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Impact of land use and land cover change on plant species diversity in the Mount Bambouto Caldera of the Western Highlands of Cameroon

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Abstract

The impact of land use and land cover (LULC) change on the diversity of plant species, loss of plant resources, and environmental degradation remains a puzzle in the context of continuous development. The quest for solutions to curb negative repercussions has increased, particularly on fragile environments where the intensity of other factors may be more aggravating. This work in the Mount Bambouto Caldera aimed to evaluate the impact of land use systems on phytodiversity and propose mitigative strategies against such impacts caused by LULC changes. Characterized by five land use systems that have evolved due to strong human pressures on agro-ecosystems over past decades, this task was achieved through surveys and stratified sampling to establish plant species diversity. The modified Whittaker technique was used comparatively in pilot studies in different strata to investigate plant species diversity. Identification and recording of plant species was followed by data analyses using Microsoft excel 2013 and SPSS version 13.0. Shannon-Wiener diversity, Pielou's evenness, and Simpson diversity indices were used to evaluate data generated from the study plots. 415 plant species were identified with 162, 37, and 70 unique to the lowland, sub-montane and montane savannah zones respectively. Plant species diversity established according to land use management systems (LUMS) decreased with altitude and varied across LUMS with a remarkable drop in richness as the natural forest was subjected to LULC changes. This study has established, for the first time, a phytodiversity inventory of the Mount Bambouto Caldera as affected by LULC and provides the basis for management options to curb devastations and enhance conservation efforts.

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Introduction

Ecosystems are under increasing pressure from human activities, with land use and land use change at the forefront of the drivers that provoke global and regional plant diversity loss (Souza *et al.,* 2015).

The Millennium Ecosystem Assessment (MEA, 2005), intimates that habitat change brought about by land use and land use change (LULUC) is one of the drivers of terrestrial phytodiversity loss, together with climate change, invasive alien species, over exploitation of resources, and pollution.

A major effect of land use on land cover is deforestation, which is rampant in the tropics, accounting for about 8% of anthropogenic carbon dioxide (CO_2) emissions and is the primary cause of species extinctions (Gullison *et al.,* 2007; Raupach *et al.,* 2007; Tubiello *et al.,* 2015).

The decline in plant species diversity occurring rapidly worldwide due to land use and land cover changes adversely affects the functioning, services and stability of ecosystems (MEA, 2005; Naeem *et al.*, 2009)and is becoming a threat to the livelihood of the inhabitants of the Mount Bambouto Caldera (Ayonghe and Ntasin, 2008).

Plant diversity in terms of richness and evenness of species, alleles, functional groups, or ecosystems (Isbell, 2012) is one of the most negatively impacted in all land use and land cover changes.

This results in imbalances in environmental moderation, the quality of natural resources and natural resource provision (food, medicine, and building materials), which all play back on human life either in the meantime or in the future.

Positive relationships between plant diversity and ecosystem functions such as carbon sequestration have been identified in some model ecosystems (van Ruijven and Berendse, 2005), although such relationships appear complex and the positive species/functional diversity relationships are not always very evident (Cadotte *et al.,* 2011).

However, limited understanding of the interrelated effects of land use and land cover change on plant diversity hinders the ability to establish and/or project how accelerated conversions of natural forest will impact the area's terrestrial ecosystem services.

The building up of negative consequences of land use and land cover change on humans and the environment propels the need to inventory and conserve biodiversity, and build and strengthen capacities of smallholder farmers who are already caught in the vicious cycle of poverty, food insecurity and natural resources degradation alleged in the Mount Bambouto Caldera (Ayonghe and Ntasin, 2008).

The Mount Bambouto Caldera which falls within the Cameroon volcanic line, habours rich mineral soils that favour plant growth and various agricultural practices, thereby attracting increasing human settlement in the area (Zangmo *et al*., 2011).

With steady increase in human activities and high levels of unprecedented deforestation around this mountain area (Fonge, 2012), phytodiversity and conservation efforts have become issues and the future of the phytobiota of this area uncertain (Ndam *et al*., 2015).

Studies in the area have opined a great loss in the resource base triggered by anthropogenic activity in the past decades, and the fragility of its predominantly steep slopes, which are marked by frequent mass movements in the rainy season (Ayonghe and Ntasin, 2008). Harvey *et al.* (2010) reported that 70% of the Mount Bambouto Caldera is unknown to botanical science and needs to be inventoried and conserved to avoid the present state of wanton species loss from land uses and frequent natural hazards. Hence, this work aimed to investigate the impacts of land use on plant diversity and establisha baseline plant checklist for future studies in plant resources conservation efforts in the Mount Bambouto Caldera.

Materials and Methods

Study area

The Mount Bambouto Caldera is located between latitudes 5°44′ and 5°36′N and longitudes 9°55′ and 10°07′E with an altitudinal range from 200 - 2700 m a.s.l. It is a multi-agricultural production system in the western highlands of Cameroon (Fig. 1a, 1b) that receives between 2000 – 3000 mm of annual rainfall. The mean monthly maximum and minimum temperatures are 32°C and 17°C, respectively with the area characterized by a moist climate with two seasons namely the rainy season, which runs from March to October, and the dry season from November to February (Toh *et al.*, 2018).

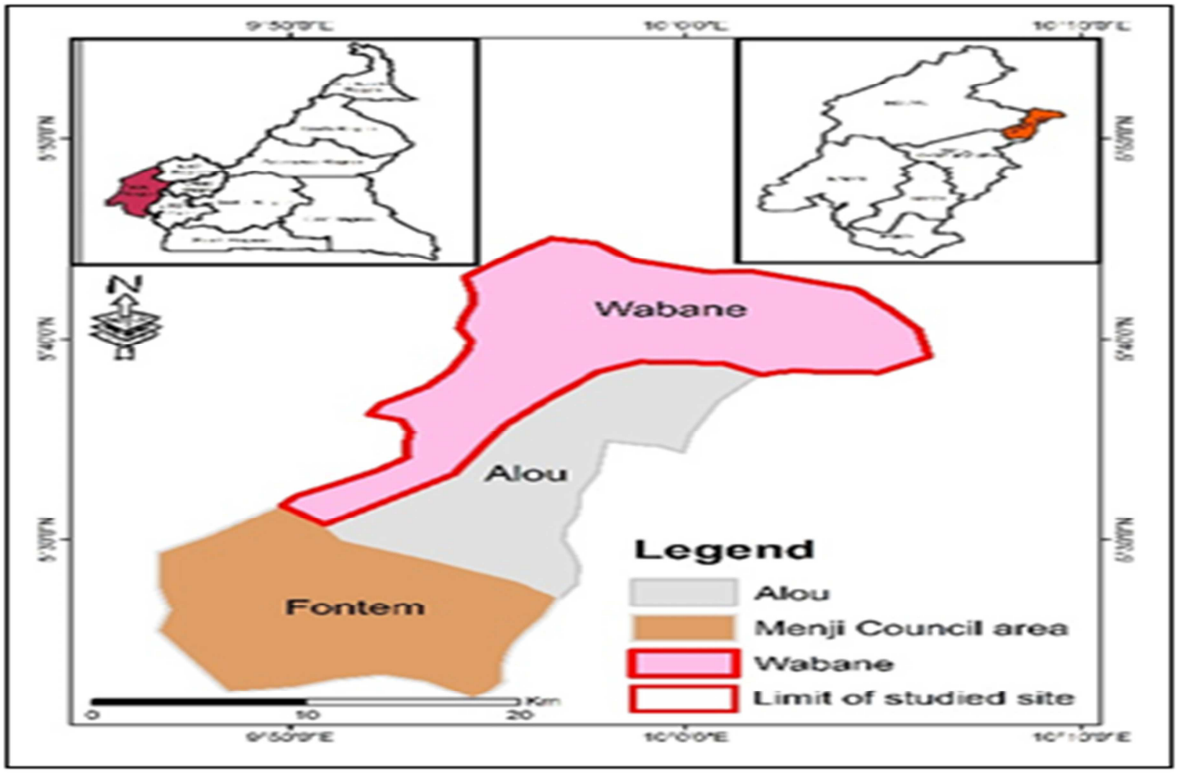

Fig. 1a. Location of Mount Bambouto Caldera (Toh *et al.*, 2018).

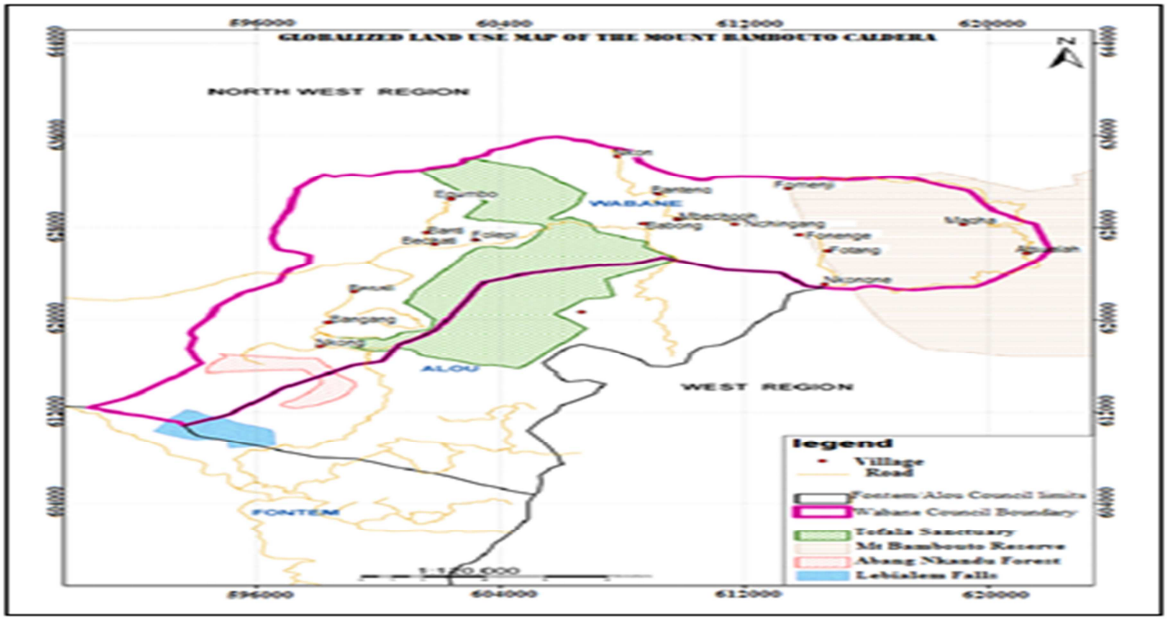

Fig. 1b. Globalized Land Use Sections in the Mount Bambouto Caldera.

Five prominent land use systems have evolved in this study area as a result of strong human pressures and have affected the agro-ecosystems over the past 30 years (Tematio *et al.,* 2011). These land use systems are grassland/animal rearing covering about 2,000 ha (Fig. 2a) in the montane zone, croplands that span over about 8,000 ha of the total surface area (Fig. 2b), settlements/agroforestry estimated at less than 200 ha (Fig. 2c), oil palm (Fig. 2d)/cocoa (Fig. 2e) plantations which preponderate approximately 5,000 ha of lowland forest, and forest/fallow lands (Fig. 2f) that occupy nearly 15,000 ha of the land surface area (Toh *et al.,* 2018).

Data collection

Plant species diversity

The modified Whittaker technique was used comparatively in pilot studies in different strata of the study site, with a total of six plots employed: two in each strata, to investigate plant species diversity. The modified Whittaker plot (Fig. 3) was set up according to Stohlgren *et al.*, 1995, with dimensions of 20 m by 50 m (1000 m²) and containing nested subplots of three different sizes: a 100 m² subplot at the centre, two 10 m² subplots at the opposite corners, and ten 1 m² subplots: six arranged systematically inside and adjacent to the 1000 m² plot perimeter and four arranged systematically outside and adjacent to the 100 m² subplot perimeter. The 20 m x 50 m plot was laid out starting from the centre and marked using a rope 25 m from the centre to both sides. Plots were placed to the major environmental gradient of the vegetation type being sampled, so as to encompass the greatest heterogeneity.

Plant species identification

Plot scanning for species identification was done starting from the 0.2 m × 5 m, to the 2 m × 5 m, 5 m × 20 m subplots, and finally to the 20 m × 50 m plot. All plant species present in these plots were identified with the help of a botanist. Any plant that was not identified in the wild was collected and later on identified in the herbarium. Subplots were handled separately and species present in a subplot laid inside another were recorded as present in all.

Photographs were taken at each 20 m × 50 m plot and 5 m × 20 m subplots to document the landscape and the structure of the vegetation. Monitoring involved identification and recording of all species present in the 20 m × 50 m plot.

Data analysis

Microsoft Excel 2013 for windows was used to input data and SPSS version 13.0 (SPSS Inc. Chicago IL, USA) was used to analyse the data collected from the field plots. The database containing information on the list of species known to occur in Africa, as prepared and updated by the National Herbarium in Cameroon, was consulted on species names and other information needed as well as authentication by Botanists at the Limbe Botanic Garden, Cameroon. Voucher specimens were deposited at the Limbe Botanic Garden.

Species diversity indices

Using data from this study, species diversity at the sampling sites and across zones was calculated using standard methods including Shannon-Wiener and three variants of Simpson's indices, as well as Hill numbers. Shannon-Wiener diversity was calculated as $H' = - \Sigma_i (P_i) (\ln P_i)$,

where P_i is the relative abundance of each species, and ln is the natural logarithm. Evenness was therefore determined using Pielou's formula:

$$\text{Evenness} = J' = \frac{H'}{-\sum_{i=1}^{s} \frac{1}{s} \ln\left(\frac{1}{s}\right)} = \frac{H'}{\ln(S)}$$

where H' is the Shannon-Wienner index, S is species richness and ln is the natural logarithm.

Simpson's index of dominance (λ) was measured using the formula given by Simpson (1949):

$\lambda = \sum_{i=1}^{s} P_i^2$ and

Species diversity according to Simpson's index: $D = \frac{1}{\lambda} = \frac{1}{\sum_{i=1}^{s} Pi^2}$

Variants of Simpson's index namely 1/D and 1-D were then computed and Hill numbers calculated as follows:

$N_0 = (\Sigma P_i^0)^1$

$N_1 = e^{(\Sigma\, Pi\, lnPi)}$

$N_2 = (\Sigma P_i^2)^{-1}$,

where P_i is the relative abundance of each species, e is exponent and ln is natural logarithm.

The data obtained was analysed using Species Diversity and Richness – PISCES Conservation Ltd (version 2.65) and Microsoft Excel. The mean was used as a measure of central tendency with standard deviation as the measure of variability. Parametric one-way analysis of variance (ANOVA) was used to test for statistically significant differences between the means of measured vegetation parameters across the five land use systems.

Results and discussion

Plant species diversity

415 plant species were recorded in the Mount Bambouto Caldera belonging to 125 families and 319 genera (Table 3). The most prominent family was Asteraceae (34 species) followed by Fabaceae (26 species) and Rubiaceae (24 species) (Fig. 4). Many species showed a specific occurrence pattern with 162, 37, and 70 being unique to the lowland area, sub-montane middle zone and montane savannah respectively (Table 3). The fern *Dryopteris felix-mas, the spike moss Sellaginella myosurus,* and the grassy *Loudetia arundincea* were the most abundant species in the Lowland, Sub-montane and Montane Savannah respectively. Overall, the most abundant plant species was *Cynodon dactylon* while *Bidens pilosa* was significantly ubiquitous across all the sections.

Table 1. Plant Species Diversity across Sampled Village Sites in the Mount Bambouto Caldera of the Western highlands of Cameroon.

SITE	S	D	1- D	1 / D	H	H MAX	E	Hill Numbers (Effective Number of Species)		
								No	N1	N2
Magha	59.000	37.193	- 36.193	0.027	3.818	4.078	0.936	59.000	45.503	37.193
Atsualah	66.000	43.596	- 42.596	0.023	3.944	4.190	0.941	66.000	51.641	43.596
Marita	55.000	37.607	- 36.607	0.027	3.778	4.007	0.943	55.000	43.725	37.607
Nkongne	65.000	36.782	- 35.782	0.027	3.820	4.174	0.915	65.000	45.621	36.782
Banteng	101.000	56.804	- 55.804	0.018	4.232	4.615	0.917	101.000	68.886	56.804
Talung	119.000	76.725	- 75.725	0.013	4.513	4.779	0.944	119.000	91.172	76.725
Ekotoneh	109.000	60.968	- 59.968	0.016	4.328	4.691	0.923	109.000	75.803	60.968
Tekouh	83.000	53.313	- 52.313	0.019	4.019	4.419	0.344	83.000	62.719	53.313
Egumbo	84.000	50.846	- 49.846	0.020	4.094	4.431	0.924	84.000	60.003	50.846
Folepi	89.000	53.570	- 52.570	0.019	4.178	4.489	0.931	89.000	65.252	53.570
Bechati	97.000	60.362	- 59.362	0.017	4.293	4.575	0.938	97.000	73.186	60.362
Besali	100.000	68.727	- 67.727	0.015	4.389	4.605	0.953	100.000	80.573	68.727
Bangang	82.000	48.169	- 47.169	0.021	4.081	4.407	0.926	82.000	59.203	48.169
Nkong	96.000	65.952	- 64.952	0.015	4.320	4.564	0.947	96.000	75.208	65.952

There were 125 tree species, 56 shrubs, and 237 herbs, with *Elaeis guineensis, Mimosa pudica,* and *Cynodon Dactylon* being the most abundant species respectively (Fig. 5). The zonal abundance of top five plant families in the study area is presented in Fig. 6 while the dominance of top twelve plant families in proportion of species richness (172 species) presented in fig. 4 ranges from the most dominant family Asteraceae to Sterculiaceae and represents 41.1% of the recorded plant species.

The comprehensiveness of this plant inventory makes it first of its kind in the study site compared to other studies previously reported in the region.

Table 2. Plant Species Diversity across Zones and Land Use Management Systems in the Mount Bambouto Caldera of Cameroon.

ZONE / LUMS	S	D	1-D	1 / D	H	HMAX	E	Hill Numbers (Effective Number of Species)		
								N0	N1	N2
Lowland Forest	298	109.949	- 108.949	0.01	4.912	5.562	0.854	298	152.620	109.949
Lowland Cropland	92	53.570	- 52.570	0.02	4.178	4.489	0.931	92	65.252	53.570
Submontane Forest	307	113.270	- 112.270	0.01	5.060	5.730	0.880	307	157.230	113.270
Submontane Cropland	103	56.804	- 55.804	0.02	4.232	4.615	0.917	103	68.886	56.804
Montane Savannah	79	48.169	- 47.169	0.02	4.081	4.407	0.926	79	59.203	48.169
Montane Cropland	62	36.782	- 35.782	0.03	3.820	4.174	0.915	62	45.621	36.782

In these studies, Focho *et al.* (2009) reported 133 medicinal plant species belonging to 59 families and 116 genera in Aguambu, Harvey *et al.* (2010) carried out surveys between Fosimondi and Bechati, Fonge *et al.* (2013) documented 100 plant species in Lewoh-Lebang, and Ndam *et al.* (2014) inventoried over 200 plant species in the Mount Bambouto Caldera in the study of medicinal plants. In all, Asteraceae saliently came out as the most common plant family in the Mount Bambouto Caldera followed by Fabaceae and Rubiaceae.

Table 3. List of Plant Species Found in the Mount Bambouto Caldera of the Western Highlands of Cameroon Following Land Use and Management Patterns.

Family	Scientific name/author	Lowland region	Submontane Middle zone	Montane Savannah	Total	Form	IUCN category
Malvaceae	*Abelmoschus moschatus* Medik.	57	62	24	143	Shrub	LC
Euphorbiaceae	*Acalypha ciliate* Forrsk.	90	36	7	133	Herb	LC
Acanthaceae	*Acanthus montanus* (nees) T. Anders	273	101	131	505	Herb	LC
Araceae	*Achomanes difformis* (Blume) Engl.	26	26	0	52	Herb	LC
Amaranthaceae	*Achyranthes aspera* L.	274	77	186	537	Herb	LC
Poaceae	*Acroceras zizanioides* (kunth) Dandy.	47	0	208	255	Herb	LC
Passifloaceae	*Adenia lobata* (Jacq.) Engl.	39	0	0	39	Herb	LC
Bombacaceae	*Adansonia digitata*† L.	9	0	0	9	Tree	LC
Zingiberaceae	*Aframomum danielli** (Hook. f.) K. Schum.	0	22	0	22	Herb	LC
Zingiberaceae	*Aframomum limbatum** (Oliv. & D. Hanb.) K. Schum.	0	129	0	129	Herb	LC
Zingiberaceae	*Aframomum melegueta*† K. Schum.	174	0	0	174	Herb	LC
Zingiberaceae	*Aframomum sanguineum*† (K.Schum) K. Schum	20	0	0	20	Herb	NE

Huaceae	*Afrostyrax lepidophyllus* Mildbr.	36	0	5	41	Herb	LC
Agavaceae (int)	*Agave americana*‡ L.	0	0	25	25	Herb	LC
Agavaceae (int)	*Agave sisalana*‡ Perrine	0	0	3	3	Herb	LC
Asteraceae	*Ageratum conyzoides* Linn.	342	52	174	568	Herb	LC
Rubiaceae	*Argostemma africanum*†	5	0	0	5	Herb	LC
Fabaceae	*Albizia adianthifolia* (Schum & Thonn.) W.F. Wight	5	79	0	84	Tree	LC
Leguminosae Mimosoideae	*Albizia zygia* (DC.) J.F. Macbr.	159	18	0	177	Tree	LC
Euphorbiaceae	*Alchornea cordata*† Benth.	84	0	0	84	Shrub	LC
Euphorbiaceae	*Alchornea cordifolia* (Schum &Thonn.) Mull,Arg.	317	137	0	454	Shrub	LC
Euphorbiaceae	*Alchornea subulata*†	84	0	0	84	Shrub	NE
Guttiferae	*Allanblackia floribunda*† Oliv.	44	0	0	44	Tree	LC
Guttiferae	*Allanblackia* sp. Ndive S.N.	6	78	0	84	Tree	LC
Alangiaceae	*Alangium chinense** (Lour.) Harms	0	15	0	15	Tree	LC
Amaryllidaceae	*Allium cepa*‡ L.	0	0	112	112	Herb	LC
Amaryllidaceae	*Allium sativum*‡ L.	0	0	256	256	Herb	LC
Amaryllidaceae	*Allium vineale*‡ L.	0	0	36	36	Herb	NE
Sapindaceae	*Allophylus bullatus* Radlk.	5	39	0	44	Shrub	VU
Xanthorrhocaceae	*Aloe barbadensis*† Mill.	62	0	0	62	Herb	LC
Apocynaceae	*Alstonia boonei* De Wild.	7	1	0	8	Tree	LC
Amaranthaceae	*Alternanthera sessilis* (L.) R. Br. Ex Roth	137	84	0	221	Herb	LC
Amaranthaceae	*Amaranthus hybridus*† L.	275	0	0	275	Herb	LC
Amaranthaceae	*Amaranthus spinosus*† Linn.	263	0	119	382	Herb	LC
Bromeliaceae	*Ananas comosus*† (L.) Merr.	124	0	0	124	Herb	LC
Bromeliaceae	*Ananas momesus*†	84	0	0	84	Herb	LC
Poaceae	*Andropogon citratus* (DC) Stapf	44	162	0	206	Herb	LC
Poaceae	*Andropogon* sp‡ L.	0	0	47	47	Herb	LC

Papilionaceae	*Anglocalyx zenkeri*† Harms	21	0	0	21	Tree	LC
Annonaceae	*Annickia chlorantha*† (Oliv.) Stten & P.J. Maas	47	0	0	47	Tree	LC
Annonaceae	*Annona muricata*† L.	12	0	0	12	Tree	LC
Fabaceae	*Anthonotha fragrans*† (Baker f.) Exell & Hillc>	62	0	0	62	Tree	LC
Fabaceae	*Anthonotha macrophylla*† P. Beauv.	26	0	0	26	Tree	LC
Anacardiaceae	*Antrocaryon klaineanum*† Pierre	7	0	0	7	Tree	LC
Rubiaceae	*Argocoffeopsis fosimondi**	0	8	0	8	Shrub	CR
Asteraceae	*Artemisia ludoviciana* Nutt	177	22	0	199	Herb	NE
Asparagaceae	*Asparagus africanus*‡	0	0	165	165	Herb	DD
Compositae	*Aspilia africana* L.M.A.A. Du Petit-Thouars	483	164	30	677	Herb	LC
Aspleniaceae	*Asplenium paucijugum*‡ Ballard	0	0	5	5	Herb	NE
Poaceae	*Axonopus compressus* (SW) P.Beauv.	10	0	88	98	Herb	LC
Meliaceae	*Azadirachata indica*† A. Juss	37	0	0	37	Tree	LC
Sapotaceae	*Baillonella toxisperma*† Pierre	10	0	0	10	Tree	VU
Apocynaceae	*Baissea gracillima*† (k. Schum) Hua	5	0	0	5	Shrub	LC
Cucurbitaceae	*Bambekea racemosa*† Cogn.	28	0	0	28	Herb	LC
Poaceae	*Bambusa* sp† Schreb.	46	0	0	46	Tree	LC
Fabaceae	*Baphia nitida*† Lodd.	101	0	0	101	Tree	LC
Fabaceae	*Baphia* sp† Lodd.	2	0	0	2	Tree	NE
Passifloraceae	*Bateria fistulosa* Mast.	37	24	0	61	Tree	LC
Begoniaceae	*Begonia adpressa*‡ Sosef	0	0	15	15	Herb	EN
Begoniaceae	*Begonia ampla*‡ Hook.f	0	0	8	8	Herb	LC
Begoniaceae	*Begonia eminii*† Warb.	3	0	0	3	Herb	LC
Begoniaceae	*Begonia pseudoviola*† Gilg.	2	0	0	2	Herb	EN
Begoniaceae	*Begonia quadrialata*† Warb.	24	0	0	24	Herb	LC
Asteraceae	*Bidens barteri*‡ (Oliv. & Hiern) T.G.J. Rayner	0	0	18	18	Herb	LC

Asteraceae	*Bidens pilosa* (Roxb.) Wild	295	108	242	645	Herb	LC
Sapindaceae	*Blighia welwitschii*† (Hiern) Radlk.	7	0	0	7	Tree	LC
Asteraceae	*Blumea aurita* (Linn.F.) DC	0	44	92	136	Tree	LC
Malvaceae	*Bombax buonopozense*† P. Beauv.	6	0	0	6	Tree	LC
Rubiaceae	*Borreria princeae* * k. Schum	0	45	0	45	Herb	LC
Rubiaceae	*Borreria* sp†	22	0	0	22	Herb	LC
Rubiaceae	*Borreria stricta*† K. Schum. Var.princeae	247	0	0	247	Herb	LC
Phyllanthaceae	*Bridelia micrantha* (Hochst.) Baill.	43	62	0	105	Tree	LC
Acanthaceae	*Brilliantaisia owariensis*† P. Beauv.	23	0	0	23	Herb	LC
Acanthaceae	*Brilliantaisia vogeliana* Ver texto	384	52	0	436	Herb	LC
Crassulaceae	*Bryophyllum pinnatum* (Lam.) Oken	145	89	42	276	Herb	NE
Scrophulariaceae	*Buchnera capitata*‡ Burm.f	0	0	2	2	Herb	LC
Fabaceae	*Caesalpinia pulcherima** L.	0	9	0	9	Herb	LC
Araceae	*Caladium Bicolor** Vent	0	5	0	5	Herb	LC
Arecaceae	*Calamus rotang*† L.	24	0	0	24	Tree	NE
Fabaceae	*Calliandra calothyrsus*† Meisn.	51	0	0	51	Tree	LC
Myrtaceae	*Callistemon viminalis*‡ (Sol. Ex Gaertn.) G. Don ex Loudon	0	0	66	66	Tree	LC
Achariaceae	*Caloncoba glauca*†	16	0	0	16	Tree	NE
Fabaceae	*Calopogonium muconoides*† Desv.	22	0	0	22	Herb	LC
Burseraceae	*Canarium schweinfurthii* * Engl.	0	8	0	8	Tree	LC
Solanaceae	*Capsicum annum* L.	25	50	0	75	Herb	LC
Solanaceae	*Capsicum Frutescence* L.	28	43	0	71	Herb	LC
Meliaceae	*Carapa procera* D.C.	15	13	0	28	Tree	LC
Caricaceae	*Carica papaya*† L.	20	0	0	20	Herb	LC
Fabaceae	*Cassia mimosoides*‡ sensu Shimabuku	0	0	80	80	Herb	LC
Fabaceae	*Cassia obtusifolia*‡ L.	0	0	51	51	Herb	LC

Fabaceae	*Cassia occidentallis* L.	109	20	0	129	Herb	NE
Fabaceae	*Cassia* sp.† L.	8	0	0	8	Herb	NE
Apocynaceae	*Catharanthus roseus* (L.) G. Don	21	29	0	50	Herb	LC
Apiaceae	*Caucalis melanantha*‡ (Hochst.) Hiern.	0	0	89	89	Herb	LC
Malvaceae	*Ceibia pentandra*† (L.) Gaerm	110	0	0	110	Tree	LC
Ulmaceae	*Celtis zenkeri*† Engl.	31	0	0	31	Tree	LC
Apiaceae	*Centella asiatica* (L.) Urb.	284	75	0	359	Herb	LC
Rubiaceae	*Cephaelis* sp.*	0	5	0	5	Shrub	LC
Icacinaceae	*Chlamydocarya thomsoniana*† Baill.	3	0	0	3	Herb	LC
Asteraceae	*Chromolaena odorata* (L.) R. M. King & Robison (= Euparium odoratum L.)	370	103	0	473	Shrub	LC
Sapotaceae	*Chrysophyllum* sp.† L.	5	0	0	5	Tree	NE
Rutaceae	*Citrus aurantifolia*† (christm.) Swingle	130	0	0	130	Tree	LC
Rutaceae	*Citrus paradisiaca*† L.	151	0	0	151	Herb	LC
Rutaceae	*Citrus sinensis*† (L.) Osbeck	259	0	0	259	Herb	LC
Capparidaceae	*Cleome viscosa*‡ L.	0	0	67	67	Herb	LC
Arecaceae	*Cocos nucifera*† L.	296	0	0	296	Tree	LC
Euphorbiaceae	*Codiaeum variegatum*† (L.) Rumph. Ex A. Juss.	33	0	0	33	Herb	LC
Rubiaceae	*Coffea arabica** L.	0	103	0	103	Shrub	LC
Rubiaceae	*Coffea robusta* L.	69	72	0	141	Shrub	LC
Sterculiaceae	*Cola acuminata** (P. Beauv.) Schott & Endl.	0	22	0	22	Tree	LC
Sterculiaceae	*Cola heterophylla** (P. Beauv.) Schott & Endl.	0	22	0	22	Shrub	LC
Sterculiaceae	*Cola lepidota* K. Schum	204	86	0	290	Tree	LC
Sterculiaceae	*Cola megalophylla** Brenan and Keay	0	9	0	9	Tree	EN
Araceae	*Colocasia esculenta** (L.) Schott	0	46	0	46	Herb	LC
Commelinaceae	*Commelina capitata*† Benth.	10	0	0	10	Herb	LC

Commelinaceae	*Commelina benghalensis* L. var. benghalensis	347	60	46	453	Herb	LC
Commelinaceae	*Commelina diffusa* Burm.f.	0	84	88	172	Herb	LC
Asteraceae	*Conyza bonnariensis* (L.)Cronq.	173	17	17	207	Herb	LC
Asteraceae	*Conyza floribunda*† Kunth	77	0	0	77	Herb	LC
Boraginaceae	*Cordia platythyrsa*† Baker	27	0	0	27	Tree	LC
Costaceae	*Costus afer* Ker Gawl	402	72	0	474	Herb	LC
Compositae	*Crassocephalum rubens*† (Juss.ex Jacq.) S. Moore	0	0	4	4	Herb	LC
Compositae	*Crassocephalum bougheyanum* C.D. Adams	8	100	0	108	Herb	VU
Compositae	*Crassocephalum montuosum*‡ (S. Moore) Milne-Redh.	0	0	79	79	Herb	LC
Fabaceae	*Crotalaria retusa* L.	6	31	0	37	Herb	LC
Cucurbitaceae	*Cucurbita mixima*† K. Koch	23	0	115	138	Herb	LC
Cupressaceae	*Cupressus funebris*‡ Endl.	0	0	115	115	Tree	NE
Cyatheaceae	*Cyatheca camerooniana* Hook.	0	6	80	86	Tree	NE
Mimosaceae	*Cylicodiscus gabunensis*† Harms	5	0	0	5	Tree	LC
Poaceae	*Cymbopogon citratus* (D.C.) Stapf	161	22	0	183	Herb	LC
Poaceae	*Cynodon dactylon* (Linn.) Pers.	297	123	339	759	Herb	LC
Cyperaceae	*Cyperus distans*† L.f.	18	0	0	18	Herb	LC
Cyperaceae	*Cyperus esculentus* L.	365	32	126	523	Herb	LC
Cyperaceae	*Cyperus fertilis*† Boeckeler	16	0	0	16	Herb	LC
Burseraceae	*Dacryodes igaganga* Aubr. & Pellegr	3	7	0	10	Tree	VU
Burseraceae	*Dacryodes edulis* (G. Don.) H.J. Lam	276	3	0	279	Tree	LC
Burseraceae	*Dacryodes Klaineana* (Pierre) H.J.Lam	0	13	0	13	Tree	LC
Leguminosae-Papilionoideae	*Dalbergia saxatilis*† Hook f.	46	0	0	46	shrub	NE
Solanaceae	*Datura stramonium*‡ L.	0	0	199	199	Herb	LC
Apiaceae	*Daucus carota*‡ L.	0	0	186	186	Herb	LC

Loganiaceae	*Desbodesia* sp† (Engl.) Tiegh	7	0	0	7	Herb	NE
Papilionaceae	*Desmodium adscendens* Miq.	425	250	0	675	Herb	LC
Leguminosae	*Dialium guineensis* Willd.	30	82	16	128	Tree	LC
Dioscoreaceae	*Dioscorea alata*† L.	28	0	0	28	Herb	LC
Dioscoreaceae	*Dioscorea bulbifera*† L.	72	0	0	72	Herb	LC
Ebenaceae	*Diospyros iturensis*† (Gurke) Letounzey & F.White	13	0	0	13	Tree	LC
Athyriaceae	*Diplazium sammatti* (Kuhn) C. Chr.	258	46	0	304	Herb	LC
Melastomataceae	*Dissotis erecta* (Guill. & Perr.) Dandy	166	22	203	391	Herb	LC
Dracaenaceae	*Dracaena mannii* Baker	47	0	65	112	Tree	LC
Dracaenaceae	*Dracaena arborea* (Willd.) Link	0	72	5	77	Tree	LC
Dracaenaceae	*Dracaena camerooniana*‡ Baker	0	0	26	26	Tree	LC
Caryophyllaceae	*Drymaria cordata* (L.) Willd.	431	111	0	542	Herb	LC
Dryopteridaceae	*Dryopteris felix-mas* (L.) Schott	590	57	0	647	Herb	LC
Fabaceae	*Duparquetia orchidaceae* Baill.	41	69	0	110	Tree	LC
Poaceae	*Echinochloa obstusiflora* Stapf	43	46	0	89	Herb	LC
Asteraceae	*Eclipta prostrata* (Linn.) L. (=E. alba (L.) Hassk.)	24	0	262	286	Herb	LC
Asteraceae	*Eclipta sp*‡ L.	0	0	46	46	Herb	NE
Palmae	*Elaeis guineensis* Jacq.	353	8	0	361	Tree	LC
Poaceae	*Eleusine indica* Gaertn.	399	138	0	537	Herb	LC
Asteraceae	*Emilia Cocinea* (Sims) g. Don	199	144	50	393	Herb	LC
Meliaceae	*Entahndrophragma angolense** (Welw.) C. DC.	0	79	0	79	Tree	VU
Meliaceae	*Entahndrophragma candollei*† Harms	6	0	0	6	Tree	VU
Compositae	*Erigeron floribundus*† (Kunth) Sch.Bip.	81	0	0	81	Herb	LC
Asteraceae	*Echinops giganteus*‡ A. Rich.	0	0	235	235	Herb	NT
Equisetaceae	*Equisetum arvense** L.	0	9	0	9	Herb	LC

Poaceae	*Eragrostis camerunensis*‡ Clayton	0	0	50	50	Tree	VU
Acanthaceae	*Eremomastax speciosa* (Hoschst.) Cufod.	401	102	0	503	Herb	LC
Asteraceae	*Erigeron floribundus* (H. B. & K.) Sch. Bip. (= Conyza floribunda H.B.& K.)	202	166	0	368	Herb	LC
Fabaceae	*Eriosema* sp‡ (DC) Desv.	0	0	18	18	Shrub	LC
Apiaceae	*Eryngiun foetidium* L.	151	85	44	280	Herb	LC
Myrtaceae	*Eucalyptus saligna* Sm	0	26	320	346	Tree	LC
Asteraceae	*Eupatorium perfoliatum*‡ L.	0	0	12	12	Herb	LC
Euphorbiaceae	*Euphorbia golodrina*† L.C. Wheeler	28	0	0	28	Herb	NE
Euphorbiaceae	*Euphorbia hirta* L.	332	49	0	381	Herb	LC
Euphorbiaceae	*Euphorbia milli* Des Moul.	357	22	0	379	Herb	LC
Euphorbiaceae	*Euphorbia prostrata*† Aiton	88	0	0	88	Herb	LC
Euphorbiaceae	*Euphorbia pulcherrima*‡ Weilld. Ex Klotzsch	0	0	29	29	Herb	LC
Moraceae	*Ficus benghalensis* L.	0	83	25	108	Tree	LC
Moraceae	*Ficus exasperata* V ahl.	74	30	0	104	Tree	LC
Moraceae	*Ficus mucuso* Welw. Ex Ficlho	16	69	0	85	Tree	LC
Moraceae	*Ficus sur* Forssk.	7	0	24	31	Tree	LC
Apocynaceae	*Funtumia elastica*† (Preuss) Stapf	69	0	0	69	Tree	LC
Rubiaceae	*Gaertnera paniculata*† Benth.	7	0	0	7	Tree	LC
Sapotaceae	*Gambeya africana*† (A.DC.) Pierre	6	0	0	6	Tree	LC
Clusiaceae	*Garcinia cola*† Heckel	142	0	0	142	Tree	VU
Rubiaceae	*Geophila afzelli*† Hiern	87	0	0	87	Herb	LC
Geraniaceae	*Geranium arabicum*‡ Forssk.	0	0	25	25	Herb	LC
Colchicaceae	*Gloriosa superba* L.	66	31	0	97	Herb	LC
Tiliaceae	*Glyphaea brevis*† (Spreng.) Monach	66	0	0	66	Herb	LC

Verbenaceae	*Gmelina arborea*† Roxb.	23	0	0	23	Tree	LC
Gnetaceae	*Gnetum africanum*† Welw.	35	0	0	35	Tree	LC
Amaranthaceae	*Gomphrena celosioides** Mart.	0	25	0	25	Herb	LC
Meliaceae	*Guarea glomerulata*‡ Harms	0	0	2	2	Herb	LC
Orchidaceae	*Habenaria mannii*‡ Hook.f.	0	0	80	80	Herb	LC
Marantaceae	*Halopegia azurea*† (K. Schum.) Milne-Redh	44	0	0	44	Herb	LC
Clusiaceae	*Harungana madagascariensis** Lam. Ex Poir	0	26	0	26	Tree	LC
Asteraceae	*Helichrysum aureum*‡ (Houtt.) Merr.	0	0	17	17	Tree	LC
Asteraceae	*Helichrysum cameroonense*‡ Hutch. & Dalziel	0	0	10	10	Tree	EN
Asteraceae	*Helichrysum cymosum*‡ (L.) D. Don	0	0	71	71	Tree	LC
Malvaceae	*Hibiscus rosa-sinensis*† L.	222	0	0	222	Shrub	LC
Malvaceae	*Hibiscus rostellatus*‡ Guill. & Perr.	0	0	23	23	Shrub	LC
Salicaceae	*Homalium dolichophyllum*† Gilg.	3	0	0	3	Tree	LC
Araliaceae	*Hygrocotyle mannii*‡ Hoof.f.	0	0	162	162	Herb	VU
Fabaceae	*Hylodendron gabunense** Taub.	0	14	0	14	Tree	LC
Liliaceae	*Hippeastrum equestre** Linn. Fil.	0	5	0	5	Herb	LC
Balsaminaceae	*Impatiens burtonii*‡ Hook.f.	0	0	27	27	Herb	LC
Balsaminaceae	*Impatiens manii* C.B. Clarke ex Hook.f.	0	26	82	108	Herb	LC
Balsaminaceae	*Impatiens sakeriana*‡ Hook.f.	0	0	23	23	Herb	VU
Balsaminaceae	*Impatiens sodenii*‡ Engl. & Warb	0	0	85	85	Herb	LC
Poaceae	*Imperata Cylindrica* var africana (Anderss.) C.E. Hubbard	44	25	0	69	Herb	LC
Fabaceae	*Indigofera* sp† L.	86	0	0	86	Shrub	LC
Convolvulaceae	*Ipomoea batatas* (L.) Lam. Batatas	94	66	116	276	Herb	LC
Convolvulaceae	*Ipomoea Involucrata* P. Beauv.	77	8	208	293	Herb	LC

Irvingiaceae	*Irvingia gabonensis*† (AuBry-Lecomte ex O'Rorke) Baill	110	0	0	110	Tree	LC
Oleaceae	*Jasminum sambac** var. duplex Voigt	0	1	0	1	Shrub	NE
Menispermaceae	*Jateorhyzia micrantha*† (Hook.F.) Excell & Menonca	27	0	0	27	Herb	LC
Euphorbiaceae	*Jatropha curcas*‡ L.	0	0	54	54	Herb	LC
Juncaceae	*Juncus tenuis*‡ Willd.	0	0	167	167	Herb	NE
Acanthaceae	*Justicia extensa** T. Anderson	0	25	0	25	Herb	LC
Acanthaceae	*Justicia oblongifolia* (Lindau) M.E. Steiner	438	127	0	565	Herb	NE
Acanthaceae	*Justicia tenella*† (nees) T. Anderson	2	0	0	2	Herb	LC
Meliaceae	*Khaya grandifolia*† C.DC.	39	0	0	39	Herb	NE
Bignoniaceae	*Kigelia africana** Benth.	0	21	0	21	Tree	LC
Cyperaceae	*Kylinga squamulata*‡ Vahl	0	0	275	275	Herb	LC
Asteraceae	*Lactuca taraxacifolia* (Willd.) Schum	242	0	239	481	Herb	NE
Cucurbitaceae	*Lagenaria siceraria*† (Molina) Standl.	47	0	0	47	Herb	LC
Asteraceae	*Laggera alata*‡ (D.Don) Sch.Bip.ex Oliv.	0	0	44	44	Herb	LC
Verbenaceae	*Lantana camara* L.	107	22	0	129	Shrub	LC
Urticaceae	*Laportea ovalifolia* (Schum.&Thonn.) Chew.	231	166	16	413	Herb	LC
Cupressaceae	*Cupressus macrocapa*	45	5	0	50	Tree	NE
Leeaceae	*Leea guineensis*† (L.) R. Br. Ex Roth	0	0	42	42	Shrub	LC
Lamiaceae	*Leonotis nepetifolia*‡ (L.) R. Br. Ex Roth	0	0	42	42	Herb	LC
Ochnaceae	*Lophira alata* Banis ex gaertn.f.	9	5	0	14	Tree	VU
Loranthaceae	*Loranthus* sp.† Jacq..	73	0	0	73	Tree	NE
Poaceae	*Loudetia arundincea*† (A. Rich) Hochst.ex Steud	26	0	372	398	Herb	LC
Meliaceae	*Lovoa trichilioides*† Harms	15	0	0	15	Tree	VU
Onagraceae	*Ludwigia decurrens*† Walt. Syn. (=Jussiaea decurrens (Walt) DC.	103	0	0	103	Herb	LC
Euphorbiaceae	*Macaranga monandra** Müll.Arg.	289	22	0	311	Herb	LC

Euphorbiaceae	*Macaranga occidentalis* (Müll.Arg) Müll. Arg.	12	0	7	19	Tree	NT
Euphorbiaceae	*Macaranga spinosa* Müll.Arg.	10	33	0	43	Tree	LC
Myrsinaceae	*Maesa lanceolata* Forssk.	0	12	0	12	Shrub	LC
Chrysobalanaceae	*Magnistipula conrauana*‡ Engl.	0	0	8	8	Shrub	EN
Euphorbiaceae	*Mallotus oppositifolius* (Geisel), Müll. Arg.	289	22	0	311	shrub	LC
Anacardiaceae	*Mangifera indica*† L.	15	0	0	15	Tree	LC
Euphorbiaceae	*Manniophyton fulvum*† Mull.Arg.	7	0	0	7	Herb	LC
Sterculiaceae	*Mansonia altissima*† (A. Chev.) A. Chev.	12	0	0	12	Herb	VU
Marantaceae	*Marantochloa pupurea* (Ridl.) Milne-Redh.	121	114	0	235	Herb	LC
Marattiaceae	*Marattia fraxinea* Sm	0	19	0	19	Herb	NE
Marchantiaceae	*Marchantia polymorpha* L.	165	72	15	252	Herb	NE
Euphorbiaceae	*Mareya micrantha*† (Benth.) Müll.Arg.	11	0	0	11	Shrub	LC
Phyllanthaceae	*Margaritaria discoidea* (Baill.) Webster	4	83	0	87	Tree	LC
Cyperaceae	*Mariscus alternifolius* Vahl(=M.umbellatus Vahl)	233	46	119	398	Herb	NE
Cyperaceae	*Mariscus flabelliformis*† kunth.	49	0	0	49	Herb	LC
Bignoniaceae	*Markhamia tomentosa* Bark.	9	87	0	96	Shrub	LC
Rubiaceae	*Massularia accuminata*† (G. Don) Bullock ex Hoyle	99	0	0	99	Herb	NE
Asteraceae	*Melanthera scandens*† (Schum. & Thonn.) Roberty	27	0	0	27	Herb	LC
Asteraceae	*Melanthera* sp* Rohr	0	50	0	50	Herb	NE
Sterculiaceae	*Melochia corchorifolia*† L.	11	0	0	11	Herb	LC
Cucurbitaceae	*Mukia maderaspatana* (L.) M.Roem.	7	1	208	216	Herb	LC
Acanthaceae	*Mendoncia* sp*	0	84	0	84	Herb	NE
Pandaceae	*Microdesmis puberula*† Hook. F. ex Planch	48	0	0	48	Herb	NE
Meliaceae	*Milicia excelsa*† (Welw.) Benth	14	0	0	14	Tree	NE
Fabaceae	*Mimosa invisa* Mart.	174	26	34	234	Shrub	LC

Fabaceae	*Mimosa pudica* L.	364	0	126	490	Shrub	LC
Cucurbitaceae	*Momordica cissoides*‡ Planch. Ex Benth.	0	0	17	17	Herb	LC
Cucurbitaceae	*Momordica foetida*† Schum. & Thonn.	48	0	0	48	Herb	LC
Annonaceae	*Monanthotaxis* sp† Baill. nov. of Bechati	2	0	0	2	Shrub	NE
Acanthaceae	*Monechma ciliatum** (Jacq.) Milne-Redh.	0	38	0	38	Herb	
Annonaceae	*Monodora myristica* (Gaertn.) Dunal.	80	36	0	116	Tree	LC
Annonaceae	*Monodora tenuifolia** Benth.	0	11	0	11	Tree	LC
Rubiaceae	*Morinda lucida*† Benth.	6	0	0	6	Tree	LC
Moraceae	*Morus alba*† L.		8	0	8	Tree	LC
Fissidentaceae	*Mosses** Schimp. Sensu stricto	0	87	0	87	Herb	NE
Musaceae	*Musa paradisiaca* L.	204	0	48	252	Herb	LC
Musaceae	*Musa sapientum* L.	17	11	0	28	Herb	LC
Cecropiaceae	*Musanga cecropioides* R. Br. Ex Tedie	118	31	0	149	Tree	LC
Rubiaceae	*Mussaenda erythrophylla*† Schumach. & Thonn.	7	0	0	7	Shrub	LC
Rubiaceae	*Mussaenda tenuiflora*† Benth.	4	0	0	4	Herb	LC
Rubiaceae	*Mussenda sp** L.	0	87	0	87	Herb	NE
Moraceae	*Myrianthus holstii*† Engl.	8	0	0	8	Shrub	NE
Moraceae	*Myrianthus arboreus* P. Beauv.	33	15	0	48	Tree	LC
Moraceae	*Myrianthus preussii*† Engl.	4	0	0	4	Herb	NT
Acanthaceae	*Nelsonia canescens*† (Lam.) Spreng.	28	0	0	28	Herb	LC
Araceae	*Nepthythis poissonii*† (Engl.) N.E. Br.	54	0	0	54	Herb	LC
Araceae	*Newbouldia laevis*† (P.Beauv.) Seamann ex Bureau	24	0	0	24	Shrub	NE
Solanaceae	*Nicotiana tabacum* L.	0	29	7	36	Herb	LC
Nymphaeaceae	*Nymphaea lotus*† L.	20	0	0	20	Herb	LC
Lamiaceae	*Ocimum gratissimum* L.	309	20	23	352	Herb	LC

Rubiaceae	*Oldenlandia corymbosa** L.	0	4	0	4	Herb	LC
Sapotaceae	*Omphalocarpum procerum*† P.Beauv.	19	0	0	19	Tree	LC
Flacourtiaceae	*Oncoba dentata*‡	0	0	4	4	Herb	LC
Rubiaceae	*Otomeria elatior*‡ (A.Rich.) Verdc.	0	0	74	74	Shrub	LC
Rubiaceae	*Oxyanthus formosus** Hook. F. ex Planch	0	3	0	3	Shrub	LC
Rubiaceae	*Oxyanthus gracilis*† Hiern	12	0	0	12	Shrub	LC
Commelinaceae	*Palisota ambigua*† (P.Beauv.) C.B. Clarke	86	0	0	86	Herb	LC
Poaceae	*Panicum maximum* Jacq.	235	20	21	276	Herb	LC
Rubiaceae	*Pauridiantha paucinervis** (Hiern) Bremek.	0	4	0	4	Tree	LC
Rubiaceae	*Pavetta gabonica*† Bremek.	5	0	0	5	Tree	LC
Menispermaceae	*Penianthus longifolius*‡ Miers	0	0	6	6	Shrub	LC
Poaceae	*Pennisectum purpureum* L.	83	123	0	206	Herb	LC
Fabaceae	*Pentaclethra macrophylla*† Benth.	41	0	0	41	Tree	LC
Lauraceae	*Persia americana* Mill.	33	59	0	92	Tree	LC
Fabaceae	*Phaseolus vulgaris*‡ L.	0	0	30	30	Herb	LC
Arecaceae	*Phoenix reclinata** Jacq.	0	11	0	11	Tree	LC
Euphorbiaceae	*Phyllanthus amarus*† Schumach. & Thonn.	122	0	0	122	Herb	LC
Solanaceae	*Physalis angulata* L.	0	27	164	191	Herb	LC
Piperaceae	*Piper capense** L. f.	0	5	0	5	Shrub	LC
Piperaceae	*Piper umbellatum* L.	396	110	0	506	Shrub	LC
Fabaceae	*Piptadeniastrum africanum*† Hook. F. ex Planch	0	0	22	22	Tree	LC
Labiatae	*Plectranthus decumbens*‡ Hook.f.	2	0	0	2	Herb	NT
Lamiaceae	*Plectranthus epilithicus*‡ B.J. Pollard	0	0	8	8	Herb	LC
Lamiaceae,	*Platostoma africanum* P. Beauv.	181	40	0	221	Herb	LC
Icacinaceae	*Polycephalium lobatum*† (Pierre) Pierre ex Engl.	2	0	0	2	Tree	LC

Araliaceae	*Polyscias fulva* (Hiern) Harms	25	17	0	42	Tree	NT
Polygonaceae	*Polygonium lanigerum*† R.Br.	50	0	0	50	Herb	LC
Polygonaceae	*Polygonium salicifolum*† Brouss es. Wild	24	0	144	168	Herb	NE
Portulacaceae	*Portulaca oleracea*‡ L	0	0	138	138	Herb	LC
Urticaceae	*Pouzolzia guineensis*‡ Benth.	0	0	37	37	Shrub	LC
Rosaceae	*Prunus africana* (Hook. F.) Kalkman	0	5	55	60	Tree	NT
Anacardiaceae	*Pseudospondias sp** Engl.	0	9	0	9	Herb	NE
Anacardiaceae	*Pseudospondias longifolia*† Engl.	6	0	0	6	Tree	LC
Myrtaceae	*Psidium guajava*† L.	52	0	0	52	Shrub	LC
Rubiaceae	*Psychotria sp*† Ruiz & Pav.	93	0	0	93	Tree	NE
Rubiaceae	*Psydrax dunlapii** (Hutch. &Dalziel) Bridson	0	3	0	3	Shrub	LC
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn	0	159	173	332	Herb	LC
Euphorbiaceae	*Tetracarpidium conophorum*† (Müll.Arg.) Hutch. & Dalziel	7	0	0	7	Shrub	LC
Myristicaceae	*Pycnanthus angolensis*† (Welw.) Warb.	5	0	0	5	Tree	LC
Arecaceae	*Raphia farinifera* (Gaertn.) Hyl.	90	90	0	180	Tree	LC
Apocynaceae	*Rauvolfia manii*† Stapf	10	0	0	10	Herb	LC
Apocynaceae	*Rauvolfia vomitoria*† Afzel.	22	0	0	22	Herb	LC
Ceratophyllaceae	*Ceratophylum sp*†	10	0	0	10	Herb	LC
Zingiberaceae	*Renealmia africana** Benth.	0	9	0	9	Herb	LC
Rubiaceae	*Richardia brasiliensis* Gomez	92	88	24	204	Shrub	LC
Euphorbiaceae	*Ricinodendron heudelotii*† (Baill.) Heckel	31	0	0	31	Tree	LC
Euphorbiaceae	*Ricinus communis*‡ L.	0	0	7	7	Shrub	LC
Rosaceae	*Rubus pinnatus* Willd.	0	6	34	40	Herb	LC
Polygonaceae	*Rumex acetosella*‡ L.	0	0	322	322	Herb	LC
Celastraceae	*Salacia lebrunii*† R. Wilczek	4	0	0	4	Shrub	VU

Marantaceae	*Sarcophrynium prionogonium* † (K.Schum.) K. Schum. Var. Prionogonium	94	0	0	94	Shrub	LC
Labiatae / Lamiaceae	*Satureja biflora*‡ (Buch.-Ham.ex D. Don) Briq.	0	0	95	95	Herb	NE
Amaryllidaceae	*Scadoxus membranaceus*† (Baker) Friis & Nordal	51	0	0	51	Herb	NE
Araliaceae	*Schefflera abyssinica* (A.Rich.) Harms	24	58	0	82	Tree	LC
Cyperaceae	*Sceleria verrucosa*† Willd.	43	0	0	43	Herb	LC
Plantaginaceae	*Scoparia dulcis*† L.	227	0	0	227	Herb	LC
Fabaceae	*Scorodoploeus zenkeri*†	6	0	0	6	Shrub	NE
Selaginellaceae	*Selaginella vogelli*‡ Vogelii	0	0	21	21	Herb	NE
Selaginellaceae	*Selaginella kraussiana* Spring	90	94	0	184	Herb	NE
Selaginellaceae	*Selaginella myosurus* Alston	0	196	0	196	Herb	NE
Selaginellaceae	*Selaginella braunii* Baker	10	74	0	84	Herb	NE
Asteraceae	*Senecio articulatus*‡ (L. f.) Sch. Bip.	0	0	49	49	Herb	NE
Asteraceae	*Senecio burtonii** Hook. F. ex Planch	0	28	0	28	Herb	VU
Asteraceae	*Senecio sp*‡	0	0	19	19	Herb	VU
Fabaceae	*Senna alata* (L.) Roxb	24	57	0	81	Herb	LC
Dracaenaceae	*Sansevieria liberica*† Gerome &Labroy	132	0	0	132	Herb	LC
Poaceae	*Setaria barbata** (Lam.) Kunth	0	67	0	67	Herb	LC
Malvaceae	*Sida corymbosa*† R. E. Fries	102	0	0	102	Herb	DD
Malvaceae	*Sida acuta* Burm. F.	226	48	0	274	Herb	LC
Malvaceae	*Sida rhombifolia*† L.	9	0	0	9	Herb	LC
Smilacaceae	*Smilax kraussiana** Meisn.	0	100	0	100	Shrub	NE
Compositae	*Solanecio biafrae** (Oliv. & Hiern) C. Jeffrey	0	26	0	26	Herb	LC
Solanaceae	*Solanum macrocarpom*† Lam.	157	0	0	157	Herb	LC
Solanaceae	*Solanum melongena*† L.	48	0	0	48	Herb	LC
Solanaceae	*Solanum nigrum* L.	0	26	84	110	Herb	LC

Solanaceae	*Solanum torvum*‡ SW.	0	0	23	23	Herb	LC
Solanaceae	*Solanum tuberosum*‡ L.	0	0	172	172	Herb	LC
Lamiaceae	*Plectranthus monostachyus* (P. Beauv.) Briq.	49	56	295	400	Herb	NE
Scrophulariaceae	*Scoparia dulcis*†	73	0	0	73	Herb	LC
Bignonaceae	*Spathodea campunulata* P. Beauv.	8	63	0	71	Tree	LC
Compositae	*Spilanthes filicaulis* (Schum. & Thonn.) C.D. Adams	204	28	83	315	Herb	LC
Phyllanthaceae	*Spondianthus preussi*† Engl.	2	0	0	2	Tree	LC
Poaceae	*Sporobolus sp*‡ R. Br.	0	0	17	17	Herb	NE
Verbenaceae	*Stachytarpheta cayennensis*† (Rich.) Vahl	31	0	0	31	Herb	LC
Caryophyllaceae	*Stellaria asiatica*†	78	0	0	78	Herb	NE
Caryophyllaceae	*stellaria media* (L.) Vill.	340	96	0	436	Herb	LC
Menispermaceae	*Stephania abysinica*† (Quart.-Dill. & A. Rich.) Walp.	14	0	0	14	Herb	LC
Asteraceae	*Syndrella nodiflora*† Gaertn.	190	0	0	190	Herb	LC
Asteraceae	*Syndrella gaertny*† (L.) Gaertn.	55	0	0	55	Herb	LC
Myrtaceae	*Syzygium jambos* (L.) Alston	0	4	17	21	Tree	NE
Apocynaceae	*Tabernaemontana sp* L	0	9	6	15	Shrub	NE
Talinaceae	*Talinum fruticosum* (Jacq.) Willd.	160	87	0	247	Herb	LC
Dichapetalaceae	*Tapura africana*† Oliv.	6	0	0	6	Tree	LC
Lamiaceae	*Tectonia grandis*† L.f	39	0	0	39	Tree	LC
Combretaceae	*Terminalia catappa*† L.	9	0	0	9	Tree	LC
Combretaceae	*Terminalia ivorensis*† A. Chev.	8	0	0	8	Tree	LC
Combretaceae	*Terminalia mantaly*† H. Perrier	26	0	0	26	Tree	LC
Combretaceae	*Terminalia superba*† Engl. & Diels	8	0	0	8	Tree	LC
Fabaceae	*Pterocarpus soyauxii*† Taub	20	0	0	20	Tree	LC
Dilleniaceae	*Tetracera alnifolia*† Willd.	46	0	0	46	Shrub	LC
Fabaceae	*Tetrapleura tetraptera*† (Schum & Thonn) Taub	33	0	0	33	Tree	LC

Sterculiaceae	*Theobroma cacao* L.	518	65	0	583	Tree	LC
Acanthaceae	*Thunbergia fasciculata*† Lindau	9	0	0	9	Tree	LC
Asteraceae	*Tithonia diversifolia*† (Hemsl.) A. Gray	26	0	0	26	Tree	LC
Ulmaceae	*Trema orientalis*† (L.) Blume	25	0	0	25	Tree	LC
Melastomataceae	*Tristemma* sp†	5	0	0	5	Shrub	NE
Asteraceae	*Tridax procumbens* L.	370	42	0	412	Herb	LC
Moraceae	*Trilepisium madagascariensis** DC.	0	95	0	95	Tree	LC
Sterculiaceae	*Triplochyton sceleroxylon*† K.Schum	7	0	0	7	Tree	LC
Tiliaceae	*Triumfeta cordifolia* A. Rich.	118	67	0	185	Tree	LC
Meliaceae	*Turraea vogelii*† Hook F. ex Benth	4	0	0	4	Herb	LC
Euphorbiaceae	*Uapaca guineensis*† Mull.Arg.	5	0	0	5	Herb	NE
Urticaceae	*Urera cameroonensis* Wedd	113	134	0	247	Shrub	NE
Annonaceae	*Uvariodendron connivens** (Benth.)R.E. Fr	0	3	0	3	Tree	NT
Asteraceae	*Vernonia abyssinica** Sch.Bip. Ex Hochst	0	5	0	5	Tree	NE
Asteraceae	*Vernonia ambigua* Kotschy & Peyr.	0	25	48	73	Shrub	LC
Asteraceae	*Vernonia amygdalina*† Del. Cent.	369	0	0	369	Shrub	LC
Asteraceae	*Vernonia conferta*‡ Benth.	0	0	83	83	Shrub	NE
Asteraceae	*Vernonia hymenolepis*‡ A. Rich.	0	0	11	11	Shrub	LC
Asteraceae	*Vernonia perrottetii*† Sch. Bip.ex Walp	0	0	61	61	Shrub	LC
Apocynaceae	*Voacanga africana* Stapf	4	94	0	98	Shrub	LC
Araceae	*Xanthosoma sagittifolium*† (L.) Schott	74	0	0	74	Herb	NE
Annonaceae	*Xylopia africana*† (Benth.) Oliv.	7	0	5	12	Tree	VU
Monimiaceae	*Xymalos monosperma* (Harv.) Baill. Ex Walp	6	26	0	32	Tree	LC
Rutaceae	*Zanthoxylum gilletii*† (De Wild.) P.G. Waterman	6	0	0	6	Tree	LC
Poaceae	*Zea mays*† L.	105	0	0	105	Herb	LC

Cucurbitaceae	*Zehneria scabra*‡ Sond.	0	0	9	9	Herb	VU
		26489	**8922**	**10345**	**45756**		

†= Species Unique to Lowland Forest; * = Species Unique to Sub-Montane Forest; ‡ = Species Unique to Montane Forest
IUCN = International Union for the Conservation of Nature; CR = Critically Endangered; EN =Endandered;
VU = Vulnerable; NT = Near threatened; LC = Least Concerned; DD = Data Deficient; NE = Not Evaluated.

The totality of species listed for the study area as distributed according to species richness per sampled village site are shown in Table 1. The sites of Banteng, Talung and Ekotoneh between 800 and 1500 m a.s.l. showed a relatively higher degree of species richness than sites below 800 m and above 1500 m A.S.L.

This trend of flora richness in altitudinal variation has also been reported by many studies on species richness along elevation gradients and across habitats and taxa (Rahbek, 1995, 1997; Austrheim, 2002; Vetaas and Gerytnes, 2002; Sanders *et al.*, 2003).

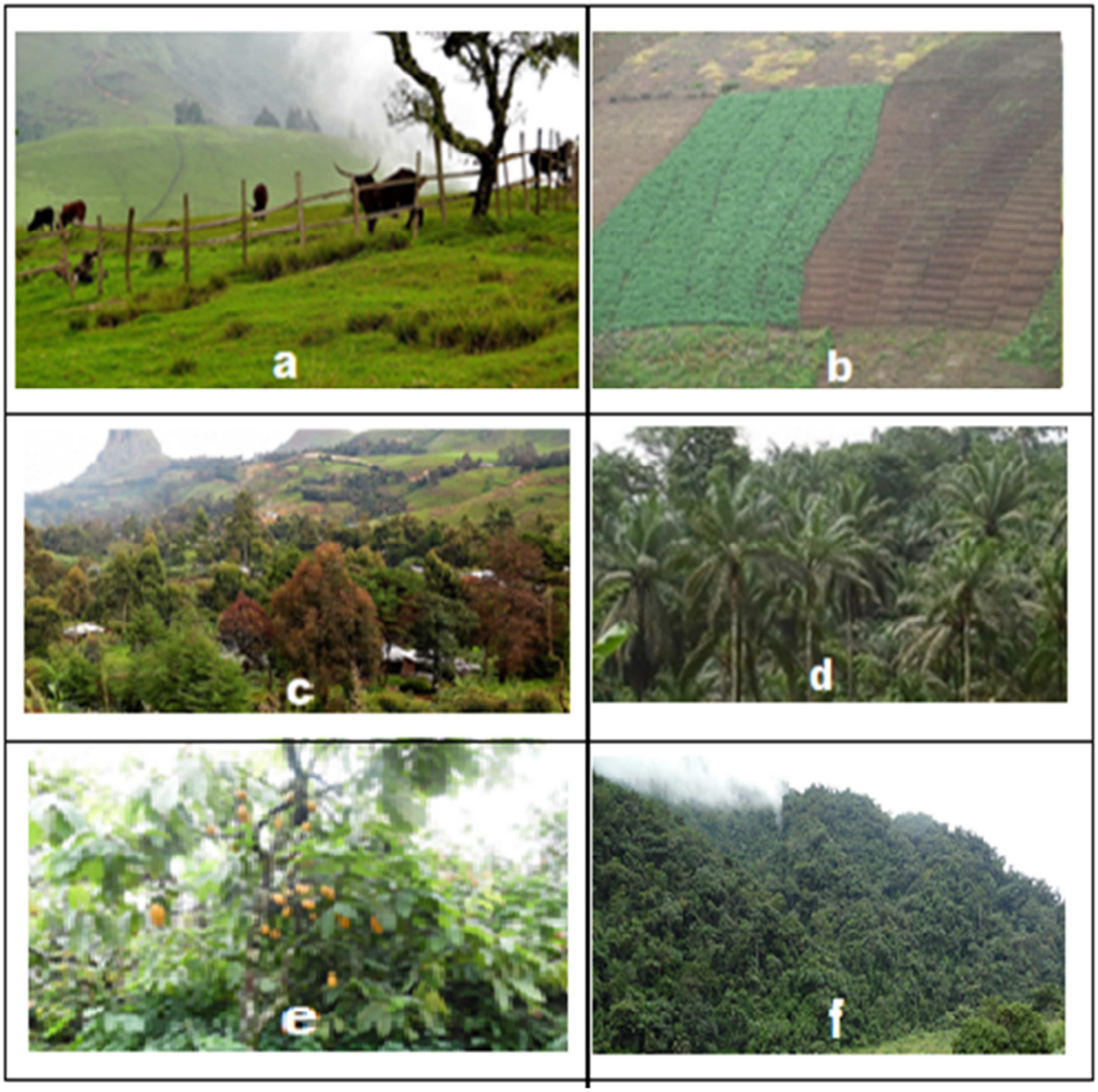

Fig. 2. Land Use Systems in the Mount Bambouto Caldera: (a) Animal grazing, (b) Cropping, (c) Settlement/Agroforestry, (d) Palm Plantation, (e) Cocoa Plantation, (f) Forest land.

The variation of Simpson's diversity index (Table 1) across sampled sites is indicative of the different zones that characterize this study area due to climatic differences as a result of change in altitude from lowland to montane savannah regions. The sites (Magha, Atsualah, Marita, and Nkongne) with Simpson diversity values range 0.027 to 0.023 and species richness between 55 and 66 species per plot also have Shannon-Wiener value range 3.778 - 3.944, which indicate a similarity in nature.

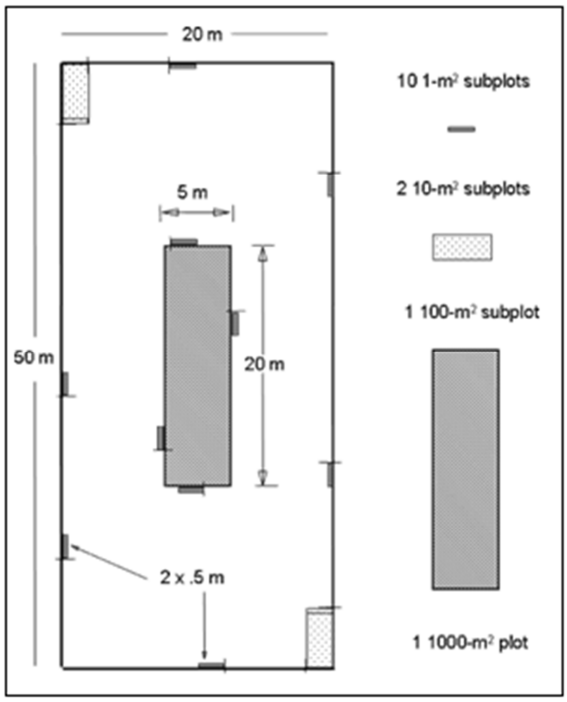

Fig. 3. Modified-Whittaker Nested Vegetation Sampling Plot (Stohlgren *et al.,* 1995).

These sites fall within the montane grassland zone, top of the caldera where horticulture is the dominant cropping system and fallowing is inexistent. The zone is characterized by intense use of agrochemicals to boost production. The lower species richness is an indication of the dominance of a few families in the colonization and occurrence of their species. This can be explained that grasses are easily dispersed to colonize new areas because of their tiny seeds (Abdi, 2013), particularly in areas characterized by high winds such as the Mount Bambouto grassland.

Other sites (Banteng, Talung, Ekotoneh, and Tekouh) with Simpson diversity values 0.019 - 0.013, species richness of plots 83 - 119 and Shannon-Wiener indices 4.019 – 4.513 (Tekouh and Talung) also portray another similarity in nature as they fall within the submontane middle zone where subsistence farming and fallowing practice is preponderant.

The richness and diversity observed in this study falls in line with the reports of others (Ayonghe and Ntasin, 2008; Harvey *et al.,* 2010; Fonge *et al.,* 2013; Ndam *et al.,* 2014), which reported the rich diversity of the flora of Cameroon, emphasizing the concentration of majority of endemic taxa around Mount Cameroon and other highland areas such as the Mount Bambouto. Harvey *et al.* (2010) opined that a lot of the phytodiversity of the Bambouto highland is still unknown to science.

The findings of this study show that the Mount Bambouto Caldera is one of the epitomes of phytodiversity (Shannon Diversity values above 3.5) in Cameroon according to the definition of Kent and Coker (1992) that a rich forest community is one with Shannon Diversity value greater than or equal to 3.5. Amongst the outstanding endemic species were the data deficient *Asparagus africanus,* near threatened *Echinops giganteus* and critically endangered *Argocoffeopsis fosimondi* in the montane savannah region*;* and the data deficient *Sida corymbosa* and unevaluated *Scorodoploeus zenkeri* in the lowland zone.Their zonal endemism insinuates their association to such habitats of differing climatic conditions. None of them was found in the richer submontane stratum that constitutes a transition between the hot tropical climate and the cold montane type.

Diversity and species richness followed the same trend across the study area, decreasing from the submontane to the montane regions (Table 2). Lowest Simpson index (0.01) occurred at the submontane forest signifying greatest diversity while the highest Simpson index (0.03) was at the montane cropland. Lowest species richness (79) was recorded at the montane cropland while the highest value (307) was obtained at the submontane forest. Overall, the distribution pattern is hump-shaped, with high

species richness in the middle elevation range between 800 and 1500 m a.s.l. This result agrees with other studies (Vazquez Garcia and Givnish, 1998; Vettas and Gerytnes, 2002) on vegetative distribution along altitudinal variation, which could adopt a monotonic decline in species richness from low to high elevation, a hump-shaped pattern with a maximum at mid-elevations (Fig. 7), or essentially a constant from the lowlands to mid-elevations followed by a strong decline further up.

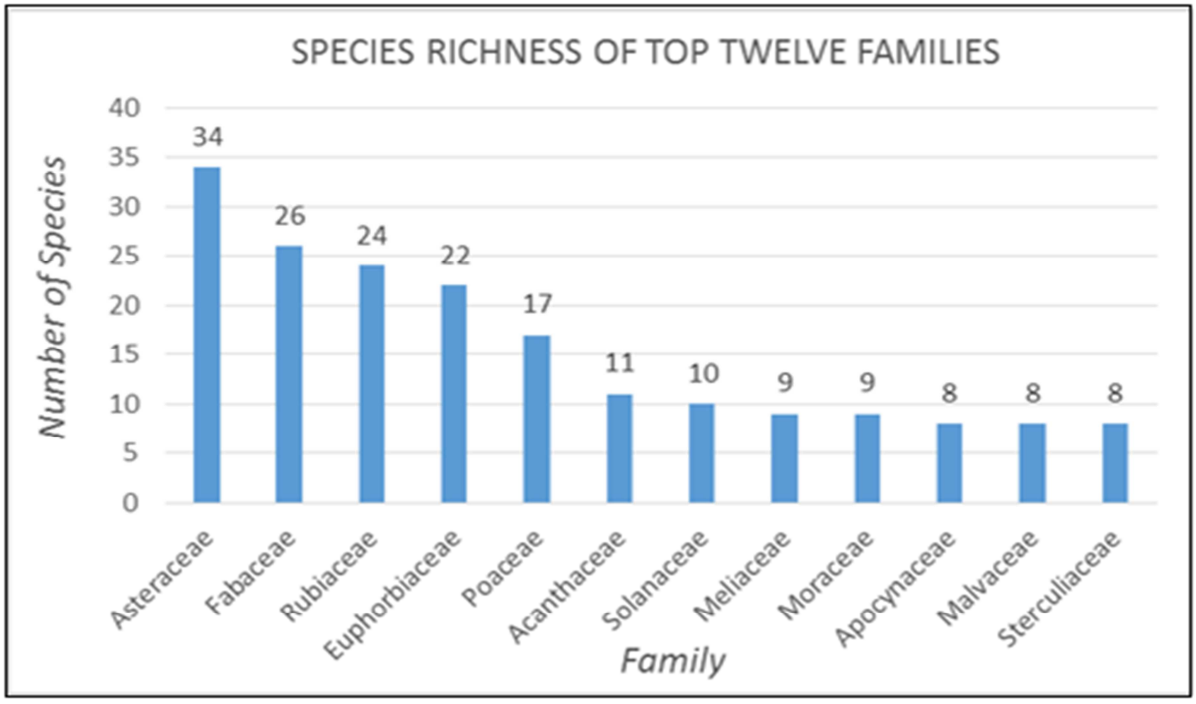

Fig. 4. Dominance of top twelve plant families based on species richness in the Mount Bambouto Caldera of the western highlands of Cameroon.

The relation between the species-richness and evenness-indices summarized by Hill numbers also show the same pattern of species diversity as projected by the Shannon-Wiener and Simpson's indices with highest values in the submontane zone and lowest values in the montane savannah area.

Plant species diversity according to land use management systems in the different zones of the study site was also established (Table 2). There was an altitudinal decrease in species richness from the lowland forest (298) to montane savannah (62) at the top, with forest species richness higher than those of cropland and savannah.

Table 2 shows that plant species richness varied considerably across land use management systems in the different zones with remarkable differences between cropland and forest, tripling in the lowland and submontane areas respectively, and over 25% between cropland and savannah. Shannon-Wiener, Simpson diversity and Hill numbers presented the same trend with cropland values lower than forest lands and montane cropland lower than montane savannah. However, the decrease in species richness and diversity between cropped and uncropped lands falls steeply towards the savannah zone and mildly towards the lowland region. Shannon-Wiener indices range from 3.8 to 5.1 indicating great diversity of plant species in the study area (Kent and Coker, 1992).

Amongst the plant species unique to the lowland, submontane and savannah areas, *Vernonia amygdalina*, *Aframomum limbatum,* and *Rumex acetosella* were found to be the most dominant species respectively. It was observed that amongst the endemic taxa and unique to the savannah zone,

the perennial herbaceous plant *Echinops giganteus* was only conspicuously present at the montane altitudinal range between 1600 to 2700 m A.S.L.

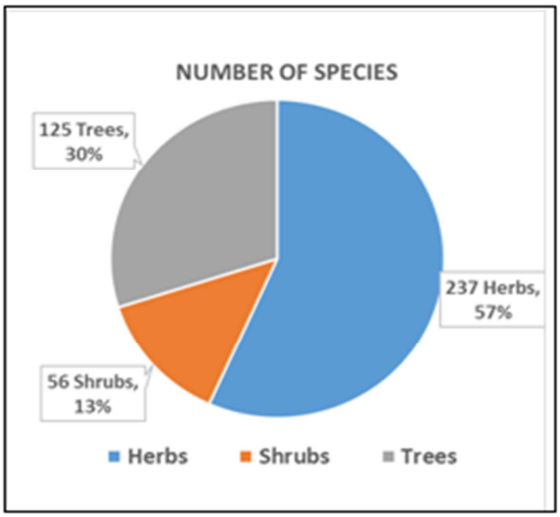

Fig. 5. Composition of plant life forms in the Mount Bambouto Caldera of the western highlands of Cameroon.

This study enlisting plant species in the Mount Bambouto Caldera (Table 3) supplements previous knowledge from less elaborate surveys that suggested the need to close the dearth of knowledge on the phytobiota in the area (Harvey *et al.*, 2010) and enrich the taxonomic checklist of vascular plants in Cameroon as published by Onana (2011).

Sixteen species identified and hereby recommended for inclusion into the checklist are *Allium vineale, Artemisia ludoviciana, Bryophyllum pinnatum, Calamus rotang, Desbodesia sp., Erigeron floribundus, Euphorbia golondrina, Helichrysum aureum, Helichrysum cymosum, Impatiens sodenii, Jasminum sambac, Justicia oblongifolia, Lactuca taraxacifolia, Satureja biflora, Scadoxus membranaceus, and Stellaria media*.

The list of plant species (Table 3) also revealed that according to IUCN redlist categorization, 1 species (*Argocoffeopsis fosimondi*) is critically endangered, 5 species (*Begonia adpressa, Begonia pseudoviola,Cola megalophylla, Helichrysum cameroonense, Magnistipula conrauana)* are endangered, 17 species are vulnerable, 7 species are near threatened, 320 species are least concerned, 2 species are data deficient, and 63 species not evaluated. Hence, there is need for immediate protection and conservation of the critically endangered *Argocoffeopsis fosimondi* and the five endangered species besides sustainable management strategies for the vulnerable and near threatened species in the Mount Bambouto Caldera and its environs.

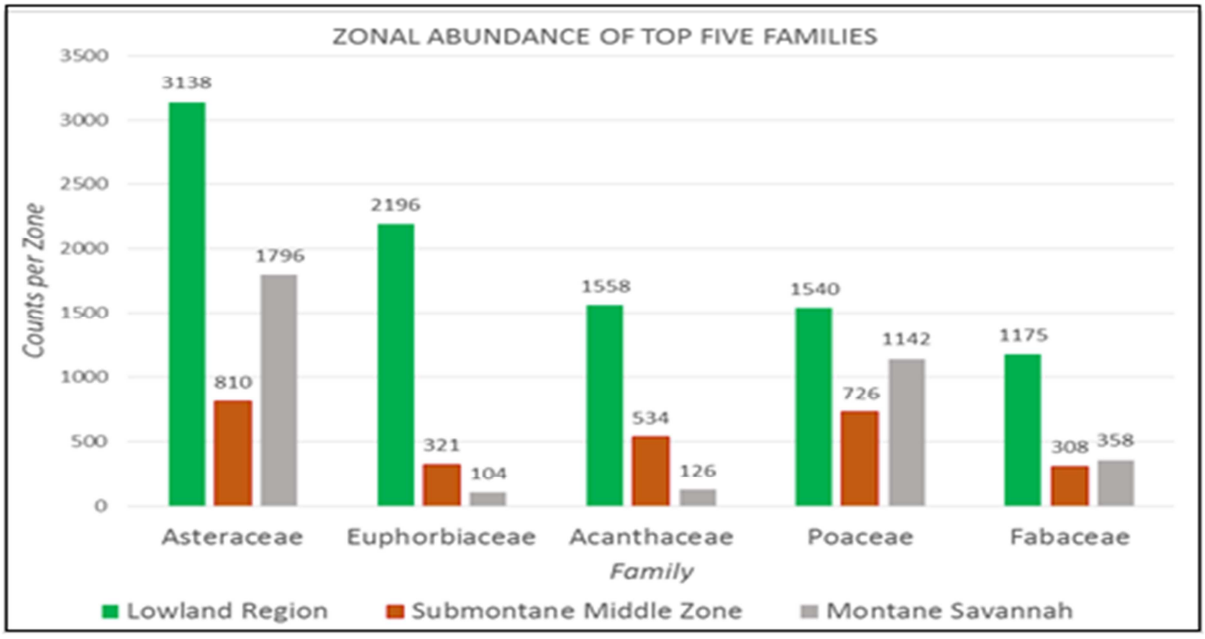

Fig. 6. Zonal abundance of top five plant families in the Mount Bambouto Caldera of the western highlands of Cameroon.

Impact of land use on phytodiversity

The impact of land use on plant species diversity was established by comparing the plant species richness and diversity of primary forest systems with other land use systems (Table 2). Fig. 8 elucidates the impact that land use change, particularly the conversion of forest and grasslands to other land uses imposes on plant species diversity. It shows that the conversion from lowland forest to cropland and submontane forest to cropland reduced species richness and diversity by more than 50% while conversion of savannah/grassland to cropland reduced species richness and diversity by less than 25%.

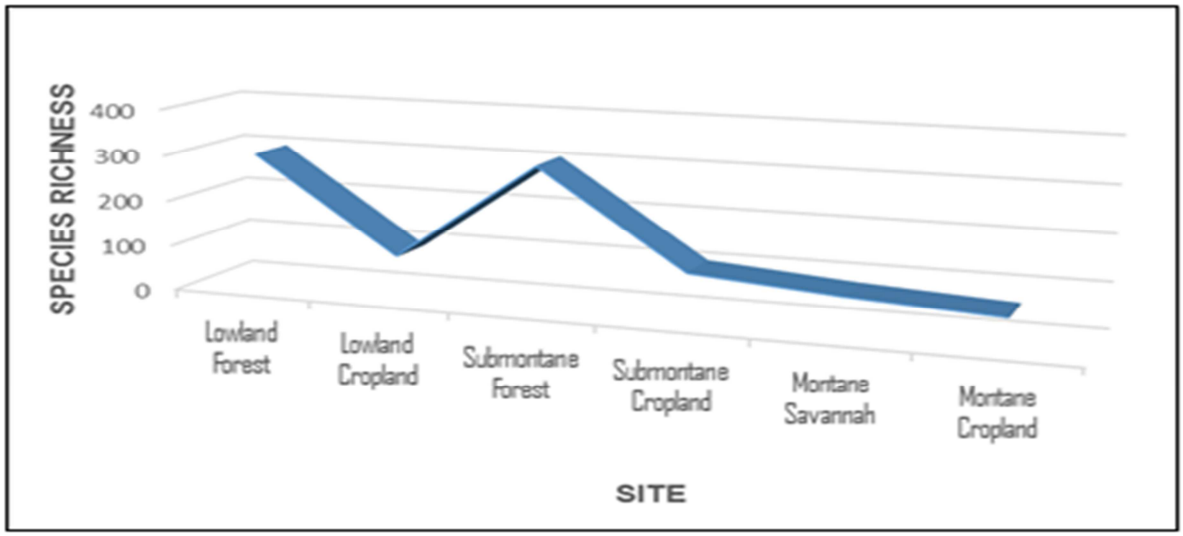

Fig. 7. Hump-shape distribution of species in the Mount Bambouto Caldera of the Western Highlands of Cameroon.

The general trend of the impact of land uses across management systems in terms of species richness and diversity is a decrease from lowland forest to savannah cropland as depicted by Fig. 8.

Low counts of some plant species including *Baphia* sp, *Begonia eminii, Begonia pseudoviola, Chlamydocarya thomsoniana, Homalium dolichophyllum, Justicia tenella, Monanthotaxis sp, Plectranthus decumbens, Spondianthus preussi,* and *Polycephalium lobatum* in the lowland region, *Uvariodendron connivens*, *Jasminum sambac, Oxyanthus formosus, Psydrax dunlapii* in the submontane middle zone and *Agave sisalana, Buchnera capitata,* and *Guarea glomerulata* in the savannah montane zone show that they are becoming threatened and could face extinction in the Mount Bambouto region in the future.

This loss in species diversity indicates the impact of land use on phytodiversity and is in line with Ayonghe and Ntasin (2008), Focho *et al.* (2009), and Fonge *et al.* (2013*)* who reported great and rapid losses in natural resources, especially plant resources for food, construction, fuel, medicine, and degrading functions of ecosystems as a result of anthropogenic activities.

Most of such activities are directly linked with deforestation for agricultural practices and other associated purposes (Thomas *et al.*, 1992 and Tchouto, 1995).

Therefore, conversion of natural ecosystems, which are centres of high endemism for many taxa (Fonge *et al.*, 2013), and their destruction due to different land use changes lead to the local extinction of globally threatened plant species, watershed destruction, and the degradation of livelihood systems that impoverishes the community other studies have reported that natural communities which face extensive land use modifications have the potential to greatly alter plant species composition and structure (Smart *et al.*, 2006; Watts *et al.*, 2012).

Forest loss is linked to species loss though difficult to quantity (Prasad *et al.*, 2010), and population growth leading to agricultural expansion and other infrastructural changes have always exacerbated the losses in land cover.

Land use changes have been found to decrease available habitats for a large number of plant species, usually allowing the persistence of only those species with adaptations for survival within the modified ecosystems (Watts *et al.*, 2012).

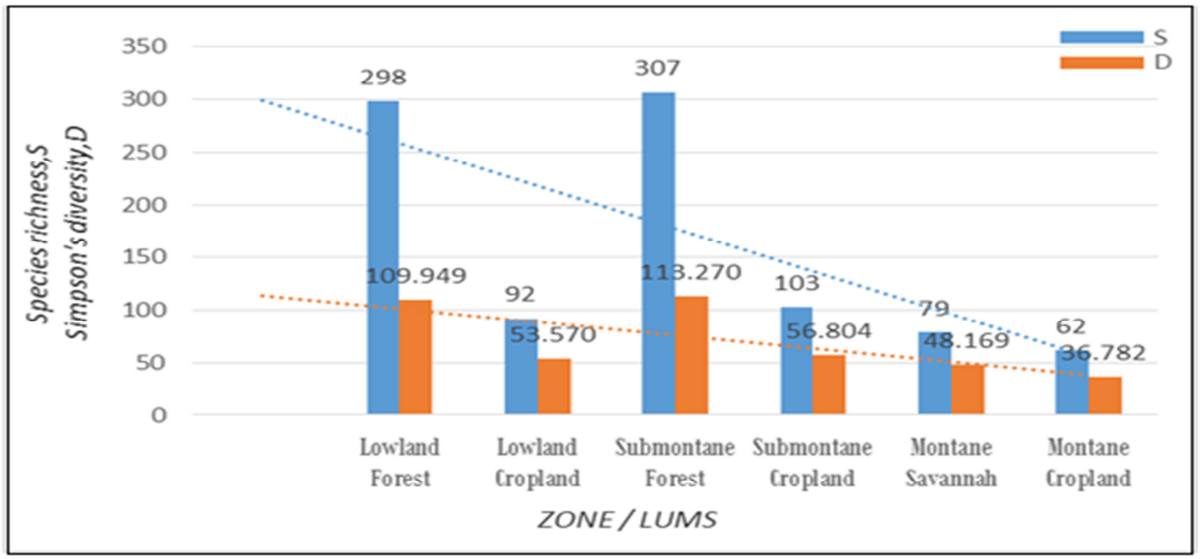

Fig. 8. Variation of species richness and diversity across land use management systems (LUMS) in the Mount Bambouto Caldera of the western highlands of Cameroon.

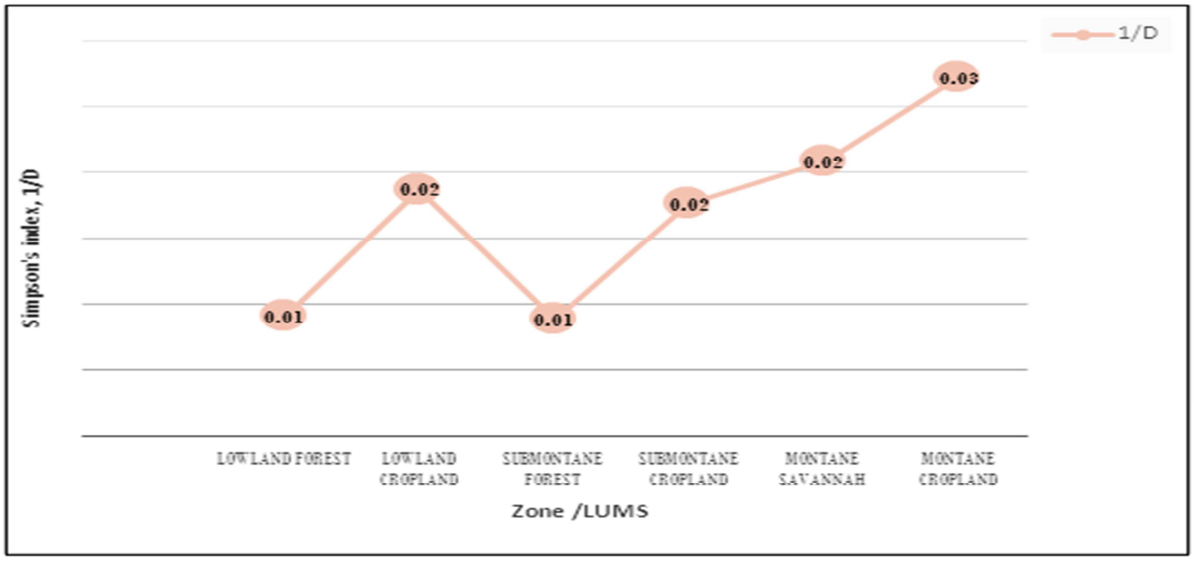

Fig. 9. Variation of Simpson's index across the land use management systems (LUMS) in the Mount Bambouto Caldera.

To have a glimpse and better understanding of the trend of plant species diversity across the land use systems in the area, Simpson's index was computed as presented in figure 9. Lowest values were found associated with the forest systems than croplands and montane savannah.

Since smaller values of Simpson's index indicate greater diversity, the variation of this index shows that forest ecosystems are richer and more diverse than croplands and savannah land use systems in the Mount Bambouto Caldera.

Hence, the more the deforestation for agriculture and other infrastructural needs, the greater the impact on plant diversity, plant resources and livelihood systems.

Conclusion

Plant species diversity in the Mount Bambouto Caldera is decreasing and following land use and land cover change patterns. Land cover depletion, intensification and extension of agricultural activities have negatively impacted plant species diversity and are aggravating the susceptibility of the landscape to erosion and mass movements. The Mount Bambouto Caldera is highly diverse with 415 plant species spread out in 125 families and species richness remarkably varying across different study strata. Shannon-Wienner index ranges from 3.8 for montane cropland to 5.1 for submontane forest. Simpson index on the other hand indicates species equitability with montane cropland of 0.03 and lowland forest and submontane forest value of 0.01. Hill numbers summarize the richness and equitability of the species with maximum values recorded in the submontane forest (N_0 = 307, N_1=157.2, N_2=113.2) and minimum values in the montane cropland (N_0 = 62, N_1=45.6, N_2=36.7). The plant species richness and high level of endemism in the area, rampant deforestation due to anthropogenic activities, natural risk factors of topography, weather, and geologic nature require that specific and intensive mitigative measures be put in place for the protection of the already critically endangered, endangered and vulnerable species amongst general strategies to conserve plant resources in the Mount Bambouto Caldera.

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References

Abdi AA. 2013. Diversity and Distribution of the Afroalpine Flora of Eastern Africa with Special Reference to the Taxonomy of the Genus Pentaschistis (Poaceae). Ph.D. Thesis, Kenyatta University, 239p.

Austrheim G. 2002. Plant diversity patterns in semi-natural grasslands along an elevation gradient in Southern Norway. Journal of Plant Ecology **161,**193-205.

Ayonghe SN, Ntasin EB. 2008. The geological control and triggering mechanism of landslides of the 20th July 2003 within the Bambouto Caldera, Cameroon. Journal of the Cameroon Academy of Sciences **7**, 191–203.

Balgah SN. 2013. Land Tenure and Land Use Dynamics in Limbe City, South West Region of Cameroon. Agriculture Science Developments **2(3),** 14-24.

Beentje HJ. 1996. Centres of Plant Diversities in Africa, the Biodiversity of African Plants, Kluwer Academic Publishers, Netherlands.

Cadotte MW, Carscadden K, Mirotchnick N. 2011. Beyond species: functional diversity and the maintenance of ecological processes and services. Journal of Applied Ecology, Blackwell Publishing Ltd **48,** 1079–1087. http://dx.doi.org/10.1111/j.1365-2664.2011.02048.x

FAO. 2014. Adapting to climate change through land and water management in Eastern Africa. Results of pilot projects in Ethiopia, Kenya and Tanzania. Rome. 180 p.

Focho DA, Ndam WT, Fonge BA. 2009. "Medicinal plants of Aguambu-Bamumbu in the Lebialem highlands, Southwest Province of Cameroon". African Journal of Pharmacy and Pharmacology **3(1),** 1-13.

Fonge BA, Egbe EA, Fongod AGN, Focho DA, Tchetcha DJ, Nkembi L, Tacham WN. 2012. Ethnobotany survey and uses of plants in the Lewoh-Lebang communities in the Lebialem highlands, South West Region, Cameroon. Journal of Medicinal Plants Research **6(5),** 855-865.

Fonge BA, Tchetcha DJ, Nkembi L. 2013. Diversity, Distribution, and Abundance of Plants in Lewoh-Lebang in the Lebialem Highlands of Southwestern Cameroon. Internal Journal of Biodiversity **2013,** 13p.
http://dx.doi.org/10.1155/2013/642579

Gullison RE, Frumhoff PC, Canadell JG, Field CB, Nepstad DC, Hayhoe K. 2007.Tropical Forests and Climate Policy. Science Journal **316**, 985-986. PMID: 17495140.

Harvey Y, Tchieuque B, Cheek M. 2010. "The plants of Lebialem highland, Cameroon," A conservation checklist. Royal botanic Garden, Kew, UK, 7-31 p.

Intergovernmental Panel on Climate Change (IPCC). 2013. Report of September 2013. www.ipcc.ch or www.climatechange2013.org. Retrieved on 17 April, 2015.

Isbell F. 2012. Causes and consequences of biodiversity decline. Journal of Natural Education. Knowledge **3,** 54.

Kent M, Coker P. 1992. Vegetation Description and Analysis. Belhaven Press, London, UK.

Millennium Ecosystem Assessment MEA. 2005. Ecosystems and Human Well-Being: Biodiversity Synthesis of the Millennium Ecosystem Assessment. World Resources Institute, Washington, DC.

Naeem S, Bunker DE, Hector A, Loreau M, Andperrings C (Eds.). 2009. Biodiversity, Ecosystem Functioning, and Human Wellbeing: An Ecological and Economic Perspective. Oxford: Oxford University Press.

Ndam LM, Mih AM, Fongod AGN, Tening AS, Temenu NA, Fujii Y. 2015. First record of Euphorbia golondrina L. C. Wheeler (Euphorbiaceae) in Cameroon. Journal of Biodiversity and Environmental Science **6(4)**, 428–434.

Ndam LM, Mih AM, Fongod AGN, Tening AS, Tonjock RK, Enang JE, Fujii Y. 2014. Phytochemical screening of the bioactive compounds in twenty (20) Cameroonian medicinal plants. International Journal of Current Microbiology and Applied Science **3(12)**, 768-778.

Nkembi L, Skeen R, Ndeloh D. 2006. The Lebialem Highlands Montane Birds' Conservation Project, Cameroon. Final Report for Rufford Foundation, UK, the Environment and Rural Development Foundation (ERuDeF).

Onana JM. 2011. The Vascular plants of Cameroon. A taxonomic checklist with IUCN assessments. The IRAD-National Herbarium of Camerron, Yaounde.

Prasad PRC, Rajan KS, Dutt CBS, Roy PS. 2010. A conceptual framework to analyse the land use/land cover changes and its impact on phytodiversity: a case study of North Andaman Islands, India. Journal of biodiversity conservation. Springer **19**, 3073-3087.
http://dx.doi.org/10.1007/s10531-010-9880-3

Rahbek C. 1995. The elevational gradient of species richness: a uniform pattern? Ecography **18,**200-205

Rahbek C. 1997. The relationship among area, elevation and regional species richness in neotropical birds. American Naturalist **149**, 875-902.

Raupach MR, Field CB, Buitenhuis ET, Ciais P, Canadell JG, QueCLe. 2007. Contributions to accelerating atmospheric CO_2 growth from economic activity, carbon intensity, and efficiency of natural sinks. Proceedings of the National Academy of Science, USA **104**, 18866-18870. PMID: 17962418.

Sanders NJ, Moss J, Wagner D. 2003.Patterns of ant species richness along elevational gradients in an arid ecosystem. Journal of Global Ecology and Biogeography **10**, 77-100.

Smart SM, Thompson K, Marrs RH, Le Duc MG, Maskell LC, Firbank LG. 2006. Biotic homogenization and changes in species diversity across human-modified ecosystems. Proceedings of the Royal Society B: Biologial Sciences Journal **273**, 2659-2665.
http://dx.doi.org/10.1098/rspb.2006.3630

Souza DM, Teixeira RFM, Ostermann OP. 2015. Assessing biodiversity loss due to land use with Life Cycle Assessment: are we there yet? Global Change Biology **21,** 32–47.

Stohlgren TJ, Falkner MB, Schell LD. 1995. A Modified-Whittaker nested vegetation sampling method. Vegetatio **117**, 113-121.

Tchoua P. 1995.The vegetation of the proposed Etinde Rainforest Reserve. Mount Cameroon and its conservation. M.Sc. Thesis. University of Edinburgh/ Royal Botanic Garden of Edinburgh.

Tematio P, Tsafack EI, Kengni L. 2011. Effects of tillage, fallow and burning on selected properties and fertility status of andosols in the Mount Bambouto, West Cameroon. Agricultural Science **2**, 334 – 340.

Thomas DW, Cheek M. 1992. Outline Botanical Survey of the Proposed Etinde Forest Reserve in the S.W. Cameroon. Report to the Cameroon Government/RBG Kew/ODA.

Toh FA, Angwafo T, Ndam LM, Antoine MZ. 2018. The Socio-Economic Impact of Land Use and Land Cover Change on the Inhabitants of Mount Bambouto Caldera of the Western Highlands of Cameroon. Advances in Remote Sensing **7**, 25 - 45
https://doi.org/10.4236/ars.2018.71003

Tubiello FN, Salvatore M, Ferrara AF, House J, Federici S, Rossi S. 2015. The Contribution of Agriculture, Forestry and other Land Use activities to Global Warming 1990–2012. Global Change Biology **21**, 2655-2660.
http://dx.doi.org/10.1111/gcb.12865

Van Ruijven J, Berendse F. 2005. Diversity-productivity relationships: initial effects, long-term patterns, and underlying mechanisms. Proceedings of the National Academy of Sciences, USA.**102**, 695-700. PMID: 15640357.
http://dx.doi.org/10.1073/pnas.0407524102

Vazquez GJA, Givnish TJ. 1998. Altitude gradients in tropical forest composition, structure, and diversity in the Sierra de Manantlan. Journal of Ecology **86**, 999-1020.

Vetaas OR, Gerytnes JA. 2002. Distribution of vascular plant species richness and endemic richness along the Himalayan elevation gradient in Nepal. Global Ecology and Biogeography **11,** 291-301.

Watts S, Ovalle DH, Herrera MM, Ollerton J.2012. Pollinator effectiveness of native and non-native flower visitors to an apparently generalist Andean shrub, Duranta mandonii (Verbenaceae). Plant Species Biology **27,** 147-158.
http://dx.doi.org/10.1111/j.1442-1984.2011.00337.x.

Zangmo TG, Nkouathio DG, Kagou DA, Wandji P, Gountie DM, Tchoua FM. 2011. Mount Bambouto Caldera (Cameroon Volcanic Line): Formation, Structure and Environmental Impact. Yes Bulletin **1,** 14-20.