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Theme: Assessment of anthropogenic pressure on Non-Timber Forest Products (NTFP) in the central area of the Nimba Mountains Biosphere Reserve – Republic of Guinea

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Abstract

The general objective of this research is to evaluate the influence of (NTFP) harvesting in the Nimba Mountains Biosphere Reserve as well as their valuation. The Accelerated Participatory Research Method was used for semi-structured interviews around the knowledge, importance and use of NTFPs. This allowed us to identify 39 species of NTFPs of plant origin and 32 of animal origin. Men exploit NTFPs at 85% while women exploit 15%. Regarding the reasons, NTFPs are exploited for the family economy 42%, followed by 23% for medicinal treatment and 18% for food, while 17% for crafts. The exploitation methods are as follows: climbing (25%), gathering (20%), hunting (15%), extraction of bark and roots (13%), piezes (10%), stem cutting (10%) and felling (7%). The proposed mitigation measures are: domestication of certain species (Piper guinneensis, Xylopia aethiopica, Garcinia cola, Raphia vinifera etc.), education and awareness of the population, development of livestock farming. However, these mitigation measures take into account the different actors involved in the use and management of Non-Wood Forest Products.

Keywords: Assessment; Anthropogenic pressure; Non-timber forest products; Core areas; Biosphere reserve

1. Introduction

Since ancient times, man has always drawn his food from nature. However, if during the 70s and 80s non-wood forest products did not arouse too much interest, the 90s showed the importance of their role in improving the living conditions of populations, particularly rural ones, and in the scientific research. But the absence of quantification and information accessible to all means that they remain poorly known. To fill these gaps that exist at the legal, technical and socio-economic level, the study on management was initiated in order to contribute to the strengthening of actions carried out both at the national level and at the sub-regional level [1].

FAO's 2015 State of Food Insecurity Report reveals that much remains to be done to end hunger and achieve food security around the world. These are both quantitative and qualitative challenges. In several African countries, these challenges are closely linked to increasing urbanization, population growth and rural exodus [2-8].

It is estimated that there are more than 150 Non-Timber Forest Products (NTFPs) important for international trade and during the 1990s, the average value of their trade was in the range of 5 to 10 billion US dollars. Non-Wood Forest Products (NTFPs) provide income to populations through their importance (medicinal plants, food plants, works of art,

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utensils) and are also key subsistence products. They allow populations to participate in the effective strategy of conservation and safeguarding of biodiversity, particularly in tropical regions.

The Nimba Mountains Biosphere Reserve is very rich in diverse products from tropical forests. Surrounded by several villages, this Nimba Mountains Biosphere Reserve is subject to human activities and illegal harvesting due to the rapid increase in population and the influx of job seekers in local mining companies.

The exploitation of Non-Timber Forest Products (NTFP) is an increasingly attractive activity for poor and unemployed people. NWFPs have attracted considerable interest in recent years as there is increasing recognition of the contribution they make to the household economy and food security as well as the achievement of environmental objectives [1].

The analysis of the income of populations living near forests has become an important theme in the debate on forest management. Scientists, policy makers and donors agree that forest products contribute significantly to rural livelihoods and the national economy in a significant number of countries [9-11]. This know-how constitutes an essential prerequisite for sustainable management of these resources, whether it involves preserving productive species from their commercial exploitation or improving them, in particular through silvicultural type actions and progressive enrichment of the forest [12, 13]. It is with this in mind that we have chosen the theme worded above in order to evaluate the influence of the removal of Non-Timber Forest Products (NTFP) in the Nimba Mountains Biosphere Reserve as well as their valuation.

2. Materials and methods

2.1. Presentation of the Study Area

The Nimba Mountains Biosphere Reserve (RBMN) is heir to the Nimba Mountains Strict Nature Reserve (RNIMN) created in 1944. It is the result of numerous scientific research projects and successful approaches by eminent researchers such as Roger Heims, M. Lamotte, R. Schnel, J.C. Leclerck, R. Roy etc. from 1939 to 1944. This integral nature reserve became a Biosphere Reserve in 1980 and its first central area became a UNESCO World Heritage Site in 1981, following the gradual degradation observed in this reserve, the first part of the area central (world heritage site)) was included on the list of heritage in danger in 1992 by the UNESCO World Heritage Committee. The Monts Nimba Biosphere Reserve covers an area of 145,200ha and corresponds to the Guinean part of the Cavally river basin. It includes three (3) categories of protected areas including:

- A cluster of three (3) central areas of 21,780 ha strictly protected including:
    - The Guinean part of the Nimba Mountains range which constitutes the UNESCO world heritage site of 12,540 ha is our main area of investigation;
    - The Bossou chimpanzee hills of 320 ha and,
    - The Déré forest of 8920 ha.
- A buffer zone of 35,140 ha where activities are strictly controlled and,
- A transition area of 88,280 ha where activities are monitored [14,15].

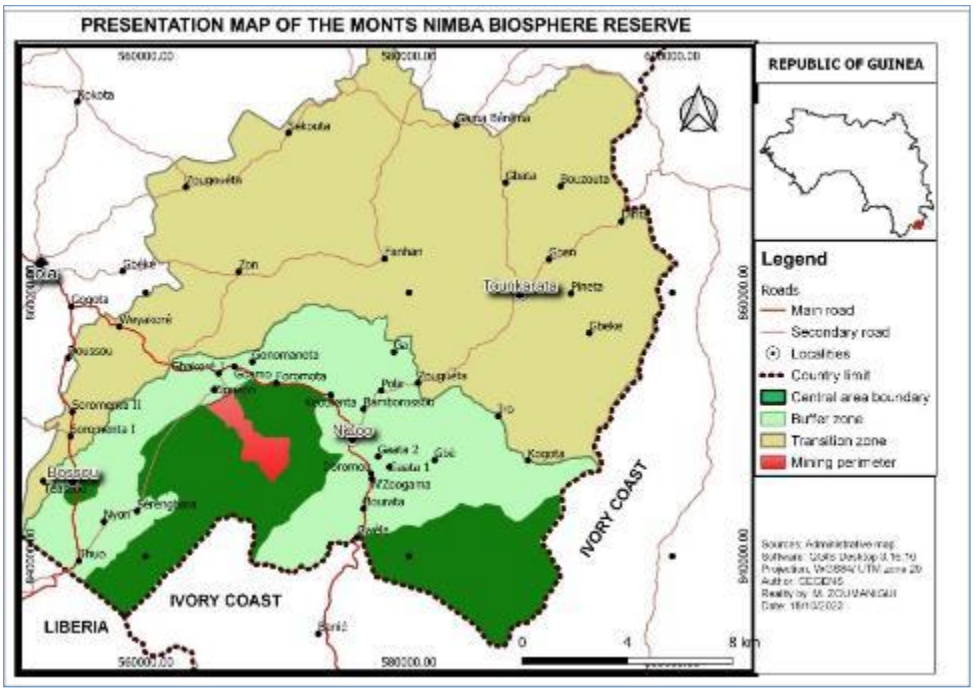

Figure 1 Map of the Nimba Mountains Biosphere Reserve

2.2. Data collection

Using the kobocollect tool, a questionnaire was developed and sent to resource people in sixteen (16) villages bordering the reserve. The Accelerated Participatory Research Method (MARP) was used to collect data from randomly selected groups of people whose size was on average 10 people without distinction of gender and age [16].

2.3. Data analysis and processing

Using Word, Excel and kobocollect software, we analyzed and processed the various data collected in the field, the results of which are mentioned in the results and interpretation section.

3. Results and interpretations

3.1. List of some NTFPs identified in the central areas of the Nimba Mountains Biosphere Reserve

Surveys with resource people and field trips in general allowed us to identify 39 resource species of NTFPs of plant origin and 32 of animal origin.

Many approaches to the classification of NTFPs are based on the type of products, the end use and finally the form and the part used. We distinguish between edible NTFPs (products for food use) and inedible NTFPs (medical and psychotropic products and artisanal products) (See table below).

Table 1 List of some non-wood forest products of plant origin identified in the three central areas

Central area	N°	Scientific name	Family	Name Konon	Part used	Status
UNESCO heritage site	1	*Aframomum meleguta K., 1904*	zingiberaceae	Kpokiyén	Fruit, leaf	Cultivated
	2	*Aframomum sp.*	Zingiberaceae	Tolanlaan	Root, leaf	Spontaneous
	3	*Ageratum conyzoïdes L., 1753*	Asteraceae	Belaapapa	leaf	Spontaneous
	4	*Allophilus africana L., 1753*	Sapindaceae	Kpouwön	leaf	Spontaneous

	5	*Alchornea cordifolia S., 1865*	euphrobiaceae	Pailèlaan	leaf, bone marrow	Spontaneous
	6	*Belschiemeidia mannii B., 1949*	Lauraceae	Kpaa	Fruit	Spontaneous
	7	*Bridelia ferruginéa B., 1849*	Euphorbiaceae	Gouan	Bark	Spontaneous
	8	*Bridelia micrantha H., 1962*	Euphorbiaceae	Löwögouan	leaf	Spontaneous
	9	*Bussea occidentalis B., 1928*	Ceasalpiniaceae	Kpayéle	Fruit	Spontaneous
	10	*Carica papaya L., 1753*	Caricaceae	Yelétia	Fruit, leaf, root	Mixed
	11	*Ceiba pentandra L., 1791*	Bombacaceae	Ouiyé	Terminal bud	Spontaneous
	12	*Cercestis afezelii S., 1857*	Araceae	Momoyeli	Liana	Spontaneous
	13	*Citrus lemon L., 1768*	Rutaceae	Gankpönon	Fruit	Cultivated
	14	*Cola nitida S., 1832*	Sterculiaceae	Towéle	Fruit	Cultivated
	15	*Costus afer K., 1823*	Zingiberaceae	Touan	Stem	Spontaneous
	16	*Dichrostachys glomerata C., 1915*	Mimosaceae	Lanan	Bark	Spontaneous
	17	*Elaeis guineensis J., 1763*	Arecaceae	Towulu	Fruit /oil	Mixte
	18	*Enantia polyarpa E., 1901*	Annonaceae	Kpilen	Bark	Spontaneous
	19	*Eremospatha macrocarpa M., 1878*	Arecaceae	Yalikoi	Liana	Spontaneous
	20	*Erythrophleum guineensis A., 1818*	Caesalpiniaceae	Kily	Bark	Spontaneous
	21	*Fagara leprieuri E., 1831*	Rutaceae	Guéyéne	Bark	Spontaneous
	22	*Ficus capensis T., 1775*	moraceae	Molaan	leat, Bark	Spontaneous
	23	*Garcinia cola H., 1883*	Gutiferaceae	Petit cola	Fruit	Spontaneous
	24	*Halopegia azurea K., 1902*	Maranthaceae	Kpönolaah	leaf	Spontaneous
	25	*Laccosperma secundiflorum K., 1891*	Arecaceae	Laaba	Liana	Spontaneous
	26	*Laccosperma robustum J., 1982*	Arecaceae	Tamou	Liana	Spontaneous
	27	*Megaphrynium macrostaschyum K., 1952*	Maranthaceae	Hagaan (hawulu)	Stem	Spontaneous
	28	*Mitragyna inermis K., 1891*	Rubiaceae	Böon	leaf, Bark	Spontaneous
	29	*Morinda morinspoides B., 2008*	Rubiaceae	Zorokpo	leaf	Spontaneous
	30	*Ochna membranessis M., 1935*	Ochnaceae	Labah	Liana	Spontaneous
	31	*Ourathea baterie A., 1775*	Ochnaceae	Hélepoulou	Liana	Spontaneous
	32	*Picralima nitida T., 1910*	Apocynaceae	Wolomoulaan	Fruit	Mixed
	33	*Piper guineensis S., 1827*	Piperaceae	Héan	Fruit	Spontaneous

	34	*Pterocarpus santalinoides D., 1825*	Fabaceae	Gbanii	Fruit	Spontaneous
	35	*Raphia vinifera P., 1806*	Arecaceae	Kele	Sap (win)	Mixed
	36	*Spondias mombin L., 1985*	Anacardiaceae	Mouwöwulu	Fruit	Spontaneous
	37	*Terminalia ivorensis A., 1909*	combretaceae	Bahii	Bark	Spontaneous
	38	*Thaumatococcus daniellii B., 1883*	Maranthaceae	Hagaan (yölor)	Stem	Spontaneous
	39	*Xylopia aethiopica A., 1841*	Annonaceae	Hébe	Fruit	Spontaneous
Bossou Chimpanzee Hill	1	*Aframomum sp.*	Zingiberaceae	Tolanlaan	Root, leat	Spontaneous
	2	*Allophilus africana L., 1753*	Sapindaceae	Kpouwön	Leaf	Spontaneous
	3	*Alchornea cordifolia S., 1865*	euphrobiaceae	Pailèlaan	Leaf, bone marrow	Spontaneous
	4	*Belschiemeidia mannii B., 1949*	Lauraceae	Kpaa	Fruit	Spontaneous
	5	*Bridelia ferruginéa B., 1849*	Euphorbiaceae	Gouan	Bark	Spontaneous
	6	*Bridelia micrantha H., 1962*	Euphorbiaceae	Löwögouan	Leaf	Spontaneous
	7	*Bussea occidentalis H., 1928*	Ceasalpiniaceae	Kpayéle	Fruit	Spontaneous
	8	*Cercestis afezelii S., 1857*	Araceae	Momoyeli	Liana	Spontaneous
	9	*Citrus limon L., 1768*	Rutaceae	Gankpönon	Fruit	Cultivated
	10	*Coffea arabica L., 1753*	Rubiaceae	Café	Seed	Cultivated
	11	*Cola nitida S., 1832*	Sterculiaceae	Towéle	Fruit	Cultivated
	12	*Colocasia esculenta L., 1832*	Araceae	Gbounain	Tuber	Cultivated
	13	*Costus afer K., 1823*	Zingiberaceae	Touan	Stem	Spontaneous
	14	*Dichrostachys glomerata C., 1915*	Mimosaceae	Lanan	Bark	Spontaneous
	15	*Elaeis guineensis J., 1763*	Arecaceae	Towulu	Fruit /oil	Mixed
	16	*Eremospatha macrocarpa M., 1878*	Arecaceae	Yalikoi	Liana	Spontaneous
	17	*Erythrophleum guineensis A., 1818*	Caesalpiniaceae	Kily	Bark	Spontaneous
	18	*Fagara leprieuri E., 1831*	Rutaceae	Guéyéne	Bark	Spontaneous
	19	*Ficus capensis T., 1775*	moraceae	Molaan	Leaf, Bark	Spontaneous
	20	*Garcinia cola H., 1883*	Gutiferaceae	Petit cola	Fruit	Spontaneous
	21	*Gingiber officinalis R., 1807*	Zingiberaceae	Lèkiyéen	Rhizome	Cultivated
	22	*Laccosperma secundiflorum K., 1891*	Arecaceae	Laaba	Liana	Spontaneous
	23	*Laccosperma robustum J., 1982*	Arecaceae	Tamou	Liana	Spontaneous
	24	*Mitragyna inermis K., 1891*	Rubiaceae	Boon	Leaf, Bark	Spontaneous

	25	*Morinda morinsdoides B., 2008*	Rubiaceae	Zorokpo	Leaf	Spontaneous
	26	*Ochna membranessis M., 1935*	Ochnaceae	Labaa	Liana	Spontaneous
	27	*Musa paradisiaca L., 1753*	Musaceae	Guii	Fruit	Cultivated
	28	*Piper guineensis S., 1827*	Piperaceae	Héan	Fruit	Spontaneous
	29	*Pterocarpus santalinoides D., 1825*	Fabaceae	Gbanii	Fruit	Spontaneous
	30	*Raphia vinifera P., 1806*	Arecaceae	Kelewulu	Sap (win)	Mixed
	31	*Spondias mombin L., 1985*	Anacardiaceae	Mouwöwulu	Fruit	Spontaneous
	32	*Terminalia ivorensis A., 1909*	combretaceae	Bahii	Bark	Spontaneous
	33	*Thaumatococus danielli B., 1883*	Maranthaceae	Hagaan (yölor)	Stem	Spontaneous
	34	*Xylopia aethiopica A., 1841*	Annonaceae	Hébe	Fruit	Spontaneous
Déré Forest	1	*Aframomum melegueta K., 1904*	zingiberaceae	Kpouwön	Fruit, leaf	Cultivated
	2	*Aframomum sp.*	Zingiberaceae	Tolanlaan	Root, leaf	Spontaneous
	3	*Allophilus africana L., 1753*	Sapindaceae	Lozotèzalaan	Leaf	Spontaneous
	4	*Alchornea cordifolia S., 1865*	euphrobiaceae	Pailèlaan	Leaf, Bone marrow	Spontaneous
	5	*Bridelia ferruginéa B., 1849*	Euphorbiaceae	Gouan	Bark	Spontaneous
	6	*Bridelia micrantha H., 1962*	Euphorbiaceae	Löwögouan	Leaf	Spontaneous
	7	*Citrus limon L., 1768*	Rutaceae	Ganikpönon	Fruit	Cultivated
	8	*Coffea arabica L., 1753*	Rubiaceae	Café	Seed	Cultivated
	9	*Cola nitida S., 1832*	Sterculiaceae	Towéle	Fruit	Cultivated
	10	*Colocasia esculenta L., 1832*	Araceae	Gbounain	Tuber	Cultivated
	11	*Costus afer K., 1823*	Zingiberaceae	Touan	Stem	Spontaneous
	12	*Dichrostachys glomerata C., 1915*	Mimosaceae	Lanan	Bark	Spontaneous
	13	*Elaeis guineensis J., 1763*	Arecaceae	Towulu	Fruit /oil	Mixte
	14	*Fagara leprieuri E., 1831*	Rutaceae	Guéyéne	Bark	Spontaneous
	15	*Ficus capensis T., 1775*	moraceae	Molaan	Leaf, Bark	Spontaneous
	16	*Garcinia cola H., 1883*	Gutiferaceae	Petit cola	Fruit	Spontaneous
	17	*Mitragyna inermis K., 1891*	Rubiaceae	Boon	Leaf, Bark	Spontaneous
	18	*Morinda morinsdoides B., 2008*	Rubiaceae	Zorokpo	Leaf	Spontaneous
	19	*Musa paradisiaca L., 1753*	Musaceae	Guii	Fruit	Cultivated
	20	*Piper guineensis S., 1827*	Piperaceae	Héan	Liana, Seed	Spontaneous
	21	*Pterocarpus santalinoides D., 1825*	Fabaceae	Gbanii	Fruit	Spontaneous

	22	*Raphia vinifera P., 1806*	Arecaceae	Kele	Sap (win), Leaflet	Mixed
	23	*Spondias mombin L., 1985*	Anacardiaceae	Mouwöwulu	Fruit	Spontaneous
	24	*Terminalia ivorensis A., 1909*	combretaceae	Bahii	Bark	Spontaneous
	25	*Theobroma cacao L., 1753*	Sterculiaceae	Cacao	Fruit, Seed	Cultivated
	26	*Xylopia aethipica A., 1841*	Annonaceae	Hébe	Fruit	Spontaneous

Source: Field survey

The analysis of this table shows us the richness and diversity of the three central areas of the Nimba Mountains Biosphere Reserve in non-wood forest products of plant origin. The UNESCO heritage site remains the area richest in natural or spontaneous species, while the Déré forest remains the area poorest in natural or spontaneous species, with fallow land and a few islands of forest dominating. The difference in number and quality of species is due to human pressure and bush fires in these three central areas, see table 2.

Table 2 List of some non-wood forest products of animal origin identified in the three central areas

Central area	**N°**	**scientific name**	**Family**	**Konon name**	**Mode of use**			
					Craftsmanship	**Food**	**Pharmacopoeia**	**Trade**
UNESCO heritage site	1	*Alcelaphus buelaphus A., 1766*	Bovidées	Bêlaie	-	+	-	+
	2	*Alectoris barbara B., 1790*	Phasianidées	hazally	-	+	-	-
	3	*Anaphe venata B., 1878*	Notodontidées	Zowolo	-	+	-	+
	4	*Atelix alventris W., 1841*	Erinacidées	Telii	-	+	-	+
	5	*Bubo bubo L., 1758*	Strigidées	Mouou	-	+	+	-
	6	*Canis adustis S., 1847*	Canidées	Kwalayilé	-	+	-	+
	7	*Céphalophus rufilatus G., 1846*	Bovidées	Toua	+	+	-	+
	8	*Cobus defassa O., 1863*	Bovidées	Loma	+	+	-	+
	9	*Crocuta crocuta E., 1777*	Hyaenidées	Houlou	-	+	-	+
	10	*Crycetomys gambianus W., 1840*	crycedidées	Bôwou	-	+	-	+
	11	*Helogale parvula*	herpestidées	Wouéen	-	+	-	-
	12	*Histrix cristata L., 1758*	Muridées	Pyi	-	+	-	+
	13	*Lycaon pictus T., 1820*	Canidées	Guebhe	-	+	-	+
	14	*Manis gigantea S., 1815*	Manidées	Ballaowolo	-	+	-	-

	15	*Ophiophagus hannah C., 1836*	Elapidées	Wooloto	-	+	-	+
	16	*Orycteropus afer P., 1766*	Oryctéroporidées	Gèhen	+	+	+	-
	17	*Panthera leo L., 1758*	Félidées	Yala	+	-	+	-
	18	*Panthera pardus L., 1758*	Panthérinées	Kwèli	+	+	+	-
	19	*Pan troglodydes verus S., 1934*	Hominidées	Wolo	-	-	-	-
	20	*Papio cynocephalus L., 1758*	Cercopithscidées	Gbon	-	+	-	+
	21	*Phacocherus aethiopicus A., 1967*	Suidées	Löwoboye-kpôlou	-	+	-	+
	22	*Potamochoerus corpus L., 1758*	Suidées	Löwoboye-tèhe	-	+	-	+
	23	*Python sebae G., 1789*	Pythonidées	Yiléen	-	+	-	+
	24	*Rattus rattus W., 1803*	Muridées	Kpéguai	-	+	-	+
	25	*Syncerus caffer S., 1779*	Bovidées	Laan	+	+	-	+
	26	*Tragelaphus buselaphus B., 1816*	Bovidées	Palaye-loma	+	+	-	+
	27	*Tockus ruahae K., 2002*	Bucerotidées	Höon	-	+	-	-
	28	*Tragelaphus delbianus P., 1766*	Bovidées	Woloon	+	+	-	+
	29	*Thryonomys swinderianus T., 1827*	Trinomidées	Hömon	-	+	-	+
	30	*Varanus exanthematicus B., 1792*	véranidées	Paan	-	+	-	+
	31	*Vipera berus L., 1758*	Viperidées	Toumou	-	+	+	+
	32	*Zonocerus variegatus L., 1758*	Pyrgomorphidées	Zalon	-	+	-	+
Bossou Chimpanzee Hill	1	*Alectoris barbara B., 1790*	Phasianidées	hazally	-	+	-	-
	2	*Anaphe venata B., 1878*	Notodontidées	Zowolo	-	+	-	+
	3	*Atelix alventris W., 1841*	Erinacidées	Telii	-	+	-	+

	4	*Bubo bubo L., 1758*	Strigidées	Mouou	-	+	+	-
	5	*Canis adustis S., 1847*	Canidées	Kwalayilé	-	+	-	+
	6	*Céphalophus rufilatus G., 1846*	Bovidées	Toua	+	+	-	+
	7	*Cobus defassa O., 1863*	Bovidées	Loma	+	+	-	+
	8	*Crycetomys gambianus W., 1840*	crycedidées	Bôwou	-	+	-	+
	9	*Helogale parvula*	herpestidées	Wouéen	-	+	-	-
	10	*Histrix cristata L., 1758*	Muridées	Pyi	-	+	-	+
	11	*Manis gigantea S., 1815*	Manidées	Ballaowolo	-	+	-	-
	12	*Orycteropus afer P., 1766*	Oryctéroporidées	Gèhen	+	+	+	-
	13	*Phacocherus aethiopicus A., 1967*	Suidées	Löwoboye-kpôlou	-	+	-	+
	14	*Pan troglodydes verus S., 1934*	Hominidées	Wolo	-	-	-	-
	15	*Potamochoerus corpus L., 1758*	Suidées	Löwoboye-tèhe	-	+	-	+
	16	*Tragelaphus buselaphus B., 1816*	Bovidées	Palaye-loma	+	+	-	+
	17	*Tockus ruahae K., 2002*	Bucerotidées	Höon	-	+	-	-
	18	*Tragelaphus delbianus P., 1766*	Bovidées	Woloon	+	+	-	+
	19	*Thryonomys swinderianus T., 1827*	Trinomidées	Hömon	-	+	-	+
	20	*Varanus exanthematicus B., 1792*	véranidées	Paan	-	+	-	+
	21	*Zonocerus variegatus L., 1758*	Pyrgomorphidées	Zalon	-	+	-	+
	1	*Alcelaphus buelaphus A., 1766*	Bovidées	Bêlaie	-	+	-	+
	2	*Anaphe venata B., 1878*	Notodontidées	Zowolo	-	+	-	+

Déré Forest	3	*Atelix alventris W., 1841*	Erinacidées	Telii	-	+	-	+
	4	*Bubo bubo L., 1758*	Strigidées	Mouou	-	+	+	-
	5	*Canis adustis S., 1847*	Canidées	Kwalayilé	-	+	-	+
	6	*Céphalophus rufilatus G., 1846*	Bovidées	Toua	+	+	-	+
	7	*Cobus defassa O., 1863*	Bovidées	Loma	+	+	-	+
	8	*Crocuta crocuta E., 1777*	Hyaenidées	Houlou	-	+	-	+
	9	*Crycetomys gambianus W., 1840*	crycedidées	Bôwou	-	+	-	+
	10	*Bubo bubo L., 1758*	Strigidées	Mouou	-	+	+	-
	11	*Helogale parvula*	herpestidées	Wouéen	-	+	-	-
	12	*Histrix cristata L., 1758*	Muridées	Pyi	-	+	-	+
	13	*Lycaon pictus T., 1820*	Canidées	Guebhe	-	+	-	+
	14	*Manis gigantea S., 1815*	Manidées	Ballaowolo	-	+	-	-
	15	*Orycteropus afer P., 1766*	Oryctéroporidées	Gèhen	+	+	+	-
	16	*Panthera pardus L., 1758*	Panthérinées	Kwèli	+	+	+	-
	17	*Pan troglodydes verus S., 1934*	Hominidées	Wolo	-	-	-	-
	18	*Papio cynocephalus L., 1758*	Cercopithscidées	Gbon	-	+	-	+
	19	*Phacocherus aethiopicus A., 1967*	Suidées	Löwoboye-kpôlou	-	+	-	+
	20	*Potamochoerus corpus L., 1758*	Suidées	Löwoboye-tèhe	-	+	-	+
	21	*Tockus ruahae K., 2002*	Bucerotidées	Höon	-	+	-	-
	22	*Tragelaphus delbianus P., 1766*	Bovidées	Woloon	+	+	-	+
	23	*Thryonomys swinderianus T., 1827*	Trinomidées	Hömon	-	+	-	+

	24	*Varanus exanthematicus B., 1792*	véranidées	Paan	-	+	-	+
	25	*Vipera berus L., 1758*	Viperidées	Toumou	-	+	+	+
	26	*Zonocerus variegatus L., 1758*	Pyrgomorphidées	Zalon	-	+	-	+

Source: Field survey

We note in this table the richness of the Nimba Mountains Biosphere Reserve in non-wood forest products of animal origin as a whole. If the UNESCO heritage site and the Déré forest show considerable wealth, the Bossou chimpanzee hill remains poor in animal species due to the restricted extent of the site and human activities within the area. central and with the dominant population, chimpanzees. Species: Cephalophus rufilatus, Vipera berus, Tragelaphus buselaphus etc. have an almost general mode of use, while Pan troglodydes verus is the species fully protected by the local population and included on the IUCN red list *(see table 3)*.

Table 3 Frequency and period of sampling of some NTFPs

N°	**Scientific name**	**ampling frequency**	**Organ removed**	**Collection period**	**Request**	**Uses**
1	*Belschiemeidia mannii*	x	Fruit		+	Eating
2	*Bridelia ferruginéa*	xx	Bark	All year round	++	Eating
3	*Enantia polyarpa*	xxx	Bark	All year round	+++	Dyeing
4	*Eremospatha macrocarpa*	xx	Stem	All year round	++	Craftsmanship
5	*Fagara leprieuri*	xx	Bark	All year round	++	Medicinal, economic
6	*Garcinia cola*	xx	Fruit, root	March-June	+++	economic, medicinal
7	*Laccosperma secundiflorum*	xx	Stem	All year round	++	Craftsmanship
8	*Laccosperma robustum*	xx	Stem	All year round	++	Craftsmanship
9	*Magaphrynium macrostaschyum*	x	Stem	All year round	++	Craftsmanship
10	*Mitragyna inermis*	x	Leaf, Bark	All year round	+	economic, medicinal
11	*Picralima nitida*	xx	Fruit	February-June	++	medicinal
12	*Piper guineensis*	xx	Fruit, Stem	March-April	+++	Economic, eating, aroma
13	*Raphia vinifera*	xxx	Sap, leaflet, bamboo	All year round	+++	Economic, social, cultural, Craftsmanship
14	*Terminalia ivorensis*	x	Bark	All year round	+	Dyeing
15	*Thaumatococus danielli*	x	Stem	All year round	++	Craftsmanship
16	*Xylopia aethiopica*	xx	Fruit	March-April	+++	Economic, medicinal, spicy

Source: Field survey ; Legend: x=low frequency; xx=average frequency; xxx=high frequency. +=low demand; ++=average demand; +++=strong demand.

From this table, we note that the strong demand for certain products such as: Garcinia cola, Piper guineensis, Raphia vinifera, Xylopia aethiopica... is a function of their economic yield while their average frequency is due to the harvest period limited to exception of Raphia vinifera whose by-products: leaflets, bamboo, cockchafer larvae, sap or wine and Enantia polucarpa which are exploited all year round; which justifies its high sampling frequency.

3.2. Constraints and opportunities for managing different categories of NTFPs

From the point of view of NTFP management, both at the level of public authorities and at the level of village communities and sellers of these different non-timber forest products, the constraints and opportunities are not the same. Some NTFPs offer more ease of management than others *(see table 4).*

Table 4 Description of uses and management constraints of NTFPs

Product categories	**Use**	**Management**	
		Constraints	**Opportunities**
NWFPs of plant origin	Eating	- Habitat collection/destruction -Seasonal products -Difficulty of conservation -Difficulty of transformation -Difficulty of legal regulation	Good knowledge of the products by the majority of stakeholders -Possibility of domestication -Ease of access to products -Job creation
	Medicinal and psychotropic drugs	-Low product knowledge (a few privileged players) -Products difficult to handle (toxicity, dangerous) -Difficulty accessing information -Difficulty of legal regulation	-Development of new products (edibles, medical) -Taking into account local know-how
	Craftsmanship	-Collection/destruction of habitats -No guarantee of the resource -Difficulty of domestication -Hunting products -Habitat destruction -Disappearance of certain species -Difficulty of conservation -Difficulty collecting and accessing information on the level of collection -Difficulty in applying the regulations in force -Poaching	-Permanent throughout the year -Valorisation of certain sectors -Job creation -Development of national markets
NWFPs of animal origin	Eating		-Valorisation of certain sectors by reorienting the uses of NTFPs (conversion of hunters into breeders) -Ease of setting up the regulatory framework (presence of eco-guards)
	Medicinal and psychotropic drugs	-Weakness of the resource -Notoriety of healers -Difficulty accessing information	-Development of new molecules or new products through scientific research -Taking into account local know-how
	Craftsmanship	No guarantee of the resource	Ease of implementing regulations

Source: Field survey

Examination of this table shows us that the management of NTFPs in the Monts Nimba Biosphere Reserve is based on the know-how of the actors and is supported by a constantly evolving regulatory framework (provision of means to eco-guards and their presence in the field) to respond to the practical difficulties present in the field. This result corresponds to that of [1]. However, if NTFPs of animal origin offer more possibilities for implementing legislative measures, it appears that NTFPs of plant origin are those for which there are numerous economic opportunities if their exploitation

was well organized. In all cases, whatever the category of products, their current method of collection (picking, harvesting, collection, hunting) does not guarantee the sustainability of the resource. Indeed, the seasonality of certain products is juxtaposed with constraints linked to the weakness of regulatory management measures on the ground when they are provided for by law.

3.3. Survey of the different markets bordering the RBMN

The results of the socio-economic surveys on the markets allowed us to know the different prices of certain NTFPs through our investigations in the markets of N'Zoo, Bossou, Tounkarata and Gbakoré, the appearance of which is recorded in the following table :

Table 5 Prices of some NTFPs encountered in the markets

N°	Scientific name	Organs	Modes of levy	Units of measurement			Price (GNF)
				Heap	Attached	Kilogram	
1	*Garcinia cola*	Fruit	Cut down, climb, collect	Per seed unit			500-1000
						x	25000-45000
2	*Xylopia aethiopica*	Fruit	Climb, collect	x			1000-2000
3	*Piper guinéensis*	Fruit	Collect, cut the stem	x			500-1000
						x	65000-75000
4	*Picralima nitida*	Fruit	Picking	Per unit of fruit			2000-3000
5	*Raphia vinifera*	Sap (win)	Cut the terminal bud			x	1500-3000
6	*Bridelia ferruginéa*	Bark	Remove the bark		x		2000-3000
7	*Elaeis guineensis*	Fruit	Climb	x			500-1000
		Oil				x	12000/1itre
8	*Eremospatha macrocarpa*	Liana	Cut the stem	Per van unit			15000-35000
9	*Laccosperma robustum*	Stem	Cut the stem		x		50000-150000
10	*Laccosperma secundiflorum*	Stem	Cut the stem		x		50000-150000
11	*Thaumatococus danielli*	Stem	Cut the stem	Per mat unit			20000-45000
12	*Game and animal products*	Animal	Hunt and trap	-Per whole animal -Per piece			-100000-320000 -25000-75000

Source: Field survey

Based on the analysis of this table, we note that NTFPs of plant origin have a capital importance in the monetary income of rural and even urban populations, which explains their high exploitation without forgetting that these species are spontaneous and do not occur that in humid tropical forests, as for NTFPs of animal origin are hunted clandestinely and the non-enforcement of hunting regulations allows hunting to be practiced at all times of the year.

3.4. Distribution of people surveyed (respondents) by category

After our surveys of resource people in the field and the analysis of the responses, we proceeded to distribute the people surveyed by categories: by gender and by age group. This allowed us to have 85% men and 15% women *(see figure 2).*

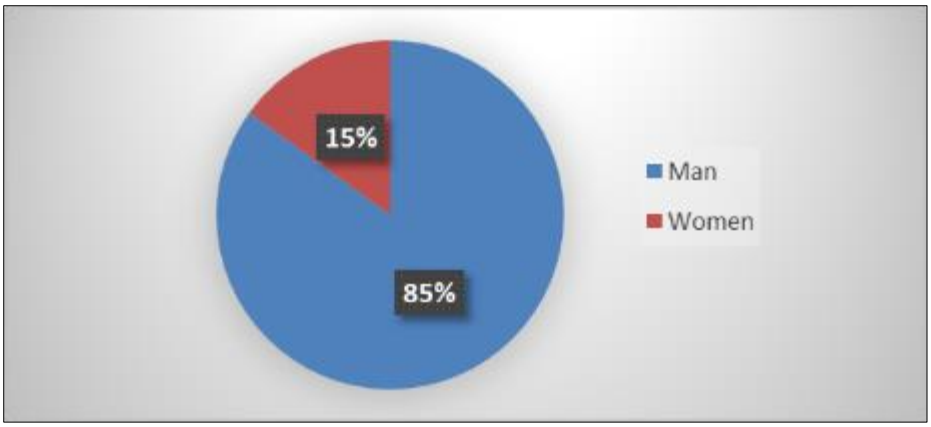

Figure 2 Distribution of people surveyed (respondents) by gender

This graph highlights the prevalence of men in the exploitation of NTFPs in the Nimba Mountains Biosphere Reserve. Men are, in priority, the operators par excellence because these operating activities require physical effort *(see figure 3).*

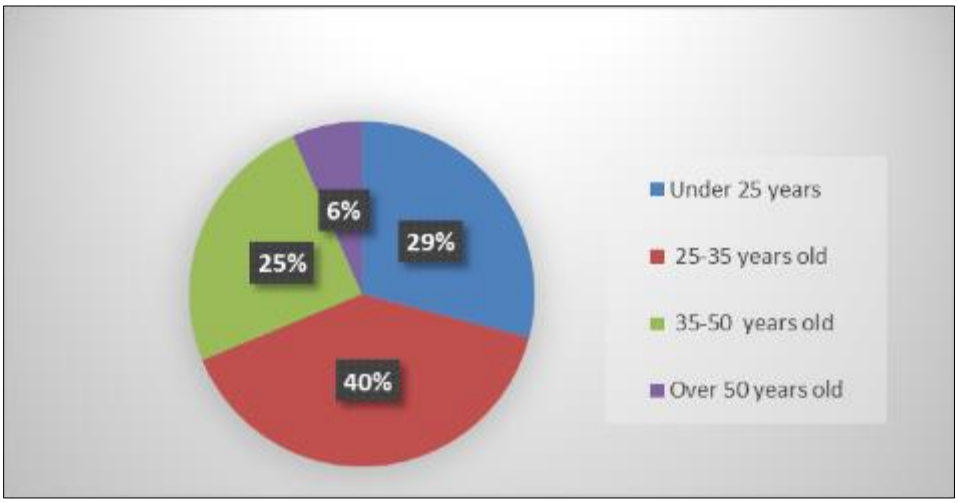

Figure 3 Distribution of people surveyed (respondents) by age group

From this graph, we notice that 40% of the population around the Nimba Mountains Biosphere Reserve is young; of such human potential, there is reason to reflect on the anthropogenic pressure and the future of NTFPs in the central areas of the Nimba Mountains Biosphere Reserve.

3.5. Utilities of Non-Timber Forest Products (NTFP)

The exploitation of NTFPs in the central areas of the Nimba Mountains Biosphere Reserve is linked to the services provided by these NTFPs to local populations who derive profits from the Reserve to satisfy their needs *(see figure 4).*

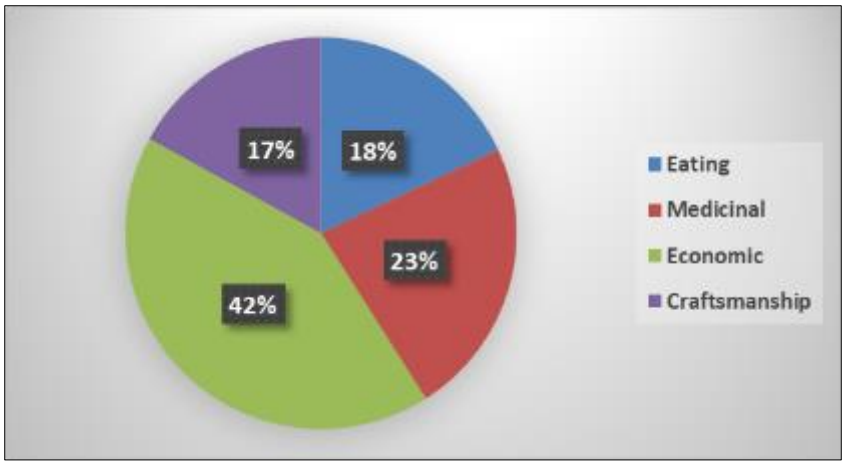

Figure 4 Percentage of use of NTFPs in the different services

It appears from these results that the majority of respondents recognize that NTFPs are exploited to meet economic needs, 42% of respondents, followed by 23% for medicinal treatment and 18% for food, while 17% of respondents recognize that the exploitation of NTFPs serves as a craft which is little practiced. This result confirms that of Enoch LOUBELO (2012) from Congo. NTFPs are part of the natural resources that the local population of the Nimba Mountains Biosphere Reserve uses to diversify their productive activities and improve their income. The local populations maintain close relations with this Reserve and have in-depth knowledge of these NTFPs as well as their use for distant years.

3.6. Operating methods

For the methods of exploitation of NTFPs, the people surveyed recognized several methods including: felling, climbing, collecting, hunting, etc. which are practiced to different degrees and follow age and gender *(see figure 5).*

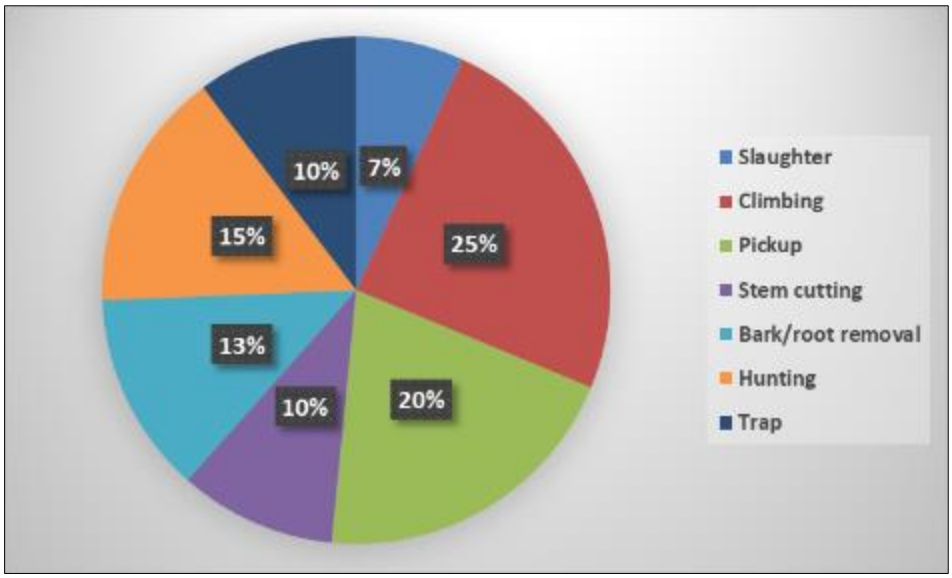

Figure 5 NTFP exploitation methods

The analysis of this graph shows us that climbing is the exploitation method most used by young people, followed by collecting for NTFPs of plant origin practiced by the elderly and women, while hunting remains the most practiced by men for NTFPs of animal origin.

The lack of application and monitoring of regulations leads to certain attempts at destruction. Operators continue to carry out destructive acts on local species; which means that these species are threatened today due to the degradation and transformation of their habitat.

3.7. Causes of NTFP degradation in the RBMN

The scarcity or disappearance of certain non-timber forest products is not a coincidence, it is due to all the human actions exerted on these NTFPs, which are none other than the causes including, among others:

- The galloping increase in the population, the influx of job seekers in local mining companies while the land for cultivation does not increase;
- The very high level of poverty of the majority peasant population;
- Uncontrolled bushfires which modify or destroy NTFP habitat;
- Lack of information on regulatory texts and non-application of these texts;
- The minimal surveillance team lacks effective means to accomplish their mission;
- Easy access to Non-Timber Forest Products (NTFP)
- The introduction of logging companies in certain central areas such as the Déré forest, which allowed agricultural exploitation in this forest;
- The installation of perennial crops in the chimpanzee hills of Bossou, which allows the permanent presence of populations in the forest;
- Weak sources of animal protein (livestock), animal protein being derived from NTFPs of animal origin.

4. Conclusion

At the end of this study we came to the following conclusion:

- 39 resource species of NTFPs of plant origin;
- 32 of animal origin;
- Men exploit NTFPs at 85% while women exploit at 15%;

Regarding the reasons, NTFPs are exploited for:

- 42% for the family economy;
- 23% for medicinal treatment;
- 18% for food, while 17% for crafts;
- The exploitation methods are as follows: climbing (25%), Pickup (20%), hunting (15%), extraction of bark and roots (13%), piezes (10%), stem cutting (10%) and felling (7%).

The proposed mitigation measures are:

- The domestication of certain species (Piper guinneensis, Xylopia aethiopica, Garcinia cola, Raphia vinifera etc);
- Education and awareness of the population on regulatory texts;
- The development of livestock farming in the villages bordering these three central areas.

However, these mitigation measures take into account the different actors involved in the use and management of non-timber forest products.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there are no conflicts of interest. *Compliance with Ethical Standards:* This article does not contain any studies involving human or animal subjects.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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