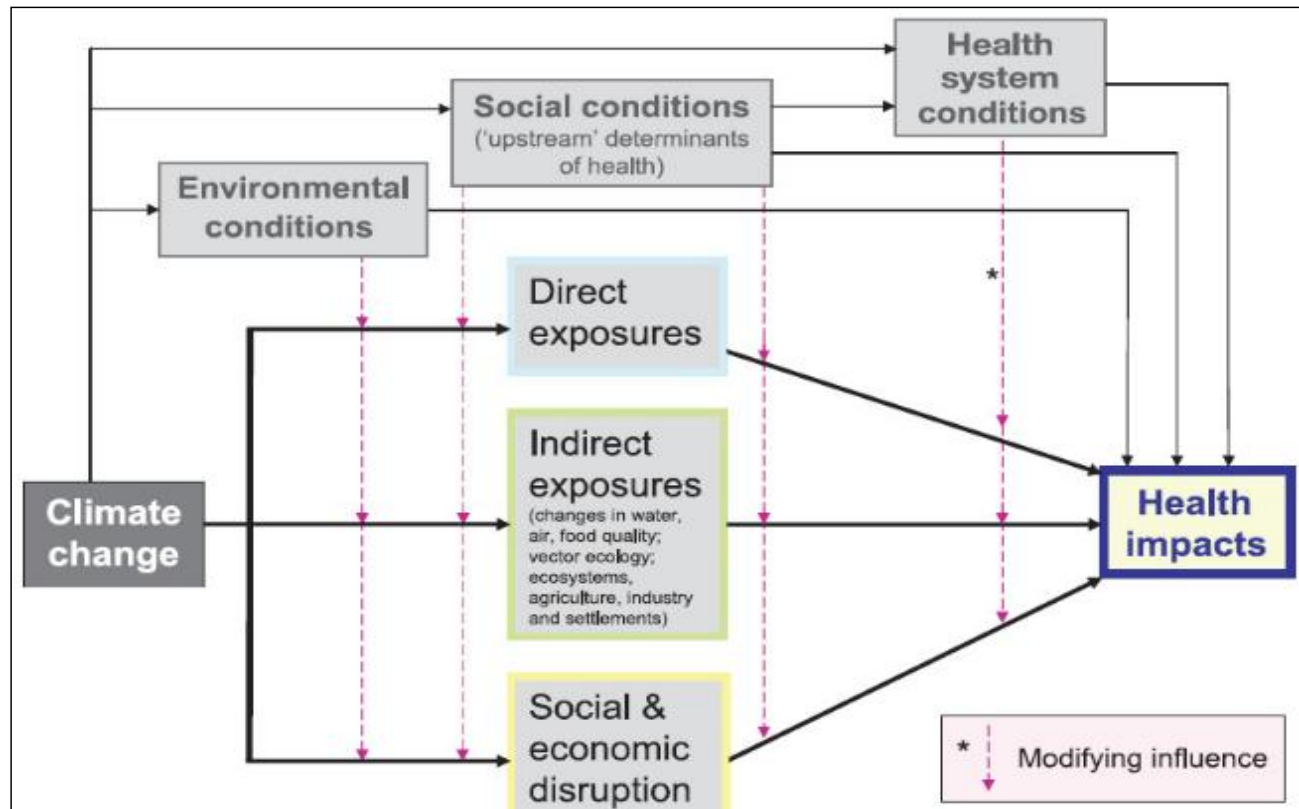


Figure 2. Pathways by which climate change affects Human Health (Confalonieri et al., 2007)

education and awareness raising across all countries. For instance, the Ethiopian government demonstrates its willingness and commitment in the area of soil and water conservation and the use of climate resilient green economy. Different awareness creation was conducted in the country by using mass media (TV, Radio, Newsletters and social Medias like face book, twitter and internet web pages) as a main tool for dissemination of information throughout the country. It is a good option to educate all peoples on the causes and impacts of climate change. The current performance and the activities of Ethiopia government and people on soil and water conservation should be seen as a model for other African countries. Although, majority of the people observed the increasing of temperature and rainfall variability from their expediciencies, majority of our people have little information concerning the basic causes of climate change and how climate change will affect the whole systems from food insecurity to risk of shortage of water and good health. So, the people of Africa should be educated and made aware of their role and how they can deliver such role in climate change adaptation and mitigations are essentials. Any governmental plan without the recognition of the people is difficult for implementation and also unsuccessful.

Adaptation and mitigation measures

After environmental education and awareness creation, the concerned stakeholders will do their best to bring change through adaptation and mitigation options. Climate change adaptation and mitigations are essential mechanisms to save the life of the vulnerable communities particularly Africa continent. An effective way to address the impacts of climate change is by integrating adaptation measures into sustainable development strategies so, as to reduce the pressure on natural resources, improve environmental risk management, and increase the social well-being of the poor is very important.

Climate change adaptation and mitigation workshops, seminars, and panel discussions are effective tools to solve the extreme temperature and rainfall variability that leads to agricultural yield reduction, water scarcity, drought and flooding, prevalence of various pathogenic diseases and expansions of deforestation in different regions. Inviting key stakeholders (High governmental officials), public and private officials, university academia's and researchers as well as individuals from all sectors; industry, road, agriculture, municipality, mining, fishery, forestry, pastoralists, hotel and tourism and other sectors

on climate change adaptation and mitigation workshops will change the attitudes of peoples towards climate change solutions.

Promoting community participation in all adaptation and mitigation plan is a key factor to implement on the ground. In generally, in order to minimize the impacts of climate change on Africa continent all governmental and non-governmental organizations, private sectors and individuals should be involved in afforestation, re-afforestation and forest conservation. Similar to forest sectors, all organizations, private and individual should give concern for water and soil conservation. The wise use of water is another task of the African people, thus, the community at large should use water in effective way, practice the culture of water harvesting and storage techniques, livelihood diversifications and enhancing the use of climate resilient green economy.

Research

Conducting research on climate change and dissemination of the finding to decision making organs and concerned stakeholders is another good way forward to minimize the impacts of climate change. Educational institutions, research centers and meteorological organization should focus on climate change research.

CONCLUSIONS

This review synthesized the impacts of climate change on Africa and its way forward for current generation to minimize damage and losses associated with climate change. Temperatures in all African countries are projected to increase faster than the global average increase in 21st century. Rainfall variability is also another concern for rain-fed dependent economy like agriculture. By reducing agricultural yields climate change can set back sustainable development, increase poverty and prevent the realizations of MDGs.

Increasing of surface temperature and rainfall variability reduce agricultural yields that severely affects the livelihoods of African people. Smallholder's farmers in Africa who depends only on rain-fed agriculture are the most vulnerable groups by the impacts of climate change. Climate change related problems like drought and flooding affects the life of African people. Although, all developing countries were affected by climate change, the severity of climate change impacts on African continent is more severe than others. Africa continent is one of the most susceptible to various climate change related problems like malaria.

The impact of climate change on Africa continent will be minimized through cooperation of various organization and stakeholders. Communication and outreach activities,

climate change adaptation and mitigation strategies and conducting research will play an important role to overcome the current problems of climate change. Thus, promoting mass communications and outreach activities, adaptation and mitigation options and conducting research on climate change will minimize the future possible impacts of climate change.

Conflict of interests

The authors have not declared any conflict of interests.

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Full Length Research Paper

Non-timber forest products and their contributions on the income of local residents in the Douala- Edea Wildlife Reserve of Cameroon

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The Douala-Edea Wildlife reserve rich in biodiversity is a reservoir for the collection of non-timber forest products (NTFPs). These products are involved in the management of natural resources by providing additional income to households. This study examines the effect or contribution of NTFPs in household incomes of local residents in the reserve and has as objective to identify and evaluate the marketing of these products in the Douala-Edea reserve. The method used was based on surveys of people who practice on a daily bases the collection, marketing and consumption of NTFPs in order to determine species, harvested products and the quantities extracted from the forest. A second survey was conducted in two local markets (Mouanko and Dehaene) located in the periphery of the reserve to determine the market value of harvested forest products. A total of 18 species have been identified as NTFPs. 100% of the plants serve for human consumption as seeds (60%), fruits (30%), sap (5%), and the simultaneous use of seeds and fruits (5%). Women and children are involved in the collection and marketing, while men are associated with children only to collect. The NTFPs estimates obtained in the surveys in March and October 2012 showed 3 tonnes and 4 tonnes of *Ricinodendron heudelotii*, 200 and 300 kg of *Irvingia gabonensis*, 100 and 200 kg of *Coula edulis*, 500 and 800 kg of *Baillonella toxisperma*. NTFPs market value varied in dollars between 800 \$ and 1600 \$ for *C. edulis* 600 \$ to 800 \$ for *R. heudelotii*, 150 \$ to 1600 \$ in *B. toxisperma*, and 400 \$ to 800 \$ for *I. gabonensis*. This represents about 39% of household income in these forest zones.

Key words: NTFPs, Protected area, management, market value, inhabitants.

INTRODUCTION

Forests in Cameroon have important biological resources, hydrological and subsoil riches in mineral resources and hydrocarbons. These resources are continually used by the population at the local level and

by national and multinational companies. However, the daily management of non-timber forest products (NFTPs) can be controversial, regulation of state administration is necessary.

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In the case of the Douala-Edea reserve, the exploitation of NTFPs is an important activity for local population. According to (Souare et al., 2012), Non-timber forest products (NTFPs) strongly contribute to livelihood security of forest-adjacent communities. This activity includes children (for trade along roads and husking of these products) and adults (collection and revenue management).

To put at the disposal of the authorities responsible of the reserve, relevant information for the efficient management of NTFP, a study was conducted around the reserve in order to identify non-timber forest products used by the population.

In the estuary of Cameroon, mangroves have been subjected to numerous studies especially the Wouri estuary and the Atlantic coasts of the Douala Edea wildlife reserve (Ndongo, 1993; Ajonina, 2008). These specific studies describe the dynamics of mangroves through biometric data on different species of *Rhizophora* sp., and their roles in stabilizing ecosystems and food for wildlife. These studies identify as poaching, degradation of mangroves with an indiscriminate use of products from the forest because of poorly controlled human activities such as (smoking of fish, construction, manufacturing of canoes) (Ajonina and Toung, 1999; Ajonina and Usongo, 2001).

The Douala-Edea reserve is part of a large forest of the west coast, the coastal region whose floristic characteristics remain poorly understood; however, two activities, NTFPs collection and fishing are remarkable. Fishing is the main activity that involves more than 60% of the workforce of the Douala-Edea reserve and can be either artisanal or industrial. Artisanal fishing is practiced by the indigenous in rivers, streams and lakes, estuaries and creeks. As against semi-industrial fishing practiced by Nigerian Beninese and Ghanaian nationals, with the use of large motorized canoes (Ajonina, 2008).

NTFPs collection is usually done by all family members. This activity together with the tapping of raffia wine is one of the main sources of significant income of households in the reserves. The NTFPs affected and collected in the reserve are *Aframumum citratum* (Mbongo), *Ricinodendron heudelotii* (Ndjansang), *Garcinia cola* (Bitter cola), mushrooms, hazelnuts, *Irvingia gabonensis* (mango), the honi of mbongo, wood for the construction of canoes and straw for houses. Experiences with non-timber forest products have been mixed, largely due to difficulties of sustainable harvesting, the economically unviable commercialization of little-known products, and the lack of biological and ecological information on many potential useful species (Belcher and Schreckenber, 2007 in Souare et al., 2012).

The objective of this study is to identify and evaluate the marketing of non-timber forest products in the Douala-Edea reserve. More specifically, to identify exploited species; to determine the contribution of the gender aspect in the NTFPs circuit; identify and quantify

the different products and evaluate their market.

METHODOLOGY

Research location

The Douala-Edea wildlife reserve, created in 1932, is located in the coastal plain of Cameroon in Douala-Kribi Basin and includes an area of 160,000 ha (Figure 1). The rivers are the natural limits of the reserve but the Sanaga River divides the reserve into two unequal parts. The South part covers almost 2/3 of the reserve and extends from the Sanaga River north to south river Nyong. The smallest part extends along the Sanaga to the tip of Souelaba along the Atlantic coast to the island Manoka. It is bounded to the east by the Kwakwa creek (Ajonina, 2008).

Inventory of non-timber forest products

The investigation included three joints, closed questions, open questions and field visits. Closed questions have been recommended to maximize the information obtained through interviews (Ndoye and Ruis, 1999; Huntington, 2000; Tchatat and Doye, 2006; Fowler 2009.). The NTFP inventory aimed at identifying the names, type of products, functions and importance of NTFP species used by the various population groups.

Data were collected through interviews with 166 members of the 9 villages, ensuring a representation of the main ethnic groups in the area and the participation of both men and women, as well as people of different age classes.

The populations in the 9 following locations according to the number of people contributed in the survey. Yavi (15) Yatou (15) Yakonzok (8) Mombo (7) Édéa (4), Ongue (32) Yambong (23) Ndogbiang (27) and Ndogtima Creek (35). In the same vein as said by Lescuyer (2010), almost all members of the households involved in the activity participated in the completion of the questionnaire to summarize practices and collected products (Figure 2).

Study of the commercial value of NTFPs

A follow up of these NTFPs was performed in two local markets directly supplied by products of the reserve to conduct surveys during the harvesting months of March and October 2012. They are the Mouanko and Dehaene markets. This survey allowed a market evaluation of non-timber forest products and the identification of other potential markets.

Using a survey sheet, sellers and retailers were approached to get them to provide information on the name of the different products, the price of these products on the local market, the quantities sold and other potential markets, the use of the product, the benefit obtained on the two main season of production. The surveys were conducted by a team of two guides as facilitators to translate the questionnaire into the local language when necessary, three students and one researcher.

Sales price (March) = Quantity (kg) x Unit price

RESULTS

Wood resources involved in the exploitation of NTFPs

In the Douala-Edea reserve, 18 species distributed in 13

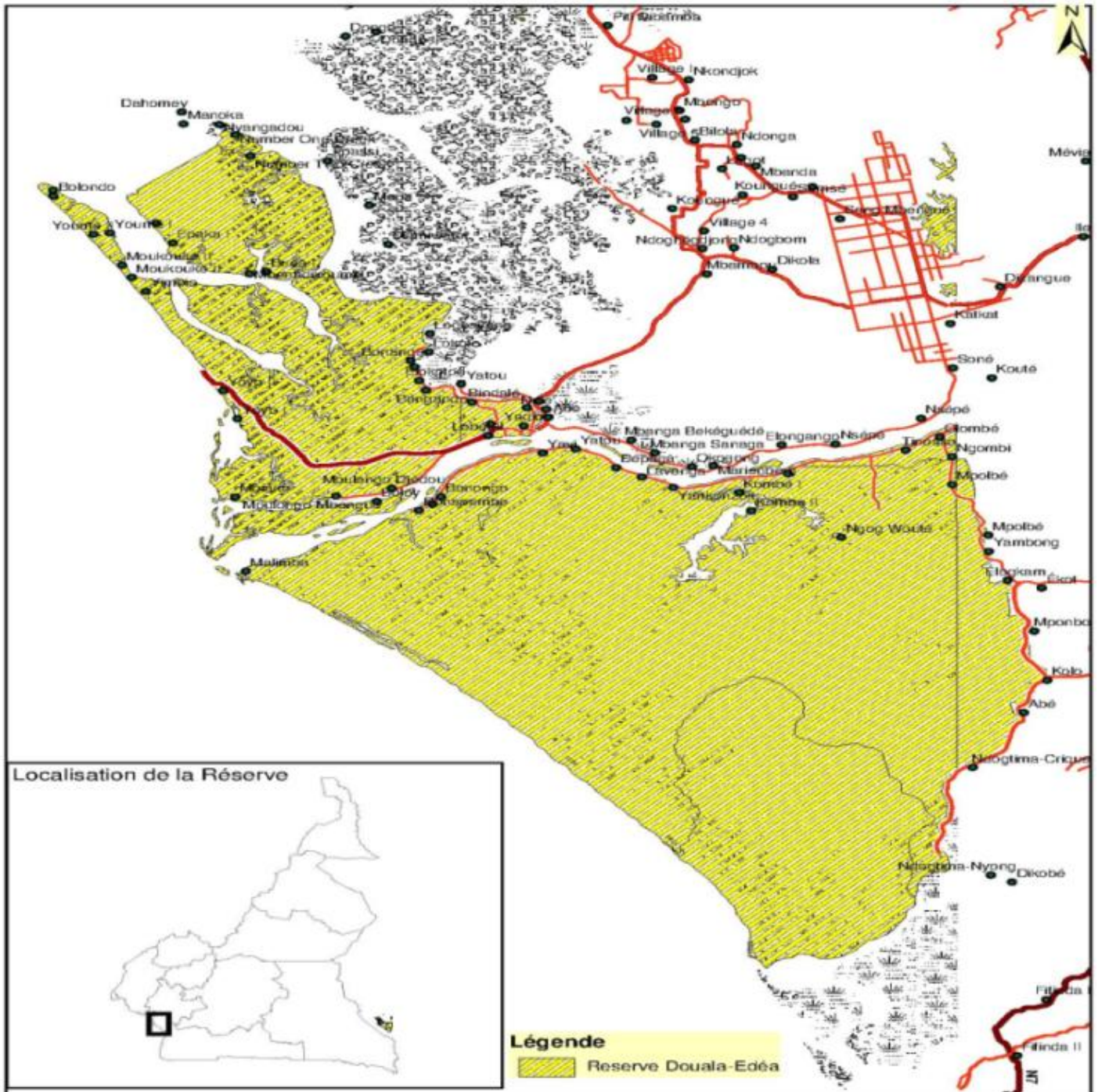


Figure 1. Location of Douala Edea Wildlife reserve.

plant families have been identified throughout the reserve as NTFPs. These products are from the left bank of the Sanaga Mouanko side and the right bank of the Nyong river. Thus two species exploited belong to the Annonaceae family (*Monodora myristica* and *Xylopia aethiopica* (Figure 5a) the Moraceae family (*Artocarpus communis* and *Treculia africana*) and the Zingiberaceae

family (*Aframomum citratum* and *Aframomum melegueta* and three species of the Palmaceae family (*Elaeis guinensis*, (Figure 5b) *Korthalsia rostrata* and *Rafia* sp.) (Table 1). About 100% of the plants are used for human consumption. About 60% are used as seeds, 30% as fruits 5% as sap and the simultaneous use of seeds and fruits at about 5%. In cooking recipes, natural products or

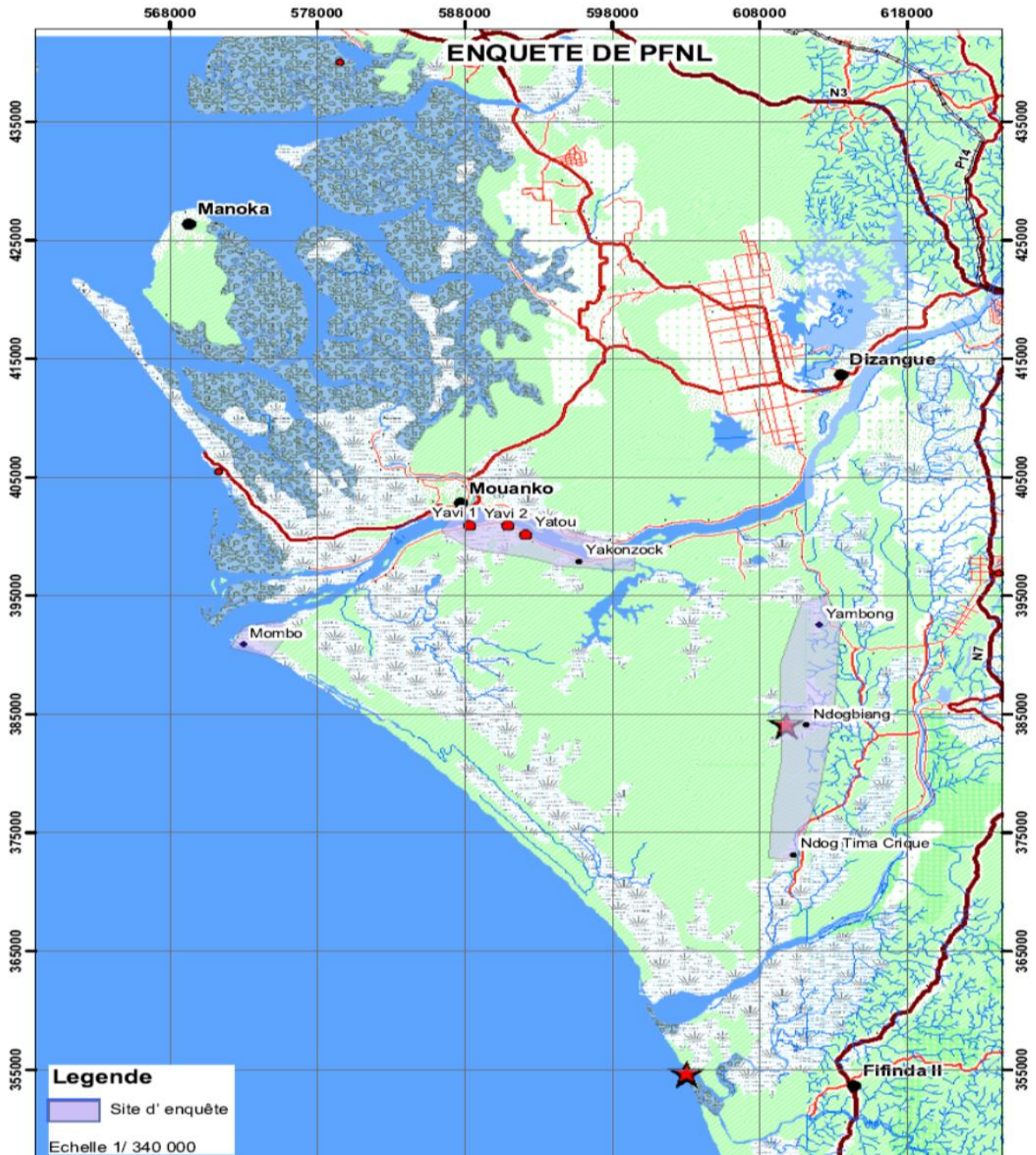


Figure 2. Research sites for NTFPs in the reserve.

derivatives are used as spices, desert or cooking oil for example *Elaeis guineensis* and *Baillonella toxisperma* produce oil for cooking. Table 2 shows the different species collected by people and their different uses.

NTFPs market

Two periodic markets are functional around the reserve, one in Mouanko, with 26 traders which operate every

Table 1. List of plants exploited as NTFPs according to their families.

Family	Scientific name
Annonaceae	<i>Monodora myristica</i> <i>Xylopia aethiopica</i>
Euphorbiaceae	<i>Ricinodendron heudelotii</i>
Guttiferae	<i>Garcinia cola</i>
Huaceae	<i>Afrotyrax lepidophyllus</i>
Irvingiaceae	<i>Irvingia gabonensis</i>
Mimosaceae	<i>Tetrapleura tetraptera</i>
Moraceae	<i>Artocarpus communis</i> <i>Treculia africana</i>
Olacaceae	<i>Coula edulis</i>
Palmae	<i>Elaeis guinensis</i> <i>Korthalsia rostrata</i>
Palmae	<i>Raphia</i> sp.
Pandaceae	<i>Panda oleosa</i>
Piperaceae	<i>Piper guineensis</i>
Sapotaceae	<i>Baillonella toxisperma</i>
Zingiberaceae	<i>Aframomum citratum</i>

Table 2. List of exploited species and their use along the bank of the Nyong and Sanaga river.

Family	local name	Scientific name	Parts Used	How to use
Annonaceae	pébé	<i>Monodora myristica</i>	Seed Grain	Food
Annonaceae	goula	<i>Xylopia aethiopica</i>	Fruits	Food
Euphorbiaceae	Njasang	<i>Ricinodendron heudelotii</i>	Seed grain	Food
Guttiferae	Nyala	<i>Garcinia cola</i>	Seed grain	Food
Huaceae	Ohmi	<i>Afrotyrax lepidophyllus</i>	Seed grain	Food
Irvingiaceae	Mia	<i>Irvingia gabonensis</i>	Fruit/ seed grain	Food
Mimosaceae	Elere	<i>Tetrapleura tetraptera</i>	Fruit	Food
Moraceae	Mucabomukala	<i>Artocarpus communis</i>	Seed grain	Food
Moraceae	Tuwé	<i>Treculia africana</i>	Seed grain	Food
Olacaceae	Ahomo/noisette	<i>Coula edulis</i>	Seed grain	Food
Palmae		<i>Elaeis guinensis</i>	Seed grain	Food
Palmae	Missolamigombe	<i>Korthalsia rostrata</i>	Fruit	Food
Palmae	Meloko	<i>Raphia</i> sp.	Sap	Beverage
Pandaceae	Panda	<i>Panda oleosa</i>	Fruit	Food
Piperaceae	Lobé	<i>Piper guineensis</i>	Fruit	Food
Sapotaceae	Aya/moabi	<i>Baillonella toxisperma</i>	Seed grain	Food
Zingiberaceae	Bongo	<i>Aframomum citratum</i>	Seed grain	Food
Zingiberaceae	Ndindin	<i>Aframomum melegueta</i>	Seed grain	Food

Wednesday and in Dehane with 60-80 traders which usually open on Thursday and Friday. The products are sold in the markets or in markets of major cities like Edea, Douala and Kribi. There is a strong gender differentiation between the participation of women, youth and men in the collection and marketing of non-timber forest products.

During collection, we find 30% of men, 40% women and 10% children. In the marketing system of different

markets, women represent 80%, children 10% and men 10%. On highways we find especially children.

In general, children assist their parents in the collection and transportation of non-timber forest products. Children whose age vary between 13 and 15 account for 65% of cases encountered and 20 years old children occasionally embark on such activities. In addition, for products such *Coula edulis*, (Figure 5c), children are specifically involved in the husking and commercialization is generally assured



Figure 3. *Irvingia gabonensis* grains



Figure 4. *Ricinodendron heudelotii* grains and their measurement technic in the market

at 100% by women in the various markets.

Amount of harvested products

The quantities of NTFP harvested depend on the yearly production. The estimates at Mouanko market show that *R. heudelotii*, *Irvingia gabonensis*, *Coula edulis* and *Baillonella toxisperma* are the main economic assets of the reserves in terms of non-timber forest products exploitation. The estimates obtained from investigations reveal in March and October 2012, respectively, 3 and 4 tons of *R. heudelotii*, (Figure 3), 200 and 300 kg for *I. gabonensis*, (Figure 4), 100 and 200 kg for *C. edulis*, 500 and 800 kg for *B. toxisperma*. Table 3 shows the estimations of the quantity of NTFP obtained from the forest harvested by some fishermen during the months of March and October 2012.

Market value of non-timber forest products

In both major markets and during the production period,

non-timber forest products bring extra income to residents throughout the year. Regardless of the market, the revenues obtained on NTFPs vary amount locals and depending on the product collected: for example, 800 \$ to 1600 \$ for *C. edulis* 600 \$ to 800 \$ for *R. heudelotii* 1500 \$ to 1600 \$ in *B. toxisperma*, and 400 \$ to 800 \$ *I. gabonensis*. In Equatorial Guinea and Gabon markets, these products cost three times that in the Cameroonian market.

DISCUSSION

The collection of non-timber forest products remains a secondary activity providing a substantial income to the inhabitants of the reserve but priority is given to products that sell more. Also, Lescuyer (2010) reports the activity of harvesting of non-timber forest products in Southern Cameroon punctual but specifies that it is the subject of attachment of populations to the forest ecosystem. The impacts of the collection of non-timber forest products observed in the forests of the Douala-Edea wildlife reserve especially fruit collection that led to the destruction of herbaceous species were observed by (Tchatat and Ndoye, 2006) in their studies on non-timber forest products in Central Africa. In addition to their medicinal use values, the economic potential of NTFPs for poverty alleviation is very high compared with traditional cash crops such as cocoa. For example, the average prices of a kilogram of *I. spp.* and *R. heudelotii* were more than 200% higher than the average price of the same quantity of cocoa between 1996 and 1999 (Ndoye and Chupezi, 2004).

The devastating exploitation techniques by partial uprooting, or felling identified by (Tchatat and Ndoye, 2006) have not been identified in the Douala-Edea wildlife reserve. The Gender remains present in the sector. Collection and marketing activities are divided within the family. Thus children and women organize around marketing while men control the collection. These results are in agreement with those of (Tchatat and Ndoye, 2006) which indicate that in Cameroon there exist a border trade around NTFPs from the Douala-Edea reserve and this is a market that is not yet fully mastered. However Ndoye and Ruiz (1999) confirmed the existence of sub-regional trade and their neighbouring countries. Thus, between Cameroon, Nigeria and the Central African Republic, there is transfer of *C. acuminata* between Cameroon, Gabon and Equatorial Guinea, the exchange of *I. gabonensis*, between Cameroon and Nigeria, exchange of *G. africanum* between Cameroon and between Gabon and Congo there is exchange of *D. eudulis*.

Conclusions

In the Douala-Edea reserve, the exploitation of non-

Table 3. Market data of some NTFPs in March and October 2012.

Familyname	Local name	Scientific name	Quantity (Kg) March	Quantity (Kg) October	Total quantity	PU (\$)	Profit in march (\$)	Profit in october	Total Profit per specie(\$)
Annonaceae	pébé	<i>Monodora myristica</i>	38	65	103	4	152	260	412
Annonaceae	goula	<i>Xylopia aethiopica</i>	12	16	28	21	60	80	140
Euphorbiaceae	Njasang	<i>Ricinodendron heudelotii</i>	3000	4000	7000	1	600	800	1400
Guittiferae		<i>Cola pachycarpa</i>	122	146	268	11	366	438	804
Guittiferae		<i>Cola nitida</i>	50	65	115	11	150	195	345
Guttiferae	Nyala, Bitter cola	<i>Garcinia cola</i>	265		265	11	794	0	794
Huaceae	Ohmi	<i>Afrotyrax lepidophyllus</i>					0	0	
Irvingiaceae	Mia, mango	<i>Irvingia gabonensis</i>	200	400	600	6	400	80	480
Mimosaceae	Elere	<i>Tetrapleura tetraptera</i>					0	0	
Moraceae	Mucabomukala	<i>Artocarpus communis</i>					0	0	
Moraceae	Tuwé	<i>Treculia africana</i>					0	0	
Olacaceae	Ahomo/noisette	<i>Coula edulis</i>	100	200	300	8	800	1600	2400
Palmae	Meloko	<i>Raphia</i> sp.					0	0	
Palmae	Missolamigombe	<i>Korthalsia rostrata</i>					0	0	
Pandaceae	Panda	<i>Panda oleosa</i>					0	0	
Piperaceae	Lobé	<i>Piper guineensis</i>					0	0	
Sapotaceae	Aya/moabi	<i>Baillonella toxispermae</i>	500	800	1300	11	1500	2400	3900
Zingiberaceae	Bongo	<i>Aframomum citratum</i>					0	0	
Zingiberaceae	Ndindin	<i>Aframomum melegueta</i>					0	0	
Total							4822	5853	10675

**Figure 5.** Some non-timber forests products: (a) *Xylopia aethiopica* fruit (b) Harvest Wine *Raphia hookeri* (c) *Coula edulis* fruit.

timber forest products remains a vital activity. It provides income to the population and helps improve their living conditions. Eighteen (18) species of NTFPs have been identified, but those mostly involved economically are *C. edulis*, *R. heudelotii*, *I. gabonensis* and *B. toxisperma*. The parts used are seeds that are used for food and we note the presence of a species used to produce raffia wine (*R. hookeri*).

NTFPs are collected by adults and children. These products supply markets in Mouanko, Dehaene, Douala, Edea, Kribi and Yaounde where they transit to neighbouring countries. Domestic markets provide income to the population of about 4822 \$ on March and 5853 \$ in October 2012. However the sector is not yet regulated to effectively play its role in improving the living conditions of the population. No trade have been identified on the field. NTFPs are collected on the sustainable manner in the forest for local consumption or market purpose.

Conflict of interests

The authors have not declared any conflict of interests.

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