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RESEARCH ARTICLE

EUCALYPTUS TREE COLONIZATION OF THE BAFUT-NGEMBA FOREST RESERVE, NORTH WEST REGION, CAMEROON

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ABSTRACT

Recent environmentalism in Cameroon and forest reserve creation has been varied in implementation and management between community and national stakeholders and policies. Good national intents for hot spot conservation saw the 1953 creation of the Bafut-Ngemba production forest reserve on the Bamenda Highlands, where today's accelerated urbanization and development has largely engulfed. Pressure on the forest reserve resources has thwarted its spatio-temporal natural tree cover climax. The study uses a field survey and secondary data treatment methodology to probe how communities at the reserve fringe have responded to unmet natural wood demands by pushing in eucalyptus tree plantations to result in forest reserve reversal. Varied income-driven circumstances generated an overwhelming embrace of a eucalyptus culture swallowing up the natural trees. A thirty-year evaluation of the tree cover revealed a near 40% loss the reserve trees while eucalyptus laden-farmland have been gained ascendancy. This ecological colonization scramble was timid in the 1980s, then rapid in the 1990s and then exponential by 2018. There is a direct relationship between this spatial gains from the eucalyptus and population growth demand trends. The study therefore opts for a quick revisit of the initial forest reserve philosophy that is now being diluted in this eucalyptus embrace. These eucalyptus trees are ecological terrorists that should never be permitted to terrorize production forest reserves.

KEYWORDS

Bamendankwe, Eucalyptus, Income, Forest Reserve, Population, Tree.

1. INTRODUCTION

The aim of this paper is to assess the spatial and time trends of the eucalyptus take-over of the forest reserve original trees. This would identify the human causes and consequences on the future of the Bafut-Ngemba Forest Reserve (BNFR) so that the reserve policy of environmental protection can continue to be a contribution to the sustainable livelihoods and the environment. The British colonial government created the Bafut-Ngemba Native Authority Forest Reserve (BNNAFR) on the Bamenda Highlands averaging 2340 metres above sea level has today become an ecological shadow of itself. These forests in Cameroon in general and particularly on the Bamenda Highlands in particular (protected or without any legal status) systematically lost their prestigious natural worth to decades of human harvesting to meet up for urban fuelwood and charcoal. The only relics that have survived this weight of degradation are scanty refuges of natural trees enveloped and stranded in exotic omnipresent eucalyptus that have quickly invaded the hitherto forest reserve from the gallery to highland surfaces.

This natural forest reserve was protected State-owned and excluded to communal anthropic activities being part of what should have made up 11% of Cameroon [1]. The post- independence target was to be a minimum 20% of Cameroon's area and projected to 30% in the 1990s [2-3]. These ambitious targets crashed in the wake of ceaseless deforestation making cover evolution between 2000 and 2005 decrease from -1 to -1.5% per year as against only -0.9% for the period 1990 to 2000 [4-5].

The communal love for eucalyptus trees in place of the BNFR trees appeared to provide substantial socio-economic benefits to the local community. The population saw better household incomes to its undertakers than what accrue from subsistence agricultural crops. Most of the highland has become a cultural landscape occupied by vast expanses of eucalyptus trees that are punctuated sparingly by built-up areas and arable land. Much of what was the old reserve forest has been lost, yielded way to the now imposing eucalyptus trees that termed ecological terrorist and identified its negative pitfalls [6-7]. This spread its bounds in disrespect of the goals of the World Summit on Sustainable Development (WSSD) and Millennium Development Goal targeted in curbing biodiversity loss [8].

The Bamendankwe eucalyptus stakeholders have thus reaped gains from the sale of products and have significantly increased their standard of living. There have seen greater gains in building materials, electricity/telephone poles and timber. How could such mass acclamations of the eucalyptus new found wealth been otherwise given that in 1960s the world market prices for coffee slumped. Farmers who dared continuance in the dying coffee production sector were hard-whipped by losses that followed infection disease of the coffee pod. The annual losses were so compounding even to the overriding Santa Coffee Estate pushing even the most hesitant coffee farmer to embrace eucalyptus planting for survival. There was instant eucalyptus planting forest reserve area and lands hitherto used for coffee as to avert a community doomsday.

The eucalyptus of varied species became the cherished target in different parts of the BNFR. In this light, noted that eucalyptus is grows in varied climatic soil conditions from semi-arid areas to highly humid dense forest and from Mediterranean climate to tropical climate [9]. Eucalyptus is therefore distributed in almost all environmental conditions in Africa. Identified eucalyptus in all the highland areas as the Bamenda Highlands with diverse ecological conditions, different altitudes and rainfall regimes [10]. This timid eucalyptus replacement of coffee farms swept progressively into degraded patches of the BNFR and gradually disregarding the environmental reserve status to human deserve. There has therefore been a progressive humanization of the reserve forest space and natural species with what human dictates want with the eucalyptus in a direct inverse relationship in between 1960 and 2018. Though such eucalyptus onset was in terms of perceived economic benefits, this

venture is now receiving question marks with the increasingly knowledge generated on its adverse environmental effects. Eucalyptus has now been understood to be an aggressive user of water and soil nutrients along water courses and Nesirine, Mubang, and Menka catchment areas are affected by dwindling water tables within the BNFR. This directly curbs local rainfall levels in the dry season such water supply drops and so neighborhoods suffer from water scarcity of long duration which increases as the rate of eucalyptus replacement of the trees of the forest reserve increases.

2. METHODOLOGY

Bamendankwe as the key study area was chosen for its representative located along the Bamenda Highland Ridge from where its south east position overlooks the extensively sprawling Down Town Bamenda city from Up-Station (Fig. 1) with a surface area 421,800 hectares. Primary data on the types and distribution of the eucalyptus species were collected through interviews with eucalyptus stakeholders and the personnel of the Bamenda I Council municipality. A total of 155 questionnaires were administered on the inhabitants to have information on eucalyptus planting practices. An elaborate field survey was carried out in combination with different remote sensing tools to generate a time-space evolution cartography of the eucalyptus coverage. Landsat images were therefore processed to evaluate areas covered at the peak moments of the political and economic crises in Cameroon of the 1990s, food crises of 2008, the escalation of the Anglophone problem since 2016 and when the Structural Adjustment Programmes of the World Bank in 2003 and 2007) as well as some available sentinel images.

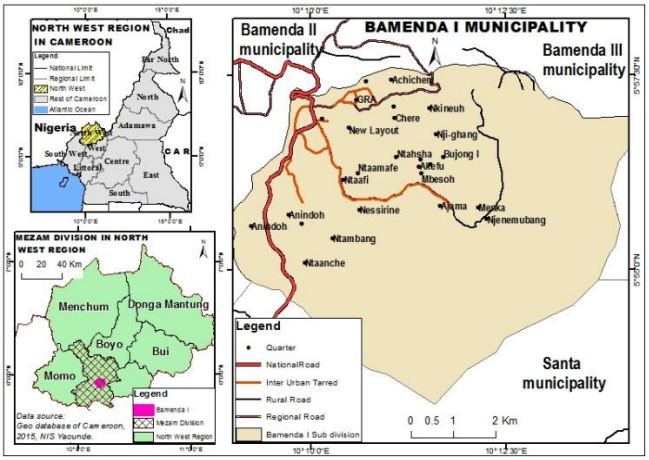

Figure 1: Location of Bamendankwe

Interviews were conducted at the Divisional Delegation of Forestry and Wildlife (Mezam) to obtain information on the general state of main environmental sectors (forest) as well as active NGOs and community-based organizations that are forging ahead with environmental conservation.

3. RESULTS AND DISCUSSIONS

3.1 The evolution of the Bafut-Ngemba Forest as a Native Authority Forest Reserve

Native authority forest reserves in Cameroon are areas of land under effective government management for conservation. Such reserves that were managed by government officials, NGOs, former project staff and institutions include Kimbi Game Reserve, Bafut Ngemba Forest Reserve, Bali Ngemba Forest Reserve, Kom-Wum Forest Reserve, Mbembe Forest Reserve, Bambui Protected Forest and the Fungom Forest Reserve. Their spatial distribution and acreage appeared spatially varied (Fig. 2).

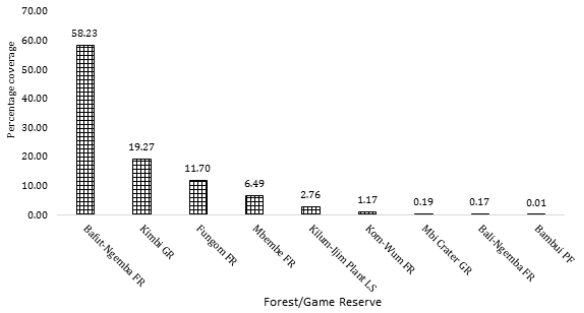

Figure 2: Distribution of forest reserves in the North West Region of Cameroon

The chart reveals that of the nine reserves created in the region the BNFR accounted for about 58.23% totaling some 421,800 ha being directly under direct government control. This particular case of BNFR was classified by the Bafut-Ngemba Native Authority Forest Reserve Order in 1953 and registered as the Eastern Region Public Notice No. 140 of 1953. It was and served as a Production Forest Reserve located at about 35km from Bamenda city, and approximately 3km from Santa the Sub-divisional headquarter on altitudes ranging between 1800 and 2500m. It was to the south east of the Bamendankwe community that comprised close to 62,000 inhabitants as of 2011 distributed on about 39 neighbourhoods in addition to the Bamenda city (355,308 inhabitants by 2016 according to the 2005 Population and Housing Census projections) [11].

The forest reserve is found within the Guinean forest of West African hotspot. The forest reserve is therefore one of the global hotspots being the 218 Endemic Bird Area [12-13]. According to a research that this reserve was habitat for monkeys, chimpanzees and antelopes amongst other species [6]. Other endemic and rare animals in are the amphibians like the *Astylosternus rheophilus*, and reptiles like *Leptosiaphos ianthinoxantha*. Scarce and endemic vegetal species include (*Blumea crispata*, *Crotalaria ledermannii*, *Dalbergia oligophylla*, *Dissotis bambutorum*, *Dissotis longisetosa*, *Helichrysum cameroonense*, *Plectranthus insignis*, *Psorospermum aurantiacum*, *Tapinanthus letouzeyi*). This reserve is host to the Bannerman's Turaco (*Tauraco bannermani)* and the Banded Wattle Eye (*Platysteira laticincta)* species of birds which are found only in the montane highlands of the North West Region of Cameroon. This endemism status raises the *raison d'être* to protect and uphold the forest reserve habitat in its natural faunal and floristic diversity. A compendium of events and circumstances, unfortunately, intertwined with the urban and human development need of neighbouring communities and Bamenda city rapidly raped this forest of what should have been most enviously preserved.

Recent studies have alluded that in 1978, this BNFR had more than half of its surface area covered with forest (70%) while farmland, water/wetland and grass/shrub occupied 22%, 4% and 4% of the surface area respectively [14]. Significant dynamics were assessed for forest and land cover classes between 1978 and 2006 with forest cover and water/wetland dropping by -37 and -1% respectively while farmland and grass/shrub increased by 28 and 10% respectively (Figure 3).

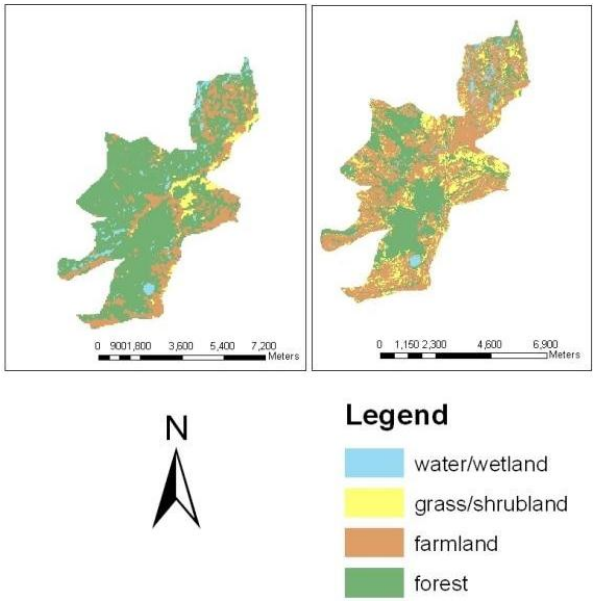

Figure 3: Bafut Ngemba reserve forest and land cover change (1978-2006)

Source: [14]

For the natural vegetation cover therefore it was an overly negative annual rates of change of -1.3 for the forest and -0.03% for water/wetland even though grass/shrub and farmland increased annually by 0.3 and 1% respectively. There is thus a generalized trend that the BNFR for the 28 years period witnessed forest cover decrease while farmland comprised eucalyptus trees rather increased. Bamendankwe inhabitants invaded the forest reserve for cocoayam farming so cut down the natural forest for access and household consumption fuelwood and for sale. Bamendankwe is noted in Bamenda city as the main charcoal suppliers especially on the city Saturday market days fetching income for 80% of its population comprised of 60% of youths. The eastern part of the reserve is equally cut

down for intense subsistence market gardening for Irish potatoes, cabbages, tomatoes, onion and a variety of spices where inhabitants of Mile 12, Santa, Akum and some from Bamenda have transformed into a cultural landscape.

Mile 12 in Santa has become as a giant collection terminal for eucalyptus forest products from where they are loaded on trucks for supply at varied destinations. The existence of a eucalyptus plank market at Mile 12 thrives well just 8 km to the south east of the reserve exposing the laxity in enforcing the laws guiding reserves by the forestry authorities. There exists a whole transportation chain economy related to whether the poles or planks form the harvesting to loading/off-loading spots and such income that varies from 600 to 800 FCFA per piece transported is paid as daily wages. This not only casts a psychological vote for eucalyptus tree long stay but an inadvertent replacement of what served as a little (or zero income generating BNFR. Some cattle herd owners live in and around the reserve also rapidly transforming it into grazing territory as they frequently fire so as to enhance rapid pasture regeneration especially from Akum in the south west of the reserve.

3.2 The eucalyptus extension trend and processes into the Bafut Ngemba Forest Reserve

Eucalyptus trees have become the dominant tree type in Bamendankwe following several years of anthropic engineering in replacement of the natural trees of the reserve. Ever since 1900s when Christian Missionaries brought it along to Cameroon, the cultivation varies in density from one part of this highland to another reflecting the relative degree of involvement and benefits that its cultivators have been making since the 1980s. The evolution pattern of eucalyptus coverage has risen rapidly from the period of economic recovery following the 1980 crises (Table 1).

Table 1: Evolution of aerial coverage of eucalyptus tree strands

Period	Area (Km²)	Percentage
1980 - 1990	30	19.4
1990 - 2000	38	24.5
2000 - 2010	44	28.4
2010 - 2018	43	27.7
Total	155	100

Source: Fieldwork, 2018

The coffee farms were established in the 1960s on spaces meant for the forest reserve. Since the collapse of the coffee economy not only has the old coffee lands been reverted to eucalyptus but space in the forest reserve whose trees have been cut down. Most especially because where the eucalyptus advances, every other type of non-eucalyptus vegetation recedes as it succumbs to the poisonous toxins secreted by the eucalyptus leaves and soil electrification. Such high degrees of anthropization through eucalyptus culture has promoted the specie to express its terrorizing majesty over much of the highland topography whereas the forest reserve has been shrinking in vegetal cover, density and acreage. The surface area covered by eucalyptus in Bamendankwe progressed rapidly between 1980-2018 (Figure 4).

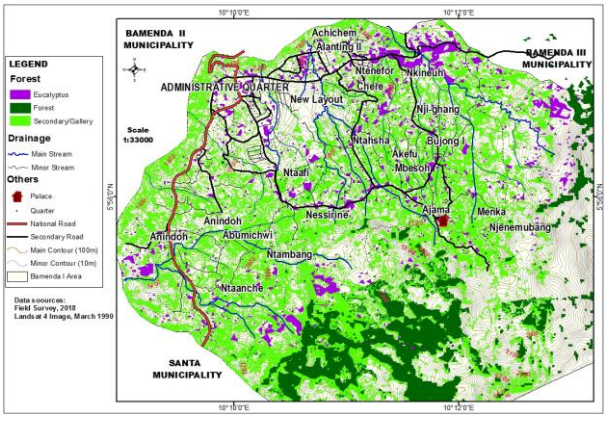

Figure 4: Eucalyptus coverage of Bamendankwe in 1990

Source: Fieldwork, 2018, Landsat 4 images of March 1990

Eucalyptus covered just 20% of the surface area in Bamendankwe during 1980. It could be understood that by this time, the bulk of the population depended for fuelwood and charcoal for what was left of the forest reserve. The 1993 unemployment rate in Cameroon soared to 24.7%, against only 7.3% in 1983-84 and 14.7% in 1987, then was the 50% devaluation of the FCFA on 12 January 1994 shooting up poverty percentage to from 40% in 1984 to 50.5% in 1996 [15]. The consequent closure in 1985 of the Santa Coffee Estate that was a giant employer of the population of Mile 12, Santa, Awing, Akum, Pinyin and Mendankwe that surround the reserve was so heart breaking.

The vexing revenge was the wanton embrace of eucalyptus economy such that in about ten years by 1990 the area covered by eucalyptus had almost doubled (reaching 36%) of the surface area that was hitherto either reserved for coffee but most especially natural trees of the BNFR that witnessed a corresponding shrink in its surface area and natural tree density. This blow on the forest reserve ecology appear matched with the divisional population growth rate that saw the population density pass from 179.39-300.63 inhabitants/km² in just 18 years between 1987 and 2005 (Table 2).

Table 2: Evolution of the population of Mezam Division, 1987 to 2005

Administrative unit	1987			2005		
	Male	Female	Total	Male	Female	Total
Bamenda I	9827	9353	19180	13797	14562	28359
Bamenda II	45563	44091	89654	89726	94551	184277
Bamenda III	19429	17758	37187	54779	55474	110253
Tubah	19138	20089	39227	22817	25725	48542
Santa	26669	30790	57459	29913	34478	64391
Bafut	17239	19182	36421	29178	28752	57930
Mezam	154443	158600	313043	254620	269507	524127

Source: [16]

The six administrative units of Mezam that create a significant impact of the forest reserve show a general increase in the population. It should be noted that all these units are neighbouring to the forest reserve just as the Bamenda City (Figure 5) whose population reveals exponential growth since 2005.

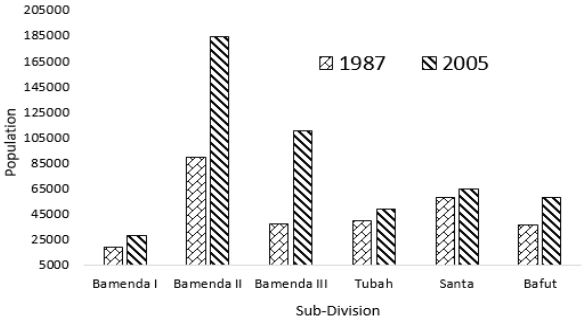

Figure 5: Population growth in Bamenda (1987-2005)

Data source: [16]

For most of the years up to 1990-1992 the population growth of the city was timid. From the year 2000, the economic recovery ushered a quick need for timber and other construction hard wood that was readily available from the eucalyptus. Many indigenes of Bamendankwe that were aware of its economic benefits engaged to cultivate more of it, without not bothering for the effects of the tree to the environment (Figure 6 and 7).

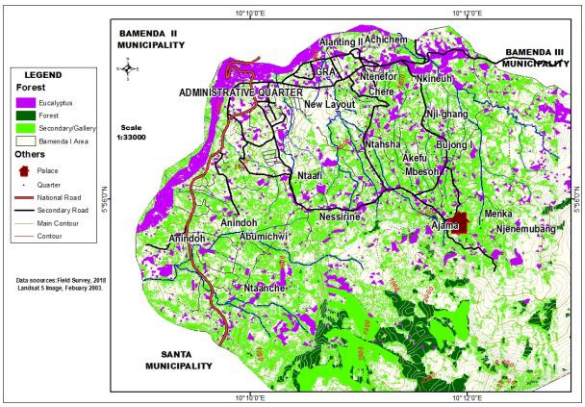

Figure 6: Coverage of eucalyptus tree cover in Bamendankwe, 2003

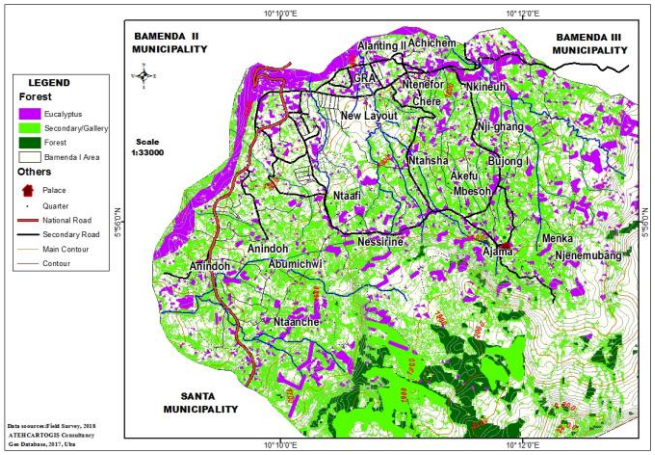

Figure 7: Coverage of eucalyptus tree cover in Bamendankwe, 2017

During this period, most of the indigenes reverted to eucalyptus for fuelwood. The densest eucalyptus plantations are currently located in Alantening, Achichem, Ntenefor, Menka, Nesirine, Ntaafi, Njenemubang (Mubang). The coverage of eucalyptus varied for the different years based on different socio-economic situations of Bamendankwe during that period. With an increase on the knowledge of the socio-economic benefits of eucalyptus, the surface area had increased to about 44% in 2017. This further reduced the available grazing land surface so that there were recurrent conflicts between Awing and Santa-Njong, Baligham and Awing, a general uprising by the villagers of Santa, Awing, Pinyin and Baligham land contract negotiated for an agro-industrial plan. This only exacerbated the number of unlawful activities in the BNFR especially forest replacement on hills are cultivated along water catchments (Table 3).

Table 3: Areas of Eucalyptus cultivation on hills

Areas of cultivation on hills	Frequency	Percentages
Along water bodies and catchments	72	46.5
Grazing lands	52	33.5
On farmlands	30	19.4
Others	1	0.6
Total	155	100.0

Source: Fieldwork, 2018

These hills tend to be areas in which most of water sources in Bamendankwe take their rise or the hills tend to be the source of water supply in Bamendankwe. Some 33.5% of the farmers opted for the cultivation of eucalyptus through indigenous and modern techniques on forest reserve and grazing lands while 19.4% choose the cultivation of eucalyptus on farmland. Takem-Mbi (2013) employed Landsat MSS, 1978 and ASTER images for 2006 and fieldwork to assess the change in forest cover in the BNFR and the results portrayed a forest cover loss of -37% for the 28 years period with average annual decrease rate of 1.3%. Conversely, farmland and shrub/grassland increased by 1 and 0.3% respectively. This implies that the new destructive practices and triggers are farming (40%); fuel wood dealers (17.5%); charcoal burners (12.5%); the Fulani with their livestock rearing (2.5%) and equally illegal timber dealers (7.5%).

The new eucalyptus culture married by the Bamendankwe farmers saw a systematic process involving seeds being sown nurseries for 7-14 days to germinate, then later pricked out into individual containers or polythene sleeves, fertilizing or manuring for healthy and vigorous seedlings, protection (from excess sunlight, strong winds, weeds, pest and diseases), regular watering (morning and evening), routine root pruning until of a plausible planting height of about 25-35 cm, in 4-5 months. Eventually ground preparation is done by eliminating competing vegetal species, creating conditions to improve moisture conservation and rooting conditions for the seedling especially during the dry season. Strip width varies from 1 to 3 m and 10 to 30 m long, depending on the objective of management. Species of Eucalyptus planted in the reserve area depends on the purpose or use of the tree. Species planted for timber and construction poles includes *E. grandis, E saligna, E globules, E hybrids, E paniculata or E camandulensis.* All species of eucalyptus can be planted for fuelwood, charcoal and apiculture.

There is often no pruning of eucalyptus as the species are self-pruning though some minor pruning maybe effected in a bid to enhance owner management, accessibility and security. Those intended for transmission poles, timber and plywood are thinned as a function of site and climatic conditions. Eucalyptus is harvested for the production of fuelwood from 3 years; poles and pulp from 6 to 8 years; transmission poles from 10 to 12 years; timber from 15 to 20 years; and plywood from 20 to 25 years. The stump heights are as close to the ground not exceeding 10 cm in height. Harvesting of eucalyptus is done using various tools depending on the age of the tree comprising machetes, handsaws and power saws. Machetes are the most used on small trees for fuelwood while handsaws are for medium sized trees intended mainly for poles while its leftovers are fuelwood. Engine saws and axes are used for large trees for production of transmission poles, timber, plywood and fuelwood. During harvesting, care is taken not to damage or loosen the bark of the stumps, as this will interfere with coppicing and also that engine oil does not spill, or slash covers the stump so as not to kill them since this also prevent them from growing straight.

Eucalyptus economic pitfalls through community value addition and income earnings as it directly and indirectly builds up to livelihood security and offer myriads of consumable and profitable income and livelihood resources. Eucalyptus cultivation in Bamendankwe complements a multitude of other livelihood activities to ensure household needs that are met year-round without which the people of Bamendankwe would have been unable to survive given the coffee income collapse that even commonplace bee keeping cannot provide (Table 4).

Table 4: Some multiple uses of the Bamendankwe eucalyptus

Products and services	Description	Household % involved	Dominant use area
Energy supply	Dead branches, left-over branches and tree barks burnt for cooking, roasting and household heating up in times of cold or crop preservation	32.3	Bamendankwe and Bamenda city
Conflict prevention	Planks sawn are used for the fencing compounds, the construction of fences for the rearing of animals like pigs, goats and prevent conflict with grazers and their cattle	47	Bamendankwe village
Building and construction engineering	Varied dimensions of planks, decking poles	96	Bamendankwe, Bamenda city and beyond
Medicinal values	Leaves of *E. globulus* cures cold and flus	62	Bamendankwe villages
Honey production	Eucalyptus flowers pollen are bee forage for bee keeping	35	Bamendankwe village
Ecosystem services	Eucalyptus ensure soil stabilisation against landslides	53.55	Bamendankwe and Bamenda city
Socio-economic services	Eucalyptus is a high value cash crop through the sale of fuel wood, planks and charcoal; window and door, wooden objects as trays	53.5	Bamendankwe and Bamenda city

Source: Fieldwork, 2018

The Bamendankwe eucalyptus planted for fuelwood fetches income from the sales of these wood that is often harvested by youths that move into the eucalyptus forests that have won over the natural BNFR trees by cutlasses or axes. The fuelwood meant for homes is, most often, harvested towards the end of the dry season in anticipation of the rainy season so that the woods has the time enough to get dry for use. The Bamendankwe eucalyptus supplies readily available hardwood for much of the Region and even national construction industry. The trees are sawn into planks (of varied dimensions: 2 by 2, 2 by 4, 2 by 6 or 2 by 8) for the building construction and other forms of engineering industry. Some are in the form of decking poles as used in storey buildings. They find a ready and an ever-expanding market in the city of Bamenda and beyond the Region. Worse to that this forest reserve offered less chances of hard wood trees in the like of eucalyptus for the making of urban and rural household furniture, doors and window frames/shutters, wooden objects and decorations

4. CONCLUSION

Eucalyptus cultivation in Bamendankwe appeared as a community stakeholder response to economic melt-down of the 1980s that bruised rural populations in Cameroon. The forest reserve communities could only thus plunge into the massive deforestation of the BNFR as an alternative source of livelihood. A revenge joke by a few individuals has grown into a veritable tragedy of the commons as natural reserve trees have given off space to eucalyptus trees on altitudes of 1600-1900m taking up over 40% of the surface land area of Bamendankwe. Apart of the negative consequence like the drying up of water resources there is the degradation of the landscape and above all the whole purpose and meaning of forest reserve is now thrown into oblivion. Mindful of the adage that *two wrongs cannot make a righ*t, then robust and tacit stratagems must be deployed as panacea to erroneous community reversal to eucalyptus in order to recover losses of the economic crises, and most urgently now that ample knowledge exists on the negate consequences of these trees. As an emergency measure, traditional authorities should even carve out spring sources and catchment areas so as to protect them with planting indigenous tree species like *cordia*, *polysia*, *pygeum* and fruit trees where they can obtain close to the same economic benefits. Eucalyptus cultivated around water catchments should be replaced by environmentally friendly trees.

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