

## EVALUATION AND FLORA DIVERSITY OF GASHAKA GUMTI NATIONAL PARK-1, GASHAKA SECTOR, TARABA STATE, NIGERIA

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### Abstract

*The alarming rate of ecosystem degradation in many parts of Nigeria has continued to have significant impacts on the country's resources, conservation potential, and climate. This pressure led to an ecological and geographical survey in Gashaka Gumti National Park 1, Taraba State, Nigeria in 2013 and 2015 to document the species composition across the different vegetation types and geomorphic gradients, and to assess the vegetation loss between 1991 and 2013. Vegetation analysis was done using standard ecological sampling procedures. Digital Elevation Mapping (DEM) was also done to estimate the altitudinal ranges of the Park, while a Normalized Difference Vegetation Index (NDVI) was calculated to ascertain vegetation loss over time. Recognized vegetation types are lowland rainforest, southern Guinea savanna, and montane. A total of 426 species were identified belonging to 306 genera and 104 families with Asteraceae dominating (37 spp.). Also, five species which have never been formally documented in any published flora of Nigeria were identified. With respect to habit, 29 grasses, 26 ferns, 19 climbers, 98 forbs, 9 sedges, 79 shrubs, 152 trees and 14 epiphytes were classified. Plant diversity decreased with increasing altitude. The DEM classified the heights of the sampled area into lowland (400 – 933 m), sub-montane (933 – 1467 m), and montane (1467 – 2000 m). The NDVI revealed higher vegetation cover in 1991 than 2013. These results indicate the importance of regular assessment of floristic composition through checklisting of species in national parks for effective and efficient species conservation and management.*

**Key Words:** *Gashaka Gumti, National Park, floral diversity, geomorphic gradient, DEM and NDVI*

### Introduction

The Nigeria vegetation is one of the most endowed in Africa containing almost all the vegetation types that exist in other African countries widely

distributed in different zones of the country. Nigeria harbors about 7895 species of plant; and this makes it one of the richest countries in the continent in terms of biodiversity (Ayodele and Yang,

2012). However, ecosystem degradation proceeds at alarming rates in many parts of Nigeria, including some protected areas which are meant to be conserved (Gumnior and Sommer, 2012). Ladipo (2010) indicated that nearly 90 % of rainforests in Nigeria has been cleared as at 2006. This clearance is not restricted to the forests alone as all habitats are under threat from civilization and other unsustainable human activities. The careless attitude of the populace and high rate of poverty in the country has also resulted in this heavy loss (Ayodele and Yang, 2012).

In order to prevent forest loss and to preserve biodiversity, the Nigerian Government has established several national parks. One of the national parks established by Government is Gashaka Gumti National Park (GGNP). It is the largest National Park in Nigeria covering an area of 6402 km<sup>2</sup>, lies between 6° - 8° latitude and 11° - 12° longitude (Akinsoji, 2003). GGNP is divided into the southern Gashaka Sector which is situated in Taraba State and the Northern Gumti sector situated in Adamawa State. The Gumti sector has an undulating topography covered by Savanna vegetation while the topography of Gashaka sector is rough, rugged and mountainous (Akinsoji, 2003). Rivers originate from the mountain tops and flow down the mountain thus providing moisture which sustains the lowland forest in addition to the savanna vegetation at lower altitudes. This sector therefore has a variety of vegetation types including lowland rainforest, woodland savanna, montane forest and montane grassland.

These vegetation types provide variety of habitats and microhabitats for

plants and animals. Habitat diversity promotes biodiversity thus accounting for the high diversity of GGNP (Oates *et al.*, 2014). The pioneering ecological study of the park was documented in Akinsoji (1994, 1996), which were unpublished preliminary vegetation surveys done as part of the Nigerian Conservation Foundation – WWF - UK Conservation Project. The first published vegetation study of the GGNP addressed specifically the ethnobotany of the park to show how the inhabitants have been using these plants for their survival (Akinsoji, 2003). Akinsoji *et al.* (2003) relied on the natural state of the vegetation of this park to compare the Point-Centered Quarter and Quadrant methods to analyze the phytosociology of its trees. Akinsoji (2005) also carried out a survey of epiphytes of the GGNP and reported that the epiphytic flora was dominated by orchids and these orchids preferred *Entada* sp. as host plant. Others works include Ayodele and Yang (2012) and Gumnior and Sommer (2012). From the analysis of species density and diversity along geomorphic gradient, Mubi and Tukur (2012) also reported some vegetation studies in GGNP. They noted that the plains and riparian areas within the GGNP had the highest mean density and diversity. Most recently anthropogenic activities such as illegal grazing, farming, and poaching have caused a concern for conservation particularly grazing, where the herdsmen have not only grazed in the park but attacked Park staff when confronted. Dunn (1995) had earlier reported increasing pressure on GGNP as a result of its situation within the sub-humid zone, and its exposure to immigration impacts from more densely cultivated

northern and southern sections. Also, revelation from satellite imagery, shows that during most of the dry season, green vegetation was absent in up to one fifth of the park (Gumnior and Sommer 2000). This was attributed largely to human activities such as cattle grazing and burning. Gumnior and Sommer (2012) further confirmed environmental degradation detected in previous imagery, and established a trend of degradation in the newer scenes.

This degradation has necessitated the need for effective and holistic conservation and management policy that requires among others efforts, a comprehensive data gathering on its floral and fauna diversity. Therefore, this present effort documents species composition and conservation status, as well as evaluates the impact of anthropogenic activities on the park using both conventional vegetation study and GIS mapping.

## **Materials and Methods**

### **Study Area**

The area under study is a subset of GGNP that lies between 07°18'E and 07°24'N and 11°34'E and 11°46'E with an area of about 289 km<sup>2</sup> situated within Gashaka LGA (Fig. 1). The park has a multitude of crucial ecological functions by encompassing most of the catchment of the Taraba River, largest tributary to river Benue. It is divided into the undulating Gumti sector in the north and the hilly to mountainous Gashaka sector in the south, where elevations rise to 2,419 m asl (above sea level) at Gangirwal, Nigeria's highest peak (Gumnior and Sommer, 2012). Located in the tropical wet and dry climatic zone, Kwano field station (583 m asl, 7°19' N,

11°35' E) has an average total annual precipitation of 1,973 mm (period: 2001-2002/2004-2008). About 95 % of the yearly rainfall is recorded between April and October, with highest monthly mean in September (332 mm). The influence of Sahara Trade Winds (Harmattan / N/East Trade winds) accounts for the absence of rainfall between December and January (Sommer and Ross, 2011). Significantly higher precipitation falls along the southeastern escarpments and allows lush rainforests to thrive albeit southern Guinea savanna is considered to be the zonal climax (Keay, 1959). The steep terrain is also responsible for the occurrence of sub-montane and montane vegetation types, contributing to a highly complex forest-savanna mosaic (Keay, 1959). Deforestation and dry season burning are believed to have turned considerable parts of semi-deciduous forests into woodlands and led to the prevalence of extensive grasslands at the expense of montane forests (Chapman *et al.*, 2004). Since its creation, GGNP has been harboring several settlements and grazing enclaves, with an estimated overall human population of 5,000 and about 10,000 cattle. Thus, legal and illegal human activities within the park such as grazing, burning, cutting of trees, and poaching, together with the poisoning of carnivores to protect cattle, have always remained an issue, sometimes resulting in violent conflicts with National Park staff. This does not only create numerous conservation challenges regarding wildlife, but puts increasing pressure on all natural resources especially in the vicinity of the enclaves (Chapman *et al.*, 2004; Sommer and Ross, 2011).

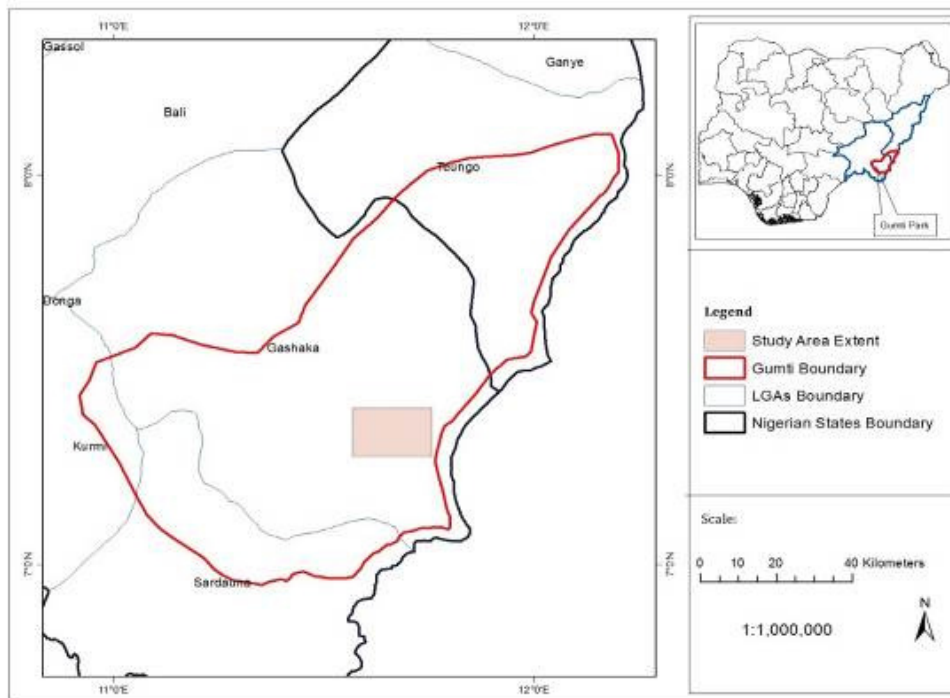


Figure 1: Map of Gashaka Gumti National Park showing study area

**Vegetation Study**

A reconnaissance study was first carried out in August 2013 while a formal vegetation study was done in October 2015. Notable information on the vegetation description and species checklist from Gidan kwano (500 m asl) to Chabbal hendu (1,980 m asl) during the reconnaissance. The ranges consist of lowland (<1000 m asl) with Kwano and Gashaka as landmarks; sub-montane (1000 – 1500 m asl) with Tonga and Bale (abandoned communities that have allowed the vegetation to grow) as landmarks; and montane (>1500 m asl) with Selbe, Chabbal Hendu as landmarks.

Lowland: The vegetation is wooded grassland but since the area is traversed by rivers and streams, there is forest vegetation along the water bodies. Altitudinal zone ranged between 500 <

and 1000 m asl. Sampling was done around Gashaka village (583 m asl) and Kwano (530 m asl). Sub-montane: The vegetation is mainly woodland savanna but the trees are smaller than those at lower altitude. The altitudinal zone ranged between 1000 and 1500 m asl and sampling was carried out around abandoned communities such as Tonga and Bale (very close to Selbe settlement). However, some Fulani herdsmen still live in some parts purposely to farm and graze. Montane: This zone comprises of grassland on the mountain top and montane forest in the river/streams valleys. The altitude is above 1500 m asl. The sampling was carried out around at Chabbal Hendu (>1800 m asl). Details of the characteristic species of each geomorphic gradient are contained in Table 1.

Table 1: Details of the sampled points across the study area

Coordinates	Elevation	Region
7.32708; 11.57879	524.3 m	Lowland
7.32739; 11.58408	560 m	Lowland
7.35736; 11.60246	1240 m	Sub-montane
7.35300; 11.60329	1308 m	Sub-montane
7.35162; 11.61328	1450 m	Sub-montane
7.35200; 11.61525	1500 m	Sub-montane
7.35342; 11.62450	1588 m	Montane
7.35803; 11.73120	1748 m	Montane
7.35727; 11.73060	1755 m	Montane
7.34741; 11.70140	1907 m	Montane

### Species Identification

Identification of all the plants, species collection, identification and photography were carried out along the geomorphic gradient on ten sampling points (Fig. 1 and Table 1) using transects (1 m x 10 m) and quadrats (10 m x 10 m). All plant specimens encountered during the reconnaissance study were identified to species level either in the field or herbarium, using appropriate floras, manuals and monographs such as Hutchinson and Dalziel (1954, 1958, 1963, 1968, and 1972), Alston (1959), Keay *et al.* (1964), Lowe and Stanfield (1974), and Akobundu and Agyakwa (1998). Identification was further confirmed at the Forestry Herbarium Ibadan (FHI) Ibadan, and the Lagos University Herbarium (LUH), University of Lagos Akoka, Lagos, Nigeria. Classification into families was based on APG III (2009) and Ayodele and Yang (2012). Representative samples of species were collected, pressed, dried and prepared as herbarium specimens using standard techniques (Radford *et al.*, 1974) and deposited at the Lagos University Herbarium (LUH) University of Lagos, Nigeria.

### GIS Analysis

ASTER DEM data for the study area was obtained from Global Land Facility Cover and imported into the ArcMap 10.0 GIS environment. The contour and slope of the study area were generated sequentially to serve as input raster data for the DEM. The DEM generated was later re-classified into three and overlaid by the sampling points. For Normalized Difference Vegetation Index (NDVI) analysis, maps of GGNP were obtained from LandSat images database. The maps used were images of GGNP taken in the years 1991 and 2013.

### Results

A total of 426 plant species were identified (Plate 1) belonging to 306 genera and 104 families with Asteraceae being the most represented family having 37 species (Table 2). In terms of habit, 29 grasses, 26 ferns, 19 climbers, 98 forbs, 9 sedges, 79 shrubs, 152 trees and 14 epiphytes were classified (Table 2). An inverse relationship was observed between plant diversity and altitude. Plant diversity reduced with increase in altitude. The low land region (Plate 2) had 211 species in 74 families, sub-montane region 174 species in 54

families, and montane 147 species in 65 families (Figs. 4 & 5). Epiphytes (9), grasses (20), and trees (96) were most abundant in the low-land region while ferns (15) and sedges (5) dominate the montane region. The sub-montane had the most abundant climbers (11), forbs (50), and shrubs (46) (Fig. 5).

The DEM classified the heights into three geomorphic gradient classes: lowland (400 – 933 m), sub-montane (933 – 1467 m), and montane (1467 – 2000 m) (Fig. 2). The mean indices of Band 1 for the LandSat TM images were higher in images from 1991 (0.21) than images from 2013 (0.14) (Figs. 3a and b).

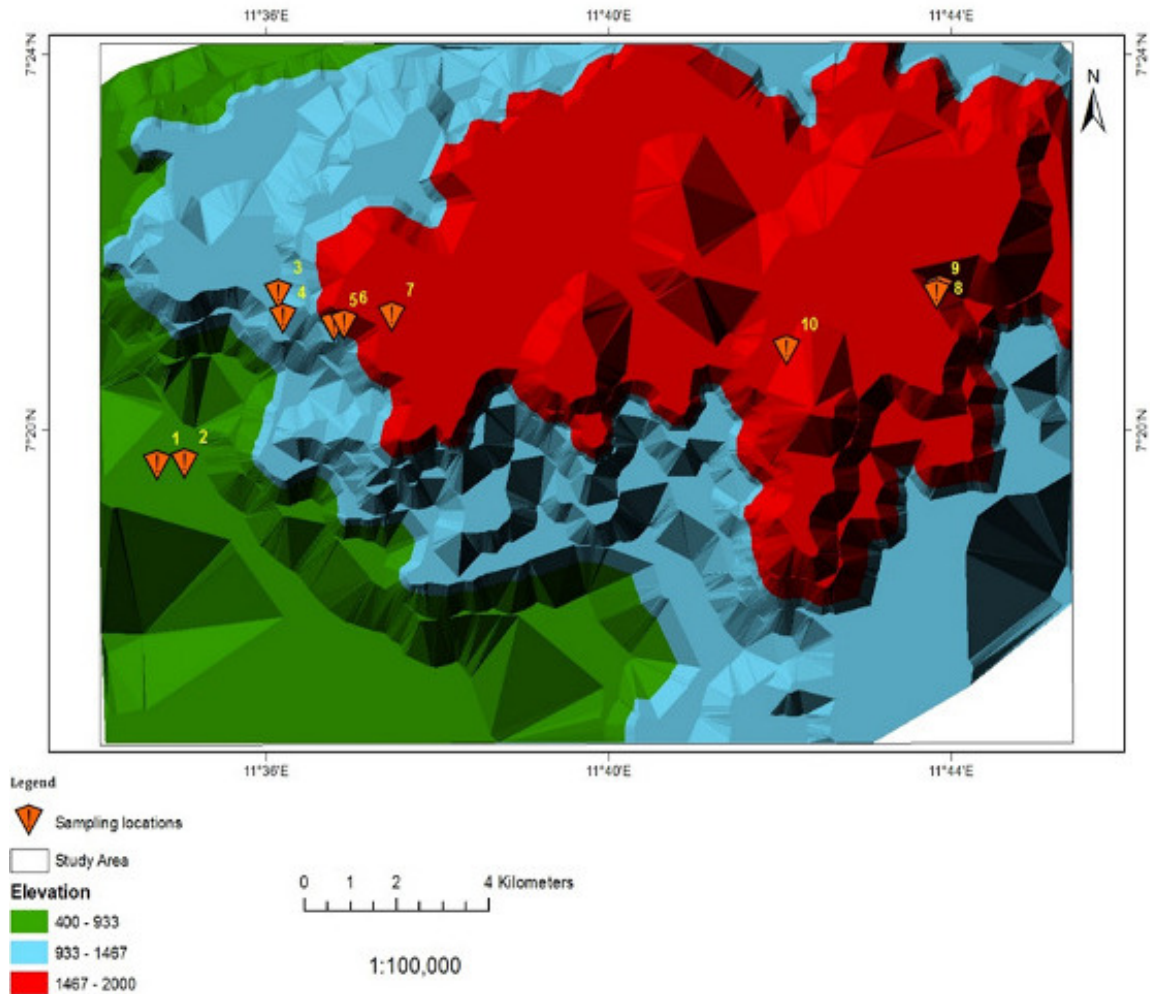


Figure 2: The DEM of the study area showing the sampling locations

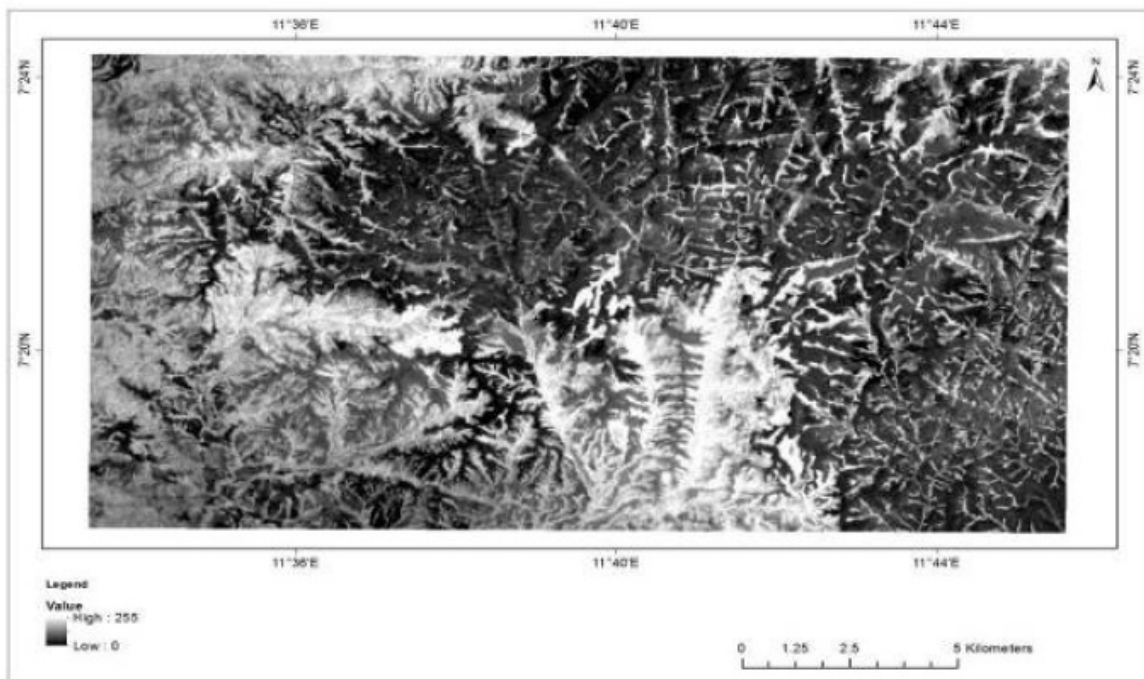


Figure 3a: Normalised Difference Vegetation Index Imagery of GGNP, 1991

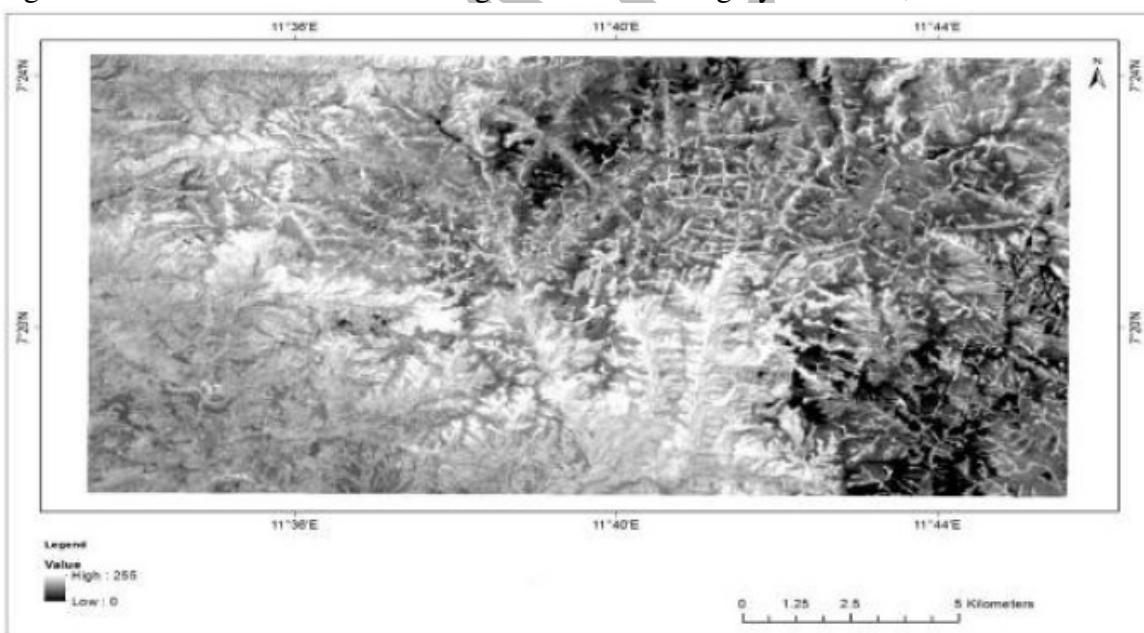


Figure 3b: Normalised Difference Vegetation Index Imagery of GGNP, 2013

Table 2: Details of Species diversity of GGNP -1

Botanical Name	Family	Habit	Low-land	Sub-montane	Montane	IUCN Status
<i>Abrus precatorius</i> Linn.	Papilionoideae	Climber	+			Not Assessed
<i>Acalypha ornata</i> Hochst. ex A. Rich.	Euphorbiaceae	Shrub	+			Not Assessed
<i>Acanthus montanus</i> (Nees) T. Anders.	Acanthaceae	Forb	+			Least Concern
<i>Achyranthes aspera</i> Linn.	Asteraceae	Forb		+		Not Assessed
<i>Adenocarpus mannii</i> Hook f.	Papilionoideae	Shrub	+		+	Not Assessed
<i>Adiantum philippense</i> L.	Adiantaceae	Fern	+			Not Assessed
<i>Adiantum</i> sp. L.	Adiantaceae	Fern			+	
<i>Aerangis biloba</i> (Lindl.) Schltr.	Orchidaceae	Epiphyte	+			Not Assessed
<i>Aframomum angustifolium</i> (Sonn.) K. Schum.	Zingiberaceae	Forb			+	Least Concern
<i>Aframomum melegueta</i> K. Schum.	Zingiberaceae	Shrub	+			Not Assessed
<i>Azelia africana</i> Sm.	Caesalpinoideae	Tree	+	+		Vulnerable
<i>Agauria salicifolia</i> (Comm.) Hook. f. ex Oliv	Ericaceae	Tree			+	Not Assessed
<i>Ageratum conyzoides</i> Linn.	Asteraceae	Forb			+	Not Assessed
<i>Aidia genipiflora</i> (DC.) Dandy	Rubiaceae	Shrub		+		Not Assessed
<i>Alafia multiflora</i> Stapf	Apocynaceae	Climber	+			Not Assessed
<i>Albizia adianthifolia</i> (Schum.) W. F. Wight	Mimosoideae	Tree	+			Least Concern
<i>Albizia glaberrima</i> (Schum. & Thonn.) Benth.	Mimosoideae	Tree	+	+		Not Assessed
<i>Albizia gummifera</i> (J. F. Gmel.) C. A. Sm.	Mimosoideae	Tree		+	+	Not Assessed
<i>Alchornea cordifolia</i> (Schum. & Thonn.) Müll. Arg.	Euphorbiaceae	Shrub	+			Not Assessed
<i>Alchornea laxiflora</i> (Benth.) Pax & K. Hoffm.	Euphorbiaceae	Shrub		+	+	Not Assessed
<i>Allophylus bullatus</i> Radlk.	Sapindaceae	Tree			+	Vulnerable
<i>Allophylus africanus</i> P. Beauv.	Sapindaceae	Shrub		+		Not Assessed
<i>Alstonia boonei</i> De Wild.	Apocynaceae	Tree	+			Not Assessed
<i>Amorphophallus abyssinicus</i> (A. Rich.) N. E.	Araliaceae	Forb	+			Not Assessed
<i>Amorphophallus</i> sp. Blume ex Decne.	Araceae	Forb	+			
<i>Anchomanes difformis</i> (Blume) Engl.	Araceae	Forb	+			Not Assessed
<i>Andropogon tectorum</i> Schum. & Thonn.	Poaceae	Grass	+	+	+	Not Assessed
<i>Aneilema beniniense</i> (P. Beauv.) Kunth	Commelinaceae	Forb		+		Not Assessed
<i>Aneilema lanceolatum</i> Benth.	Comelinaceae	Forb	+	+		Not Assessed
<i>Angraecum subulatum</i> Lindl.	Orchidaceae	Epiphyte	+			Least Concern
<i>Aningeria altissima</i> (A. Chev.) Aubrév. & Pellegr.	Sapotaceae	Tree			+	Not Assessed
<i>Annona senegalensis</i> Pers.	Annonaceae	Tree	+			Not Assessed
<i>Anogeissus leiocarpus</i> (DC.) Guill. & Perr.	Combretaceae	Tree	+			Not Assessed
<i>Anthocleista djalonenis</i> A. Chev.	Loganiaceae	Tree			+	Not Assessed
<i>Anthonotha macrophylla</i> P. Beauv.	Caesalpinoideae	Tree		+		Not Assessed
<i>Anthonotha noldeae</i> (Rossberg) Exell & Hillc.	Caesalpinoideae	Tree		+		Not Assessed
<i>Antiaris toxicaria</i> Scott-Elliot ex A. Chev.	Moraceae	Tree	+			Not Assessed
<i>Antidesma membranaceum</i> Müll. Arg.	Euphorbiaceae	Tree	+			Not Assessed
<i>Aspilia africana</i> (Pers.) C. D. Adams	Asteraceae	Forb		+		Not Assessed
<i>Aspilia angustifolia</i> Oliv. & Hiern	Asteraceae	Forb			+	Not Assessed
<i>Aspilia helianthoides</i> (Schum. & Thonn.) Oliv. & Hiern	Asteraceae	Shrub			+	Least Concern
<i>Asplenium dregeanum</i> Kunze	Aspleniaceae	Fern			+	Not Assessed
<i>Asplenium preussii</i> Hieron.	Aspleniaceae	Fern			+	Not Assessed
<i>Asplenium stuhlmannii</i> Hieron.	Aspleniaceae	Fern	+			Not Assessed



<i>Asplenium theciferum</i> (Humb. Bonpl. & Kunth) Mett.	Aspleniaceae	Fern				+	Not Assessed
<i>Aubrevillea kerstingii</i> (Harms) Pellegr.	Mimosoideae	Tree	+	+			Not Assessed
<i>Axonopus compressus</i> (Sw.) P. Beauv.	Poaceae	Grass	+	+		*	Not Assessed
<i>Bambusa vulgaris</i> Schrad. ex Wendel.	Poaceae	Shrub	+				Not Assessed
<i>Begonia macrocarpa</i> Warb.	Begoniaceae	Forb				+	Not Assessed
<i>Beilschmiedia mannii</i> (Meisn.) Benth. & Hook. f.	Lauraceae	Tree				+	Not Assessed
<i>Berlinia grandiflora</i> (Vahl) Hutch. & Dalz.	Caesalpinoideae	Tree	+				Not Assessed
<i>Bersama abyssinica</i> (Planch.) Verdcourt	Melanthaceae	Tree	+				Not Assessed
<i>Bidens pilosa</i> Linn.	Asteraceae	Forb		+			Not Assessed
<i>Blighia sapida</i> Konig	Sapindaceae	Tree	+	+			Not Assessed
<i>Blighia unijugata</i> Bak.	Sapindaceae	Tree	+				Not Assessed
<i>Bolbitis acrostichoides</i> (Afzel. ex Sw.) Ching.	Bolbitidaceae	Fern	+			+	Not Assessed
<i>Bombax costatum</i> Pellegr. & Vuillet	Bombacaceae	Tree	+				Not Assessed
<i>Borassus aethiopicum</i> Mart.	Arecaceae	Tree	+				Not Assessed
<i>Borreria verticillata</i> (Linn.) G. F. W. Mey.	Rubiaceae	Forb		+			Not Assessed
<i>Boswellia dalzielii</i> Hutch.	Burseraceae	Tree	+				Not Assessed
<i>Brachiaria jubata</i> (Fig. & De Not.) Stapf	Poaceae	Grass	+	+		+	Not Assessed
<i>Brachystegia eurycoma</i> Harms	Caesalpinoideae	Tree	+	+			Not Assessed
<i>Breonadia salicina</i> (Vahl) Hepper & J.R.I. Wood	Rubiaceae	Tree	+				Not Assessed
<i>Bridelia atroviridis</i> Müll. Arg.	Euphorbiaceae	Tree	+				Not Assessed
<i>Bridelia speciosa</i> Müll. Arg.	Euphorbiaceae	Tree	+			+	Not Assessed
<i>Brillantaisia nitens</i> Lindau	Acanthaceae	Shrub			+		Not Assessed
<i>Buchnera capitata</i> Benth	Scrophulariaceae	Forb			+		Not Assessed
<i>Bulbophyllum bequaertii</i> De Wild.	Orchidaceae	Epiphyte				+	Not Assessed
<i>Bulbophyllum congolanum</i> Schltr.	Orchidaceae	Epiphyte	+				Not Assessed
<i>Bulbostylis</i> sp. Kunth	Cyperaceae	Sedge				+	Not Assessed
<i>Burkea africana</i> Hook.	Caesalpinoideae	Tree	+				Not Assessed
<i>Caesalpinia bonduc</i> (Linn.) Roxb.	Caesalpinoideae	Shrub			+		Not Assessed
<i>Calamus deerratus</i> Mann & Wendl	Arecaceae	Tree	+				Not Assessed
<i>Calopogonium mucunoides</i> Desv.	Papilionoideae	Climber			+		Not Assessed
<i>Calypstrochilum christyanum</i> (Rchb. f.) Summerh.	Orchidaceae	Epiphyte	+				Not Assessed
<i>Calypstrochilum emarginatum</i> (Sw.) Schltr.	Orchidaceae	Epiphyte	+				Not Assessed
<i>Campylospermum flavum</i> (Schumach. & Thonn.) Farron	Ochnaceae	Shrub	+	+		+	Not Assessed
<i>Carapa procera</i> DC.	Asclepiadaceae	Tree				+	Not Assessed
<i>Cassipourea congoensis</i> R. Br. ex DC.	Rhizophoraceae	Tree				+	Not Assessed
<i>Ceiba pentandra</i> (Linn.) Gaertn.	Bombacaceae	Tree	+	+			Not Assessed
<i>Celosia trigyna</i> Linn.	Amaranthaceae	Forb		+			Not Assessed
<i>Celtis philippensis</i> Blanco	Ulmaceae	Shrub	+				Not Assessed
<i>Chassalia kolly</i> (Schumach.) Hepper	Rubiaceae	Shrub	+				Not Assessed
<i>Chloris pilosa</i> Schumach.	Poaceae	Grass				+	Not Assessed
<i>Chromolaena odorata</i> (L.) R. M. King & H. Rob.	Asteraceae	Shrub	+				Not Assessed
<i>Chrysophyllum albidum</i> G. Don	Sapotaceae	Tree	+				Not Assessed
<i>Cissampelos mucronata</i> A. Rich.-Diels	Menispermaceae	Climber			+		Not Assessed
<i>Cissampelos owariensis</i> P. Beauv. ex DC.	Menispermaceae	Climber				+	Not Assessed
<i>Cissus aralioides</i> (Welw. ex Bak.) Planch.	Vitaceae	Climber			+		Not Assessed
<i>Cissus populnea</i> Guill. & Perr.	Vitaceae	Climber			+		Not Assessed

<i>Clausena anisate</i> (Willd.) Hook. f. ex Benth.	Rutaceae	Tree		+	+	Not Assessed
<i>Cleistopholis patens</i> (Benth.) Engl. & Diels	Annonaceae	Tree		+		Not Assessed
<i>Clematis hirsuta</i> Guill. & Perr.	Ranunculaceae	Climber		+		Not Assessed
<i>Cleome ciliata</i> Schum. & Thonn.	Capparidaceae	Forb		+		Not Assessed
<i>Clerodendrum capitatum</i> (Willd.) Schum. & Thonn.	Verbenaceae	Shrub		+		Not Assessed
<i>Clerodendrum formicarum</i> Gürke	Verbenaceae	Shrub		+		Not Assessed
<i>Cnestis ferruginea</i> DC.	Connaraceae	Shrub	+			Not Assessed
<i>Cochlospermum planchonii</i> Hook. f.	Cochlospermaceae	Forb	+	+		Not Assessed
<i>Coffea brevipes</i> Hiern	Rubiaceae	Tree	+			Not Assessed
<i>Cola gigantea</i> A. Chev.	Sterculiaceae	Tree	+			Not Assessed
<i>Cola millenii</i> K. Schum.	Sterculiaceae	Tree	+	+		Not Assessed
<i>Combretum molle</i> R. Br. ex G. Don	Combretaceae	Tree	+	+		Not Assessed
<i>Combretum</i> sp. Loefl.	Combretaceae	Climber	+			Not Assessed
<i>Commelina africana</i> Linn.	Commelinaceae	Forb		+		Least Concern
<i>Commelina benghalensis</i> Linn.	Commelinaceae	Forb			+	Not Assessed
<i>Commelina diffusa</i> Burm. f.	Commelinaceae	Forb	+			Least Concern
<i>Commiphora kerstingii</i> Engl.	Burseraceae	Tree	+			Not Assessed
<i>Connarus griffonianus</i> Baill.	Connaraceae	Shrub	+			Not Assessed
<i>Coreopsis asperata</i> Hutch. & Dalz.	Asteraceae	Forb		+		Not Assessed
<i>Coreopsis barteri</i> Oliv. & Hiern	Asteraceae	Forb		+		Not Assessed
<i>Costus afer</i> Ker-Gawl.	Zingiberaceae	Shrub	+			Not Assessed
<i>Costus englerianus</i> K. Schum.	Zingiberaceae	Forb	+			Not Assessed
<i>Costus spectabilis</i> (Fenzl.) K. Schum.	Zingiberaceae	Forb	+		+	Not Assessed
<i>Crassocephalum biafrae</i> (Oliv. & Hiern) S. Moore	Asteraceae	Forb		+		Not Assessed
<i>Crassocephalum rubens</i> (Juss. ex Jacq.) S. Moore	Asteraceae	Forb		+		Not Assessed
<i>Crassocephalum</i> sp. Moench	Asteraceae	Forb		+		Not Assessed
<i>Crinum jagus</i> (Thomps.) Dandy	Liliaceae	Forb	+	+	+	Not Assessed
<i>Crinum zeylanicum</i> Linn.	Liliaceae	Forb	+		+	Not Assessed
<i>Crossopteryx febrifuga</i> (Afzel. ex G. Don) Benth.	Rubiaceae	Tree	+			Not Assessed
<i>Crotalaria atrorubens</i> Hochst. ex Benth.	Papilionoideae	Forb		+		Not Assessed
<i>Crotalaria retusa</i> Linn.	Papilionoideae	Forb		+		Not Assessed
<i>Crotalaria</i> sp. Linn.	Papilionoideae	Forb		+		Not Assessed
<i>Croton macrostachyus</i> Hochst. ex Del.	Euphorbiaceae	Tree		+	+	Not Assessed
<i>Ctenium</i> sp. Panz.	Poaceae	Grass	+		+	Not Assessed
<i>Culcasia scandens</i> P. Beauv.	Araceae	Epiphyte	+			Least Concern
<i>Curculigo pilosa</i> (Schum. & Thonn.) Engl.	Hypoxidaceae	Forb	+			Not Assessed
<i>Cussonia barteri</i> Seemann	Araliaceae	Tree		+		Not Assessed
<i>Cuviera nigrescens</i> (Sc. Elliot ex Oliv.) Wernham	Rubiaceae	Shrub		+		Not Assessed
<i>Cyanotis angusta</i> C. B. Cl.	Commelinaceae	Forb			+	Not Assessed
<i>Cyanotis longifolia</i> Benth.	Commelinaceae	Forb		+		Not Assessed
<i>Cyathea dregei</i> Kunze	Cyatheaceae	Fern			+	Not Assessed
<i>Cyathea manniana</i> Hook.	Cyatheaceae	Fern			+	Not Assessed
<i>Cyperus articulatus</i> Linn.	Cyperaceae	Sedge		+		Least Concern
<i>Cyperus denudatus</i> Linn.	Cyperaceae	Sedge	+			Not Assessed
<i>Cyperus tenuiculmis</i> Boeck.	Cyperaceae	Sedge	+			Least Concern
<i>Dactyloctenium aegyptium</i> (Linn.) P. Beauv.	Poaceae	Grass	+			Not Assessed

<i>Daniellia oliveri</i> (Rolfe) Hutch. et Dalz.	Caesalpinioideae	Tree	+	+	+	Not Assessed
<i>Desmodium gangeticum</i> (Linn.) DC.	Papilionoideae	Shrub		+		Not Assessed
<i>Desmodium repandum</i> (Vahl) DC.	Papilionoideae	Forb		+		Not Assessed
<i>Desmodium</i> sp. Desv.	Papilionoideae	Forb		+		
<i>Desplatsia dewevrei</i> (De Wild. & Th. Dur.) Burret	Tiliaceae	Tree	+			Not Assessed
<i>Detarium macrocarpum</i> Harms	Caesalpinioideae	Tree		+		Not Assessed
<i>Digitaria nuda</i> Schumach.	Poaceae	Grass	+		*	Not Assessed
<i>Diodia sarmentosa</i> Sw.	Rubiaceae	Forb			+	Not Assessed
<i>Dioscorea</i> sp. Linn.	Dioscoreaceae	Climber		+		
<i>Diospyros monbutensis</i> Gürke	Ebenaceae	Tree	+			Not Assessed
<i>Diplazium sammati</i> (Kuhn) C. Christ.	Athyriaceae	Fern	+			Not Assessed
<i>Dissotis bamendae</i> Brenan & Keay	Melastomataceae	Forb		+	+	Vulnerable
<i>Dissotis brazzea</i> Long.	Melastomataceae	Shrub		+		Not Assessed
<i>Dissotis</i> cf. <i>decumbens</i> (P. Beauv.) Triana	Melastomataceae	Forb			+	Not Assessed
<i>Dissotis elliotii</i> Gilgvar. <i>elliotii</i>	Melastomataceae	Shrub		+	+	Not Assessed
<i>Dissotis fruticosae</i> (Brenan) Brenan & Keay	Melastomataceae	Shrub	+	+		Not Assessed
<i>Dissotis rotundifolia</i> (Sm.) Triana	Melastomataceae	Forb	+	+		Not Assessed
<i>Dissotis senegambiensis</i> (Guill. & Perr.) Triana.	Melastomataceae	Forb			+	Not Assessed
<i>Dissotis theifolia</i> (G. Don) Hook. f.	Melastomataceae	Shrub			+	Not Assessed
<i>Dissotis tubulosa</i> (Sm.) Triana	Melastomataceae	Shrub		+	+	Not Assessed
<i>Dombeya</i> cf. <i>ledermannii</i> Engl.	Sterculiaceae	Tree			+	Endangered
<i>Doryopteris nicklesi</i> Tard	Sinopteridaceae	Fern	+			Not Assessed
<i>Dracaena deisteliana</i> Engl.	Agavaceae	Shrub			+	Not Assessed
<i>Dracaena mannii</i> Bak.	Agavaceae	Tree	+			Not Assessed
<i>Dracaena phrynioides</i> Hook.	Agavaceae	Tree	+			Not Assessed
<i>Drynaria volkensii</i> Hieron.	Drynariaceae	Fern			+	Not Assessed
<i>Echinops giganteus</i> A. Rich.	Asteraceae	Forb		+	+	Not Assessed
<i>Echinops gracilis</i> O. Hoffm.	Asteraceae	Shrub		+		Not Assessed
<i>Elaeis guineensis</i> Jacq.	Arecaceae	Tree	+			Not Assessed
<i>Elephantopus mollis</i> Kunth	Asteraceae	Forb		+		Not Assessed
<i>Emilia coccinea</i> (Sims) G. Don	Asteraceae	Forb		+		Not Assessed
<i>Ensete gillettii</i> (De Wild.) E. E. Cheesman	Musaceae	Forb			+	Not Assessed
<i>Entada africana</i> Guill. & Perr.	Mimosoideae	Tree	+			Not Assessed
<i>Entandrophragma angolense</i> (Welw.) C. DC.	Meliaceae	Tree	+		+	Vulnerable
<i>Eragrostis aspera</i> (Jacq.) Nees	Poaceae	Grass	+	+	+	Not Assessed
<i>Eragrostis tenella</i> (Linn.) P. Beauv. ex Roem	Poaceae	Grass	+	+	+	Not Assessed
<i>Eragrostis tenuifolia</i> (A. Rich.) Hochst. ex Steud.	Poaceae	Grass			+	Not Assessed
<i>Eriosema glomeratum</i> (Guill. & Perr.) Hook. f.	Papilionoideae	Shrub		+		Not Assessed
<i>Erythrophleum suaveolens</i> (Guill. & Perr.) Brenan	Caesalpinioideae	Tree	+			Not Assessed
<i>Eugenia gilgi</i> Engl. & v. Brehm.	Myrtaceae	Tree		+	+	Not Assessed
<i>Eulophia cristata</i> (Sw.) Steud.	Orchidaceae	Forb			+	Not Assessed
<i>Eulophia horsfallii</i> (Batem.) Summerh.	Orchidaceae	Forb	+			Not Assessed
<i>Euphorbia glomerata</i> A. Berger.	Euphorbiaceae	Forb	+			Not Assessed
<i>Faurea speciosa</i> Welw	Proteaceae	Tree			+	Not Assessed
<i>Ficus polita</i> Vahl	Moraceae	Tree		+		Not Assessed
<i>Ficus</i> sp. Linn.	Moraceae	Tree			+	

<i>Ficus sur</i> Forssk.	Moraceae	Tree			+	+	Not Assessed
<i>Ficus thomningii</i> Blume	Moraceae	Tree	+			+	Not Assessed
<i>Ficus vallis-choudae</i> Del.	Moraceae	Tree			+	+	Not Assessed
<i>Ficus vogelii</i> Miq.	Moraceae	Tree			+		Not Assessed
<i>Fimbristylis hispidula</i> (Savi) Boeck.	Cyperaceae	Sedge	+				Not Assessed
<i>Fimbristylis</i> sp. Vahl	Cyperaceae	Sedge				+	
<i>Galinsoga ciliata</i> (Raf.) Blake	Asteraceae	Forb			+	+	Not Assessed
<i>Garcinia acuminata</i> A. Chev.	Sterculiaceae	Tree			+		Not Assessed
<i>Garcinia smeathmanii</i> (Planch. and Triana) Oliv.	Sterculiaceae	Tree				+	Not Assessed
<i>Gardenia imperialis</i> K. Schum.	Rubiaceae	Tree				+	Not Assessed
<i>Geniosporum rotundifolium</i> Briq.	Lamiaceae	Shrub			+		Not Assessed
<i>Gladiolus primulinus</i> Bak.	Iridaceae	Forb				+	Not Assessed
<i>Gloriosa superba</i> Linn.	Liliaceae	Shrub	+				Least Concern
<i>Guizotia scabra</i> (Vis.) Chiov.	Asteraceae	Forb			+		Not Assessed
<i>Gutenbergia nigriflora</i> (Benth.) Oliv. & Hiern	Asteraceae	Forb	+		+		Not Assessed
<i>Hallea stipulosa</i> (DC.) Leroy	Rubiaceae	Tree	+			+	Vulnerable
<i>Harungana madagascariensis</i> Lam. ex Poir.	Hypericaceae	Tree	+		+		Not Assessed
<i>Haumaniastrum</i> sp. Duvign. & Plancke	Lamiaceae	Forb			+		
<i>Helichrysum</i> cf. <i>cameroonense</i> Hutch. & Dalz.	Asteraceae	Forb				+	Threatened
<i>Helichrysum cymosum</i> (Linn.) Less.	Asteraceae	Forb				+	Not Assessed
<i>Hibiscus surattensis</i> Linn.	Malvaceae	Shrub			+		Not Assessed
<i>Hibiscus tilliaceous</i> Linn.	Malvaceae	Shrub			+		Not Assessed
<i>Humularia</i> sp. P. A. Duvign.	Papilionoideae	Shrub			+		
<i>Hymenocardia acida</i> Tul.	Hymenocardiaceae	Tree	+		+		Not Assessed
<i>Hyparrhenia rufa</i> (Nees) Stapf	Poaceae	Tree	+			+	Not Assessed
<i>Hyparrhenia</i> sp. Fourn.	Poaceae	Grass	+		+		
<i>Hypericum revolutum</i> Vahl	Hypericaceae	Shrub			+	+	Not Assessed
<i>Hypericum riparium</i> A. Chev.	Hypericaceae	Shrub			+	+	Not Assessed
<i>Hypoestes rosea</i> P. Beauv.	Acanthaceae	Shrub	+			+	Not Assessed
<i>Hypoestes triflora</i> (Forsk.) Roem. & Schult.	Acanthaceae	Forb				+	Not Assessed
<i>Hypoestes verticillaris</i> (Linn. f.) Soland. ex Roem. & Schult.	Acanthaceae	Forb			+		Not Assessed
<i>Hypoxis</i> sp. Linn.	Hypoxidaceae	Forb				+	
<i>Hyptis suaveolens</i> Poit.	Lamiaceae	Shrub	+				Not Assessed
<i>Impatiens kamerunensis</i> Warb.	Balsaminaceae	Forb				+	Not Assessed
<i>Imperata cylindrica</i> (Linn.) P. Beauv.	Poaceae	Grass	+		+	+	Not Assessed
<i>Indigofera pulchra</i> Willd.	Papilionoideae	Forb			+		Not Assessed
<i>Ipomoea cairica</i> (Linn.) Sweet	Convolvulaceae	Climber	+				Not Assessed
<i>Ipomoea heterotricha</i> F. Didr.	Convolvulaceae	Climber			+		Not Assessed
<i>Ipomoea quamoclit</i> Linn.	Convolvulaceae	Climber					Not Assessed
<i>Irvingia gabonensis</i> (Aubry-Lecomte ex O'Rorke) Baill	Irvingiaceae	Tree	+				Threatened
<i>Isobertinia doka</i> Craib & Stapf	Caesalpinoideae	Tree	+				Least Concern
<i>Isobertinia tomentosa</i> (Harms) Craib & Stapf	Caesalpinoideae	Tree	+				Not Assessed
<i>Isolona</i> cf. <i>maitlandii</i> Keay	Annonaceae	Tree			+		Not Assessed
<i>Ixora</i> sp. Linn.	Rubiaceae	Shrub			+		
<i>Justicia</i> sp. Linn.	Acanthaceae	Forb			+		
<i>Kalanchoe crenata</i> (Andr.) Haw.	Crassulaceae	Forb				+	Not Assessed

<i>Khaya grandifoliola</i> C. DC.	Meliaceae	Tree	+	+		Vulnerable
<i>Khaya senegalensis</i> (Desr.) A. Juss.	Meliaceae	Tree	+			Vulnerable
<i>Kigelia africana</i> (Lam.) Benth.	Bignoniaceae	Tree	+			Not Assessed
<i>Kyllinga bulbosa</i> P. Beauv.	Cyperaceae	Sedge			+	Least Concern
<i>Kyllinga pumila</i> Michx.	Cyperaceae	Sedge	+			Not Assessed
<i>Lactuca taraxacifolia</i> (Willd.) Schum. ex Hornemann	Asteraceae	Forb		+		Not Assessed
<i>Laggera aurita</i> (Linn. f.) Benth. ex C.B. Clarke	Asteraceae	Forb			+	Not Assessed
<i>Laggera pterodonta</i> (DC.) Sch. Bip. ex Oliv.	Asteraceae	Shrub			+	Not Assessed
<i>Lannea acida</i> A. Rich.	Anacardiaceae	Tree			+	Not Assessed
<i>Lannea kerstingii</i> Engl. & K. Krause	Anacardiaceae	Tree			+	Not Assessed
<i>Lannea schimperii</i> (Hochst. ex. A. Rich.) Engl.	Anacardiaceae	Tree			+	Not Assessed
<i>Lastreopsis subsimilis</i> (Hook.) Tind.	Dryopteridaceae	Fern			+	Not Assessed
<i>Lecaniodiscus cupanioides</i> Planch. ex Benth.	Sapindaceae	Tree	+	+		Not Assessed
<i>Lemna paucicostata</i> Hegelm. ex Engelm.	Lemnaceae	Forb	+			Least Concern
<i>Leonotis nepetifolia</i> (Linn.) Ait. f.	Lamiaceae	Shrub			+	Not Assessed
<i>Leptaspis zeylanica</i> Nees ex Steud.	Poaceae	Grass	+	*		Not Assessed
<i>Liparis nervosa</i> (Thunb.) Lindl.	Orchidaceae	Forb			+	Not Assessed
<i>Lippia multiflora</i> Moldenke	Verbenaceae	Shrub			+	Not Assessed
<i>Lippia</i> sp. Linn.	Verbenaceae	Shrub			+	Not Assessed
<i>Lobelia columnaris</i> Hook. f.	Campanulaceae	Forb			+	Vulnerable
<i>Lonchocarpus sericeus</i> (Poir.) H. B. & K.	Papilionoideae	Tree	+			Not Assessed
<i>Lophira alata</i> Banks ex Gaertn. f.	Ochnaceae	Tree	+			Vulnerable
<i>Lophira lanceolata</i> Van Tiegh. ex Keay	Ochnaceae	Tree	+	+		Not Assessed
<i>Loudetia simplex</i> (Nees) C. E. Hubbard	Poaceae	Grass			+	Not Assessed
<i>Ludwigia octovalvis</i> (Jacq.) P.H. Raven	Onagraceae	Forb	+			Least Concern
<i>Lycopodium cernuum</i> Linn.	Lycopodiaceae	Fern			+	Not Assessed
<i>Lycopodium</i> sp. Linn.	Lycopodiaceae	Fern	+			Not Assessed
<i>Maesa lanceolata</i> Forsk.	Myrsinaceae	Tree			+	Not Assessed
<i>Malacantha alnifolia</i> (Bak.) Pierre	Sapotaceae	Tree			+	Not Assessed
<i>Mangifera indica</i> Linn.	Anacardiaceae	Tree	+			Not Assessed
<i>Manilkara obovata</i> (Sabine & G. Don) J. H. Hemsl.	Sapotaceae	Tree	+			Not Assessed
<i>Marantochloa purpurea</i> (Ridl.) Milne-Redh.	Marantaceae	Forb	+			Not Assessed
<i>Margaretta rosea</i> Oliv.	Apocynaceae	Forb			+	Not Assessed
<i>Margaritaria discoidea</i> (Baill.) G.L. Webster	Euphorbiaceae	Tree	+			Not Assessed
<i>Mariscus flabelliformis</i> Kunth.	Cyperaceae	Sedge			+	Not Assessed
<i>Mariscus longibracteatus</i> Cherm.	Poaceae	Grass	+			Not Assessed
<i>Megaphrynium macrostachyum</i> (Benth.) Milne-Redh	Marantaceae	Shrub	+			Not Assessed
<i>Microglossa angolensis</i> Oliv. & Hiern	Asteraceae	Shrub			+	Not Assessed
<i>Mikania cordata</i> (Burm. f.) B.L. Robinson	Asteraceae	Climber			+	Not Assessed
<i>Milicia excelsa</i> (Welw.) C.C. Berg	Moraceae	Tree	+			Threatened
<i>Millettia</i> sp. Wight & Arn.	Papilionoideae	Tree			+	Not Assessed
<i>Mimosa pigra</i> Linn.	Mimosaceae	Forb	+			Not Assessed
<i>Mimusops kummel</i> Bruce ex A. DC.	Sapotaceae	Tree			+	Not Assessed
<i>Monodora myristica</i> (Gaertn.) Dunal	Annonaceae	Tree			+	Not Assessed
<i>Monodora tenuifolia</i> Benth.	Annonaceae	Tree	+			Not Assessed
<i>Monotes kerstingii</i> Gilg	Dipterocarpaceae	Tree	+			Not Assessed

<i>Mostuea hirsuta</i> (T. Anders. ex Benth.) Baill. ex Bak.	Loganiaceae	Shrub	+			Not Assessed
<i>Mussaenda elegans</i> Schum. & Thonn.	Rubiaceae	Shrub	+			Not Assessed
<i>Mussaenda erythrophylla</i> Schum. & Thonn.	Rubiaceae	Shrub	+			Not Assessed
<i>Napoleona imperialis</i> P. Beauv.	Lecythidaceae	Tree	+			Not Assessed
<i>Nephrolepis undulata</i> (Afzelius ex Sw.) J. Sm.	Nephrolepidaceae	Fern	+	+	+	Not Assessed
<i>Nephrolepis biserrata</i> (Sw.) Schott.	Nephrolepidaceae	Fern	+			Not Assessed
<i>Nervilia shirensis</i> (Rolfe) Schltr.	Orchidaceae	Forb	+			Not Assessed
<i>Newtonia buchananii</i> (Baker) G. C. C. Gilbert & Boutique	Mimosoideae	Tree		+		Not Assessed
<i>Nuxia congesta</i> R. Br. ex Fresen.	Loganiaceae	Tree			+	Not Assessed
<i>Nymphaea lotus</i> Linn.	Nymphaeaceae	Forb	+			Not Assessed
<i>Ocimum suave</i> Willd.	Lamiaceae	Shrub	+	+	+	Not Assessed
<i>Olax subscorpioidea</i> Oliv.	Olacaceae	Shrub	+	+		Not Assessed
<i>Opilia celtidifolia</i> (Guill. & Perr.) Endl. ex Walp.	Opiliaceae	Tree	+			Not Assessed
<i>Oplismenus burmannii</i> (Retz.) P. Beauv.	Poaceae	Grass		+		Not Assessed
<i>Oplismenus hirtellus</i> (Linn.) P. Beauv.	Poaceae	Grass			+	Not Assessed
<i>Oxalis corniculata</i> Linn.	Oxalidaceae	Forb		+		Not Assessed
<i>Palisota hirsuta</i> (Thunb.) K. Schum.	Commelinaceae	Shrub	+			Not Assessed
<i>Pandanus candelabrum</i> P. Beauv.	Pandanaceae	Tree	+			Not Assessed
<i>Panicum maximum</i> Jacq.	Poaceae	Grass	+		+	Not Assessed
<i>Parinari excelsa</i> Sabine	Chrysobalanaceae	Tree	+			Not Assessed
<i>Paspalum scrobiculatum</i> Linn.	Poaceae	Grass			+	Least Concern
<i>Paullinia pinnata</i> Linn.	Sapindaceae	Climber	+	+	+	Not Assessed
<i>Pennisetum polystachion</i> (Linn.) Schult.	Poaceae	Grass	+			Not Assessed
<i>Pennisetum</i> sp. Linn. Rich.	Poaceae	Grass			+	
<i>Peperomia fernandopoiana</i> C. DC.	Piperaceae	Epiphyte			+	Not Assessed
<i>Peperomia reflexa</i> (Linn. f.) A. Dietr.	Piperaceae	Epiphyte			+	Not Assessed
<i>Persea americana</i> Mill.	Lauraceae	Tree		+	+	Not Assessed
<i>Phaulopsis barteri</i> (T. Anders.) Lindau	Acanthaceae	Forb	+			Not Assessed
<i>Phaulopsis falcisepala</i> C. B. Cl.	Acanthaceae	Forb		+		Not Assessed
<i>Phillipia (Erica) mannii</i> (Hook. f.) Beentje	Ericaceae	Shrub			+	Not Assessed
<i>Phoenix reclinata</i> Jacq.	Arecaceae	Tree	+			Not Assessed
<i>Piliostigma thonningi</i> (Schum.) Milne-Redhead	Caesalpinioideae	Tree	+	+		Not Assessed
<i>Pittosporum viridiflorum</i> Sims	Pittosporaceae	Tree			+	Not Assessed
<i>Platynerium alaicorne</i> Desv.	Platyneriaceae	Fern	+			Not Assessed
<i>Platynerium angolense</i> Welw. ex Hook.	Platyneriaceae	Fern	+			Not Assessed
<i>Pleiocarpa pycnantha</i> (K. Schum.) Stapf	Apocynaceae	Tree		+		Not Assessed
<i>Pleopeltis preussii</i> Tardieu	Polypodiaceae	Fern	+			Not Assessed
<i>Pollia condensata</i> C. B. Cl.	Commelinaceae	Shrub	+			Not Assessed
<i>Polyscias fulva</i> (Hiern) Harms	Araliaceae	Tree		+	+	Not Assessed
<i>Polygonum lanigerum</i> var. <i>africanum</i> Meisn.	Polygonaceae	Forb	+			Not Assessed
<i>Polygonum pulchrum</i> Blume	Polygonaceae	Shrub	+			Least Concern
<i>Polysphaeria arbuscular</i> K. Schum.	Rubiaceae		+	+		Not Assessed
<i>Polystachya dolichophylla</i> Schltr.	Orchidaceae	Epiphyte	+			Not Assessed
<i>Polystachya</i> sp. Hook.	Orchidaceae	Epiphyte			+	
<i>Prosopis africana</i> (Guill. & Pen.) Taub.	Mimosoideae	Tree	+			Not Assessed
<i>Protea madiensis</i> Oliv.	Proteaceae	Shrub	+	+	+	Not Assessed

<i>Prunus africana</i> (Hook. f.) Kalkman	Rosaceae	Tree			+	Vulnerable
<i>Pseudarthria hookeri</i> Wight & Arn.	Papilionoideae	Forb		+		Not Assessed
<i>Pseudocedrela kotschyi</i> (Schweinf) Harms	Meliaceae	Tree	+			Not Assessed
<i>Spondianthus preussii</i> Engl. var. <i>preussii</i>	Euphorbiaceae	Tree	+			Not Assessed
<i>Pseudospondias microcarpa</i> (A. Rich.) Engl.	Anarcadiaceae	Tree	+			Not Assessed
<i>Psorospermum aurantiacum</i> Engl.	Hypericaceae	Shrub			+	Not Assessed
<i>Psorospermum febrifugum</i> (Hook. f.) Keay & Milne-Redhead	Hypericaceae	Shrub		+		Not Assessed
<i>Psychotria chalconeura</i> (K. Schum.) Petit	Rubiaceae	Shrub			+	Least Concern
<i>Psychotria peduncularis</i> (Salisb.) Steyerem.	Rubiaceae	Shrub	+	+	+	Not Assessed
<i>Psychotria subcordata</i> Britton	Rubiaceae	Tree			+	Not Assessed
<i>Psychotria vogeliana</i> Benth.	Rubiaceae	Shrub		+		Not Assessed
<i>Psydrax subcordata</i> (DC.) Bridson	Rubiaceae	Tree	+		+	Not Assessed
<i>Pteridium aquilinum</i> (Linn.) Kuhn	Dennstaedtiaceae	Fern		+	+	Not Assessed
<i>Pteris acanthoneura</i> Alston.	Pteridaceae	Fern	+			Not Assessed
<i>Pteris togoensis</i> Hieron.	Pteridaceae	Fern			+	Not Assessed
<i>Pterocarpus</i> sp. Jacq.	Papilionoideae	Tree	+			Not Assessed
<i>Pterygota mildbraedii</i> Engl.	Sterculiaceae	Tree			+	Not Assessed
<i>Rangaeris rhipsalisocia</i> (Rchb. f.) Summerh.	Orchidaceae	Epiphyte	+			Not Assessed
<i>Raphia hookeri</i> Mann & Wendl.	Arecaceae	Tree	+			Not Assessed
<i>Raphia sudanica</i> A. Chev.	Arecaceae	Tree	+			Vulnerable
<i>Rauvolfia caffra</i> Sond.	Apocynaceae	Tree			+	Not Assessed
<i>Rauvolfia vomitoria</i> Afzel.	Apocynaceae	Tree	+		+	Not Assessed
<i>Rhynchelytrum repens</i> (Willd.) C. E. Hubbard	Poaceae	Grass	+			Not Assessed
<i>Ricnodendron heudelotii</i> (Baill.) Pierre ex Pax	Euphorbiaceae	Tree	+			Not Assessed
<i>Ritchiea albersii</i> Gilg.	Capparaceae	Tree			+	Not Assessed
<i>Rothmannia urcelliformis</i> (Hiern) Bullock ex Robyns	Rubiaceae	Tree			+	Not Assessed
<i>Rothmannia whitfieldii</i> (Lindl.) Dandy	Rubiaceae	Tree	+			Not Assessed
<i>Salacia</i> sp. Linn.	Celastraceae	Tree	+			Not Assessed
<i>Sarcocephalus latifolius</i> (Sm.) E. A. Bruce	Rubiaceae	Shrub	+	+	+	Not Assessed
<i>Satureja punctata</i> (Benth.) Briq.	Lamiaceae	Forb			+	Not Assessed
<i>Scadoxus multiflorus</i> (Martyn) Raf.	Amaryllidaceae	Forb	+			Not Assessed
<i>Schefflera abyssinica</i> (Hochst. ex A. Rich.) Harms	Araliaceae	Climber			+	Not Assessed
<i>Schizachryium</i> sp. Nees	Poaceae	Grass	+			Not Assessed
<i>Scleria</i> sp. Berg.	Poaceae	Forb			+	Not Assessed
<i>Scleria verrucosa</i> Willd.	Poaceae	Grass	+			Not Assessed
<i>Selaginella myosurus</i> (Sw.) Alston	Selaginellaceae	Fern		+		Not Assessed
<i>Selaginella</i> sp. P. Beauv.	Selaginellaceae	Fern	+	+		Not Assessed
<i>Senecio mannii</i> Hook. f.	Asteraceae	Shrub			+	Not Assessed
<i>Senna obtusifolia</i> Linn.	Caesalpinioideae	Shrub		+		Not Assessed
<i>Sesbania macrantha</i> Welw. ex Phill. & Hutch.	Papilionoideae	Shrub			+	Not Assessed
<i>Setaria megaphylla</i> (Steud.) Dur. & Schinz	Poaceae	Grass	+		+	Not Assessed
<i>Setaria</i> sp. P. Beauv.	Poaceae	Grass			+	Not Assessed
<i>Sida corymbosa</i> R. E. Fries	Malvaceae	Forb			+	Not Assessed
<i>Sida linifolia</i> Juss. ex Cav.	Malvaceae	Shrub		+		Not Assessed
<i>Siphonochilus aethiopicus</i> (Schweinf.) B.L. Burt	Zingiberaceae	Forb	+			Not Assessed
<i>Siphonochilus nigericus</i> (Hutch. ex Hepper) B.L. Burt	Zingiberaceae	Forb	+			Not Assessed

<i>Smilax kraussiana</i> Meisn.	Smilacaceae	Climber	+		+	Not Assessed
<i>Solanum aculeastrum</i> Dunal	Solanaceae	Shrub			+	Not Assessed
<i>Solanum dasyphyllum</i> Schum. & Thonn.	Solanaceae	Shrub		+		Not Assessed
<i>Solanum</i> sp. Linn.	Solanaceae	Shrub	+			Not Assessed
<i>Solanum wrightii</i> Benth.	Solanaceae	Shrub			+	Not Assessed
<i>Solenostemon monostachyus</i> (A. Chev.) Brenan	Lamiaceae	Forb	+	+		Not Assessed
<i>Sporobolus africanus</i> (Poir.) Robyns & Tournay	Poaceae	Grass			+	Not Assessed
<i>Sterculia rhinopetala</i> K. Schum.	Sterculiaceae	Tree	+			Not Assessed
<i>Sterculia</i> sp. Linn.	Sterculiaceae	Tree	+			Not Assessed
<i>Sterculia tragacantha</i> Lindl.	Sterculiaceae	Tree		+		Not Assessed
<i>Stomatanthes africanus</i> (Oliv. & Hiern) R.M. King & H. Rob.	Asteraceae	Forb	+	+		Not Assessed
<i>Striga aspera</i> (Willd.) Benth.	Scrophulariaceae	Forb		+		Not Assessed
<i>Strombosia scheffleri</i> Engl.	Olacaceae	Tree			+	Not Assessed
<i>Stylochiton barteri</i> N. E. Br.	Araceae	Forb	+			Not Assessed
<i>Symphonia globulifera</i> Linn. f.	Clusiaceae	Tree	+	+	+	Not Assessed
<i>Syzygium guineense</i> (Wild.) DC.	Myrtaceae	Tree	+	+		Not Assessed
<i>Syzygium guineense</i> (Wild.) DC. <i>subsp. bamendae</i>	Myrtaceae	Tree			+	Not Assessed
<i>Syzygium guineense</i> (Wild.) DC. <i>subsp. guineense</i>	Myrtaceae	Tree			+	Not Assessed
<i>Tabernaemontana contorta</i> Stapf	Apocynaceae	Tree		+		Not Assessed
<i>Tabernaemontana pachysiphon</i> Stapf	Apocynaceae	Tree	+			Not Assessed
<i>Tagetes erecta</i> Linn.	Asteraceae	Forb		+		Not Assessed
<i>Tapinanthus bangwensis</i> (Engl. & K. Krause) Danser	Loranthaceae	Epiphyte			+	Not Assessed
<i>Tephrosia vogelii</i> Hook. f.	Papilionoideae	Shrub		+		Not Assessed
<i>Terminalia avicennioides</i> Guill. & Perr.	Combretaceae	Tree	+			Not Assessed
<i>Terminalia glaucescens</i> Planch. ex Benth.	Combretaceae	Tree	+	+		Not Assessed
<i>Terminalia laxiflora</i> Engl.	Combretaceae	Tree		+		Not Assessed
<i>Terminalia schimperiana</i> Hochst.	Combretaceae	Tree	+			Not Assessed
<i>Terminalia superba</i> Engl. & Diels	Combretaceae	Tree	+			Not Assessed
<i>Tetrapleura tetraptera</i> (Schum. & Thonn.) Taub.	Mimosoideae	Tree	+			Not Assessed
<i>Thalia welwitschii</i> Ridl.	Marantaceae	Shrub	+			Not Assessed
<i>Thonningia sanguinea</i> Vahl.	Balanophoraceae	Epiphyte	+			Not Assessed
<i>Tithonia diversifolia</i> (Hemsl.) A.Gray	Asteraceae	Shrub		+		Not Assessed
<i>Trema orientalis</i> (L.) Blume	Ulmaceae	Tree		+	+	Not Assessed
<i>Trichilia preuriana</i> A. Juss	Meliaceae	Tree	+			Not Assessed
<i>Trichomanes</i> sp. Linn.	Hymenophyllaceae	Fern			+	Not Assessed
<i>Trilepisium madagascariense</i> DC.	Moraceae	Tree	+			Not Assessed
<i>Triumfetta dubia</i> De Wild.	Tiliaceae	Shrub		+		Not Assessed
<i>Uapaca heudelotii</i> Baill	Euphorbiaceae	Tree	+			Not Assessed
<i>Uapaca togoensis</i> Pax	Euphorbiaceae	Tree	+	+	+	Not Assessed
<i>Urelytrum</i> sp. Hack.	Poaceae	Grass	+			Not Assessed
<i>Urena lobata</i> Linn.	Malvaceae	Shrub	+			Not Assessed
<i>Urginea altissima</i> (Linn. f.) Bak.	Hyacinthaceae	Forb			+	Not Assessed
<i>Vernonia ambigua</i> Kotschy & Peyr.	Asteraceae	Shrub		+		Not Assessed
<i>Vernonia calvoana</i> Hook. f.	Asteraceae	Shrub		+		Not Assessed
<i>Vernonia glaberrima</i> Welw. ex O. Hoffm.	Asteraceae	Shrub		+		Not Assessed
<i>Vernonia glabra</i> (Steetz) Vatke	Asteraceae	Forb		+		Not Assessed



<i>Vernonia guineense</i> Benth.	Asteraceae	Forb		+	+	Not Assessed
<i>Vernonia pauciflora</i> (Willd.) Less.	Asteraceae	Forb		+		Not Assessed
<i>Vernonia tenoreana</i> Oliv.	Asteraceae	Shrub		+		Not Assessed
<i>Vigna cf. reticulata</i> Hook. f.	Papilionoideae	Climber		+		Not Assessed
<i>Virectaria multiflora</i> (Sm.) Bremek.	Rubiaceae	Forb		+		Not Assessed
<i>Vitellaria paradoxa</i> C. F. Gaertn.	Sapotaceae	Tree		+		Vulnerable
<i>Vitex chrysocarpa</i> Planch. ex Benth.	Verbenaceae	Tree	+			Not Assessed
<i>Vitex doniana</i> Sweet	Verbenaceae	Tree			+	Not Assessed
<i>Vitex grandifolia</i> Gürke	Verbenaceae	Tree	+			Not Assessed
<i>Vittaria guineensis</i> Desv.	Vittariaceae	Fern			+	Not Assessed
<i>Voacanga africana</i> Stapf	Apocynaceae	Tree	+			Not Assessed
<i>Vossia</i> sp. Wall. & Griff.	Poaceae	Grass	+			Not Assessed
<i>Zanthoxylum leprieurii</i> Guill. & Perr.	Rutaceae	Tree		+		Not Assessed
<i>Zanthoxylum zanthoxyloides</i> (Lam.) Zepern. & Timler	Rutaceae	Tree		+	+	Not Assessed

**Key:** IUCN = International Union of Conservation of Nature

IUCN (2015): Version 2015-4.

+ = Present

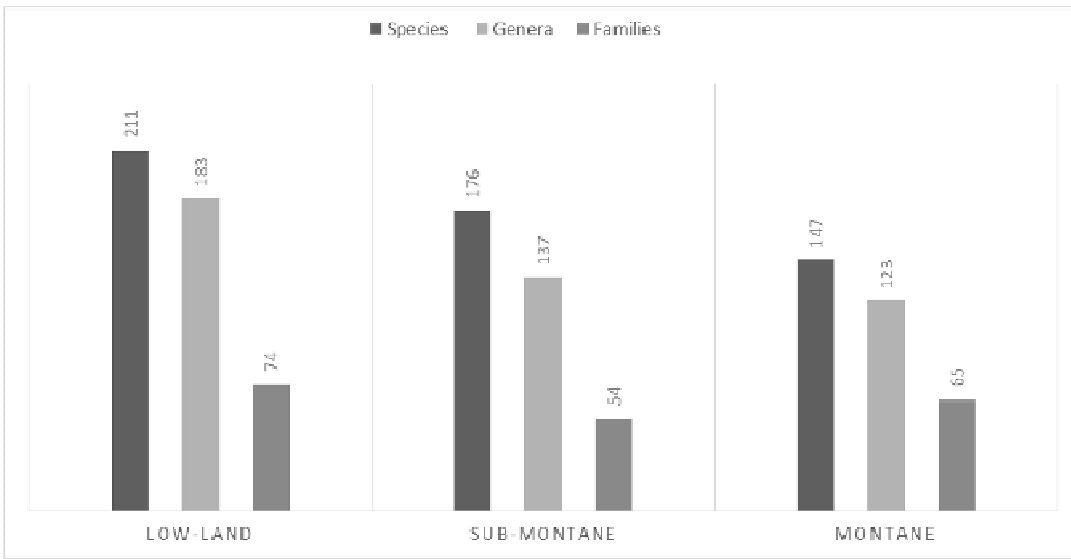


Figure 4: Summary of species composition along the altitudinal regions

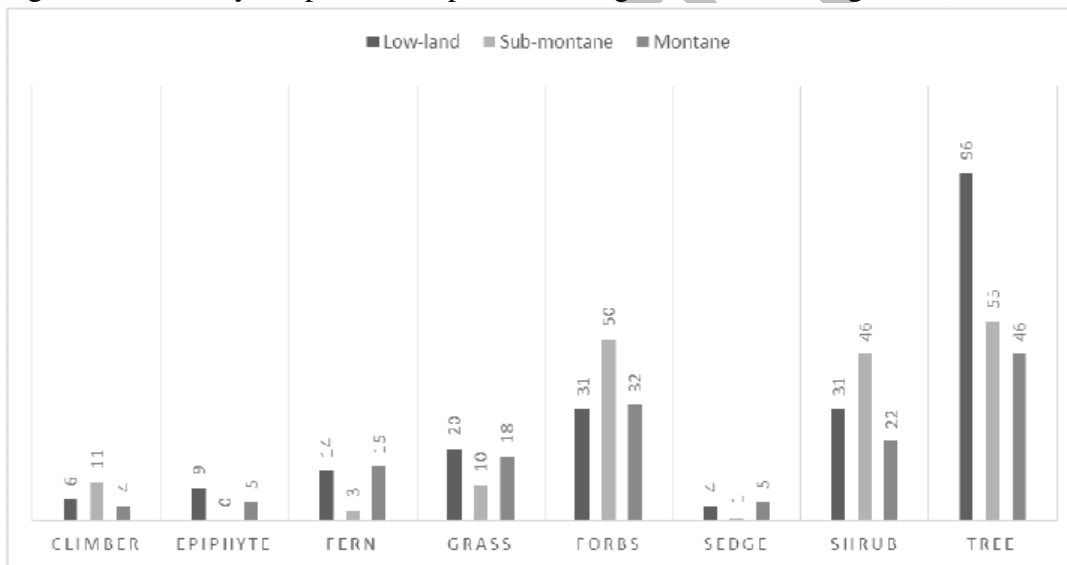


Figure 5: Summary of species habits distribution across the studied site

### Discussion

Several authors have published flora and checklists of Nigerian plants; they include Hutchinson and Dalziel (1954, 1958, 1963, 1968, 1972) on angiosperms, gymnosperms and pteridophytes, Alston (1959) on ferns, Keay *et al.* (1964) on trees, Lowe and Stanfield (1974) on sedges, and Akobundu and Agyakwa (1998) on weeds, as well as Ayodele and Yang (2012) on vascular plants. Akinsoji

(1994, 1996), Akinsoji (2003), Akinsoji *et al.* (2003) and Akinsoji (2005) are the only works on the vegetation of GGNP known to the authors. Good as these works were, they cannot be said to have appropriately documented the flora of the GGNP since they are all vegetation specific. As a result of this there is the urgent need to formally document extensively the various plants of the vegetationally complex National Park

along its geomorphic gradient as a sectoral project. This is because the park remains one of the two least disturbed and the largest in the country with peculiar combination of several vegetation types mimicking the complex Nigerian vegetation.

#### **Vegetation Types**

**Lowland rainforest:** A lowland tropical rainforest type comprises the following vertical tiers: emergent canopy, base canopy, middle tier and forest understory. Lowland forest was only present in the lowland region, particularly along the riparian areas of the Park. Gumnior and Sommer (2012) using remote sensing reported similar findings. Emergent trees may attain heights of 35 to 50 m, and sometimes even higher; these species appear to poke through an otherwise fairly even canopy top, whose height is typically about 25 to 30 m. Emergent trees in the region include *Khaya grandifolia*, *Ceiba pentandra*, *Milicia excelsa* and *Terminalia superba* while the base canopy consists of *Albizia* spp., *Erythrophleum suaveolens* and *Ficus* spp. Mid tier plants consist of intermediate height trees, tall shrubs and epiphytes that do not require the light intensity of the canopy trees such as *Celtis philippensis* and *Olax subscorpioidea*. The forest floor receives relatively little sunlight, and thus is rarely choked with vegetation; nevertheless, one finds here a myriad of low growing shrubs, ground trailing lianas, ferns, lichens and mosses. Expectedly, this forest support a plethora of terrestrial avafauna, arthropoda, amphibians and reptiles as observed during this study.

**Derived savanna:** This zone is characterized by mosaic of vegetation

because it shares ecological characteristics from both the lowland and montane vegetation. This was observed along Selbe, Tonga and Yakuba routes with altitude between 1000 and 1500 m asl. The derived savanna resulted from farming and grazing pressure. In this vegetation type, the flora is now characterized by grasses such as *Andropogon tectorum*, *Hyparrhenia* spp., *Urelytrum* sp. and *Imperata cylindrica*. Associated herbaceous species include *Scadoxus multiflorus* and *Stomatanthes africanus* while woody species include *Sarcocephalus latifolius*, *Piliostigma thonningi* and *Combretum* sp.

**Montane vegetation:** During this study, the highest elevation was observed at Chabbal Hendu with altitude up to 1900 m asl which is characteristic of this montane region. However, according to Akinsoji (1996), the highest point on the Gotel Mountains (2419 m asl) is Gangrewal, located in the southeastern fringe of the park. The floristic composition differs from one point to another along the altitude because of slope, fire, grazing etc. leading to the formation of mosaic vegetation. The observed mosaic vegetation is made up of montane forest and grassland.

Chabbal Hendu is located on the altitude range between 1800 and 2000 m asl with a conspicuous influence of altitude on vegetation. The forests do not show any emergents but the canopy layer is discernible although it does not form a complete cover. Canopy trees include *Albizia gummifera*, *Symphonia globulifera*, *Croton monostachyus*, *Syzygium guineense* subsp. *bamendae*, *Prunus africana*, *Ficus* spp., *Entandrophragma angolense*, *Strombosia scheffleri*, *Garcinia smeathmanni*,

*Carapa procera*, *Bridelia speciosa*, *Campylospermum flavum*, *Clausena anisata*, *Trema orientalis* and *Ritchiea albersii*. Some specific characteristics such as the bark thickness that ranges between 0.2 and 1.5 cm, and buttresses as seen on *Syzygium* and stilt roots as observed on *Anthocleista* were observed on the trees in this region. Also, the barks are heavily coated with lichen patches and 'pads' of epiphytic bryophytes and pteridophytes such as *Asplenium dregeanum*, *Asplenium preussii*, *Asplenium theciferum*, and *Nephrolepis undulata*.

The shrub layer is dominated by *Psychotria peduncularis*, *Chassalia kolly*, *Dracaena deisteliana*, *Desmodium rependum* and *Ocimum suave* while the gaps are dominated by herbaceous species such as *Commelina benghalensis* and *Ageratum conyzoides*, and juveniles of trees such as *Dombeya* cf. *ledermannii*, *Milletia* sp., and *Clausena anisata*. Lianes identified are *Smilax kraussiana* and *Paullinia pinnata*.

The grassland has been subjected to annual fire and grazing. The effect of both fire and grazing has prevented the forest extension, changed the floristic composition and allowed the development and expansion of fire resistant forest edge species like *Hypericum revolutum* which form thickets at the forest edge as observed at Chabbal Hendu. There is woodland vegetation along the mountain sides at slightly lower altitudes between Selbe and Chabbal Hendu. Common grasses identified include *Chloris pilosa*, *Eragrostis* spp., *Paspalum scrobiculatum*, *Sporobolus africanus* and *Pennisetum* sp. Trees include *Entada africana*, *Combretum molle*, *Lophira*

*lanceolata* and *Annona senegalensis* while scattered shrubs are *Sarcocephalus latifolius*, *Protea madiensis*, *Gardenia imperialis* and *Solanum aculeastrum*.

Southern Guinea Savanna: Apart from the montane and lowland forest in the southern parts of the park, the rest of the vegetation is savanna. The Southern Guinea Savanna occurs in the lowland and sub-montane regions. It is characterized by the presence of grasses which are subjected to annual fires while the trees, shrubs and forbs were considerably scattered along the terrain. Dominant woody species are *Lophira lanceolata*, *Daniellia oliveri*, *Azelia africana*, *Crossopteryx febrifuga*, *Piliostigma thonningii*, *Entada africana*, *Prosopis africana*, *Annona senegalensis*, *Combretum* spp., and *Terminalia schimperiana*. Also, characteristic dominant grasses include *Andropogon tectorum*, *Hyparrhenia rufa*, *Pennisetum polystachion*, *Ctenium* sp. and *Schizachryum* sp.

On the hilly side, some species such as *Uapaca togoensis*, *Hymenocardia acida*, *Piliostigma thonningii* and *Bridelia atroviridis* were found to occur in pure stands with their stems and branches covered by epiphytic species of lichens, mosses, ferns (*Platyserium* spp.) and some orchids such as *Aerangis biloba*, *Angraecum subulatum*, *Bulbophyllum congolanum*, *Calypetrochilum christyanum*, *Calypetrochilum emarginatum*, *Eulophia horsfallii*, *Polystachya dolichophylla*, and *Rangaeris rhipsalisocia*. Single stands of *Anogeissus leiocarpus* with intermittent occurrence of *Borassus aethiopicum* were observed on moister soils along the streams in the valley.

Other species in this sub-ecosystem include *Khaya senegalensis*, *Alchornea cordifolia*, *Mussaenda elegans*, *Panicum maximum*, *Setaria megaphylla*, *Raphia sudanica*, *Phoenix reclinata*, *Breonadia salicina*, *Brachystegia eurycoma*, *Berlinia grandiflora*, *Erythrophleum suaveolens*, *Polysphaeria arbuscula*, *Vitex chrysocarpa*, *Uapaca heudelotii* and *Pandanus candelabrum*. Other noticeable geophytic forbs include *Costus spectabilis* (the Nigeria National flower), *Crinum zeylanicum*, *Crinum jagus*, *Amorphophallus* sp., *Amorphophalus abyssinicus*, *Scadoxus multiflorus*, *Siphonochilus aethiopicus*, *Curculigo pilosa*, *Gloriosa superba*, and a shrub *Cochlospermum planchonii* which flowers immediately after fires before leaves are produced.

#### **Diversity**

The 426 plant species identified in this region accounts for one-fifteenth of the total vascular plants diversity in Nigeria as reported from the compilations of Ayodele and Yang (2012). Diversity in the region was further enriched by its proximity to Cameroon and this led to the occurrence of certain East African flora which were not reported by Hutchinson and Dalziel (1954) in West Tropical Africa and Ayodele and Yang (2012) in Nigeria. The new additions are; *Anthonotha noldeae* (Rossberg) Exell & Hill, *Psychotria subcordata* Britton, *Pterygota mildbraedii* Engl., *Tagetes erecta* Linn., and *Tithonia diversifolia* (Hemsl.) A. Gray.

#### **Conservation**

IUCN protected area management categories classify protected areas according to their management objectives. GGNP is a category II protected area because it is a National

Park. Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities (IUCN, 2014).

Several of the species in this report have not been assessed by IUCN till date. Nonetheless, twelve vulnerable species were identified out of which ten are trees and two are forbs. *Lophira alata*, *Khaya senegalensis*, *Khaya grandifoliola*, *Entandrophragma angolense*, *Allophylus bullatus*, *Hallea stipulosa*, *Prunus africana*, and *Azelia africana* are vulnerable trees mainly felled for timber in Africa. *Vitellaria paradoxa* is harvested for its shea butter while *Raphia sudanica* is over-exploited for palm wine in Northern Nigeria (Burkill, 1985). Strict policies should be developed and enforced in GGNP and Nigeria as a whole to prevent felling and over-and unsustainable-exploitation of these species.

Vulnerable herbaceous species are *Lobelia columnaris* and *Dissotis bamendae*. *Lobelia columnaris* is not known for any use, however, its reduction in population may be as a result of the reduction of its habitat as reported by Cheek *et al.* (2000). They reported that the plant is usually threatened by fires from grassland moving into forest edges; forest loss due to timber extraction and clearance for agricultural land. Similarly, *Dissotis bamendae* has no known use except for ornamental purposes but its vulnerability is attributed to the conversion of natural habitat to

farmland, for grazing and for cultivation; increasing frequency of fires may also pose a threat to this species. These forbs can be conserved by reducing forest loss to agriculture or creating biodiversity offsets when such lands are to be occupied.

Three species were threatened from the list: *Irvingia gabonensis*, *Helichrysum* cf. *cameroonense*, and *Milicia excelsa*. According to IUCN (2015), *Irvingia gabonensis* population have declined due to logging operations, expansion of human settlements and poor natural regeneration. Other reasons may be over-exploitation of the plant for its fruits. *Milicia excelsa* is threatened because it suffers from heavy exploitation as source of timber, even for exports. The plant is also prone to gall attacks, especially in plantations, and its seed loses viability quickly (IUCN, 2015). *Dombeya* cf. *ledermannii* was the only endangered species in the location as at the time of this study. IUCN (2015) discloses that this endangerment is as a result of vegetation clearance for agriculture and over-exploitation of the plant for its bast fibres.

#### **GIS Analysis**

The contribution of remote sensing to ecology has been intensely documented. However, remote sensing for GGNP will be better explained using elevation models because of the characteristic geomorphic gradient of the park. Volarik (2010) explained that Digital Elevation Model (DEM) contains information both on altitude and topography and considered it to be a useful tool for transferring the knowledge of vegetation tiers from easily classifiable sites to the sites that are not easily classifiable. This indicated the dominance of this method

over spatial characterization used by Gumnior and Sommer (2012) and Mubi and Tukur (2012). Volarik (2010) further stressed that DEM determines the spatial resolution of all derived maps, such as a map of slope, aspect, and curvatures. DEM is considered to be the main prerequisite map for spatial modelling in ecology and has been used as a source of variables in numerous vegetation studies such as Davis and Goetz (1990), Del Barrio *et al.* (1997), Gottfried *et al.* (1998) and Guisan *et al.* (1998).

Result from the ground truthing data for this study is similar to that of the DEM except in the sub-montane classification between 933 and 1467 m. In this classification, while the ground truthing data categorized elevations 1500 m and 1588 m as sub-montane, the DEM categorized the elevations under montane. This is one of the advantages of using DEM in vegetation analysis of mountainous regions. Normalised Difference Vegetation Index (NDVI) can be calculated from satellite imagery and is generally recognised as a reliable index of ground vegetation cover (Hess *et al.*, 1996). Therefore, the higher indices reflected by imagery from 1991 indicated higher vegetation cover than 2013. This difference is due to natural and anthropogenic factors, the combination of which determines the species composition of vegetation (Bakker and ter Heerdt, 2005).

#### **Conclusion**

Effective and efficient conservation with adequate management of species habitats in national parks can be achieved through proper eco-taxonomic studies, reducing the effect of anthropogenic and natural factors in reserved areas to

minimum threshold. Ecological studies alongside GIS analysis have revealed the rate of degradation within the studied area. To the best knowledge of the authors, this is lacking in previous works on the GGNP. Therefore, we recommend that a detailed ecological studies should be carried out within GGNP and other reserved areas in Nigeria to know their biodiversity status which will later serve as a guide to formulate a better policy and law to protect our national heritage.

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