Forestry Consulting

STUDY OF THE TYPIFICATION OF THE MIOMBO IN THE PROVINCE OF HUAMBO TROUGH THE USE OF SATELLITE IMAGES OF HIGH-MEDIUM RESOLUTION

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1. Introduction

The vegetation knowledge abouth forest ecosystemsis an important aspect for the management of the forest resource and necessary for innumerable activities of investigation and development for its importance as a fundamental subsystem within the ecological system. This is the reason about the scientific community is focused on the miombo vegetation (Eugenio *et al*., 2014).

The miombo is one of the most important ecosystems in southern Africa cone, covering outstanding areas of Angola, Malawi, Mozambique, Tanzania, Zimbabue, Zambia, land part of the Democratic Republic of Congo covering about 270 million ha (Fig 1). The Miombo, lacking the typical appearance of a tropical moist forest, is dominated in its tree stratum by species of *Brachystegia* spp., *Julbernardia* spp. and *Isoberlinia* spp. (Campbell *et al*., 1996); is the largest seasonal dry tropical forest by extension in Africa.This type of ecosystem is made up by mosaics of dry forests and wooded savannas, characterized by a high diversity of flora and wildlife (Ryan *et al*., 2011), average productivity and high social value in terms of wood fuel, construction materials, pasture, food and medicinal plants (MINADERP, 2010). In addition, miombo woodlands play an important role in the fixation of atmospheric CO2, because in normal conditions they can fix up to 110 mg C/ha, between plant biomass and soils (Ryan *et al.,* 2011).

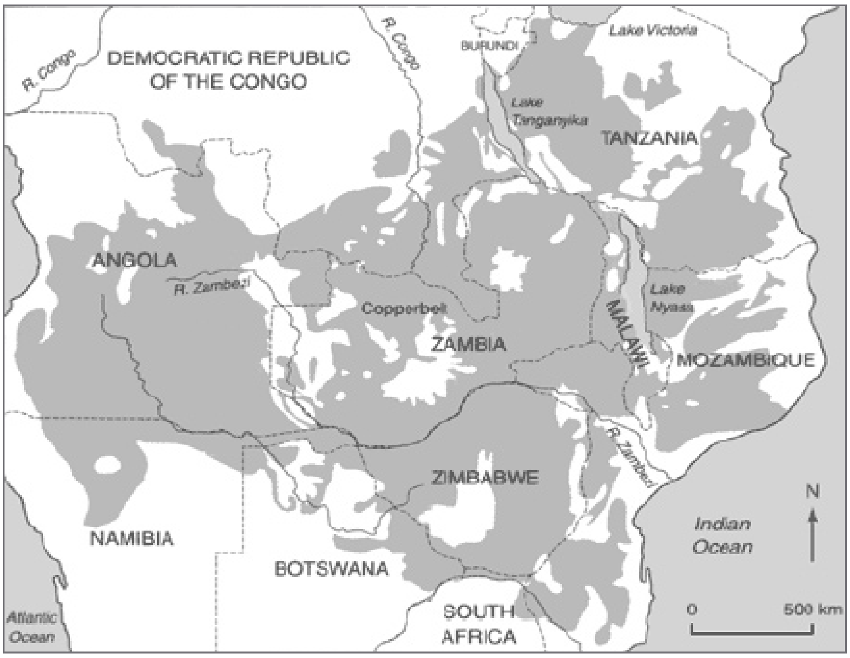


Fig 1Distribution of Miombo woodlands. Source: White, 1983.

Although the enormous extent of the miombo, different authors have contrasted the structure differences in Miombo (Trapnell 1959, Strang 1974, Guy 1981, Chidumayo 1993, 2004, Luoga *et al.*, 2002, Banda *et al.* 2006). White (1983) divides two types of Miombo as dry and wet. Dry Miombo exists in areas that receive less than 1000 mm of annual rainfall. Miombo moist exists in areas that receive more than 1000 mm per year. On the other hand, the main difference with respect to floristic composition as well as structure is seen mainly at the local level (Campbell *et al.* 1996). The origin of these differences is not clear: geomorphic landscape evolution; Edaphic factors, mainly soil moisture and nutrients (Astle 1969; Campbell *et al.*, 1988); the effects of fire (Freson *et al.,* 1974; Lawton 1978; Kikula 1986) and the historical and present uses of the soil along with other anthropic factors that are involved (Robertson 1984; Chidumayo 1987 and Campbell *et al.* 1996). Authors classify Miombo woodland into four stratos: according to fallow age: young fallows (range 7-8 yrs), medium-aged fallows (range 10–14yrs), old fallows (range 20-21 yrs), and mature forests (undisturbed forests or woodlands, showing structural features characteristic of later stages of stand and succession development).

The Angolan Mopane Woodlands ecoregion stretches from southwestern Angola into northern Namibia, between 15 ° S and 21 ° S latitude. It lies inland of the Namib escarpment, but mostly to the west of the Zambezian Baikiaea Woodlands. These Miombo forests are one of the most relevant ecological coverages, consisting of forests rich in biodiversity, with approximately 8,500 plant species of which 54% are endemic (Desanker, Frost, Justice, & Scholes, 1997).

In Angola, the miombo woodlands have been and are a strongly disturbed ecosystem. It presents a strong contrast to physiognomic level, structural and biomass, most of its surface in contact with humans, with respect to the few existing mature formations (Davies *et al.,* 2010).

These forests are exposed every day to the great pressures exerted by the communities that seek to satisfy their needs. Incidences of their destruction are indiscriminate cuttings for the production of charcoal, the immense devastation of areas for agricultural activity and the constant damage caused by fires, whether of natural or human origin (Bockeus *et al.*, 2006). These reasons lead to the loss of biodiversity and the degradation of natural ecosystems, an alarming cause that leads to the study of the patterns of structure and composition of these forests (Eugenio *et al.*, 2014).

The composition, structure and dynamics of a forest represents an initial step for its knowledge, because associated to it can be built a theoretical basis that supports the conservation of genetic resources and the recovery of these, being the starting point for the adequacy of criteria and methods of conservation and restoration (Araujo *et al.,* 2009). Knowledge of vegetation provides information on those species most susceptible to disturbances in a given region (Ramírez *et al.*, 2001) and helps predict their evolution (Jones *et al.*, 2004).

2. Background

2.1. Miombo's structure and composition

Although there are not many studies focusing on the characterization of the miombo in Angola (Cabral *et al*, 2012; Sanfilipo, 2013), recent studies in this regard in two provinces representative of miombo show that presents a very heterogeneous composition, being of average between 11 and 18 species, among which*Albizia antunesiana, Anisophyllea boehmii, Bobgunnia madagascariensis, Brachystegia boehmii, Brachystegia longuiflora, Brachystegia spiciformis, Hymenocarida acida, Monote* spp, *Ochna schweinfurthiana, Parinari curatelifolia, Pericopsis angolensis, Psorospermum febrifugum, Pterocarpus angolensis, Randia Kuhnian* F. Hoffm. Schum. (*Rothmannia engleriana*) *Syzygium guineense* and *Terminalia Brachistema*. The density found in these works is around 2000 individuals.ha^{-1} for adult individuals while the regeneration density varies greatly humidity and canopy cover, with data ranging from 1900 to 8000 individuals ha^{-1} (Dovala, 2015). These data also do generally agree with the literature for miombo species, which appear density data between 1000-4100 individual per ha^{-1} (Campbell, 1996; Banda et al., 2006; Backéus et al., 2006). In relation to the total biomass found, the data of these studies are also similar to those found in the specific literature of Miombo in other areas, (Frost in Campbell, 1996), with a total biomass between 96.75 and 131 Ton.ha^{-1} (Dovala, 2015) and compared to the volume also exists enough uniformity with the data found both outside Angola with a volume of 117 m^3.ha^{-1} found in Zambia (Chidumayo, 1987), as in Angola data between 66.91 m3 ha-1 (Sanfilipo, 2013) and 111.85 m^3.ha^{-1}and 91.93 m3 ha^{-1} (Dovala, 2015).

2.2. Biodiversity index

Biodiversity is set within a dynamic and evolving context, and its process and composition are in constant flux as a result of natural and human-induced factors. Biotic sequences and soil development - and soils support plant life - are a result of complex ecological phenomena combining a number of biological, chemical and physical processes requiring years, and sometimes even centuries, to be seen (Jeffers, 1996).

In each geographical unit, in each landscape, there is a variable number of communities. Therefore, in order to understand the changes in biodiversity in relation to landscape structure, the separation of alpha, beta and gamma components (Whittaker, 1972) can be very useful, mainly for measuring and monitoring the effects of human activities (Halffter, 1998). Alpha diversity is the species richness of a particular community to which we consider homogeneous, beta diversity is the degree of change or replacement in species composition between different communities in a landscape, and gamma diversity is the species richness Set of communities that integrate a landscape, resulting from both alpha diversity and beta diversity (Whittaker, 1972).

In order to understand the changes in biodiversity in relation to landscape structure, the separation of alpha, beta and gamma components (Whittaker, 1972) can be very useful, mainly to measure and check the effects of human activities (Halffter, 1998).

A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness.

This way of analyzing biodiversity is convenient in the current context of the rapid transformation of natural ecosystems, since a simple listing of species for a region is not enough.

In order to check the effect of changes in the environment, information on biological diversity in natural and modified communities (alpha diversity) is necessary to know their contribution at regional status and to be able to design conservation strategies and carry out concrete actions at local level.

Biological diversity can be quantified in many different ways. The two main factors considered when measuring diversity are richness and evenness. Richness is a measure of the number of different kinds of organisms present in a particular area. For example, species richness is the number of different species present. The more species present in a sample, the 'richer' the sample. Species richness as a measure on its own takes no account of the number of individuals of each species present. It gives as much weight to those species which have very few individuals as to those which have many individuals.

However, diversity depends not only on richness, but also on evenness. Evenness compares the similarity of the population size of each of the species present. Evenness is a measure of the relative abundance of the different species making up the richness of an area.

2.3. Forest inventory and remote sensing

The images analysis, field observations on sample plots and the analysis of forest/non-forest interfaces are three essential sources of data for assessing the main characteristics of diversity. The use of satellite images combined with field sampling will allow characterization of wooded areas (species, structures, stages of development, special environments), insofar as a relevant and adequate typology has been developed, and will also provide valuable information on the fragmentation and structure of the forest cover. Apart from these more general observations, the height of cover, its thickness, the stage of development and the proportion of species can also be estimated - and these variables, in fact, allow the "structural" diversity of forests to be characterized.

2.4. Study area

The study area is located in Huambo province (Fig 2), in the central plateau of Angola with an area of approximately 34,270 km², and an estimated population of 1.9 million inhabitants, approximately 15% of the national total (USAID, 2008).

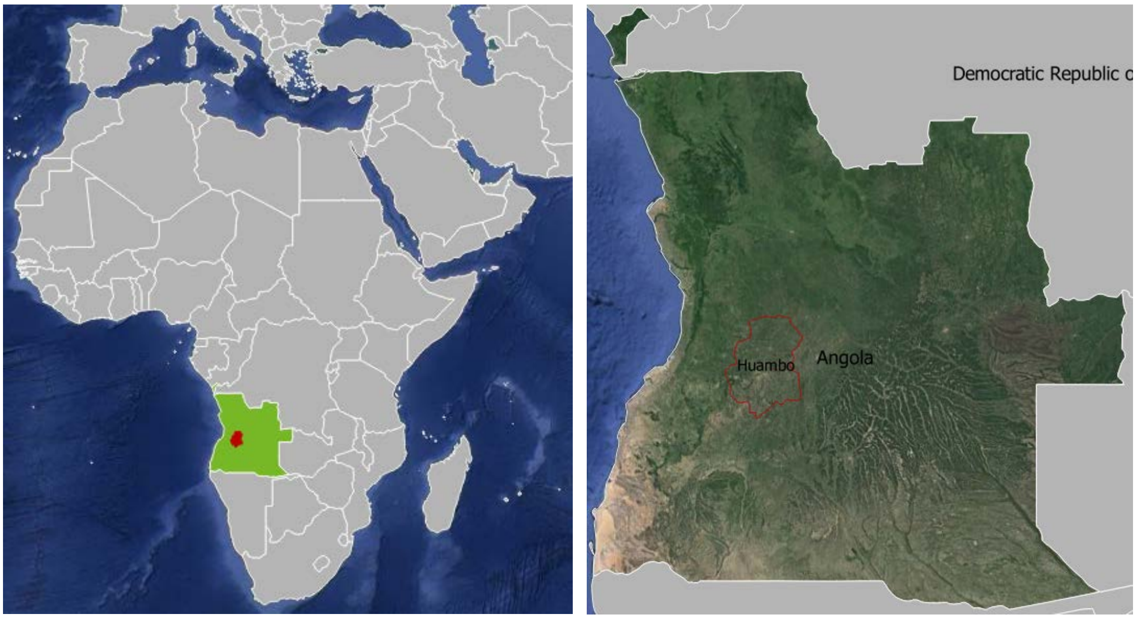


Fig 2 Huambo location (IDAF).

Huambo is a province of central Angola with an area of about 29,827 km2 and is divided into 11 municipalities: Huambo, Caála, Ekunha, Longonjo, Ukuma, Bailundo, Tchinjenje, Mungo, Katchiungo, Tchicala Tcholoanga and Londuimbali.

It is located in a central plateau, where mountains reach higher elevations. Môco Mountain, in Londuimbali municipality, with 2620 meters, is the highest peak in the province and in Angola. In these central mountains rise most of the rivers of Angola, many of which drain to the Atlantic Ocean, like Cuanza and Cunene. The dominant general in miombo floristic formation is constituted by *Brachystegia* spp., *Combretum* spp. and *Julbernardia* spp., whereas in savannas or deforested areas dominant species are Graminae dominated by *Hyparrehenia* spp. and *Androgon* spp. In badly drained areas vegetation found is constituted by hydrophilic formations dominated by high permanent Graminae, while in those permanently under water, Ciperaceae is the dominant vegetation (Cabral, 2009).

2.4.1. *Physical environment*

Mature undisturbed miombo is usually formed by a closed deciduous forest, generally in areas geologically ancient and nutrient-poor soils (Campbell, 1996). The main biophysical factors in the formation of these ecosystems are high solar radiation and temperature throughout the year, plus an annual seasonal climate variation that causes vertical gradients of soil moisture.

The climate of the areas of miombo distribution is characterized by long dry seasons, which can last 7-8 months. The most typical miombo soils are poor soils with a high concentration of aluminum and acidic leachate often shallow and stony (Desanker and Prentice, 1994).

2.4.2. *Climate*

Miombo woodland is situated within the southern sub-humid tropical zone of Africa. About two-thirds of the region falls within the Köppen Cw climate class, indicating a warm climate with a dry winter; the rest falls into the Aw (hot climate with dry winter – 26% of 62 sites) and BSh (hot dry steppe – 8%) climate classes.

The climate is humid mesothermic with dry winters and hot summers with maximum annual averages of temperatures below 20 °C. The wet season runs from October to April being the dry season between May and September (MJIU, 1961).

The 10-90% percentiles for mean annual precipitation and mean annual temperature are 710-1365 mm and 18.0-23.1°C, respectively. Coefficients of variation in annual rainfall are less than 30%. More than 95% of annual rainfall occurs during a single 5-7 month wet season. A few sites in northern Tanzania and north-eastern Angola have two wet seasons; these and some sites in south-eastern Mozambique receive >5% of their annual rainfall during the dry months. The ratio of annual precipitation to evapotranspiration varies from 0.5 to 1.1 (Frost in Campbell, 1996).

The mean annual temperature in Angola is 21 ºC and the average monthly temperatures have a low range of variation (4.5 °C). October is the hottest month having a mean temperature of 23.5 ºC and July is the coolest one with an average temperature of 18.5 ºC (Fig 3).

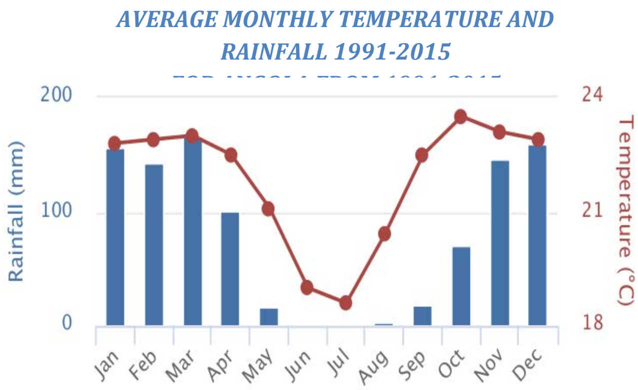


Fig 3. Average temperature and rainfall in Angola. (Climate change knowledge portal 2015).

Huambo has a humid subtropical mild summer climate that is mild with dry winters, mild rainy summers and moderate seasonality. This climate is usually found in the highlands of some tropical countries. According to the Holdridge life zones system of bioclimatic classification, Huambo is situated in or near the subtropical moist forest biome.

The miombo is divided into wet miombo and dry miombo. The dry miombo is represented in southern Malawi, Zimbabwe and Mozambique, in areas with rainfall lower than 1000 mm/year. In these ecosystems, plant diversity is very high. Meanwhile, the wet miombo appears in areas with an annual rainfall greater than 1000 mm/year in parts of western Angola, northern Zambia, Tanzania and southeast of central Malawi (Frost in Campbell, 1996). The origin of these differences is unclear: geomorphic evolution of the landscape; soil factors, particularly moisture and soil nutrients; the effects of fire; and the historical and present land use along with other human factors are involved (Chidumayo, 1987).

2.4.3. *Soil*

Miombo woodland soils are typically acid, have low cation exchange capacities (CEC), and are low in nitrogen, exchangeable cations (total exchangeable bases: TEB) and extractable phosphorus. Soils derived from Precambrian metavolcanics, metacarbonates and some biotite-rich gneisses have a marginally higher base status, as shown by the occasional high values for individual cations and phosphorus. Organic matter levels are generally low, except under densely wooded vegetation. Nevertheless, organic matter contributes substantially to cation exchange capacity in these soils (Frost in Campbell 1996). The most representative soils in Huambo province are Orthic and Xanthic Ferrasol (Fig 4).

Fig 4. FAO soil classification of Huambo (Ministério do Ultramar ,1965).

2.4.4. *Ecological features*

Mature forests, relatively unchanged, have a layer comprising 10-20 m tall with a canopy of trees, mostly wide, pinnate leaves. At ground level a shrub layer of broadleaf discontinuous, and often sparse but continuous layer and herbaceous, small reeds, grasses herbs C4 heliophytic appears. The biomass of large mammals is very low, and is dominated by large-sized species.Miombo comprising forests are finally dominated by savanna at the end of its range of formations.

The miombo generally has a structure with 2 or 3 layers. The inferior strata, generally composed of shrubs, trees and regeneration oppressed youth in the tops of the highest trees and a dominant upper layer trees. This natural formation is distinguished from other African savanna, woodland and forest formations by the dominance of tree species in the family Fabaceae, subfamily Caesalpinioideae mainly by species of the genera *Brachystegia, Julbernardia* and *Isoberlinia* (Campbell et al., 1996). The diversity of canopy tree species is low, overall, although the species richness of the plant is high. Several authors have contrasted the differences in structure between mature miombo and regrowth in different places (Chidumayo, 2004; Luoga et al., 2002).

Plant density varies between 1500 and 4000 plants per hectare, while the density of trees over 2 m height varies between 380 and 400 trees per hectare. The average height of adult trees is around 10-20 m, and its basal area varies depending on the annual rainfall, temperature and evapotranspiration, although in general, the authors are between 7-19 m^2(Chidumayo, 1987).

The average volume varies between 14-59 m3 per hectare in the dry miombo and between 41-100 m^3 per hectare in the dry miombo (Frost in Campbell, 1996).

2.5. Image classification

The classification is a stage to obtain information of the image with the objective of identifying the elements that it contains. For this, it's necessary the use of algorithms in the spectral data analysis to establish the identity of each pixels. The final result is cartography with different classes defined according to the study.

The most appropriate method to classify an image when the area of interest is known is the supervised classification. This method uses pixels with known identity to classify the pixels of unknown identity. The different classes are stablished based on spectral composition of the training regions. These training regions can be created or selectedas inputs from a previously created file.

However, to make the process work more effectively, has been reinforced by previous knowledge of field (field data, aerial photographs...), climatic data, and biography about forest of Huambo and the classes of types of miombo there are already located in this study.

This method has three stages: training, application of the classification algorithm and the final validation.

1. Training stage: The aim in this stage is to identify and delimit a set of pixels characteristics of the defined classes (Lillesand et al., 2004). These areas of training are used to train the classification algorithm and in this way to characterize the classes spectrally. The different categories are defined by several spectral signatures close them so it is very important to define carefully each category.

2. Algorithms of classification

This stage is characterized by the assignment of each class defined in the training phase to the pixels of the image. Therefore, it is necessary to apply an algorithm that determines the similarity between the spectral pattern of each category and the curve of the pixel. There are several classifiers, for example TheMinimum Distance Algorithm.More detailed information on this classifier can be found in the previous project report call "*Spatial dynamic and quantification of deforestation and degradation in miombo forest of Huambo province (Angola)".* This algorithm will be used in the classification to obtain the different types of miombo.

3. Validation of classification

The classification is finished when the accuracy is evaluated through the degree of agreement between the categories assigned by the classifier and the information of the ground truth (Lillesand et al., 2004).

The most usual tool is the confusion matrix. This matrix shows the relationship between two classifications of the study area. The first one corresponds to the ground truth for a series of points (reference classification) and the second corresponds to the algorithm (automatic classification). The confusion matrix shows in columns the reference classification and in files the automatic classification. The results can be expressed in pixels or in percentages.

The numbers in the diagonal of the confusion matrix are correctly classified pixels. The rest of numbers are wrong pixels. The ratio between the number of well-rated pixels and the total number of pixels to be classified gives the quality factor of the classification

3. Objectives

The objective of this work will be to develop a methodology of typification of Miombo forest based on analysis of satellite images of medium and hight resolution and to elaborate the thematic mapping of typification of the Miombo in the province of Huambo (Angola).

The result of this study will increase the knowledge of Miombo in Angola. The information is very important to obtain a model of management of these forest formations that allows a sustainable use by the local communities

The specific objectives in this project are:

1. The study and the analysis of the variability of the Miombo masses in the Huambo province
2. The design of the field work carried out through geoprocessing techniques for an efficient work that allows collecting all the variability present in the forests of the study area. The field work will consist of a qualitative and quantitative jungle characterization, supported by parcels of forest inventory oriented to the objectives of the work
3. The characterization of the different types of miombo through different indices and indicators based on the silviculture characteristics of the inventory plots.
4. The thematic mapping of types of Miombo in the province of Huambo obtained through the application of the algorithms of classification based on the types defined with the indicators analysis.

4. Methodology

4.1. Image acquisition

The correct selection of the dates of the images is essential for the analysis and obtaining of results. In this sense, it is very important to know the different types of available sensors and their characteristics and resolutions (Lillesand et al., 2014).

The images acquisition requires the following steps (Fig 5):

1. Analyse to select the appropriate satellite image
2. Image quality control
3. Images selection with less than 5% of clouds;
4. Preprocessing process:
    4.1. Georeferencing images in order to assign spatial coordinates;
    4.2. Converting the multispectral bands from DN to reflectance
    4.3. Mosaicking temporally different images

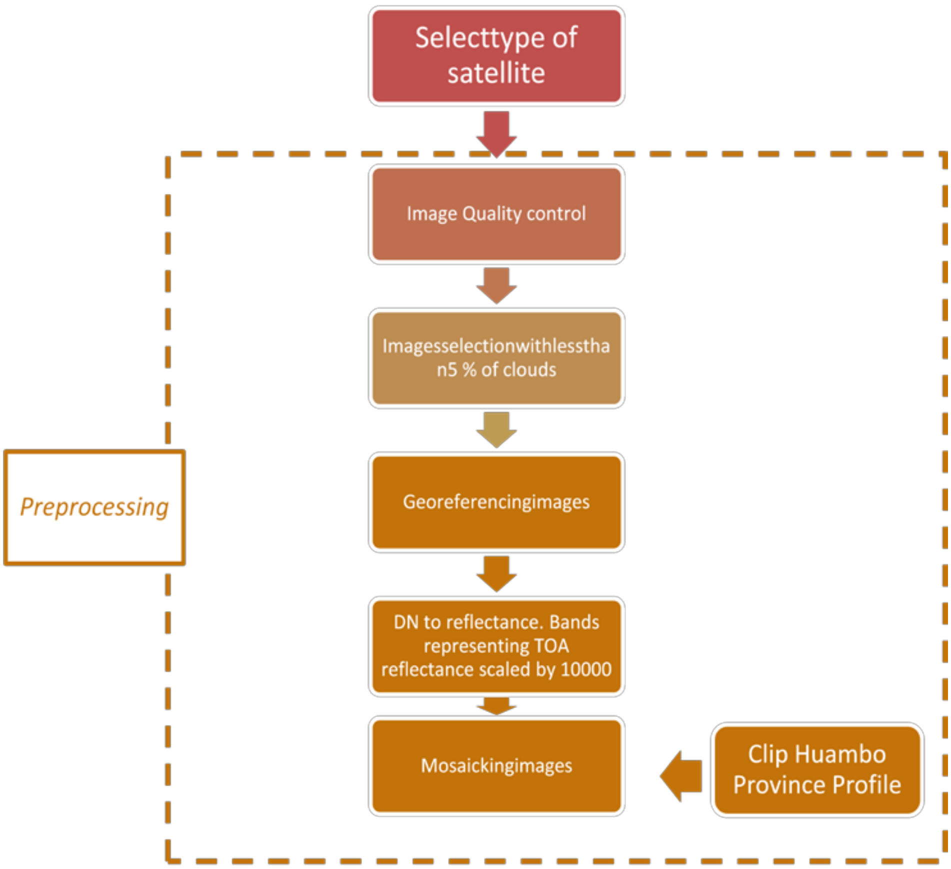


Fig 5. Standard workflow of images preprocessing

4.1.1. *Select type of satellite and Image Quality Control*

For this study, three different types of satellite were compared: Landsat 7 ETM +, Landsat 8 OLI and Sentinel 2A MSI (Fig 6). Aster satellite was discarded because, as can see in the Fig 8, there were not enough images to cover the entire province of Huambo.

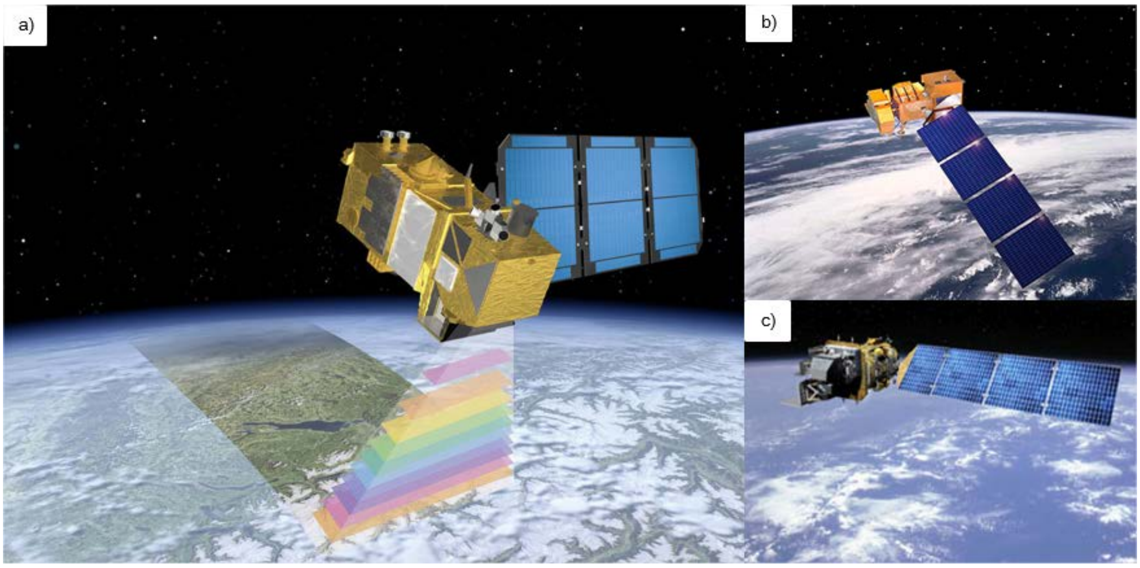


Fig 6. a) Sentinel 2A MSI launched June 23, 2015; b) Landsat 7 ETM+ launched April 15, 1999, c) Landsat 8 OLI launched February 11, 2013.

The data about the spectral signature of vegetation and the relative spectral responses of the instruments are somewhat different. To make the comparison, it is derived the averaged reflectance of vegetation, as expressed in the spectral signature, weighted by the relative spectral response of each sensor in each band. It has been calculated the reflectance for each band and the Normalized Vegetation Index too (Fig 7).

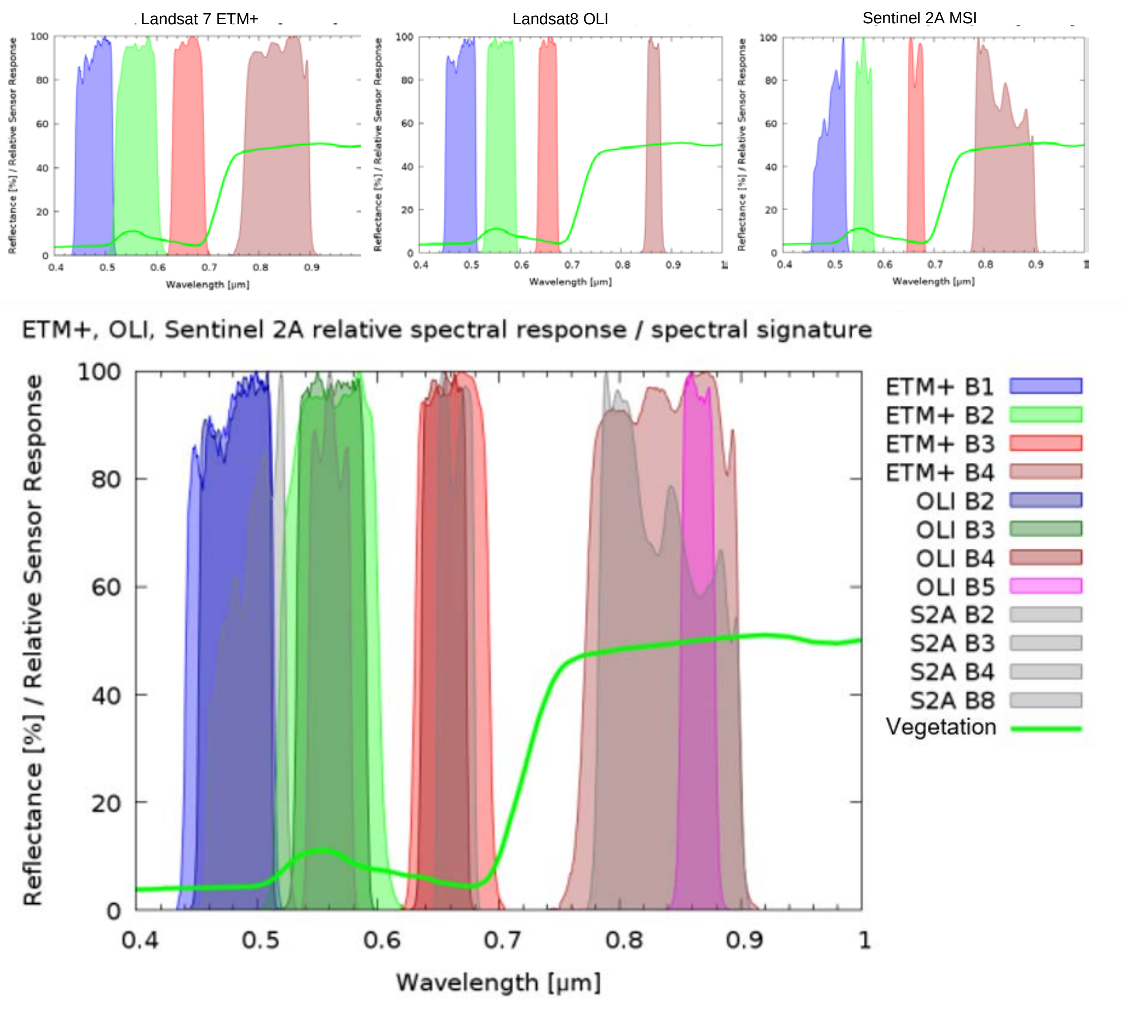


Fig 7. Comparison of the spectral resolution of the satellites Landsat 7 ETM+, Landsat 8 OLI and Sentinel 2A MSI.

It is omitted the bands 5, 6 and 7 of Sentinel 2 that capture the vegetation ramp to be compared. Also since Landsat sensors do not have this feature there is nothing to compare. It is observed that although the bands are judiciously designed to capture vegetation, all three sensors capture slightly different versions of the same feature. At the same time, it is necessary to know the shape of the actual relative sensor responses as a function of wavelength.

The Table 1 shows the average band reflectance (percent) for vegetation using weighted sensor sensitivities.

Table 1. Sensor bands reflectance average.

Band	Landsat 7	Landsat 8	Sentinel 2
B	3.87	3.93	3.30
G	7.86	8.88	8.39
R	4.51	4.67	4.16
NIR	38.54	34.03	32.56
NDVI	0.79	0.76	0.77

The values in this table are very similar and differ only in a negligible way. The differences noted above would possibly disappear in a real case under the uncertainty introduced by atmospheric effects and their correction. This is good news, but we should remember that we have chosen a very simple spectral signature to vegetation. We cannot rule out that a more complicated signature could possibly fare worse, introducing artefacts and discrepancies in the results as different type of Miombo forest.

In fact, small but significant differences in spectral responses have been found that may require due attention in critical applications. Landsat 7 and Landsat 8 have 30 meters of spatial resolution against Setniel-2 that have 10 meters (Mandanici and Bitelli, 2016).

Other types of payment satellites (Aster in Fig 8 or Rapideye in Fig 9) were discarded because of the high cost and because there were not enough images to cover the entire area.

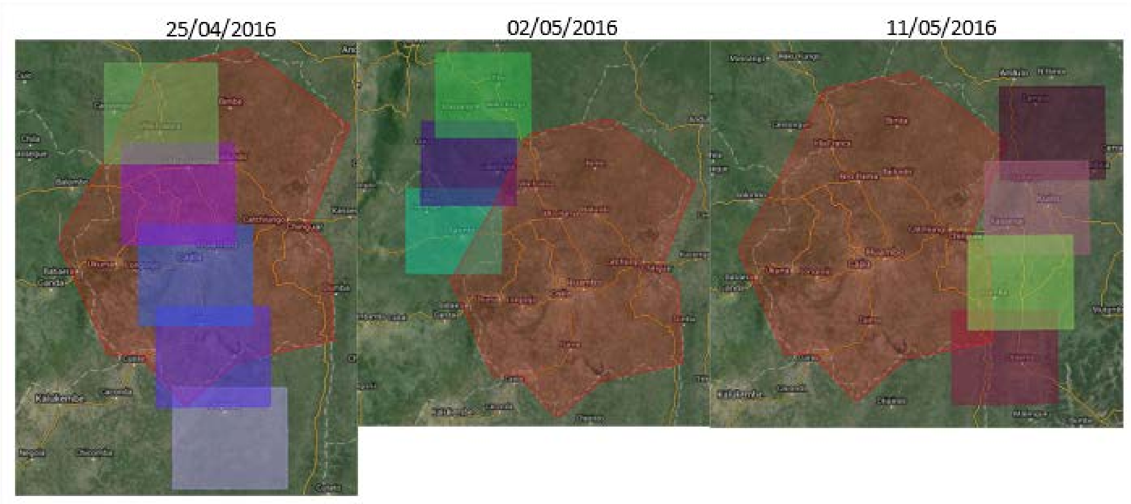


Fig 8. Images of satelite Aster in 2016 in the province of Huambo.

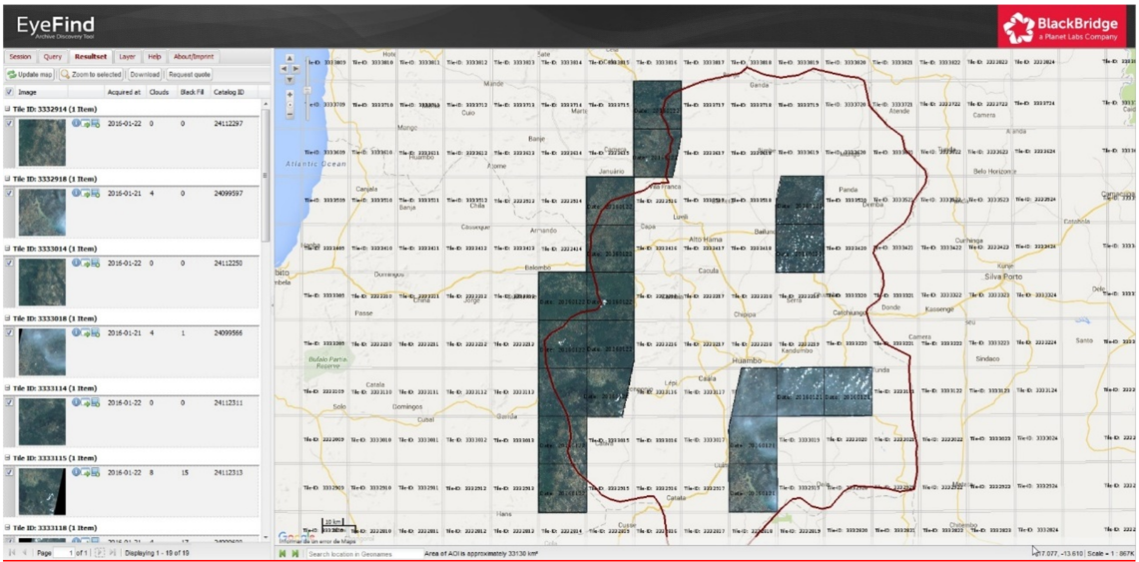


Fig 9. Images of satelite Rapideye in 2016 in the province of Huambo.

4.1.2. *Images selection*

Sentinel 2A satellite images were acquired to cover the whole study area. June has been considered most appropriate month because the miombo forest has not lost its leaf yet. The miombo forest still has leaf during the dry season.

This unique environmental monitoring programme is making a step change in the way we manage our environment, understand and tackle the effects of climate change and safeguard everyday lives. For this reason, nowadays it is the best free satellite to calculate forest parameters. As can see in Table 2it has quite Red-Edge spectral bands to analyse the vegetation.

Table 2 Spectral and spatial resolution of Sentinel 2A

Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

It is necessary to know the situation of the province of Huambo to download Sentinel 2A images. The Fig 10 shows the area in which Huambo province is located.

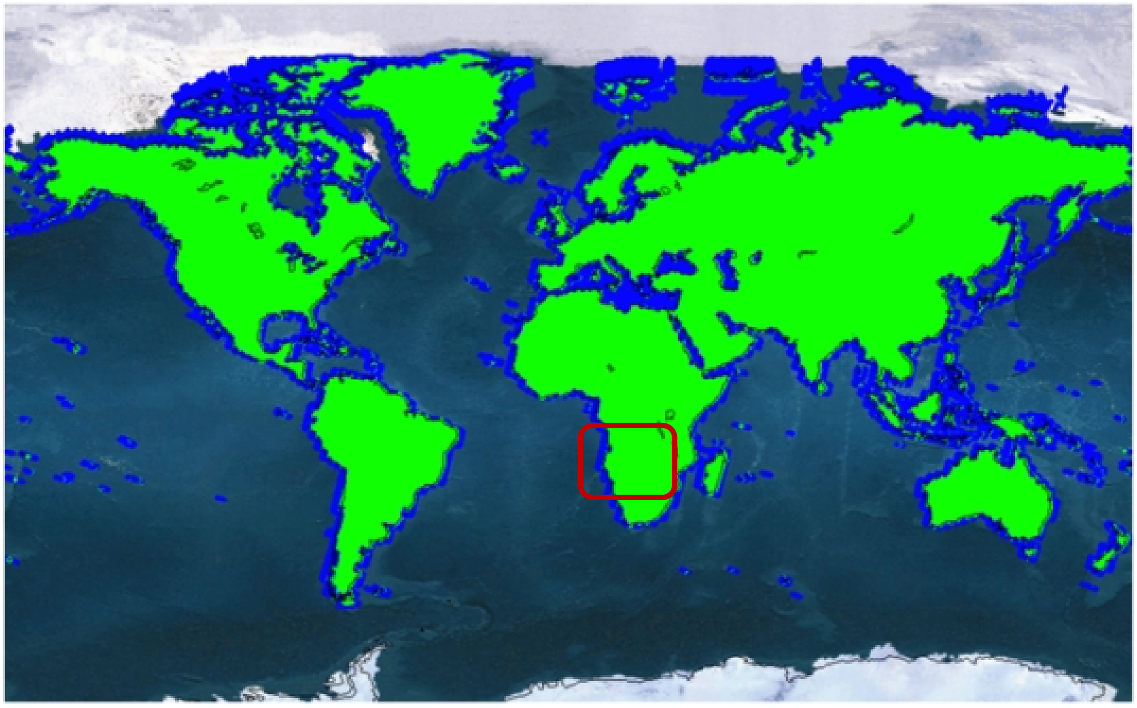


Fig 10. Geographical coverage of Sentinel 2A.

Products are a compilation of elementary granules of fixed size, within a single orbit. A granule is the minimum indivisible partition of a product (containing all possible spectral bands).For Level-1C and Level-2A, the granules, also called tiles, are 100x100km2 ortho-images in UTM/WGS84 projection (Fig 11). The UTM (Universal Transverse Mercator) system divides the Earth's surface into 60 zones. Each UTM zone has a vertical width of 6° of longitude and horizontal width of 8° of latitude(Fig 11). Tiles are approximately 500 MB in size. Tiles can be fully or partially covered by image data. Partially covered tiles correspond to those at the edge of the swath.

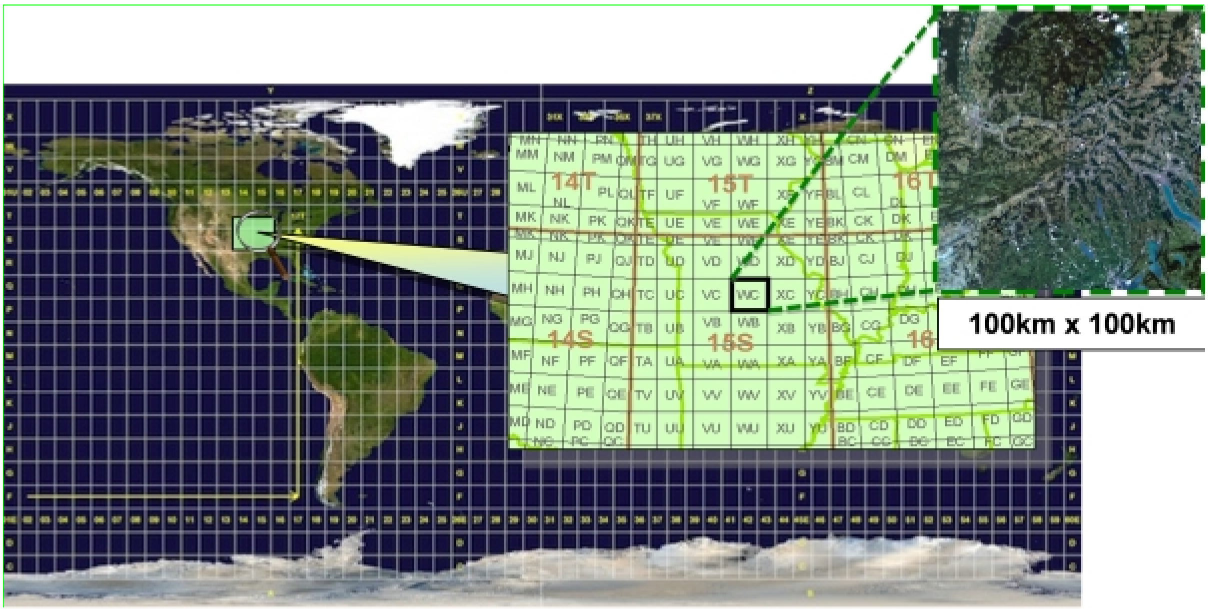


Fig 11. Level 1-C product tiling.

All granules, required in the user's Area of Interest (AOI), are included in the delivered product.

The Payload Data Ground Segment (PDGS) is responsible for the systematic processing and archiving of Sentinel-2 up to Level-1C.

The continuous acquisition of Sentinel-2 image data in a given MSI mode is called a "datatake". The maximum length of an imaging datatake is 15,000 km (e.g. continuous observation from northern Russia to southern Africa). All products contain granules/tiles from a single datatake. A datatake is presented inside a product as a set of one or more datastrips (corresponding to acquisition segments downlinked to different ground stations).

Twenty-six Sentinel 2A images have been collected (Fig 12) during the dry season to complete the province of Huambo (Angola)between 01/06/2016 to 20/06/2016. The images must have less than 5% of cloud coverage.

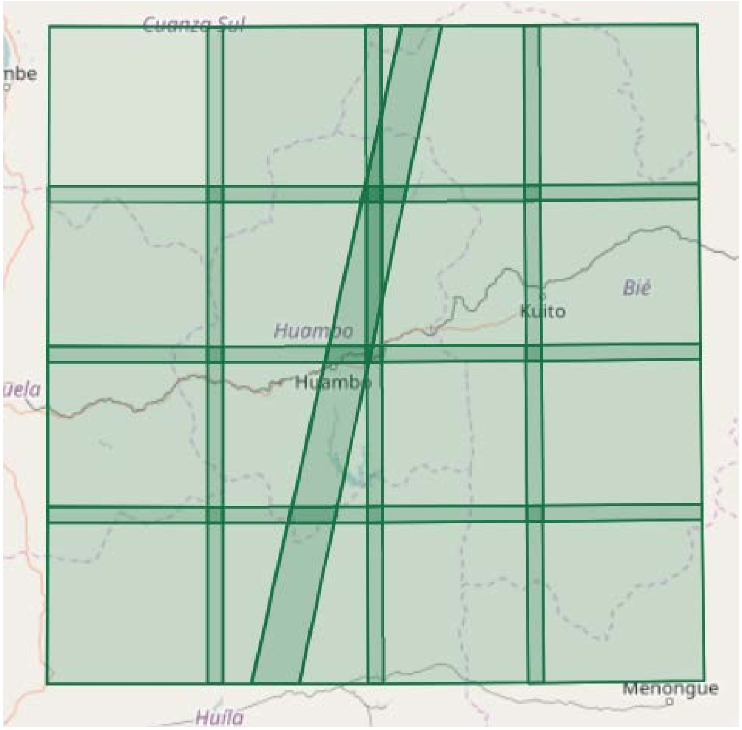


Fig 12. Twenty-six Sentinel 2A image were needed to complete the whole study area. (ESA webpage).

Images are already georeferenced in WGS84 datum and UTM projection in a north up (map) orientation, and are of Level 1C of the Product Generation System.The Level-1C product (Fig 13) is composed of 100x100 km2 tiles (ortho-images in UTM/WGS84 projection). The Level-1C product results from using a Digital Elevation Model (DEM) to project the image in cartographic geometry. Per-pixel radiometric measurements are provided in Top Of Atmosphere (TOA) reflectances along with the parameters to transform them into radiances. Level-1C products are resampled with a constant Ground Sampling Distance (GSD) of 10, 20 and 60 m depending on the native resolution of the different spectral bands. In Level-1C products, pixel coordinates refer to the upper left corner of the pixel.

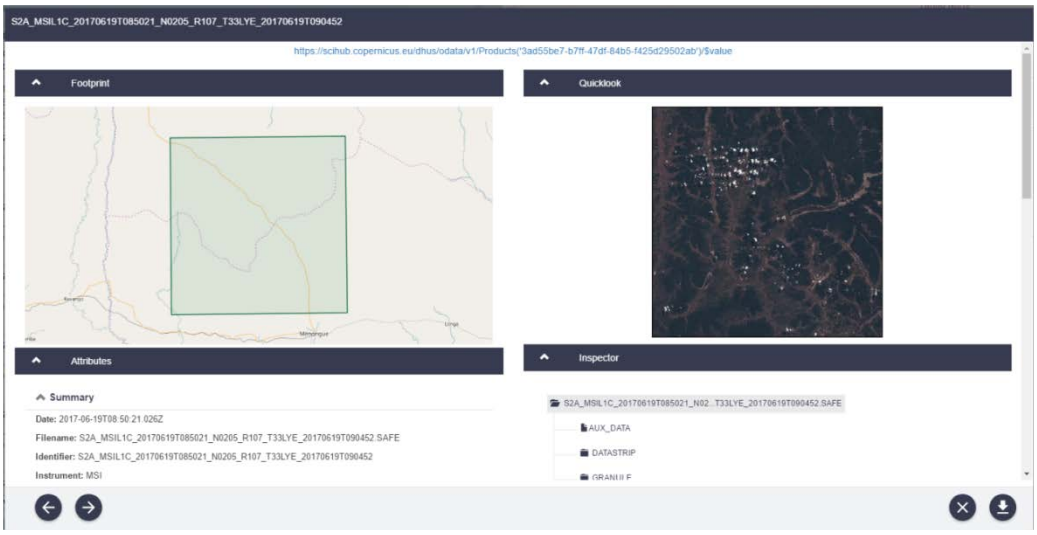


Fig 13 One of the twenty-six images of Sentinel 2A that have been used.

Level-1C products will additionally include Land/Water, Cloud Masks and ECMWF data (total column of ozone, total column of water vapour and mean sea level pressure).

The final list of selected images was downloaded from ESA webpage archive and it is show in Table 3.

Table 3 List of Sentinel 2A images used to develop the project

Number of image	Satellite	Date	Swath code	Number of bands
1	Sentinel 2A MSI	04/06/2016	33LWE	16 bands
2	Sentinel 2A MSI	04/06/2016	33LWF	16 bands
3	Sentinel 2A MSI	04/06/2016	33LWG	16 bands
4	Sentinel 2A MSI	04/06/2016	33LWH	16 bands
5	Sentinel 2A MSI	04/06/2016	33LXE	16 bands
6	Sentinel 2A MSI	04/06/2016	33LXF	16 bands
7	Sentinel 2A MSI	04/06/2016	33LXG	16 bands
8	Sentinel 2A MSI	04/06/2016	33LXH	16 bands
9	Sentinel 2A MSI	07/06/2016	33LWE	16 bands
10	Sentinel 2A MSI	14/06/2016	33LWE	16 bands
11	Sentinel 2A MSI	14/06/2016	33LWF	16 bands
12	Sentinel 2A MSI	14/06/2016	33LWG	16 bands
13	Sentinel 2A MSI	14/06/2016	33LWH	16 bands
14	Sentinel 2A MSI	14/06/2016	33LXE	16 bands
15	Sentinel 2A MSI	14/06/2016	33LXF	16 bands
16	Sentinel 2A MSI	14/06/2016	33LXG	16 bands
17	Sentinel 2A MSI	14/06/2016	33LXH	16 bands
18	Sentinel 2A MSI	17/06/2016	33LVF	16 bands
19	Sentinel 2A MSI	17/06/2016	33LVG	16 bands
20	Sentinel 2A MSI	17/06/2016	33LWE	16 bands
21	Sentinel 2A MSI	17/06/2016	33LWF	16 bands
22	Sentinel 2A MSI	17/06/2016	33LWG	16 bands
23	Sentinel 2A MSI	17/06/2016	33LWH	16 bands
24	Sentinel 2A MSI	17/06/2016	33LXF	16 bands
25	Sentinel 2A MSI	17/06/2016	33LXG	16 bands
26		20160617	33LXH	

4.1.3. *Preprocessing process*

a) Images selection with less than 5 % of clouds

The selection of images was made with the criterion of less than 5 percent of clouds. In this project, the images were in the month of June, so there were no clouds *b) Georeferencing images in order to assign spatial coordinates*

Depending on the processing type, georeferencing is not always required. In the specific case of this study, several control points had been using to improve the precision in the spatial coordinates

c) Converting the multispectral bands from DN to reflectance

The effects of the atmosphere should be considered in order to measure the reflectance at the ground. Images in radiance can be converted to Top Of Atmosphere (TOA) Reflectance (combined surface and atmospheric reflectance) in order to reduce the in between-scene variability through a normalization for solar irradiance.

In this case, the Sentinel-2 data contain 13 UINT16 spectral bands representing TOA reflectance scaled by 10000, so that once downloaded and due to the characteristics of this sensor, the images are already converted from DN to reflectance

d) Mosaic images

It is usually to use more than one image to cover the study area. In this sense, a mosaic process of the images must be carried out to generate a single continuous image without appreciation of the union (Gutiérrez & Nieto, 2006).

The aspects to be considered are geometric, radiometric and the union line. Mosaicking is not a perfectly clean process: it often requires additional image processing to remove some of the 'noise' near the stitch. Once created the mosaic, cut according to the limit of Huambo province.

4.2. Field work

4.2.1. *Plots distribution*

Forest inventory is an accounting of plants and their related characteristics of interest over a well-defined land area. Inventories based on plot sampling in adequate detail constitute a solid basis for analysis if it is recognized that the measurement of biodiversity is to a large extent already carried out in the areas covered by regional inventories.

The distribution of the plots was made from the generation of a preliminary mapping of miombo based on the historical cartography of the province of Huambo. The Fig 14shows the different sources used in the distribution of plots.

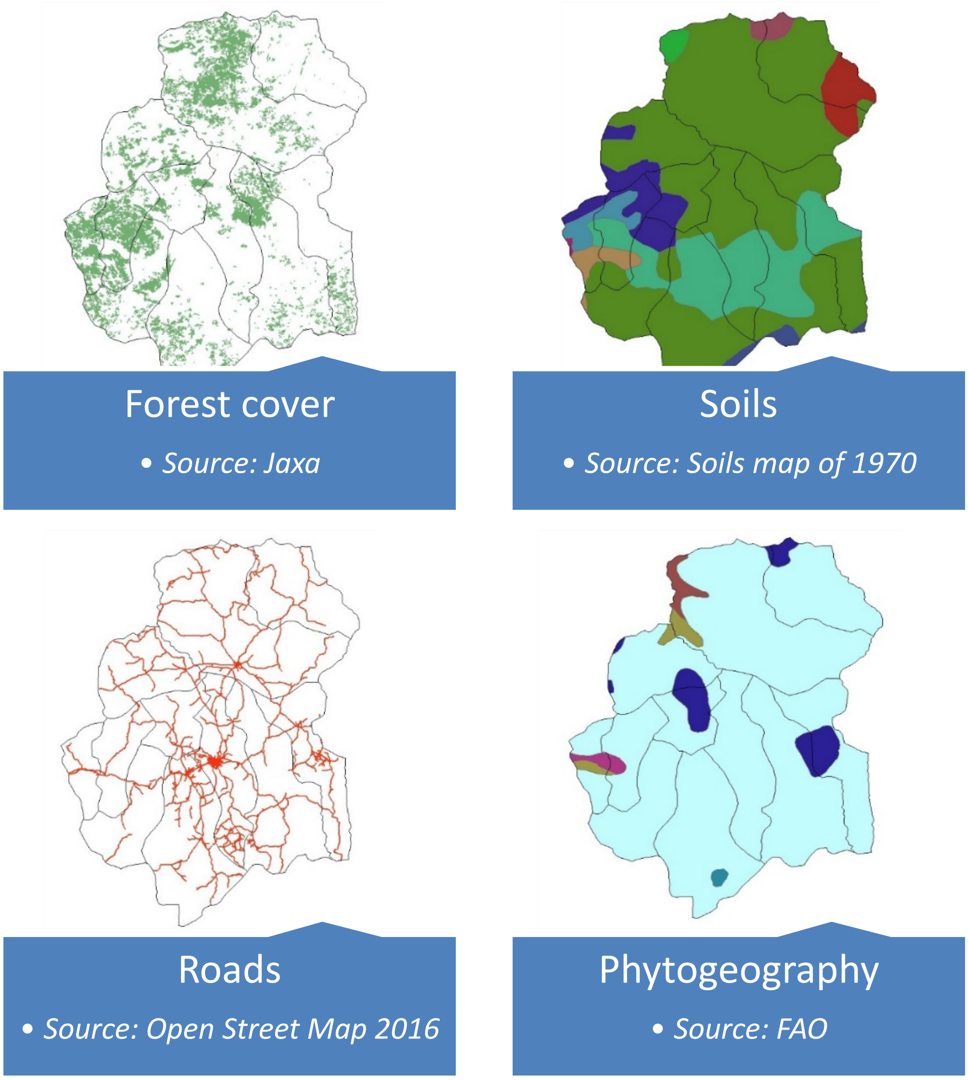


Fig 14. Base maps.

The result based on a random distribution of plots is showed in the Fig 15.

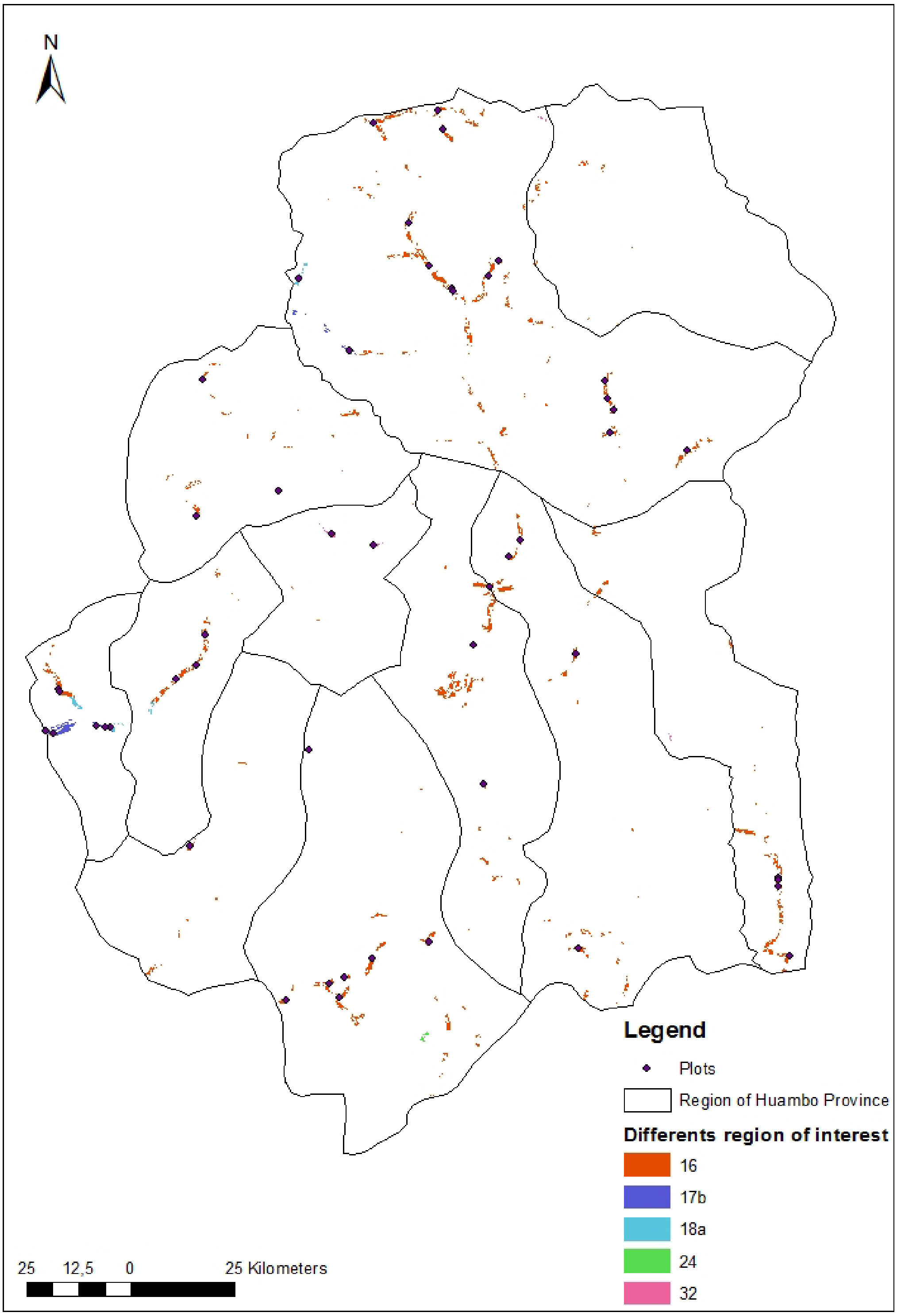


Fig 15. Sample plots location.

4.2.2. *Forest inventory and analysis of plot data*

Vegetation data were collected from 50 sample circular plots with a size of 314.16 m^2.

The measures taken from samples were:

- Species identification
- Height of individual (m)
- Diameter at breast height (cm).
- Canopy cover from regenerated in each quarter of a plot oriented north, east, south and west. (%).
- Height from regenerated species (m).

These measures evaluate structure land mosaic as measure, number, size and shape.

To extract the full value of the field data, these require a processing, filtering and addition to a database with which we can extract the required results in an easy and efficient, without loss of information.

To do this, at first, a filtering of the field statistics was performed to homogenize the database. It was necessary to eliminate two of the 50 plots as there were no species identification data, which would generate a quantity of data difficult to link.The summary of forest inventory appears in the Annex 1.

This step was preceded by the calculation of basimetric area from the diameter, as well as the frequency of each species and its density, given as trees per hectare and trees per plot. Finally, the three most representative species of the forest structure of the plot were chosen according to their frequency.

Sampling intensity

Species richness estimation and comparison has had a wide range of applications. In nearly all biodiversity studies, however, the compilation of complete species census and inventories often requires extraordinary efforts and is an almost unattainable goal in practical applications. There are undiscovered species in almost every taxonomic survey or species inventory. Consequently, the simple count of species (empirical or observed richness) in a sample underestimates the true species richness (observed plus undetected), with the magnitude of the negative bias possibly substantial. In addition, empirical richness strongly depends on sampling effort and thus also depends on sample completeness. Generally, there are two approaches (an asymptotic approach via species richness estimation and a non-asymptotic approach via rarefaction and extrapolation) to infer species richness and make fair comparisons among multiple assemblages based on possibly unequal-sampling effort and incomplete samples that miss many species.

The asymptotic approach aims to estimate the asymptote of a species accumulation curve. Then the estimated asymptote is used as a species richness estimate which can be compared across assemblages. This approach is based on statistical sampling-theory methods of estimating species richness. We focus on the nonparametric estimators which are universally valid for all species abundance distributions (Chao and Chiu, 2016).

A practical problem that arises when measuring species richness and species diversity is determining when you have done sufficient collecting to stop sampling, or in other words, to know when you've gotten just about all the species that matter. A technique is to generate a cumulative species richness/ sample (or cumulative species/area) curve, which plots the cumulative number of species collected (y-axis) vs. the number of samples collected (x-axis). Based on a reference sample, the software EstimateS (Colwell*et al.,* 2012) computes several widely-used statistical estimators of asymptotic species richness, the true number of species in the assemblage sampled. These estimators aim to reduce the effect of undersampling, which inevitably biases the observed species count.

This curve is a plot of species richness as a function of the number of individuals and sampling units.

Biodiversity indexes

The biodiversity indexes measured with the data of the inventory plots were:

- *Simpson's Index of Diversity (D).*

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It considers the number of species present, as well as the abundance of each species.

It models the probability that two randomly selected individuals will be from the same category based on the equation:

$$D = \sum pi^2$$

where pi represents the proportion of each category, (n/N), where n is the total number of organisms of a particular species and N is the total number of organisms of all species. This index is capable of providing a single value for an attribute that is defined by two or more categories and addresses the fact that larger proportions of a category may, in fact, reduce diversity. In addition, when more than two categories are used to describe a single attribute, Simpson’s index can reflect the dispersion in multiple categories. This alleviates the need to identify a single category to reflect diversity.

With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give Simpson's Index of Diversity (1 – D). The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. This makes more sense. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.

Another way of overcoming the problem of the counter-intuitive nature of Simpson's Index is to take the reciprocal of the Index. Simpson's Reciprocal Index (1 / D) is the value we computed to evaluate Simpson´s Index. This index was computed with the proportion of species and the proportion of shape (m^2/ha).

- *Shannon´s diversity index (H)*

Shannon´s diversity index (H) is another index that is commonly used to characterize species diversity in a community. Like Simpson's index, Shannon's index accounts for both abundance and evenness of the species present. The proportion of species relative to the total number of species (pi) is calculated, and then multiplied by the natural logarithm of this proportion (lnpi).

$$H = -\sum_{i=1}^{S} pi \ln pi$$

In contrary to the Simpson's diversity index, Shannon's index gives more importance to less common categories, for example, rare species.

This index indicates the uniformity of significance values across all species in the sample. It measures the average degree of uncertainty in predicting which species will belong to an individual chosen at random from a collection. The Shannon index increases as both the richness and the evenness of the community increase. The fact that the index incorporates both components of biodiversity can be seen as both a strength and a weakness. It is a strength because it provides a simple, synthetic summary, but it is a weakness because it makes it difficult to compare communities that differ greatly in richness.

This index was computed with the proportion of species and the proportion of basal area (m^2/ha).

- *Pielou's index (J)*

Pielou's index (J) measure species evenness.

$$J = \frac{H'}{\ln(S)}$$

Where H' is Shannon-Weiner diversity $H' = e^{-\sum_{i=1}^{S} pi \ln pi}$ that provides a means of comparing the diversity between two or more ecosystems which goes beyond the most basic species-per-unit-area metric and S is the total number of species in a sample, across all samples in dataset. This index was computed with the proportion of species and the proportion of basal area (m^2/ha).

- *Margalef diversity index*

Margalef diversity index (d) includes how similar the species are, and decreases the weighting of closely related species.

$$d = \frac{(S-1)}{\ln N}$$

Where S is the number of species, and N is the total number of individuals in the sample. This index was computed with the proportion of species and the proportion of basal area (m^2/ha). In this case, the results are very different if densities or basal area are used instead of total numbers (Gamito, 2010).

- *Importance Value Index (IVI)*

Importance Value is a measure of how dominant a species is in each forest area.

$$IVI = \frac{(\mathrm{Dr} + \mathrm{Dom} + \mathrm{Fre})}{\Sigma(\mathrm{Dr} + \mathrm{Dom} + \mathrm{Fre})} x100$$

It considers these data:

Relative frequency (Fre), the percent of inventory points occupied by one species as a percent of the occurrence of all species.

$$Frecuency\ (Fre) = \frac{Area\ of\ plots\ in\ which\ a\ species\ occurs}{Total\ area\ sampled} x100$$

Relative density (Dr), the number of individuals per area as a percent of the number of individuals of all species.

$$Relative\ density\ (Dr) = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species} x100$$

Relative basal area (Dom), the total basal area of Species A as a percent of the total basal area of all species. Basal area is the sum of the cross-sectional area of all the trees/plants of species A.

$$Dominance\ (Dom) = \frac{Total\ basal\ area\ of\ a\ species}{Total\ area\ sampled} x100$$

Each of these values is expressed as a percent, and ranges from 0 to 100. The Importance Value is the sum of these three measures, and can range from 0 to 300.

A high importance value indicates that Species A is well represented in the stand because of some combination of a large number of individuals of Species A compared with other species in the stand, or a smaller number of individuals of Species A, but the trees are large compared with others in the stand.

4.2.3. *Cluster computering*

Modified TWINSPAN algorithms (Roleček*et al.* 2009) were computed through R statistics software. Modified TWINSPAN is a sequence of divisions calculated by standard TWINSPAN (Hill and Šmilauer, 2005), each time applied on the most heterogeneous group. These are separate variables for the different levels of abundance of a species. Samples are ordinated using Reciprocal Averaging (RA). A dichotomy is then made using the RA centroid line to divide the samples into two groups (negative and positive). This dichotomy is then refined using an iterative procedure. The clusters of samples obtained are then ordered so that similar clusters are near each other. This procedure continues in a hierarchical fashion to subdivide the groups until the minimum group size initially selected by the user is obtained. Species are then classified using the sample (quadrat) classification. In the original output, a table is then produced showing species-by-site (quadrat or sample) relationships.

As a summary, the Fig 16 shows the workflow followed to obtain the vegetation groups that will later be used in the classification to obtain the special distribution of the different types of miombo.

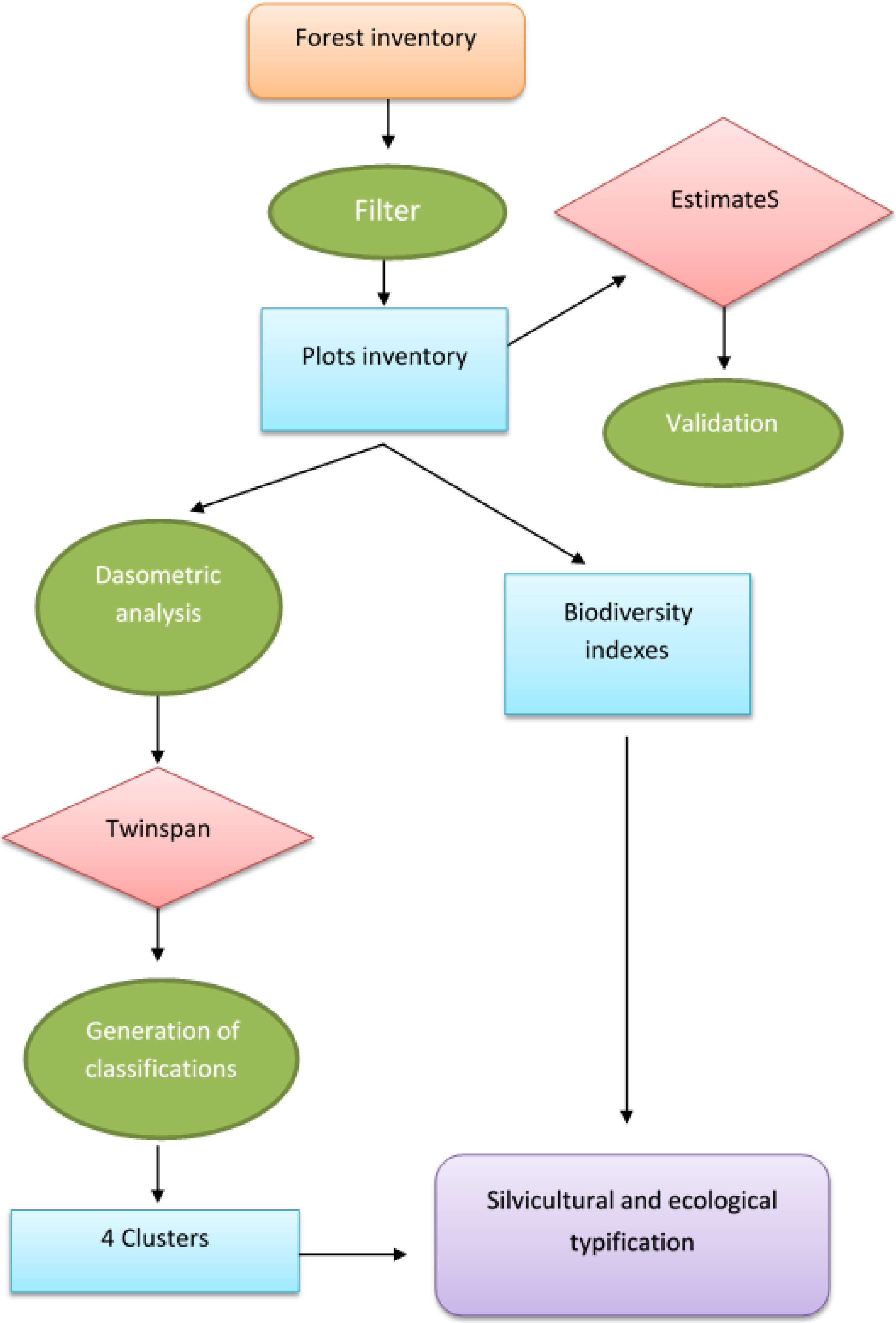


Fig 16. Workflow to obtain the miombo types.

4.3. Analyse Images

4.3.1. *Spectral signature*

One of the bases of remote sensing is to measure at different wavelengths, electromagnetic energy that interacts with the material.

The different types of land cover (forests, cultivated soils, water sheets, etc.) Distinguish by the energy they reflect and emit. These "spectra" that characterize the type of cover observed are their spectral signature.

Specifically, the spectral signature of vegetation (Fig 17) is characterized by a clear contrast between regions of the spectrum corresponding to the red of the visible and the near infrared (Lobo, 1995). While in the visible region, the pigments in the leaf absorb the

Most of the light they receive, in the near infrared these substances are quite transparent.

For this reason, healthy vegetation offers low reflectivity in the red band of the spectrum (between 600 and 700 nm) and high in the near infrared (between 800 and 1000 nm), so that the greater the "Vigor" that presents the vegetation, the greater the contrast between the values of reflectance captured in both bands.

The basis of the classification process will convert the reflectance of each pixel multispectral images from Sentinel 2 in a thematic map. In Fig 17, it can see the characteristics of the spectral signature of vegetation

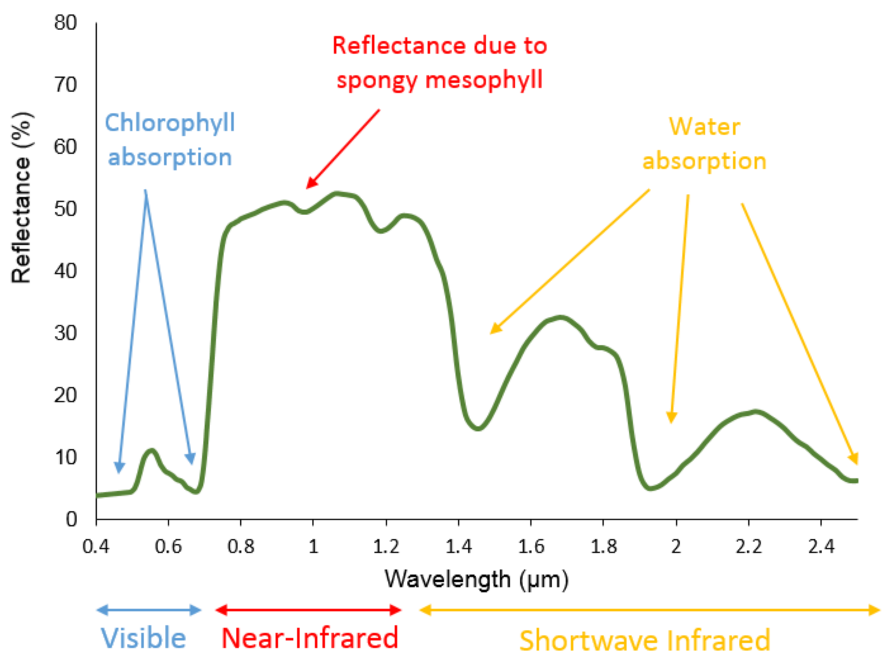


Fig 17. Spectral signature of vegetation (McCoy, 2005).

4.3.2. *Workflow to obtain differents types of miombo*

The workflow to obtain the results of the different types of miombo in the Huambo province is showed in the Fig 18.

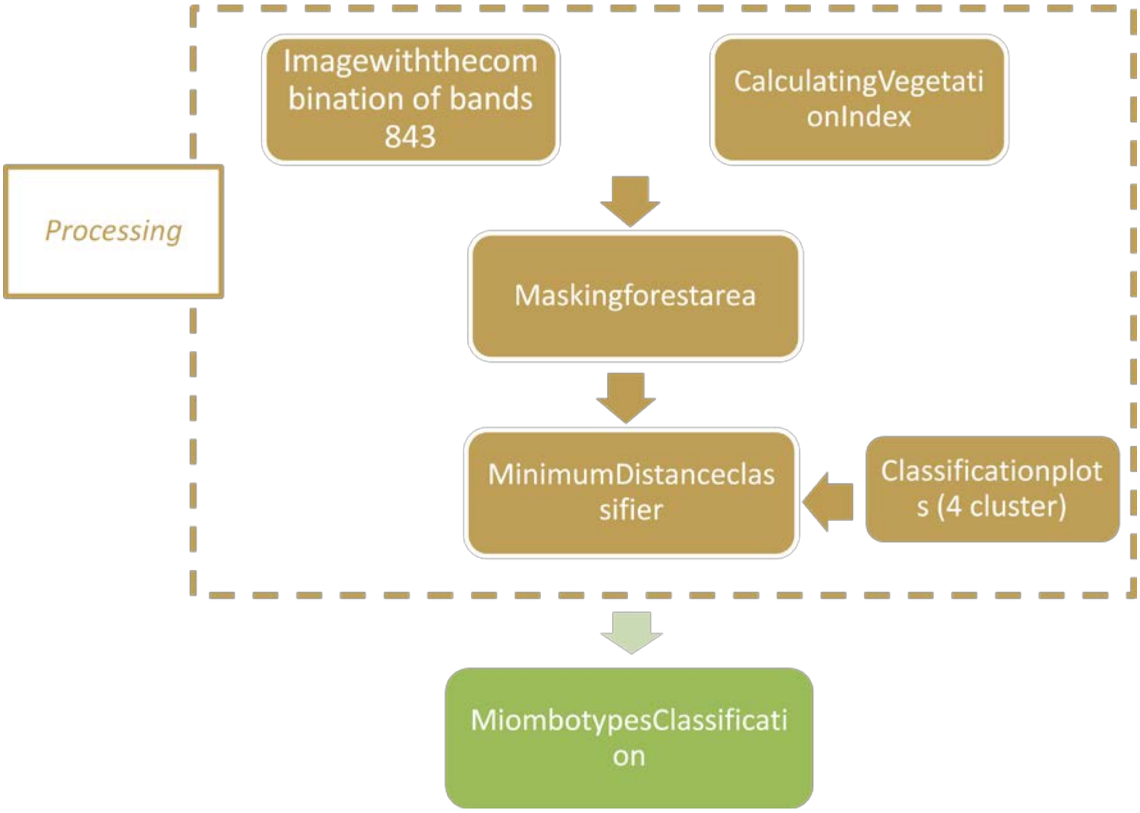


Fig 18. Workflow of classification process.

Based on the generated mosaic, the combination of bands 843 has been selected to clearly detect the vegetation. In addition, the NDVI index has been calculated in order to mask vegetation within a range. The mask of the vegetation has been applied on the mosaic of the combination of the bands. In this sense, the classification has only been made on areas with vegetation because of the objective is the typification of masses of miombo.

4.3.3. *Classifying the image mosaic with Minimum Distance algorithm*

In supervised classification, the image processing software is guided by the user to specify the miombo classes of interest. The user defines “training regions” – areas in the map that are known to be representative of a miombo type based on the four classes defined from biodiversity indexes and silviculture analysis. In this case, the field plots divided according to the four previously defined classes were used as areas of training in the classification process.

The software determines the spectral signature of the pixels within each training area, and uses this information to define the mean and variance of the classes in relation to all of the input bands or layers. Each pixel in the image is then assigned, based on its spectral signature, to the class it most closely matches.

The Fig 19shows the basic workflow in the classification process.

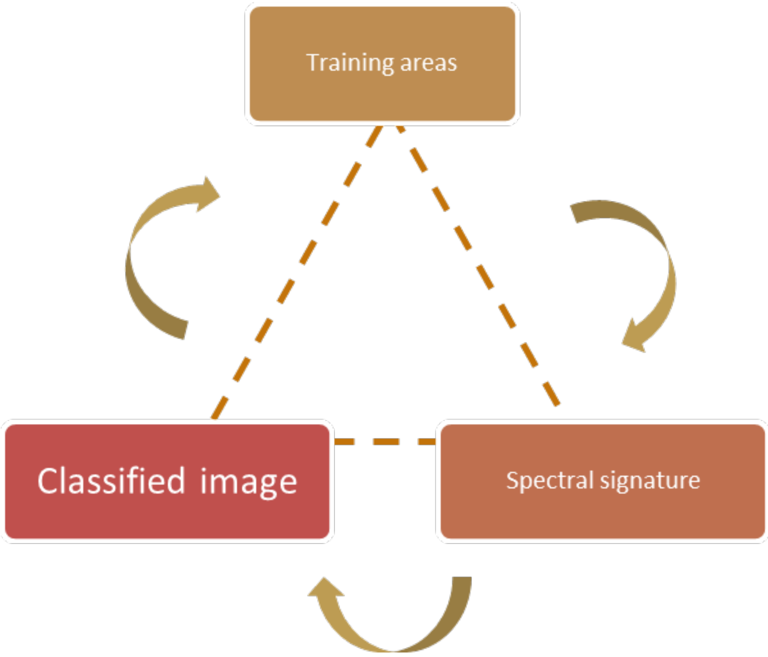


Fig 19. Supervised Classification Diagram.

In this study the algorithm of Minimun Distance was applied because had better results than others algorithms such us Maximum Likelihood. Minimum Distance algorithm calculates the Euclidean distance between spectral signatures of image pixels and training spectral signatures. Therefore, the distance is calculated for every pixel in the image, assigning the class of the spectral signature is closer. In the application of the algorithm it was forced to classify all the pixels of the mask corresponding to vegetation. In this way all the pixels will belong to a type of miombo.

4.3.4. *Elaborating vegetation indices (NDVI)*

The normalized difference vegetation index (NDVI) is an indicator of photosynthetic activity which measures the light reflected from vegetation. NDVI is calculated on a per-pixel basis as the normalized difference between the red and near infrared bands from an image:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

NDVI can be calculated for any image that has a red and a near infrared band. In the case of Sentinel 2 corresponds to the bands 4 (R) and 8 (NIR). NDVI served to ratify and improve the supervised classification of Minimum distance.

An interesting application, as proposed by Rao et al. (2007) and Govender et al (2007) is to use the NDVI to mask areas without vegetation of an image and then apply spectral classification procedures only to vegetation cover. This procedure has been applied in this project.

5. Results and discussion

5.1. Miombo types analysis

The software Estimates 9.0 (Colwell, 2013) was applied to establish the representativeness of the sampling and to compare the richness between landscapes and sampling sites a species / individual'sasymptotic species richness. The Fig 20shows the graphic produced.

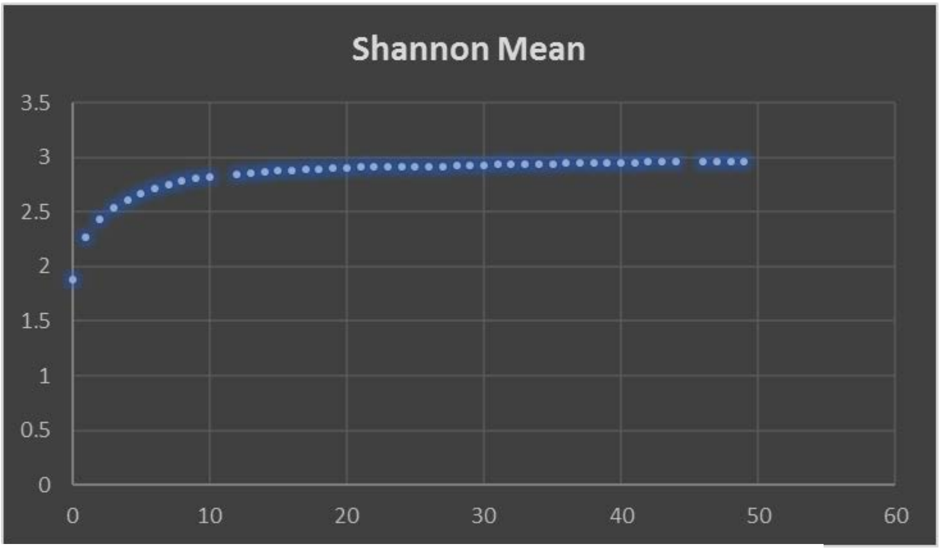


Fig 20. Asymptotic species richness curve elaborated with EstimateS software.

This curve is a plot of species richness as a function of the number of individuals and sampling units, including both smaller and larger numbers of individuals and sampling units than in the reference sample. We model the species accumulation curve as asymptotic to an estimate of the species richness of the larger community represented by the empirical sample. Shannon index typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. In this case, value of 3 indicates a medium-high biodiversity. This technique assumes that initially you will be collecting new species with each subsequent sample, but after a while you will be collecting the same species you have already collected in previous samples. Thus, you will get a curve that starts to flatten out. Once the curve levels off there is no need to sample further. The asymptotic curve shows that from 40 samples, biodiversity in this region is good estimate.

The mean Shannon index curve (Fig 20) shows that the number of plot (48) where enough to the correct compute of richness indexes.

The Shannon index in Huambo´s Miombo woodlands was below 3. While it was found that the value of this index scored 4.27 points in Bereku Forest Reserve, Tanzania (Giliba, 2011). The lowest value in Huambo indicates less biodiversity and eveness that in the mature Biombo.

Thefour Types found may indicate different degrees of degradation and recovery with respect to the preserved or mature Miombo.

5.1.1. *Environmental indexes*

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat.

It is usual to use Simpson's Reciprocal Index value because this value increases with the biodiversity like the others biodiversity´s indexes values do (Table 4).

Table 4 Simpson´s Reciprocal Plot Index

ID_plot	1/Simpson´s index	ID_plot	1/Simpson´s index	ID_plot	1/Simpson´s index	ID_plot	1/Simpson´s index
0	2.674	**13**	5.848	**25**	5.814	**37**	3.546
1	5.917	**14**	5.714	**26**	7.092	**38**	2.298
2	3.236	**15**	5.618	**27**	3.460	**39**	5.714
3	8.264	**16**	3.355	**28**	6.756	**40**	10.204
4	3.787	**17**	5.586	**29**	4.902	**41**	9.345
5	8.474	**18**	7.633	**30**	7.633	**42**	3.194
6	6.135	**19**	3.831	**31**	5.618	**43**	5.181
7	5.025	**20**	5.128	**32**	4.273	**44**	2.785
8	6.578	**21**	12.500	**33**	1.254	**46**	4.386
9	4.065	**22**	3.921	**34**	7.142	**47**	4.566
10	1.872	**23**	5.952	**35**	5.714	**48**	7.575
12	7.462	**24**	6.622	**36**	4.347	**49**	4.464

At the individual plot level, we find trough Estimates software the highest biodiversity values in plots 40 and 21, although these plots are in different clusters according to canonical analysis performed using Modified TWINSPAN algorithms.

The average inverse and reciprocal Simpson´s index value for each cluster is shown in Table 5.

Table 5 Simpson´s Reciprocal Cluster Index

Cluster	Reciprocal Simpson´s Index	Inverse Simpson´s Index
0	5	0.778
1	6.717	0.827
2	5.813	0.807
3	1.563	0.335

The score of biodiversity according Simpson´s index is in cluster 1.

The Shannon index increases as both the richness and the evenness of the community. Typical Shannon index values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4 (Magurran, 2004). In this case were found values between 0.492, and 2.567. The lowest values are in Type 3, the most degradated kind of forest miombo detected in this study.

Table 6Shannon´s diversity Plot index

ID_plot	Shannon´s index	ID_plot	Shannon´s index	ID_plot	Shannon´s index	ID_plot	Shannon´s index
0	1.350	**13**	2.030	**25**	2.071	**37**	1.490
1	2.080	**14**	1.989	**26**	2.130	**38**	1.047
2	1.452	**15**	2.125	**27**	1.690	**39**	2.154
3	2.353	**16**	1.791	**28**	2.070	**40**	**2.567**
4	1.700	**17**	2.047	**29**	1.887	**41**	2.345
5	2.417	**18**	2.202	**30**	2.223	**42**	1.546
6	2.114	**19**	1.729	**31**	1.891	**43**	1.957
7	1.819	**20**	1.814	**32**	1.755	**44**	1.411
8	2.112	**21**	**2.753**	**33**	**0.492**	**46**	1.996
9	1.701	**22**	1.676	**34**	2.127	**47**	1.927
10	**0.907**	**23**	1.997	**35**	1.942	**48**	2.269
12	2.172	**24**	2.237	**36**	1.755	**49**	1.810

The high richness is in sample plot 21 that scores 24 of the 39 species detected in this forestry inventory. The mean Shannon´s diversity index values for each forest type are shown in Table 4.

Table 7Shannon´s diversity Cluster index

Cluster	Shannon index value
0	1.85
1	2.132
2	2.0
3	0.7

Species evenness refers to how close in numbers each species in an environment is. Pielou´s index bounded by 0 and 1, with a larger index value indicating a more even community. The less evenness in communities between the species, the lowest value (Table 8).

Table 8 Pielou´s Plot Eveness

ID_plot	Pielou	ID_plot	Pielou	ID_plot	Pielou	ID_plot	Pielou
0	0.246	**13**	0.485	**25**	0.506	**37**	0.283
1	0.510	**14**	0.466	**26**	0.536	**38**	0.182
2	0.272	**15**	0.534	**27**	0.345	**39**	0.549
3	**0.670**	**16**	0.382	**28**	0.505	**40**	**0.830**
4	0.349	**17**	0.494	**29**	0.421	**41**	0.665
5	**0.715**	**18**	0.576	**30**	0.589	**42**	0.299
6	0.528	**19**	0.359	**31**	0.422	**43**	0.451
7	0.393	**20**	0.391	**32**	0.369	**44**	0.261
8	0.527	**21**	1.000	**33**	**0.064**	**46**	0.469
9	0.349	**22**	0.341	**34**	0.535	**47**	0.438
10	**0.064**	**23**	0.470	**35**	0.444	**48**	**0.616**
12	0.559	**24**	0.597	**36**	0.369	**49**	0.389

The highest evenness is in plots 5, 3, 40 and 48. The lower evenness in plots 10 and 33 both include in cluster 3. The value for each cluster is shown in Table 9.

Table 9 Pielou´s Cluster Eveness

Cluster	Pielou Eveness
0	1.807
1	2.326
2	2.112
3	0.273

Is in cluster 2 where we found more evenness between species and biodiversity.

5.1.2. *Fact sheets of miombo types*

We found four stratos(types of miombo forest) according to the dasometric measures (basal area, height, density and diametrer values).

The main dominant species were identified because they are in the most of cluster plots (occurrence) and because its higher density (plants / plot or plant / ha) in them.

Main factors involved in miombo forest segmentation are showed in the Table 10, Table 11,

Table 12and Table 13 Characteristics of type 3

:

Table 10Characteristics of type 0

Huambo forest (Angola) — Type 0

Description

Number plots:	21	**Soil type:**	Orthic ferralsols
FCC (%):	49.21	**Density (N. ha^{-1})**	2147
Total species:	30	**Shannon´s Index**	1.85
Plots:	0, 1, 6, 14, 15, 19, 20, 23, 25, 27, 28, 29, 32, 34, 35, 37, 38, 43, 44, 47 and 48		

Stratum description

The main species are composed of the genus *Brachystegia* spp., and *Isoberlinia angolensis* (Benth.) Hoyle & Brenan, being both dominant species of Miombo (Cambell*et al.*, 1996).
Species diversity is smaller than in stratum 1 and 2. Most trees have a diameter of less than 7.5 cm; This may indicate that it is a type of young forest, but of a consolidated dynamics due to its diametrical distribution.

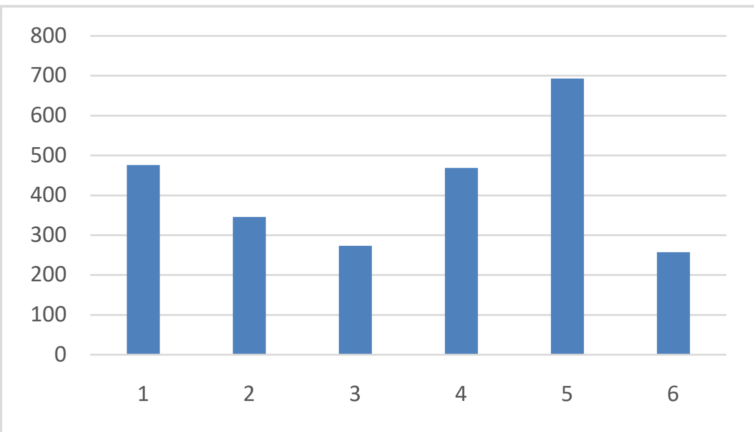
Stand composition main species

	Species	D	H	G	DMC	Nha^{-1}
1	*Brachystegia spiciformis* Benth	9.21	6.69	3.71	0.098	475.69
2	*Brachystegia bohemii*	9.92	5.66	2.38	0.106	345.4
3	*Isoberlinia angolensis* (Benth.) Hoyle & Brenan	8.63	5.61	1.88	0.090	273.75

Stand composition secondary species

	Species	D	H	G	DMC	N.ha^{-1}
4	*Julbernardia paniculata* (Benth.) Troupin	9.68	6.23	4.25	0.102	468.78
5	*Albizia antunesiana* Harms	8.55	5.14	4.14	0.088	693.21
6	*Anisophyllea boehmii* Engl.	8.24	5.25	1.78	0.086	257.30

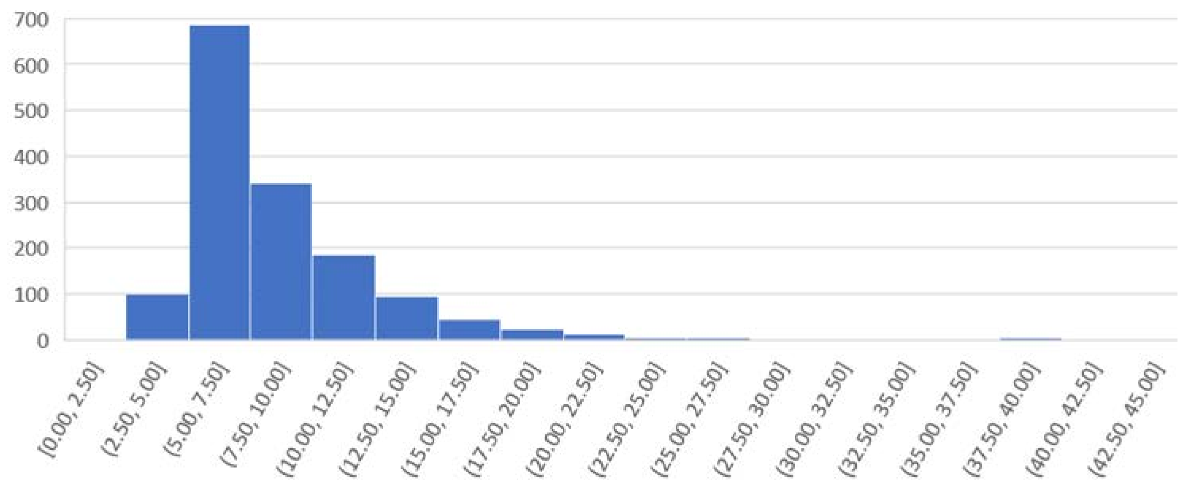
Density species (N.ha^{-1})



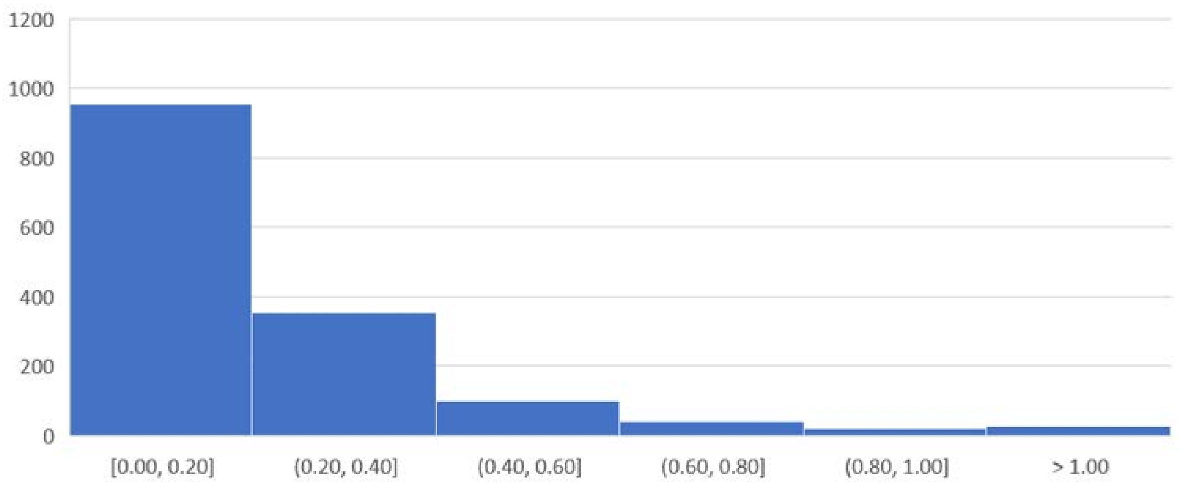
Other species present in the stratum

Bobgunnia madagascariensis
Brachystegia tamarindoides
Brachystegia utilis
Diplorhynchus condylocarpon
Erythropleum africanum
Rothmannia engleriana
Syzygium guineense
Uapaca gossweileri
Gardenia volkensii
Hymenocardia acida
Monotes spp
Ocha schweinfurthiana
Parinari curatellifolia
Pericopsis angolensis
Pterocarpus angolensis
Terminalia brachystemma
Uapaca Kirkiana

Diameter distribution (cm)



Basimetric distribution ($m^2.ha^{-1}$)



Heights distribution (m)

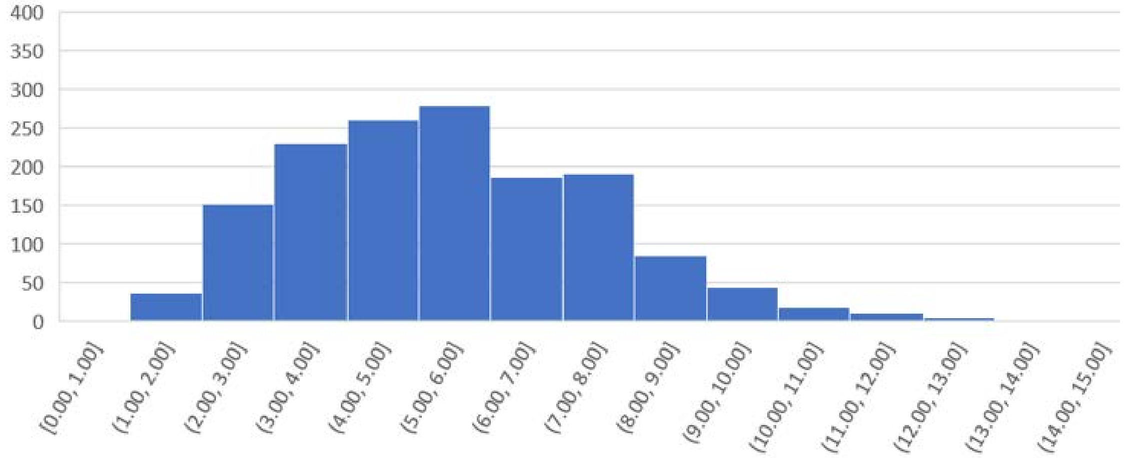


Table 11 Characteristics of type 1

Huambo forest (Angola)	Type 1

Description

Number plots:	10	**Soil type:**	Orthic ferralsols y Xanthic ferralsols(Plot 18).
FCC (%):	49.02	**Density ($N.ha^{-1}$)**	1658.76
Total species:	34	**Shannon´s Index**	2.132
Plots:	2, 3, 7, 8, 13, 16, 18, 21, 26 and 30		

Description

This stratum presents a wide range in diameter and height with top values but the most of trees have diameters smaller than 7.5 cm, and moderate height.

Julbernardia paniculata (Benth.)Troupin is a pioneer and faster growing species. It colonizes degraded areas because agriculture and fire. Highlights regeneration of *Hymenocardia acida*, fast growing pioneerspecies (Boaler, 1966) appears in plot 26 with 509 plants /ha density and average dimeter of 2.9 cm (hight density and young trees, which may be a sign of recovery after perturbation). This cluster is in evolution towards mature Miombo after pertubation. We found the highest species biodiversity in this Type.

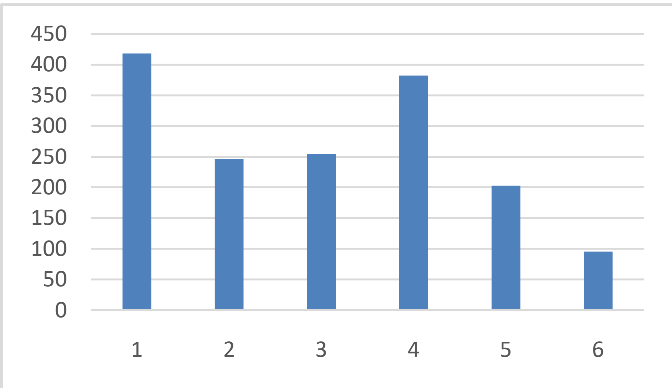
Stand composition main species

	Species	D	H	G	DMC	$N.ha^{-1}$
1	*Albizia antunesiana* Harms	10.28	5.28	4.14	0.096	418.35
2	*Anisophyllea boehmii* Engl.	9.80	5.23	2.427	0.106	246.69
3	*Julbernardia paniculata* (Benth.) Troupin	12.76	7.85	2.362	0.114	254.64

Stand composition secondary species

	Species	D	H	G	DMC	Nha
4	*Syzygium guineense* (Willd.) DC	7.63	4.48	1.80	0.069	381.97
5	*Monotes* spp.	7.73	4.86	1.03	0.073	202.76
6	*Hymenocardia acida* Tul.	6.51	4.55	0.435	0.057	95.49

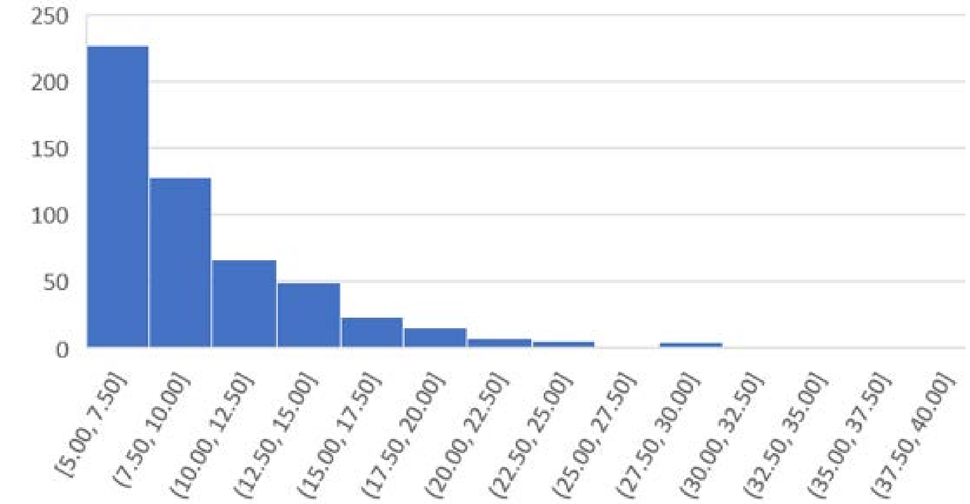
Density species



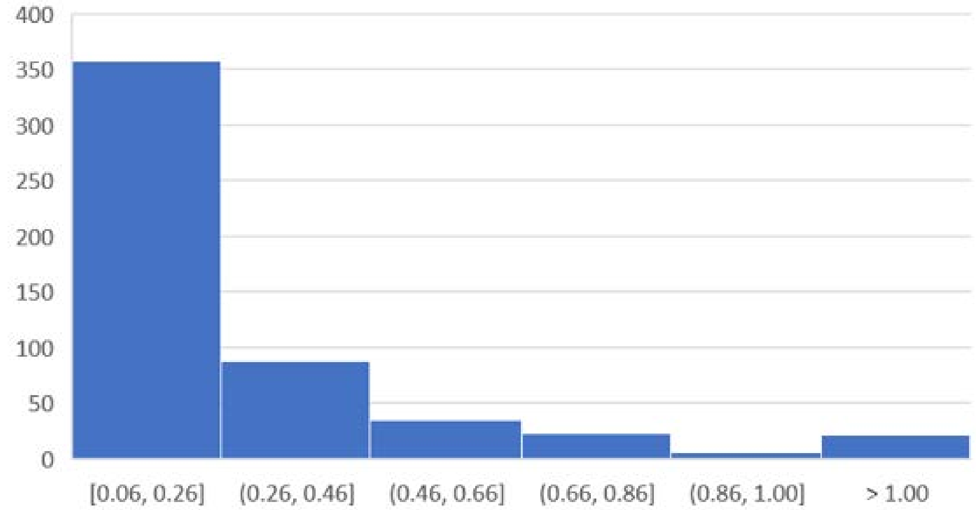
Other species present in the stratum

Brachystegia boehmii
Brachystegia spiciformis
Bobgunnia madagascariensis
Brachystegia tamarindoides
Brachystegia utilis
Diplorhynchus condylocarpon
Ehretia amonea
Euclea natalensis
Erythropleum africanum
Rothmannia engleriana
Rothmannia engleriana
Syzygium guineense
Jubelnardia paniculata
Parinari curatellifolia
Pericopsis angolensis
Pseudolachnostylis maprouneifolia
Pterocarpus angolensis
Terminalia brachystemma
Uapaca Kirkiana
Dombeya rotundifolia

Diameter distribution (cm)



Basimetric distribution ($m^2.ha^{-1}$)



Heights distribution (m)

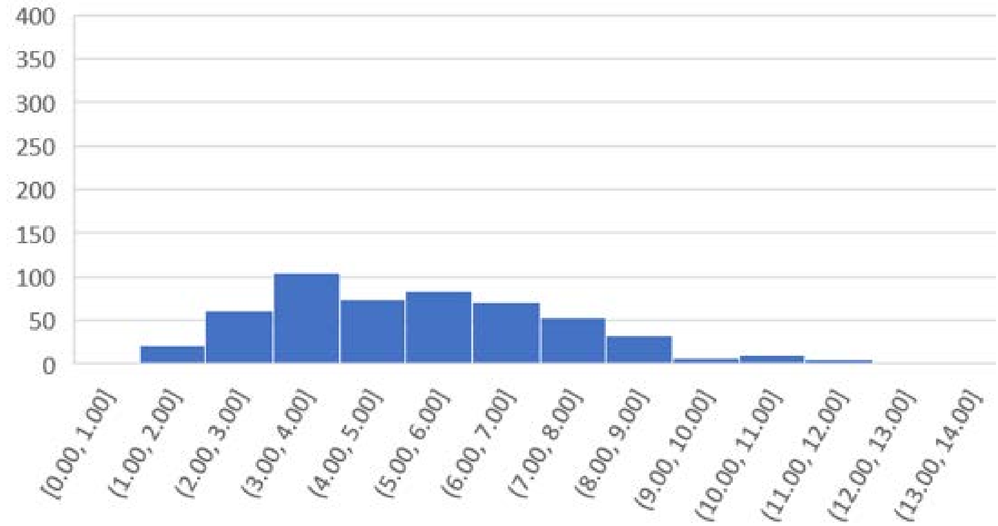
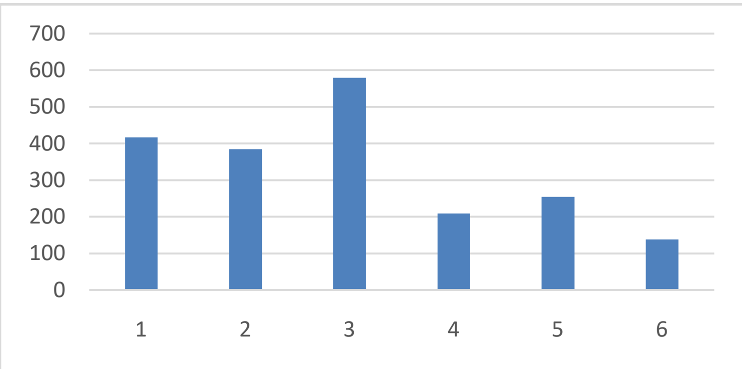


Table 12 Characteristics of type 2

Huambo forest (Angola)						Type 2
Description						
Number plots:	15			**Soil type:**		Orthic ferralsols
FCC (%):	52.05			**Density (N.ha^{-1})**		2406.41
Total species:	35			**Shannon´s Index**		2.0
Plots:	4, 5,9,12.17,22,24,31,36,39,40,41,42,46 and 49					
Description						
Highlight the strong present of *Combretum collinum* Fresen (in plot number 46), species tolerant to the fires in soil.The main and secondary species have bigger diametric ranges and wide heights in relation to the whole of the stratum. This fact gives us an idea of the great variability of these genera, combining mature species with regenerated. The main species correspond to the dominant genera of the miombo, the symbiosis between the genera *Monotes* spp and *Isorberlinea* spp where they are associated very frequently stands out. According dasometric characteristics we can consider Type 2 like a stratum in transition towards a mature state. Great variability in this Type combining mature and regenerated species.						
Stand composition main species						
	Species	**D**	**H**	**G**	**DMC**	**N.ha^{-1}**
1	*Brachystegia spiciformis* Benth	11.18	6.77	3.969	0.116	416.87
2	*Monotes* spp	8.53	5.36	2.548	0.088	384.86
3	*Julbernardia paniculata* (Benth.) Troupin	10.92	7.53	5.687	0.113	579.33
Stand composition secondary species						
	Species	**D**	**H**	**G**	**DMC**	**N.ha^{-1}**
4	*Isoberlinia angolensis* (Benth.) Hoyle & Brenan	11.62	7.02	2.879	0.120	208.67
5	*Combretum collinum* Fresen	8.47	5.79	1.616	0.087	254.03
6	*Hymenocardia acida* Tul.	8.66	5.21	1.068	0.090	137.93

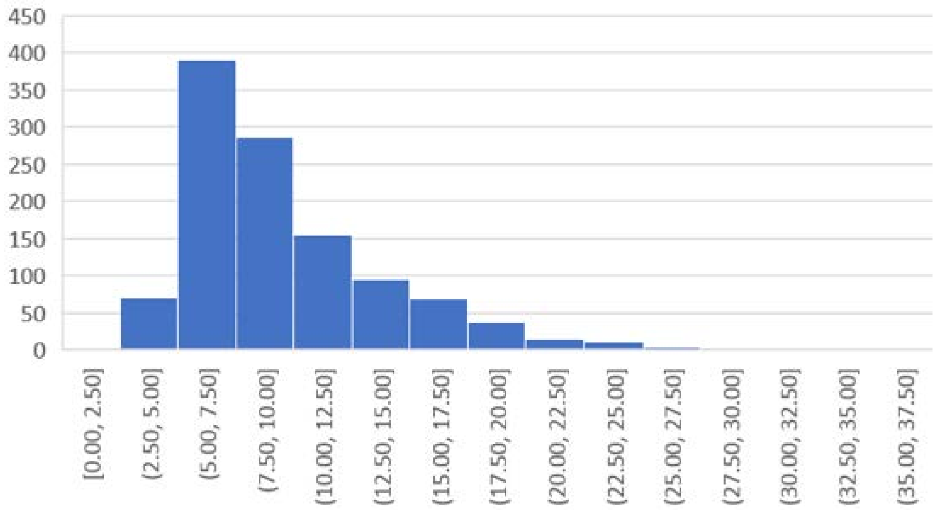
Density species (N.ha^{-1})



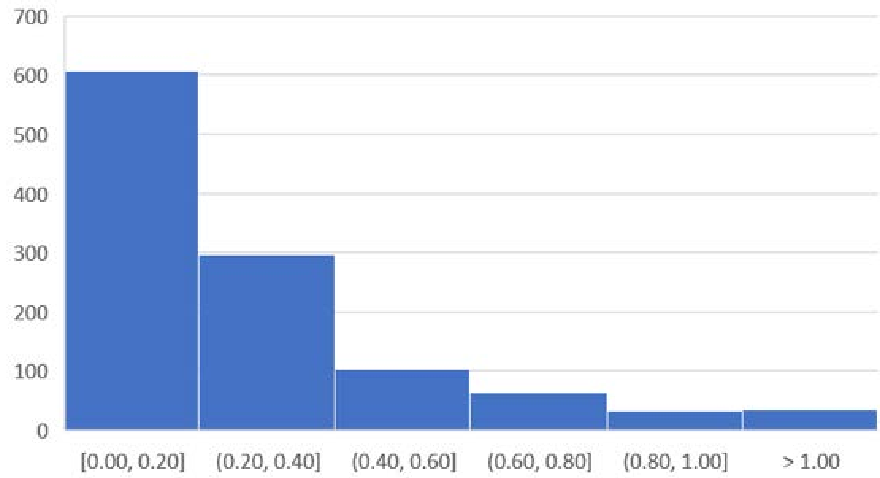
Other species present in the stratum

Albizia antunesiana
Anisopyllea boehmii
Bobgunnia madagascariensis
Brachistegia tamarindoides
Cassia abbreviata
Diplorynchus condylocarpon
Erythrina abyssinica
Erythropleum africanum
Euclea natalensis
Gardenia volkensii
Hymenocardia acida
Isoberlinea angolensis
Monotes spp
Ocha schweinfurthiana
Parinari curatelifolia
Pericopsis angolensis
Rothmannia engleriana
Strychnos cocculoides
Swartzia madagascariensis
Syzygium guineense
Terminalia brachystemma
Uapaca benguellensis
Uapaca goswoilleri
Uapaca kirkiana

Diameter distribution (cm)



Basimetric distribution ($m^2.ha^{-1}$)



Heights distribution (m)

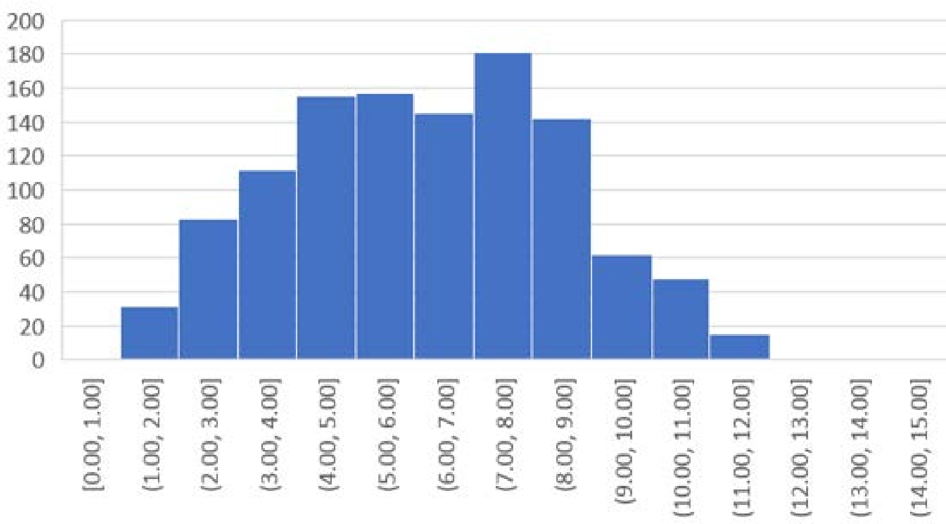
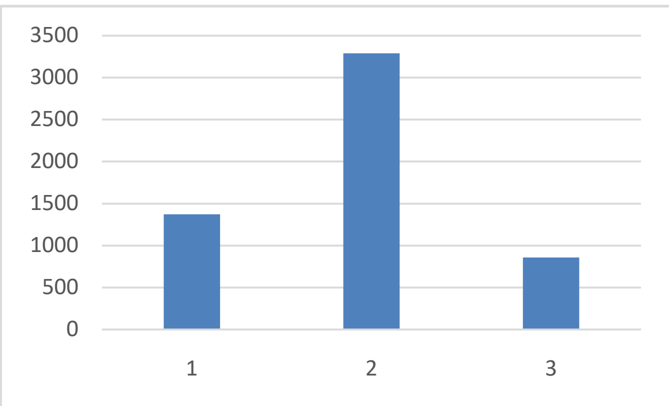


Table 13 Characteristics of type 3

Huambo forest (Angola)						Type 3
Description						
Number plots:	2				**Soil type:**	Orthic ferralsols y Xanthic ferralsols
FCC (%):	68.75				**Density ($N.ha^{-1}$):**	3451.61
Total species:	10				**Shannon´s Index:**	0.7
Plots:	10 and 33					
Description						
Low diversity of species, but dominant species of Miombo are here. High density of plants with small diameters. Plants of *Albizia* y *Brachistegia* gendera are tallest than in the other clusters where they appear. Presence of *Combretum collimun* Fresen and *Pterocarpus angolensis* DC with a significant presence percentage in the stratum but without significant diametric values. This type of forest is clearly a young forest with abundant regeneration that shows a recent recovery after a major disturbance caused possibly by fire.						
Stand composition main species						
	Species	**D**	**H**	**G**	**DMC**	**$N.ha^{-1}$**
1	*Albizia antunesiana* Harms	9.04	5.88	9.418	0.095	1370.96
Stand composition secondary species						
	Species	**D**	**H**	**G**	**DMC**	**$N.ha^{-1}$**
2	*Erythrophleum africanum* (Welw. ex Benth.) Harms	7.91	5.51	17.60	0.081	3290.32
3	*Brachistegia boehmii* Taub	8.24	5.29	5.036	0.086	859.43

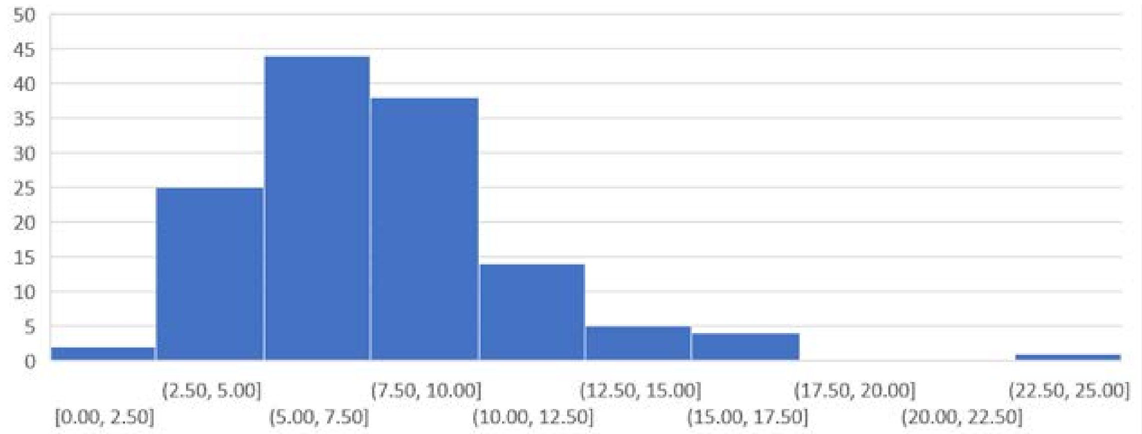
Density species($N.ha^{-1}$)



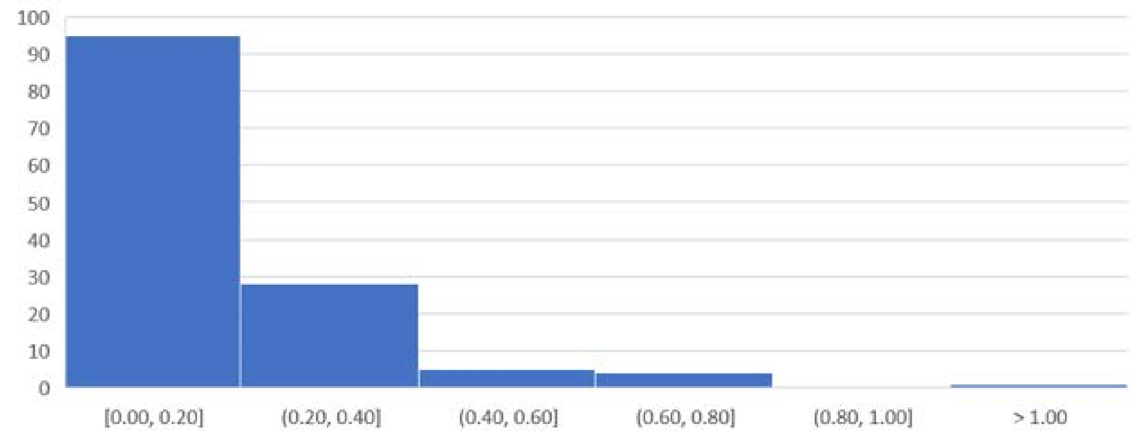
Other species present in the stratum

Combretum collimun Fresen
Parinari curatellifolia *Planch. Ex Benth.*
Pseudolachnostylis maprouneifolia *Pax*
Euclea natalensisA.DC.
Pterocarpus angolensis DC
Syzygium guineense (Willd.) DC
Brachystegia utilis Burtt Davy & Hutch

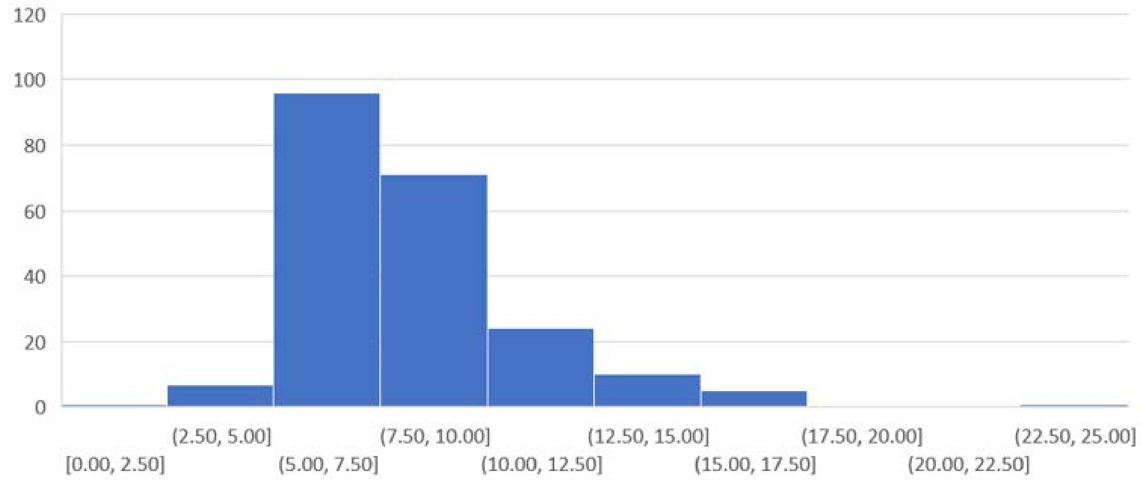
Diameter distribution (cm)



Basimetric distribution ($m^2.ha^{-1}$)



Heights distribution (m)



5.2. Generation of thematic mapping of miombo types

5.2.1. *Removal of soil and non-significant elements*

This procedure consisted in the elimination of the image of those elements that could interfere in the spectral pattern of the miombo types. In this case, the calculation of NDVI index was used to eliminate the bare soil and the low dense vegetation. The areas of the images with low values of NDVI index were masked to analyze only areas of interest. The minimum value of the NDVI index was defined analyzing the histograms and through the visualization with different combinations of the bands of the image. The Fig 21shows the mask in which the classification is realized.

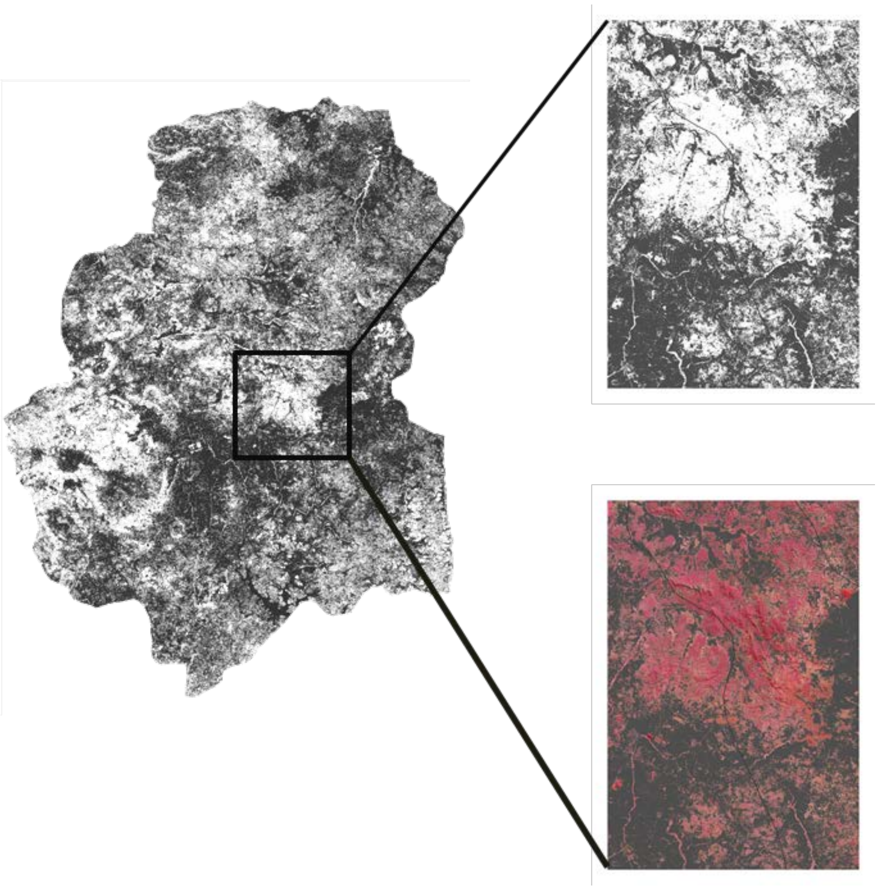


Fig 21 NDVI mask in which the classification was realized

5.2.2. *Spectral signatures of the different types of miombo masses*

The spectral signature for each type of miombo was calculated once the four types of miombo were obtained. The Fig 22shows the spectral signatures for the types of miombo. It was observed that although the signatures are similar they show differences that allow differentiating between the types of miombo.

Fig 22. Spectral signatures of the differents types of miombo

5.2.3. *Classification of the different types of miombo masses*

The training areas selected correspond to the field plots classified based on the four types of miombo defined (0, 1, 2 and 3). Seventy percent of the total of plots was used in the classification process and the remaining plots in the validation process. The Table 14 shows the number of plots inside each type of miombo defined.

Table 14 Number of plots according to miombo types.

Miombo types	Number of plots
0	15
1	7
2	11
3	1

The statistical separability between the spectral patterns of the four types of miombo selected through the training sites was calculated using the measure of transformed divergence (Jeffries-Matusita). The values of the diverged divergence fluctuate in an interval between 0 and 2, being those closest to the maximum those that have greater separability and those of less than 1.5 that have a poor separability. The separability measure should be considered as a warning against the probability of correctly classifying each category. In this case, the most similar classes were the type of miombo 0 and 2 as also could be observed in the spectral signatures respectively. The Fig 23shows the separability of the classes. The different classes obtained show similar spectral signatures and little separability between them because all classes correspond to a single forest structure (miombo). The miombo is characterized by being present in a uniform climate, with little altitudinal variation and with homogeneity in the distribution of species. Therefore, the classes are so close to each other.

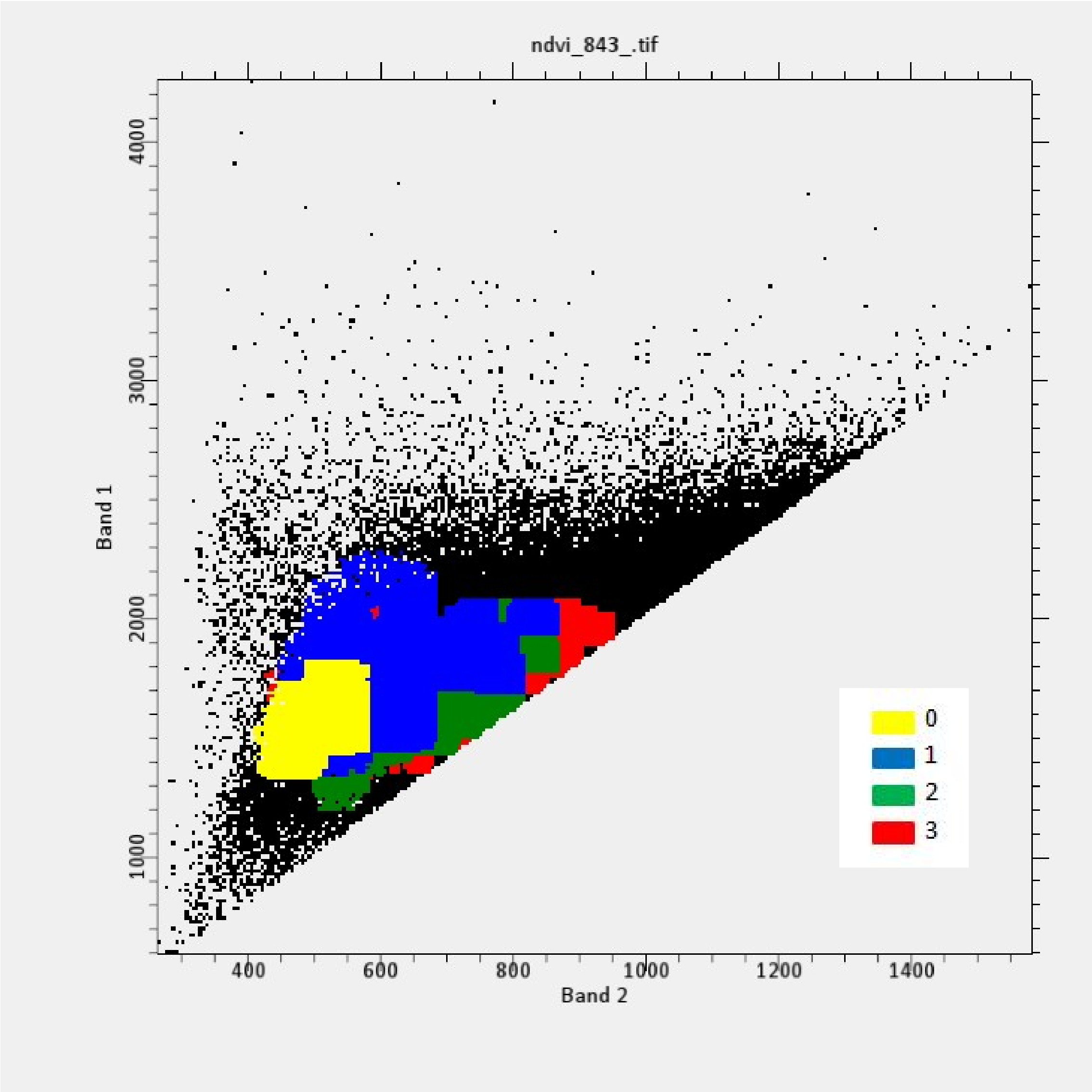


Fig 23 Separability between types of miombo defined

Once the separability of the classes was analyzed, the classification was performed. The algorithm used was the minimum distance due to it showed the best results. The Fig 24shows the classification of the types of miombo for the province of Huambo.

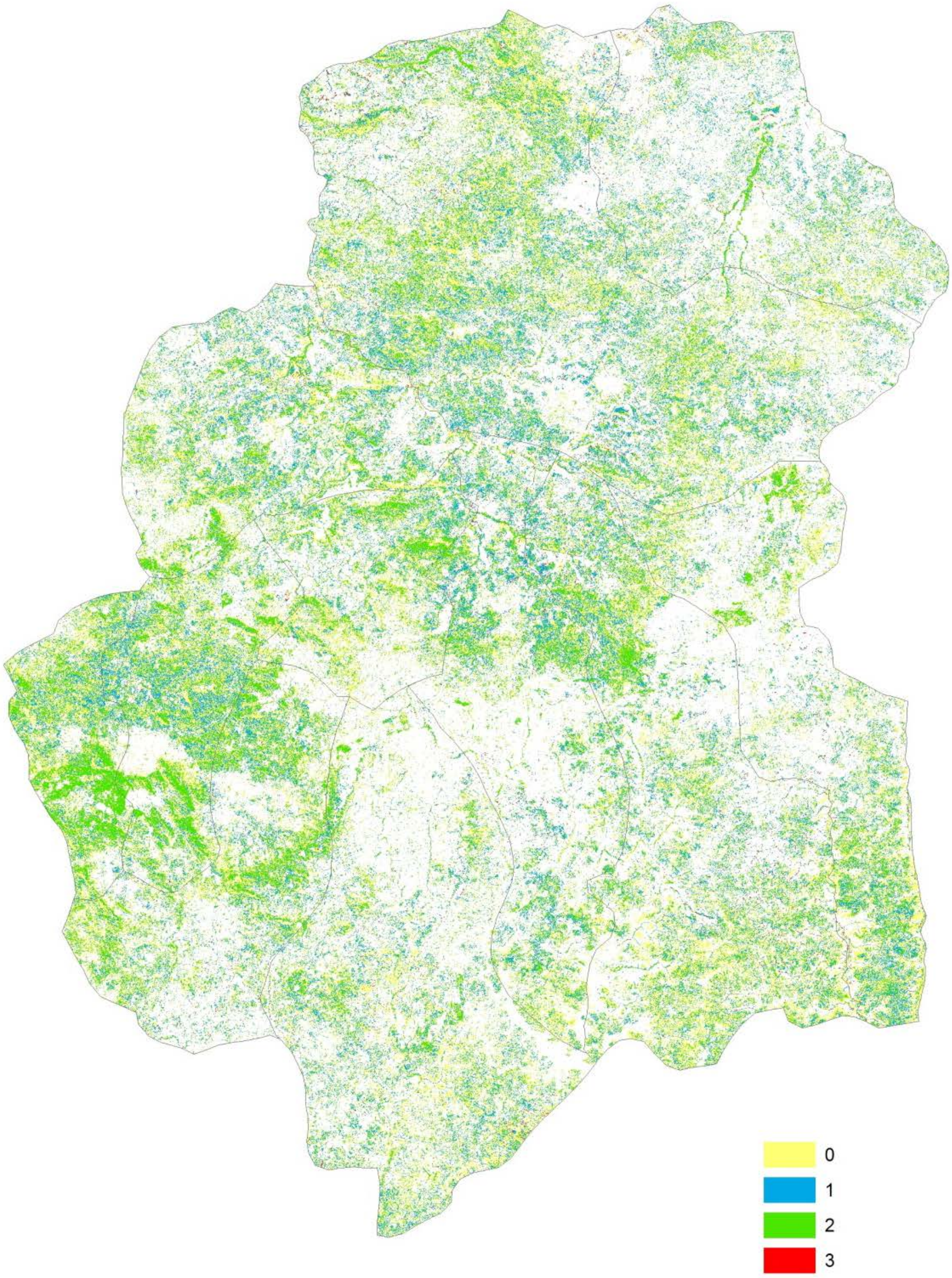


Fig 24 Classification of the different types of miombo in the province of Huambo

The area designated according to the types of miombo for the province of Huambo is:

- Type of miombo 0: 63 487.64 ha
- Type of miombo 1: 31 913.42 ha
- Type of miombo 2: 34 965.27 ha
- Type of miombo 3: 18 072.12 ha

The following figures show clippings of each of the typologies of miombo classified. As previously mentioned, the forest type 0 (Fig 25)is a forest with typical features of an intermediate state between degraded and mature miombo. Its presence in sloping areas is an indicator that has not been subjected to agriculture, but its low slope makes it accessible to other traditional uses such as firewood, charcoal, the extraction of wild fruits or livestock.

With these data, it is concluded that rather than being a miombo in the process of transition, it is a formation that, being in slopes and areas with difficulty of retention of water, the growth of the dominant species like *Brachystegia* or *Julbernardia* is lower as can bechecked in the diametric distribution figures of these species. Thus enabling *Albizia* to be installed and developed vigorously in areas with a great difficulty in absorbing water. Taking advantage of the gaps that remain in these sloping areas.

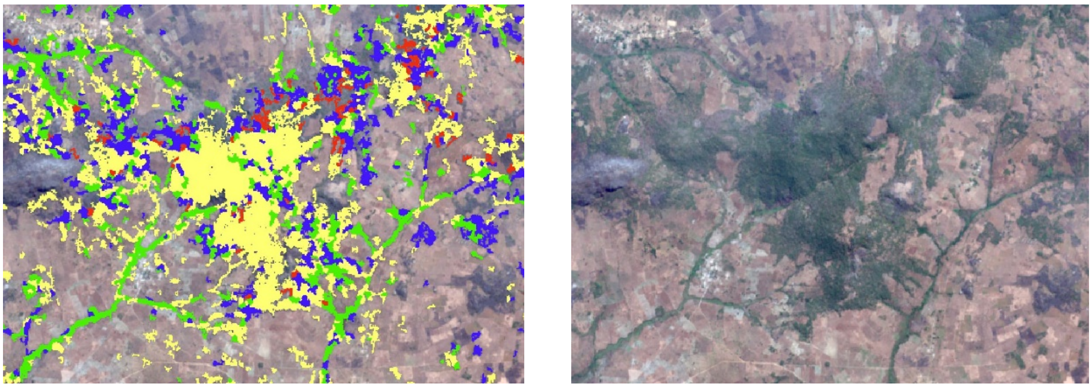


Fig 25 Forest Type 0 of miombo grouped in mountain areas (yellow).

The Fig 26shows in green, the surface obtained for Type 2, which has been described like a miombo forest in an advanced state of transition towards mature miombo. This state stands out for having a high influence of species like *Brachystegia*, *Julbernardia*, *Isoberlina* or *Combretum*, as well as a greater height of the arboreal canopy and diameters of greater thickness.

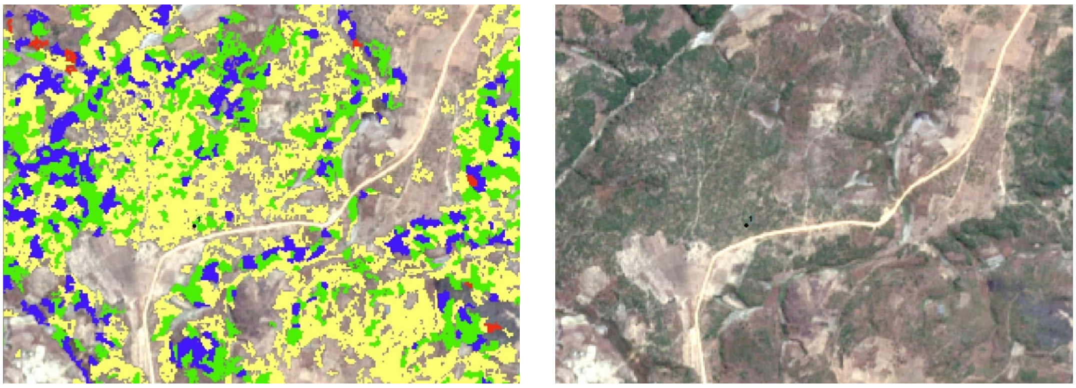


Fig 26 Forest Type 2 of miombo (green)

The classification groups the miombo forest type2 in small spots, especially in the areas of greater slope or more inaccessible. It should be noted that the groups show continuous yellow, blue and green colors in a highly intercalated form (Types 0, 1 and 2 respectively), since these three types differ very little in the composition of species. Their main differences are found in the structure and distribution of these species, and in the state of the forest as described above.

The Fig 27shows in blue color the forest type 1 described in this research.This type of forest is characterized by being a forest intervened which we have described as intervened. It was distinguished by an irregular diametric distribution of the main species, substitution of *Isoberlinia* and *Brachystegia*species by *Albizia* or *Hymenocardia* species, which are notable for being colonizers of degraded forest areas or with a low vegetation cover, as well as fire resistant.

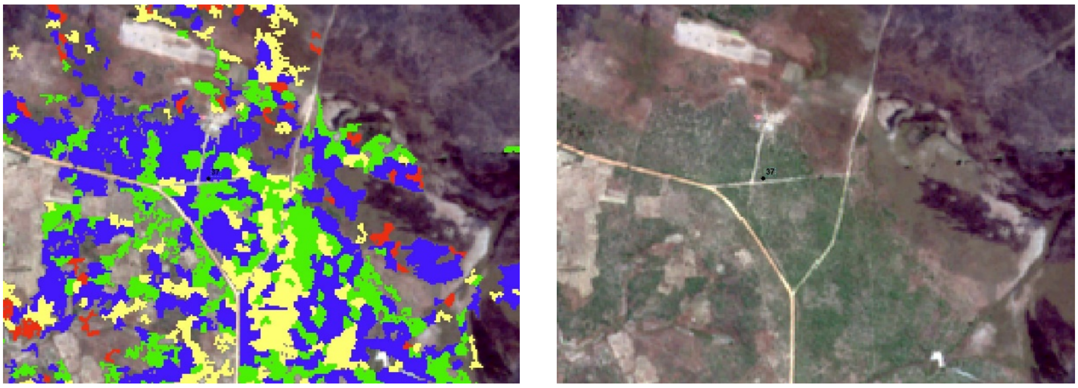
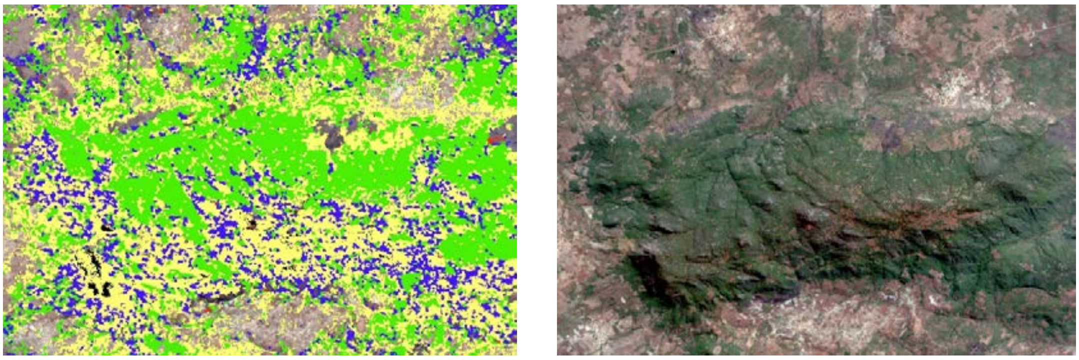


Fig 27 Forest Type 1 of miombo (blue)

The type 1 of miombo (blue colour), is concentrated around the communication routes, and in areas with low slope as shown in Fig 27. This justifies the description made since it facilitates the access of the population for the extraction of timber and non-timber resources.

The Fig 28shows that mature miombo (Type 2, colour green) is grouped in the mountainous areas with difficult access, but with less slope and can therefore afford a greater soil thickness.This, has allowed the trees to further develop and rise the highest tall and diameter for the trees of this region. The location of this type of forest hinders human access and important logging and burning activities for later cultivation. On the other hand, type 0 appears in areas of maximum slope or spaces midway between degraded and mature areas. And lastly, Type 1 of miombo, appears in areas with a more hollowed forest where the canopy cover is not



complete.

Fig 28 Forest Type 2 of miombo (green)

The type 3 of miombo (red colour) is found to a lesser extent (Fig 29). This type of forest is found in the margins of the forest mass, near roads, or close to populations. This type of miombo presented a high degree of degradation, and a different specific composition with a high density of young trees of colonizers species and with a high density of pioneer species trees.

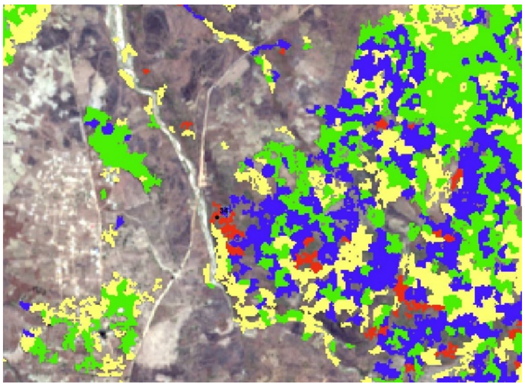


Fig 29 Forest Type 3 of miombo (red)

As a consequence of the characteristics of this type of forest structure (miombo), the classification accuracy was 46.1%.This result comes directly from the confusion matrix made in the validation phase in which the rest of plots that were not used in the classification process were used in this phase. There is no standardized range in the literature that considers the accuracy achieved as acceptable or not, but depends on the restriction considered in each case.

6. CONCLUSIONS

Based in the results, the conclusions of this study are summarized below.

The causes of the result of the classification could be explained due to the context of the study and the reality of the data. First, it must be taken into account that the classification has been carried out on a single type of forest mass (miombo). In addition, this forest mass presents a high level of degradation in some areas. Different stages of degradation in the same ecosystem, it could cause a spectral signature a little different. In this sense, in very advanced stages of degradation, where forest cover is low, the greater presence of soil in the image would also cause a distortion of the data.

This leads to the second cause, the pixel size. A 10-by-10-meter pixel such as that of the Sentinel-2 image will probably not be a pure pixel, ie, it will be a pixel that will mix the spectral signature of a type of miombo with that of the ground. This is because the size and density of the miombo's leaves do not cover completely the size of the pixel.

In spite of this, and after the exhaustive study of silvicultural characterization of the different types of miombo, it has made a classification considering this characterization and the characteristics of the study area in terms of slope, climate, spatial distribution and soil composition.

As for the characterization of miombo types, the Table 15 shows the number of plots where each species appears and the percentage of the total sample plots where the species are in the different types of forest founded.

Table 15 Presence of different species in forest types

Species	Forest Types				%
	0	1	2	3	
Upandandjamba	9	1	4	-	29
***Albizia antunesiana* Harms**	9	9	8	2	58
***Anisophyllea boehmii* Engl.**	12	9	8	-	60
***Bobgunnia madagascariensis* (Desv.) J.H.Kirkbr. & Wiersema**	7	1	7	-	31
***Brachystegia boemii* Taub**	18	3	10	1	67
***Brachystegia spiciformis* Benth**	19	3	13	-	73
Brachystegia tamarindoides Benth	5	4	7	-	33
***Brachystegia utilis* Burtt Davy & Hutch**	4	7	-	1	25
***Cassia abbreviata* Oliv**	-	-	1	-	2
***Combretum collinum* Fresen.**	-	2	8	-	21
***Diplorhynchus condylocarpon* (Müll.Arg.) Pichon**	7	3	3	-	27
***Dombeya rotundifolia* (Hochst.) Planch**	2	3	1	-	13
***Ehretia amoena* Klotzsch**	-	1	-	1	4
Erythrina abyssinica Lam. ex DC.	-	1	3	-	8
***Erythrophleum africanum* (Welw. ex Benth.) Harms**	3	2	1	1	15
Euclea natalensis A.DC.	-	1	3	2	13
Gardenia volkensii K.Schum.	5	1	5	-	23
Hymenocardia acida Tul	6	8	12	-	54
***Isoberlinia angolensis* (Benth.) Hoyle & Brenan**	17	9	10	1	77
Jubernardia paniculata (Benth.) Troupin	11	6	10	-	56
***Kraussia floribunda* Harv.**	2	-	-	-	4
***Monotes* spp**	13	8	12	-	69
Ocha schweinfurthiana F. Hoffm.	18	8	11	1	79
Parinari curatellifolia Planch. Ex Benth.	14	4	6	1	52
Pericopsis angolensis (Barker) Meeuwen	5	2	11	-	38
***Pseudolachnostylis maprouneifolia* Pax**	1	4	1	1	15
***Pterocarpus angolensis* DC**	5	2	9	-	33
***Randia Kuhniana* F. Hoffm. Schum.**	-	-	1	-	2
***Rothmannia engleriana* (K. Schum.) Keay**	6	5	8	-	40
***Sterculia quinqueloba* (Garcke) K. Schum**	1	1	-	-	4
***Strychnos cocculoides* Baker**	-	-	1	-	2
***Swartzia madagascariensis* Desv.**	-	-	1	-	2
***Syzygium guineense* (Willd.) DC**	11	8	10	-	60
***Terminalia brachystemma* Weiw. Ex Hiern**	13	9	1	-	48
***Uapaca benguellensis* Muell.**	1	-	5	-	13
***Uapaca gossweileri* Hutch.**	9	3	3	-	31
***Uapaca kirkiana* Müll. Arg**	13	3	3	-	40

A total of 39 woody species were recorded. The floristic inventory indicated that it is an area medium botanical with a total of 39 species. The species of the goods prevail are:

- *Albizia antunesiana* Harms appears in 56.25% of plots with hight density.
- *Brachystegia specifornmis* was found in 73% of plots.
- *Brachystegia bohemii* in 62.5% of plots.
- *Monotes* spp in 66.67%.

After the processing of the forest inventory in whole the region, percentage refers to the plants present occurring with greater frequency were:

- *Albizia antunesiana* Harms (13.22%)
- *Brachystegia spiciformis* Benth (12%)
- *Ocha schweinfurthiana*F.Hoffm (8.63%)
- *Julbernardia paniculata* (Benth.) Troupin (8.50%)
- *Brachystegia boehmii* Taub (8.06%)

The score IVI (Importance Value Index) was for *Brachystegia spiciformis* Benth, followed by *Albizia antunesiana* Harms, *Monotes* sppand *Juberanrdia paniculata* (Benth.)Troupin those for its abundance, frequency and dominance.

The Angolan miombo forest is dominated by species of the genus *Brachystegia, Isoberlinia* and *Julbernardia* (Sanfilippo *et al.*, 2013). In contrast, this study reveals also a great presence of *Ocha, Albizia*and *Monotes*genus.

Pericopsis angolensis (Baker) Meeuwen, Diplorhynchus condylocarpon (Müll.Arg.) Pichonand and Strychnos cocculoides Baker species appear with different frequency for forest types 0, 1 and 2 with 42.85%, 50% and 86.66% respectively. These species are mentioned as resistant to fire (Bockeus et al. 2006). Albizia anthunesiana Harms, Erithroipheum africanum, Parinori curate, Pterocarpus angolensis and Uapaca kirkiana are also menconate like fire resistant to fires species (Musambachime, 2016).

The plots 4 and 49 of miombo forest type 2, do not present the species chosen as representative (*Brachystegia, Isoberlinia* and *Julbernardia* sp), which made us identify the data of dominant species for these plots.In plot 4, *Monotes* spp appears as a prominent species in the regenerated strata, also this species emphasized in the strata tree withdiameters between 5 and 10 cm. Its frequency of heights is concentrated in heights smaller than 5m. For plot 49, *Brachistegia tamarindoides* and *Pterocarpus angolensis*species are prominent in the arboreal stratum with heights between 7 and 10 m.

Comparison of species grouping and forest characteristics of each type

The increased presence of *Albizia, Brachystegia* and*Isoberlinia*in type 1 with small diameters indicates a high recruitment of these speciesReflects the characteristics of mature miombo at the level of species present as well as in type 2, with one important difference: in type 2, tree diameters are larger indicating a more advanced stage in the ecological succession towards mature miombo forest (Fig 30and Fig 31).

A higher frequency of *Albizia*than*Brachystegia* and *Jubernardia* in type 0 reinforces the idea of transition a half-way between miombo in regeneration and mature miombo of type of forest.

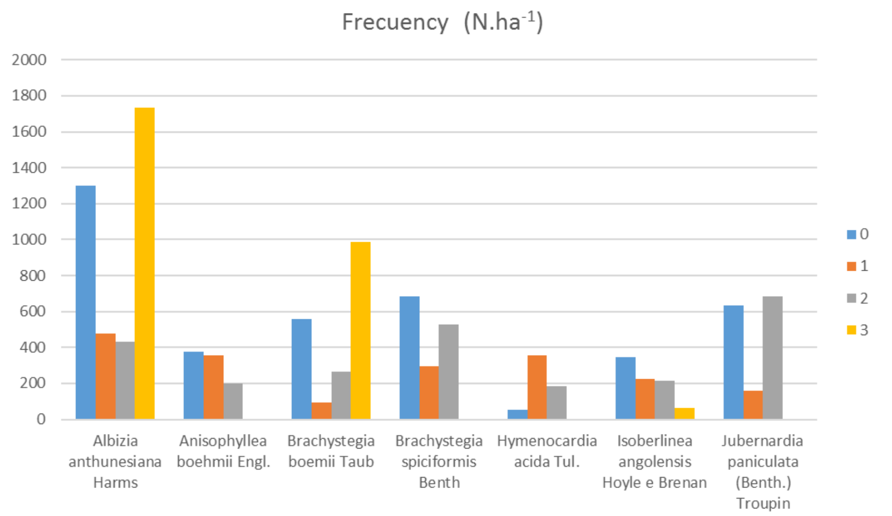


Fig 30Average frecuency of species

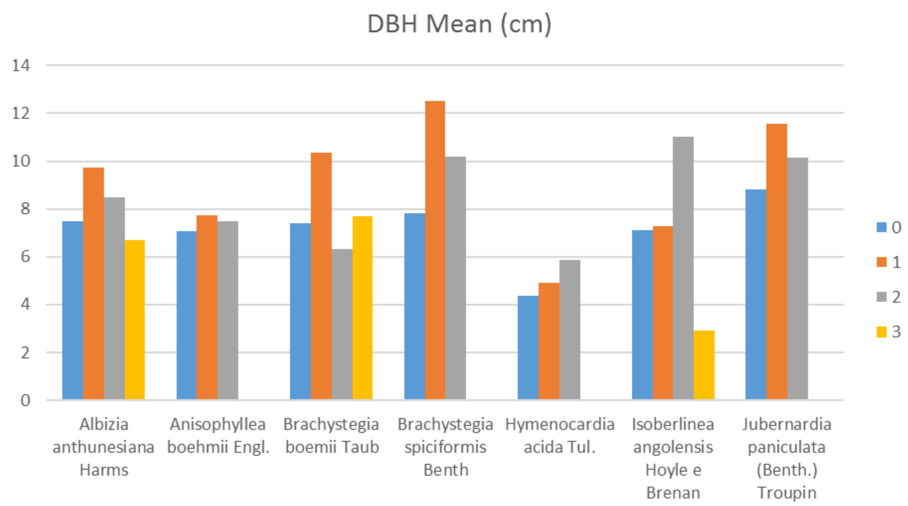


Fig 31 Average frequecy of diameter

The main species present in the Type 0 maintain an equality in diametric values (evenness) excepting *Jubernardia*, since it is capable of regenerating under closed canopy with competitive advantage against *Brachistegia* or *Isoberlinea*.

However, in Type 2 these three species exceed the *Albizzia's* diametric value. This is one more reason to conclude that Typo 2 presents a more advanced structure in the ecological succession towards mature miombo (Fig 32).

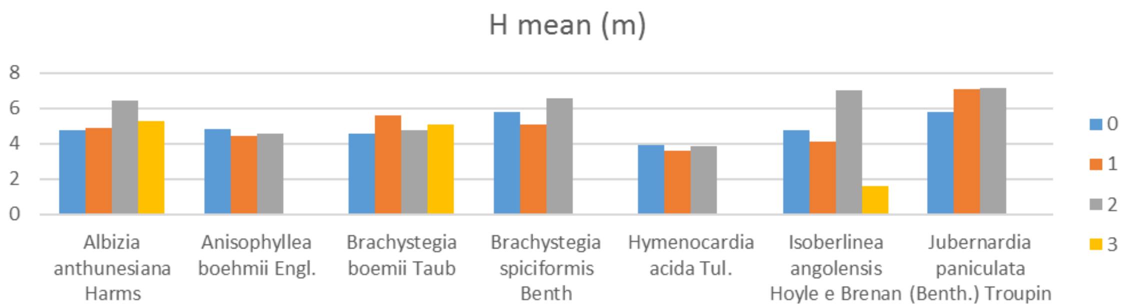


Fig 32 Average frequency of height

In type 1 it is observed how *Brachystegia* and *Jubernardia* present very low density but they are adult trees, with the greater diameters for these species in the whole studied surface, giving basimetric values very elevated and maintaining their height within the average in comparison with the other types.

In Type 3, highlight the absence of *Anisophyllea*, *Brachystegia spiciformnis*, *Hymenocardia acida* and *Jubernadia paniculata*, which constricts with a high frequency of Albizya and *Brachistegia Boemii* stands out. This may be due to the regenerative capacity of *Albyzia* populations in respond to environmental disturbances. Therefore, regenerate in a much faster way in the first 5 years than *Brachistegia spiciformis* populations (Campbell, 1996).

High *Albizia* canopy cover may be preventing the regeneration of *Brachistegia spiciformis* which regenerates better in open forest. In this type of miombo the highest canopy cover is given among the types described (68.75%).

In the type 1, for *Brachistegia* and *Jubernardia* gender are found the highest values of average diameter (Fig 31). This data, with the analytical result of plots show the presence of species typical of mature miombo with large diameters but with low regenerated rate. This may indicate an external disturbance to the natural dynamics for this type of miombo forest. These species are highly prized for charcoal and firewood. According to some authors (Bockues I,2016), *Brachistegia* and *Jubernardia* species are sensitive to fire in ages of regenerated.

This can also be indicative of a disturbance caused by fire in Type 1 given the low frequency of this kind of tree per hectare and the absence of young trees in the lower diameter classes (Fig 33 and Fig 34).

The absence of species in some diametric classes may indicate the selective extraction of some specimens of trees (Fig 35).

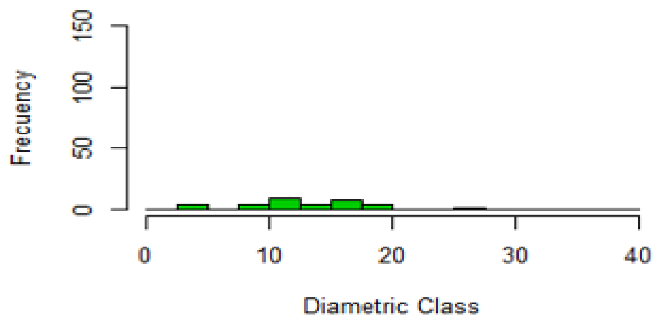


Fig 33 Diameter distribution of Jubernadia

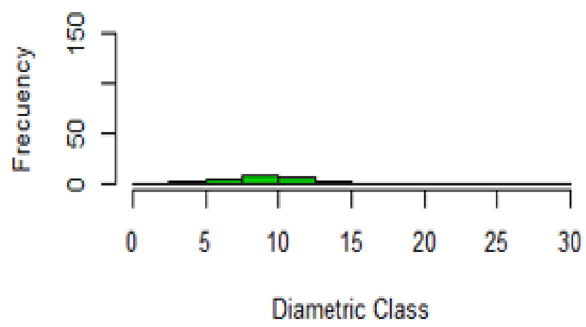


Fig 34 Diameter distribution of Brachystegia spiciformis

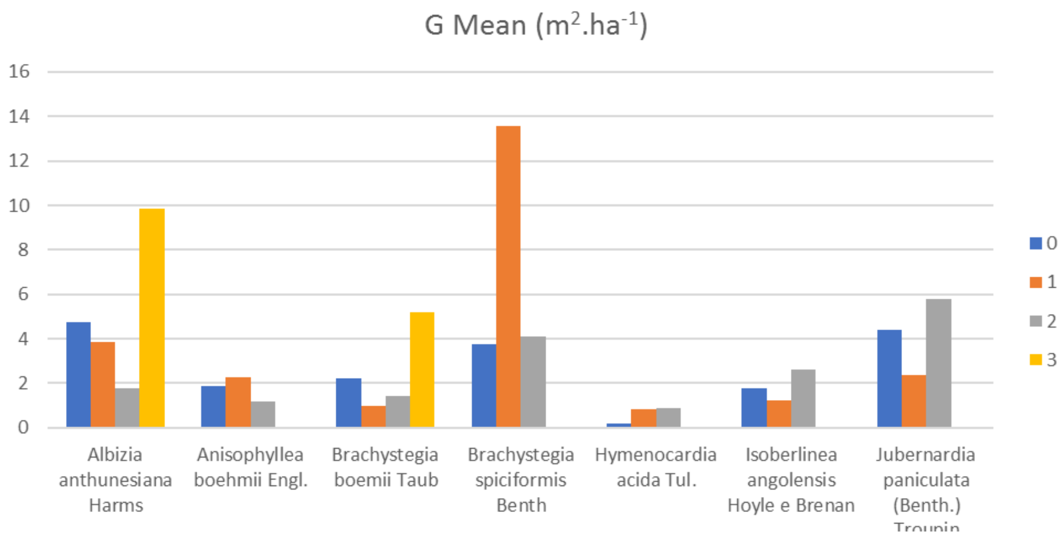


Fig 35 Basal area of species for each type

Highlights regeneraion of *Hymenocardia acida* Tul in plot 26 with 509 plants /ha with average dimeter of 2.9 cm which may be also a sign of recovery after perturbation.

Do not overlook the presence of a species that is pioneering and resistant to fire*Erythrophleum africanum* (Welw. ex Benth.) Harms. which appears in a significant way in one of the plots of type 3.

Erythrophleum africanum also are with a high frequency in plots 14 and 15. These data can give us an idea of the importance of fire dynamics in miombo ecosystems.

With regard to Type 2, we are at an advanced stage of forest recovery. In 1986, Stomgard proposed a model that predicts a trasnsition from a dominated forest of *Brachistegia* and *Jubernalia* spp towards a dominated forest of Combretum after cultivation and abandonment of fields under a changing agriculture management (Campbell, 1996).

The data obtained indicate that we are facing in a forest of *Brachisgtegia* and *Jubernardia* with residual presence of *Combretum.* This, coupled with the high number of smaller feet present leads us to affirm that this type of forest (Type 2) comes from a succession of abandoned crops. So, Type 2 is nearest of mature miombo because have *Combretum collinum* Fresen trees with diameter upper 5 cm. *Combretum collinum* Fresen is an indicator species of mature miombo (Orwa C. *et al.,* 2009).

7. Bibliography

Araújo, P.S.F.; Christo, A.G.; Rodrigues, G.B.R. y Silva, A. F. 2009. *Composição florística e estrutura de um fragmento de floresta estacional semidecidual aluvial em viçosa (MG)*. Floresta, Curitiba, PR. Vol. 39, No. 4, p. 793-805 p.

Astle, W.L. 1969. *The vegetation and soils of Chishinga Ranch, Luapula Province, Zambia. Kirkia* 7, 73-102.

Banda T., Schwartz, M.W & Caro, T. 2006. *Woody vegetation structure and composition along a protection gradient in a miombo ecosystem in western Tanzania*. Forest Ecology & Management, 230: 179-185.

Boaler, S.B. 1966. *Ecology of a Miombo Site, Lupa North Forest Reserve, Tanzania: III. Efects of the Vegetation of Local Cultivations Practices*. Journal of Ecology, pp. 577-587.

Bockeus, I.; Pettersson, B; Stromquist, L. y Ruffo, C. 2006. *Tree communities and structural dynamics in miombo Brachystegia Julbernandia Woodland, Tanzania*. Forestry Ecology and Management. 230: 171-178.

Cabral, A., Vasconcelos, M. and Oom, D. 2010. *Comparing Information Derived from Global Land Cover Datasets with Landsat Imagery for The Huambo Province and Guinea-Bissau.* Wagner W., Székely, B. (eds.): ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7B.

Cabral, AIR, Vasconcelos MJ, Oom, D. and Sardinh, R. 2011*. Spatial dynamics and quantification of deforestation in the central-plateau woodlands of Angola (1990-2009)*. Applied Geography 31:1185-1193.

Campbell, B.M. and du Toit, R.F. 1988. *Relationships between wood resources and the use of species for construction and fuel in the communal lands of Zimbabwe*. Monographs in Systemic Botany of the Misssouri. Botanic Gardens 25, 331-341.

Campbell BM. 1996.*The Miombo in Transition: Woodlands and Welfare in Africa*. Centre for International Forestry Research: Bogor, Indonesia.

Chao, A. and Chiu, C. H. (2016). *Species richness: estimation and comparison*. Wiley StatsRef: Statistics Reference Online. 1-26.

Chidumayo, E.N. 1987. *Woodland structure, destruction and conservation in the copper belt area of Zambia*. Biological Conservation 40, 89-100.

Chidumayo, E.N. 1993. *Responses of miomboto harvesting: ecology and manage*ment. SEI, Stockholm. 132 pp.

Chidumayo, E. N. 2004. *Development of Brachystegia-Julbernardia woodland after clear-felling in central Zambia: evidence for high resilience*. Applied Vegetation Science, vol. 7, no. 2, pp. 237–242.

Colwell, R.K., Chao, A., Gotelli, N.J., Lin, S.Y., Mao, C.X., Chazdon, R.L. and Longino J.T. 2012. *Models and estimators linking individual-based and sample-based rarefaction, extrapolation, and comparison of assemblages*. Journal of Plant Ecology 5:3-21

Colwell, R. K. 2013. *EstimateS: Statistical estimation of species richness and shared species from samples.* Version 9. User's Guide and application published at: http://purl.oclc.org/estimates.

Davies, G.M., Pollard, L. and Mwenda, M.D. 2010*. Perceptions of land-degradation, forest restoration and fire management: A case study from Malawi.* Land degradation and Development. 21(6):546-556.

Desanker, P. V., Frost, P. G. H., Frost, C. O., Justice, C. O., & Scholes, R. J.1997. *The Miombo network: framework for a terrestrial transect study of land-use and land-cover change in the Miombo ecosystems of Central Africa*. The International Geosphere-Biosphere Programme Report 41, Stockholm, Sweden.

Dovala Luísa F. L. 2015. *Estrutura e resposta da regeneração e sua resposta à humidade e densidade da copa de uma população de Miombo, na reserva Brito Teixeira, Chianga, Huambo, Angola*. Tesis de Licenciatura en Ingeniería Forestal. 91 pp.

Eugenio, J.G., Sanfiliplo, M., García, Y., Castillo, I., & Arteaga, Y. (2014). *Estructura y composición del bosque miombo del sector norte de Canjombe, Angola.*Revista Forestal Barbacoa, 33: 306-316.

Freson, R., Goffinet, G. and Malaisse, F. 1974. *Ecological effects of the regressive succession in muhulu-miombo-savanna in Upper Shaba, Zaire.* In: Proceedings of the first international congress of ecology. Structure, functioning and management of ecosystems, The Hague, September 1974, 365-371. PUDOC, Wageningen, Netherlands.

Frost, P. 1996. *The ecology of miombo woodlands*. In: Campbell, B. (ed.) The miombo in transition: woodlands and welfare in Africa. CIFOR, Bogor. pp. 11-58.

Giliba, R.A., Boon, E.K., Kayombo C.J. Musamba E.B., Kashindye, A.M. and Shayo P.F. 2011. *Species Composition, Richness and Diversity in Miombo Woodland of Bereku Forest Reserve, Tanzania*. J Biodiversity, 2(1): 1-7 (2011).

Govender, M., Chetty, K. y Bulcock, H. 2007. *A review of hyperspectral remote sensing and its application n vegetation and water resource studies*. Water SA 33(2): 145-152

Gutiérrez, C. P., & Nieto, Á. L. M. 2006. *Teledetección: nociones y aplicaciones*. Carlos perez.

Guy, P.R. 1981. *Changes in the biomass and productivity of woodlands in the Sengwa Wildlife Research Area, Zimbabwe*. Journal of Applied Ecology, 18: 507-519.

Halffter, G. 1998. *A strategy for measuring landscape biodiversity*. Biology International, 36: 3-17.

Hill, M.O. & Šmilauer, P. 2005. *TWINSPAN for Windows version 2.3*. Centre for Ecology and Hydrology & University of South Bohemia, Huntingdon & Ceske Budejovice.

Jeffers, J.N.R. 1996. *Measurement and characterisation of biodiversity in forest ecosystems. New methods and models*. European Forest Institute, EFI Proceedings, 6: 59-67.

Jones, E.R.; Wishnie, M.H.; Deago, J.; Sautu, A. y Cerezo, A. 2004*. Facilitating natural regeneration in Saccharum spontaneum (L.) grasslands within the Panama Canal watersheds: effects of tree species and tree structure on vegetation recruitment patterns*. For. Ecol.Management, 138, 357-368 p.

Kikula, I.S. 1986. T*he influence of fire on the composition of miombo woodland of Southwest Tanzania*. Oikos 46, 317-324.

Lawton, R.M. 1978. *A study of the dynamic ecology of Zambian vegetation*. Journal of Ecology 66, 175-198.

Lillesand, T. M., Kiefer, R.W., y CHipman, J.W. 2004. *Remote Sensing and Image Interpretation*. New York. Wiley. 763p.

Lillesand, T., Kiefer, R. W., & Chipman, J. 2014. *Remote sensing and image interpretation*. John Wiley & Sons.

Luoga, E.J., Witkowski, E.T.F. & Balkwill, K. 2002. *Harvested and standing wood stocks in protected and communal miombo woodlands of eastern Tanzania*. Forest Ecology & Management, 164: 15-30.

Lobo, A. 1995. *La observación remota de los ecosistema*s. En “Análisis de la variabilidad espacio-temporal y procesos caóticos en ciencias ambientales”. Geoforma Ediciones. Logroño.

Magurran EA 1988. *Ecological Diversity and Its Measurement*. Princeton: Princeton University Press, P. 179

Mandanici, E.; Bitelli, G. 2016. *Preliminary Comparison of Sentinel-2 and Landsat 8 Imagery for a Combined Use*. Remote Sens., 8, 1014.

McCoy, R. 2005. *Fields methods in remote sensing*. New York. The Guildford Press

Ministério do Ultramar, 1965. *Carta generalizada do solos de Angola*. Escala: 1:3,000,000.

MJIU. ,1961.*Carta geral dos solos de Angola, Distrito do Huambo. Missão de pedologia de Angola*, Memórias da Junta de Investigações do Ultramar.

Musambachime M. 2016. *One Zambia, One Nation, One Country*. Congress. XLIBRIS. 690 p.

Orwa C, A Mutua, Kindt R , Jamnadass R, S Anthony. 2009 *Agroforestree Database:a tree reference and selection guide version. 4.0.*http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp

Ramírez, N.; González, M. y Williams, G. 2001. *Anthropogenic disturbance and tree diversity in montane rain forests in Chiapas, México*. Forest Ecology and Management, 154,311-326 p.

Rao, N.R., Garg, P.K y Ghosh, S.K. 2007. *Development of an agriultrual crops spectral libray and classification of crops at cultivar level using hyperspectral data*. Precision Agric. 8:173*185

Robertson, E.F. 1984. *Regrowth of two African woodland types after shifting cultivation*. Ph.D. thesis, University of Aberdeen.

Roleček, J., Tichý, L., Zelený, D. and Chytrý, M. 2009.*Modified TWINSPAN classification in which the hierarchy respects cluster heterogeneity*. Journal of Vegetation Science, 20: 596–602.

Ryan. CM, Williams. M, Grace.J,. 2011. *Above- and Belowground Carbon Stocks in a Miombo Woodland Landscape of Mozambique*. Biotropica, 1-10.

Strang, R.M. 1974. *Some man-made changes in successional trends on the Rhodesian highveld*. Journal of Applied Ecology, 111: 249-263.

Sanfilippo, M. 2013. *Trinta arboves e arbustos do Miombo Angolano. Guía de campo para a identificacao*. ONG COSPE Firenze. 74 p

Trapnell, C.G. 1959. *Ecological results of woodland burning experiments in northern Rhodesia*. Journal of Ecology, 47: 129-168.

USAID. 2008.*118/119 biodiversity and tropical forest assessment for Angola*. United States Agency for International Development.

White, F. 1983. *The vegetation of Africa*. Natural Resources Research, XX, Unesco, Paris, pp. 86-101.

Whittaker, R. H. 1972. *Evolution and measurement of species diversity*. Taxon, 21(2/3): 213-251.

8. Annex

8.1. Data description of the Forest Inventory of Huambo

The following describes the information and relevant units of the descriptive sheets of each plot:

***Species>** The main species for the diameter distribution have been chosen from the relationship of G and D.

D> Mean diameter of each species measured in centimeters.

H> Height of each species measured in meters.

G> Basal area (m^2/hectare) of each species.

Nplot> Number of feet per plot.

Nha> Number of feet per hectare.

Density> The graph represents the percentage of presence of each species in the plot.

Total diameter distribution> Representation of the diametric distribution of the ensemble of species of the study plot

Forest Inventory Huambo | Plot | 0

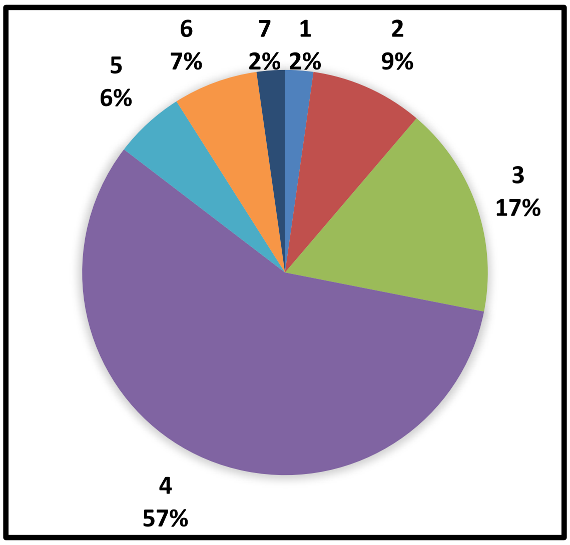
General description

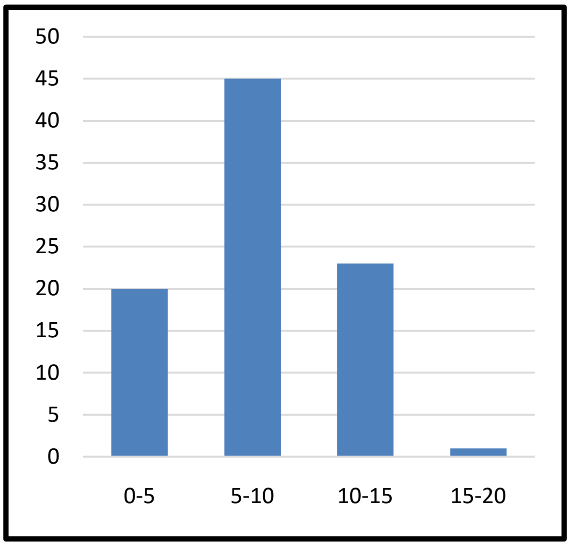
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	7
X	580972.281788	Stratum	0
Y	8686332.403333	Plot height (m)	1779

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Brachystegia Boehmii*	3.5	1.9	0.06	2	64
2	*Brachystegia spiciformis*	7.1	4.2	1.20	8	255
3	*Isorbelinea angolensis*	6.3	3.3	2.05	15	477
4	*Jubernardia paniculata*	9.0	4.4	11.47	51	1623
5	*Parinari curatelifolia*	8.0	4.7	0.90	5	159
6	*Terminalia brachystemma*	3.4	3.0	0.23	6	191
7	*Uapaca kirkiana*	7.6	2.3	0.29	2	64

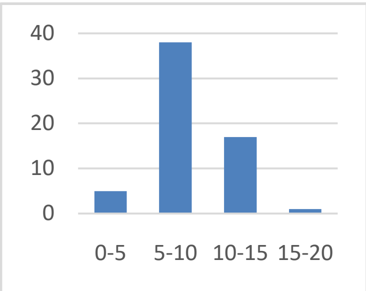
Density	Total diameter distribution

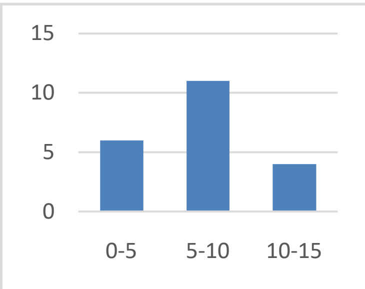


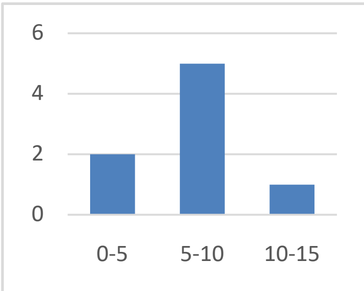


Diameter distribution main species

Juberandia paniculata	*Isorbelinea angolensis*	*Brachystegia spiciformis*







Forest Inventory Huambo | Plot | 1

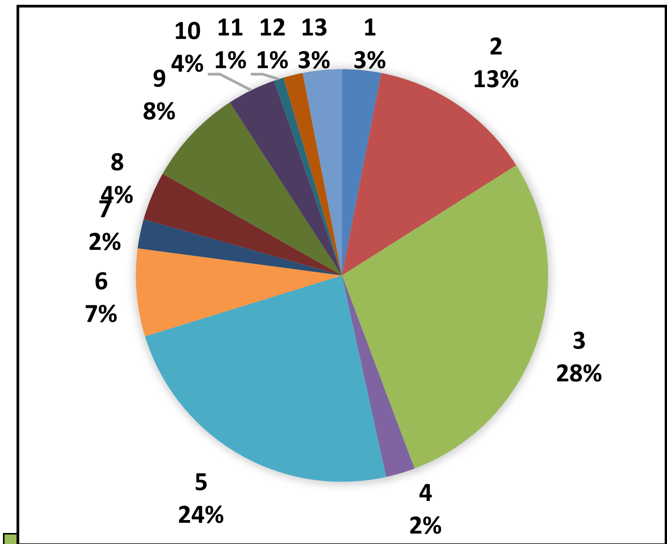
General description

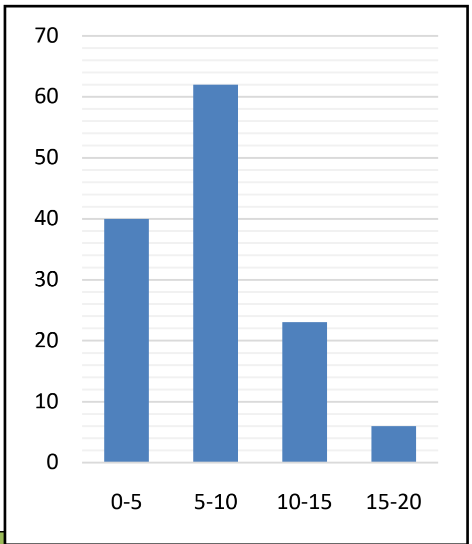
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	13
X	517985.879584	Stratum	0
Y	8552202.209098	Plot height (m)	1686

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	8.9	4.7	0.94	4	127
2	*Brachystegia boehmii*	6.7	4.3	2.24	17	541
3	*Brachystegia spiciformis*	7.8	5.6	7.40	37	1178
4	*Gardenia volkensii*	9.6	6.0	0.72	3	95
5	*Isoberlinea angolensis*	7.0	4.5	4.75	31	987
6	*Jubernardia paniculata*	6.8	5.1	1.36	9	286
7	*Monotes* spp.	10.1	3.1	0.86	3	95
8	*Ocha schweinfurthiana*	4.4	2.3	0.29	5	159
9	*Pterocarpus angolensis*	10.4	7.3	3.09	10	318
10	*Syzygium guineense*	4.7	2.9	0.33	5	159
11	*Uapaca gosswoileri*	6.2	3.5	0.10	1	32
12	*Uapaca kirkiana*	5.4	5.8	0.15	2	64
13	Upondanjamba	4.7	3.3	0.24	4	127

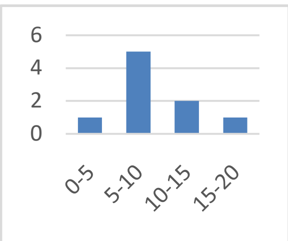
Density	Total diameter distribution

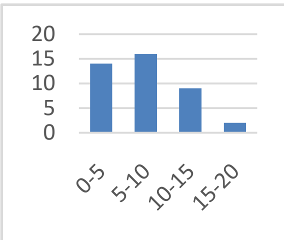


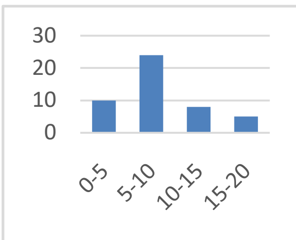


Diameter distribution main species

Pterocarpus angolensis	*Isorbelinea angolensis*	*Brachystegia spiciformis*







Forest Inventory Huambo | Plot | 2

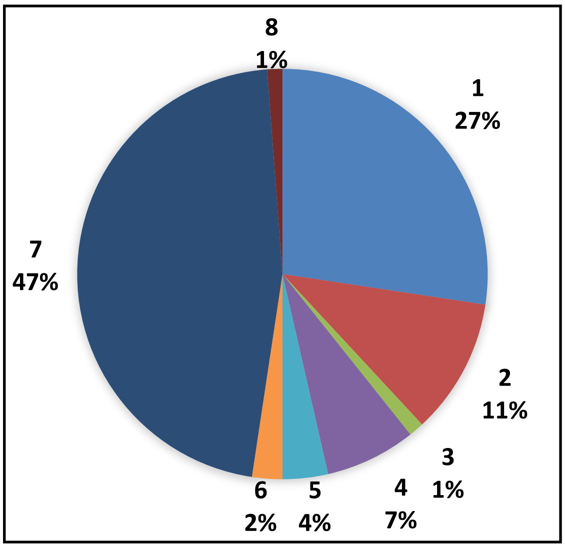
General description

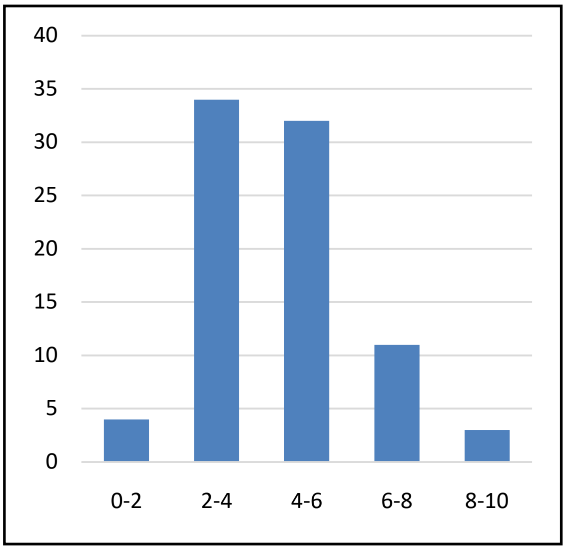
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	8
X	517985.879584	Stratum	1
Y	8552202.209098	Plot height (m)	1850

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	5.3	2.7	1.81	23	732
2	*Brachystegia tamarindoides*	3.5	1.9	0.29	9	286
3	*Brachystegia utilis*	6.5	4.0	0.11	1	32
4	*Diplorhynchus condylocarpon*	4.5	3.5	0.31	6	191
5	*Hymenocardia acida*	6.3	5.0	0.33	3	95
6	*Isoberlinea angolensis*	3.3	1.8	0.06	2	64
7	*Monotes* spp.	3.5	2.2	1.37	39	1241
8	*Terminalia brachystemma*	7.0	3.1	0.12	1	32

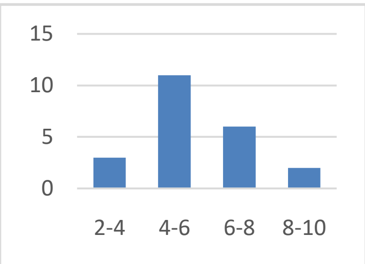
Density	Total diameter distribution

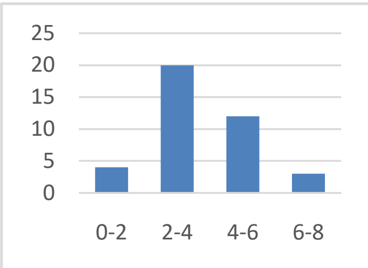


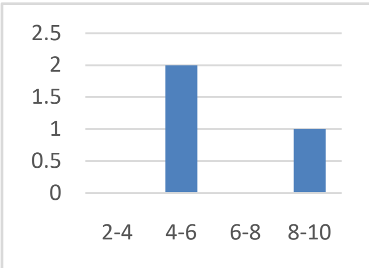


Diameter distribution main species

Albizia antunesiana	*Monotes* spp.	*Hymenocardia acida*







Forest Inventory Huambo | Plot | 3

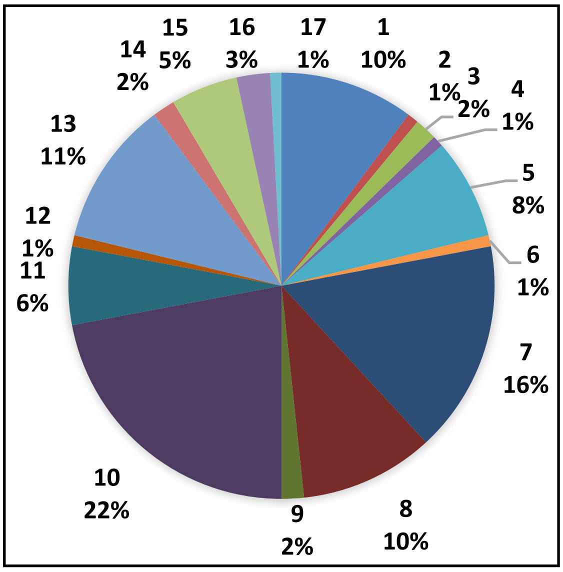
General description

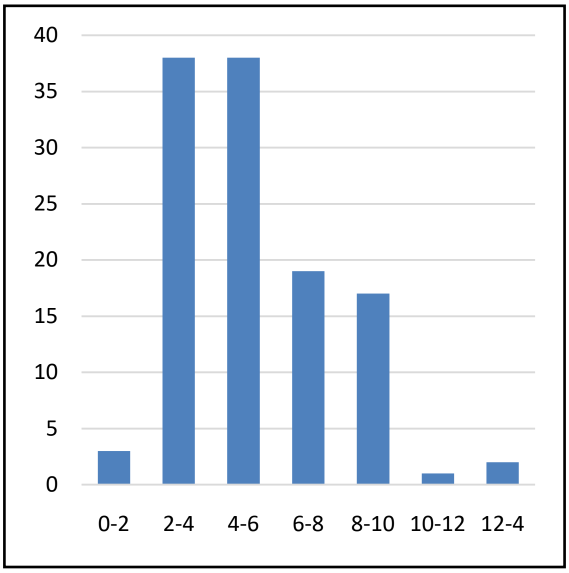
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	17
X	577419.197008	Stratum	1
Y	8729255.917786	Plot height (m)	1379

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	5.2	2.9	0.90	12	382
2	*Brachystegia utilis*	2.9	1.6	0.02	1	32
3	*Combretum collinum*	2.1	1.8	0.02	2	64
4	*Erythrina abyssinica*	4.1	1.6	0.04	1	32
5	*Erythrophleum africanum*	6.6	3.9	1.17	9	286
6	*Gardenia volkensii*	4.4	2.7	0.05	1	32
7	*Hymenocardia acida*	3.9	2.7	0.89	19	605
8	*Isoberlinea angolensis*	5.7	3.6	1.15	12	382
9	*Julbernardia paniculata*	6.2	5.1	0.25	2	64
10	*Monotes* spp.	4.7	3.7	1.69	26	828
11	*Pericopsis angolensis*	4.8	3.0	0.44	7	223
12	*Pseudolachnostylis maprouneifolia*	4.0	3.2	0.04	1	32
13	*Pterocarpus angolensis*	6.7	4.9	1.74	13	414
14	*Rothmannia engleriana*	3.8	4.5	0.08	2	64
15	Syzygium guineense	5.9	4.0	0.59	6	191
16	*Terminalia brachystemma*	9.0	7.5	0.62	3	95
17	*Uapaca kirkiana*	6.4	4.0	0.10	1	32

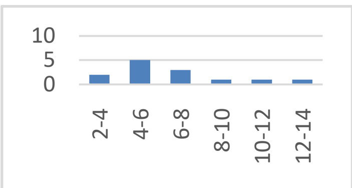
Density	Total diameter distribution

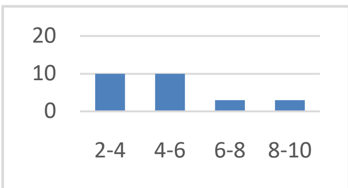


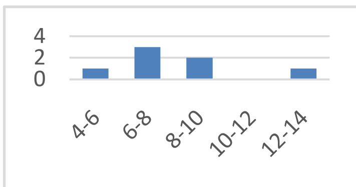


Diameter distribution main species

Pterocarpus angolensis	*Monotes* spp.	*Erythrophleum africanum*







Forest Inventory Huambo — Plot 4

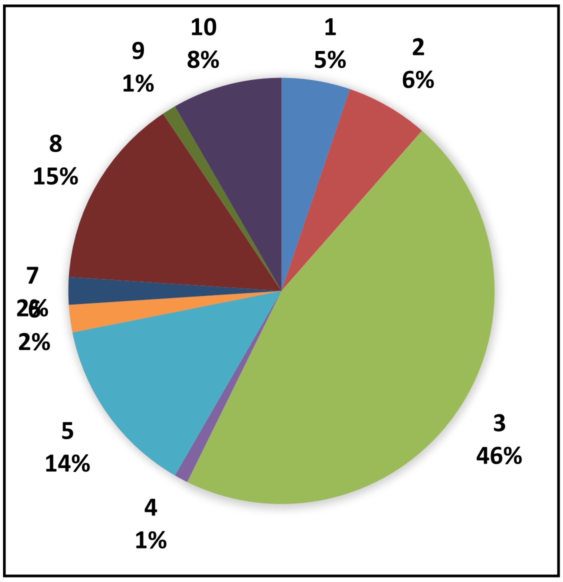
General description

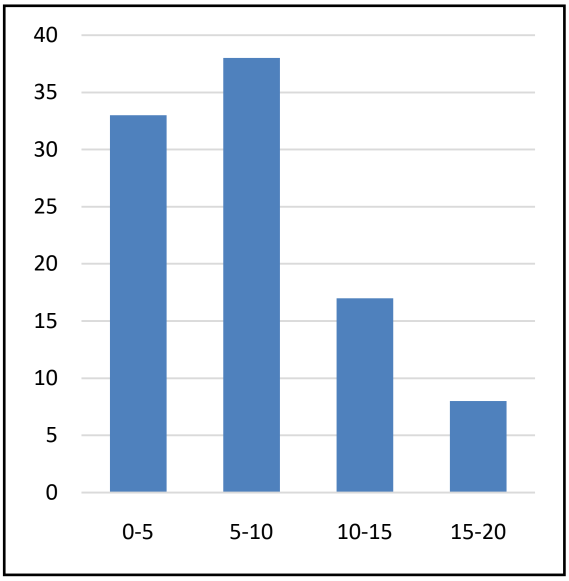
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	556386.819116	Stratum	2
Y	8671564.402476	Plot height (m)	1441

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Cassia abbreviata*	8.4	5.7	1.22	5	159
2	*Hymenocardia acida*	7.1	4.0	0.96	6	191
3	*Monotes* spp.	8.2	3.4	9.35	44	1401
4	*Ochna schweinfurthiana*	8.0	2.5	0.16	1	32
5	*Pericopsis angolensis*	5.6	3.4	1.70	13	414
6	*Randia Kuhniana*	3.5	2.3	0.06	2	64
7	*Swartzia madagascariensis*	6.1	3.1	0.22	2	64
8	*Syzygium guineense*	6.9	4.0	2.25	14	446
9	*Uapaca benguellensi*	18.0	4.0	0.82	1	32
10	*Uapaca gossweileri*	9.0	5.0	1.89	8	255

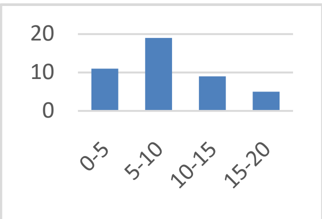
Density	Total diameter distribution

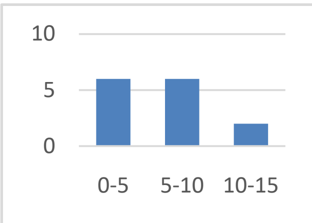


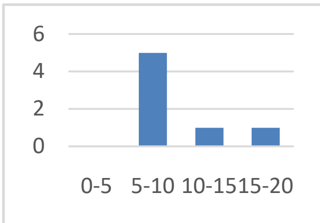


Diameter distribution main species

Monotes spp.	*Syzygium guineense*	*Uapaca gossweileri*







Forest Inventory Huambo | Plot | 5

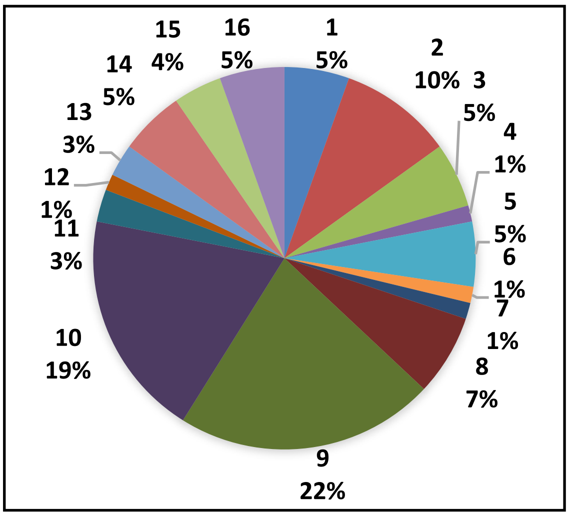
General description

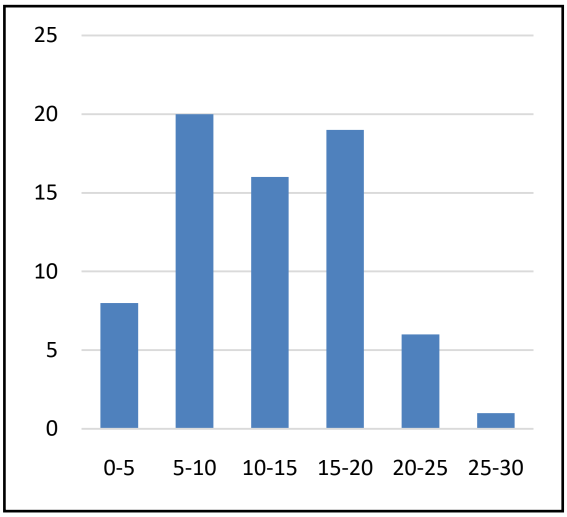
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	16
X	575494.924304	Stratum	2
Y	8691964.139111	Plot height (m)	1425

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	6.1	4.4	0.39	4	127
2	*Brachystegia boehmii*	15.7	8.1	5.00	7	223
3	*Brachystegia spiciformis*	18.6	9.1	3.63	4	127
4	*Brachystegia tamarindoides*	17.0	8.5	0.73	1	32
5	*Combretum collinum*	7.8	4.4	0.69	4	127
6	*Erythrophleum africanum*	17.3	9.0	0.76	1	32
7	*Gardenia volkensii*	3.0	1.8	0.02	1	32
8	*Hymenocardia acida*	4.5	2.3	0.30	5	159
9	*Isoberlinea angolensis*	12.1	7.5	6.69	16	509
10	*Jubernardia paniculata*	17.5	9.5	11.36	14	446
11	*Monotes* spp.	8.5	3.2	0.37	2	64
12	*Ocha schweinfurthiana*	7.0	3.0	0.12	1	32
13	*Parinari curatellifolia*	16.2	9.5	1.33	2	64
14	*Pterocarpus angolensis*	11.1	7.5	1.41	4	127
15	*Strychnos cocculoides*	8.2	4.2	0.52	3	95
16	*Syzygium guineense*	10.0	4.9	1.04	4	127

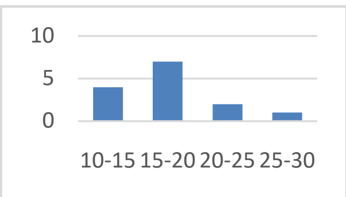
Density	Total diameter distribution

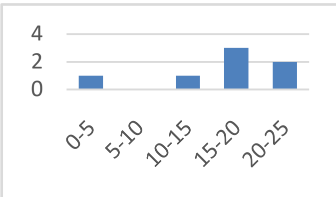


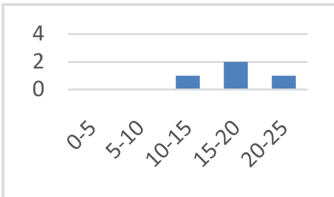


Diameter distribution main species

Juberandia paniculata	*Brachystegia boehmii*	*Brachystegia spiciformis*







Forest Inventory Huambo | Plot | 6

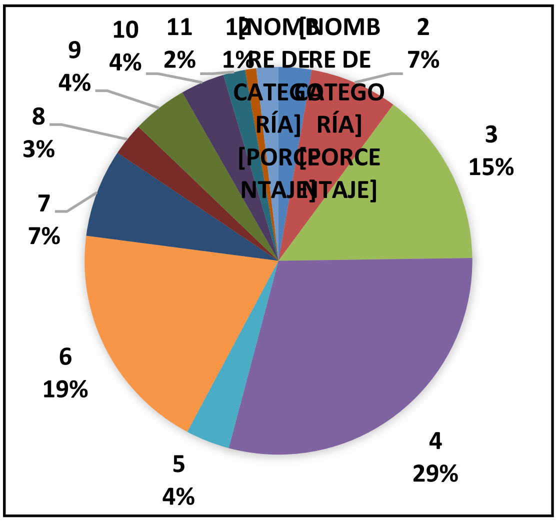
General description

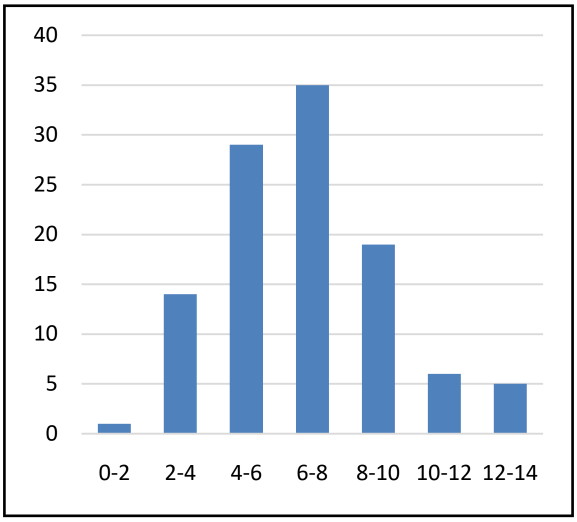
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	13
X	519406.320506	Stratum	0
Y	8631739.206034	Plot height (m)	1851

Stand composition

	*Species	D	H	G	Nplot	Nha
1	Albizia antunesiana	7.3	3.8	0.42	3	95
2	*Anisophyllea boehmii*	5.9	5.1	0.75	8	255
3	*Brachystegia boehmii*	5.8	3.4	1.60	16	509
4	*Brachystegia spiciformis*	6.7	4.2	4.10	32	1019
5	*Hymenocardia acida*	7.8	5.4	0.73	4	127
6	*Isoberlinea angolensis*	6.5	4.2	2.69	21	668
7	*Jubernardia paniculata*	6.4	3.8	0.99	8	255
8	*Monotes* spp.	9.0	7.5	0.62	3	95
9	*Ocha schweinfurthiana*	5.8	4.1	0.49	5	159
10	Syzygium guineense	7.2	5.7	0.54	4	127
11	*Terminalia brachystemma*	5.8	2.6	0.17	2	64
12	*Uapaca gosswoileri*	6.2	3.0	0.10	1	32
13	*Uapaca kirkiana*	6.0	3.0	0.19	2	64

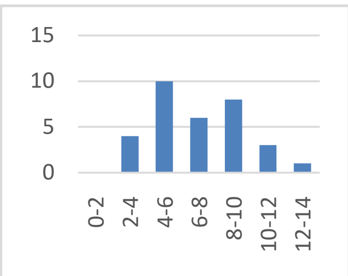
Density	Total diameter distribution

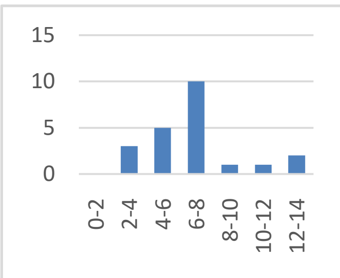


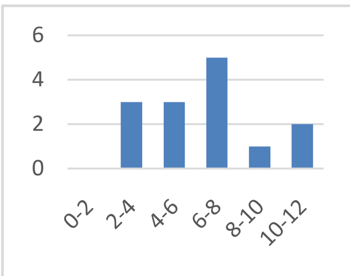


Diameter distribution main species

Brachystegia spiciformis	*Isoberlinea angolensis*	*Brachystegia boehmii*







Forest Inventory Huambo | Plot 7

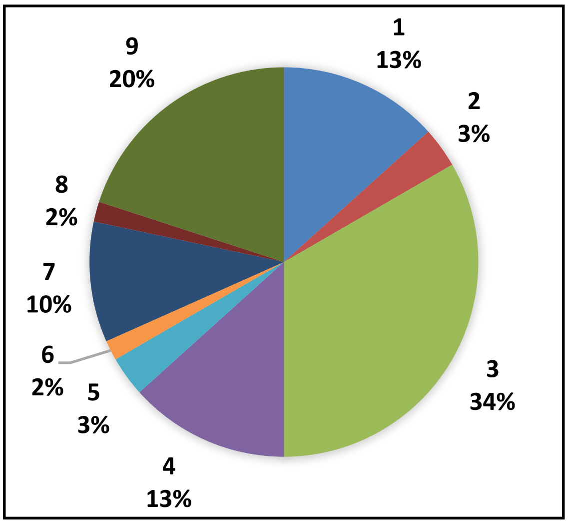
General description

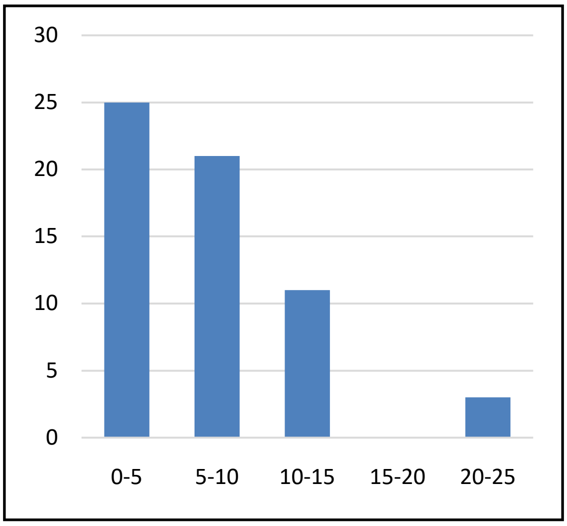
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	9
X	637600.832667	Stratum	1
Y	8647390.746393	Plot height (m)	1755

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	13.6	5.8	4.51	8	255
2	*Brachystegia boehmii*	17.9	7.8	1.69	2	64
3	*Hymenocardia acida*	5.7	3.3	2.17	20	637
4	*Isoberlinea angolensis*	4.8	2.3	0.56	8	255
5	*Monotes* spp.	8.6	4.4	0.45	2	64
6	*Ocha schweinfurthiana*	8.2	4.5	0.17	1	32
7	*Parinari curatellifolia*	4.2	2.3	0.30	6	191
8	Syzygium guineense	10.7	4.7	0.29	1	32
9	*Terminalia brachystemma*	5.9	3.8	1.32	12	382

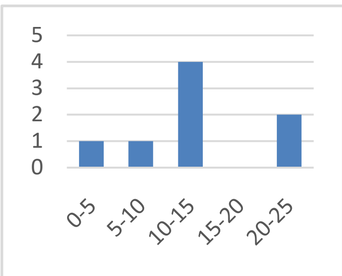
Density	Total diameter distribution

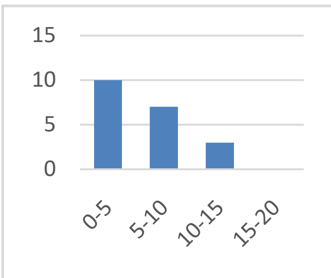


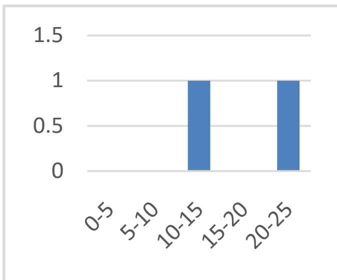


Diameter distribution main species

Albizia antunesiana	*Hymenocardia acida*	*Brachystegia boehmii*







Forest Inventory Huambo | Plot | 8

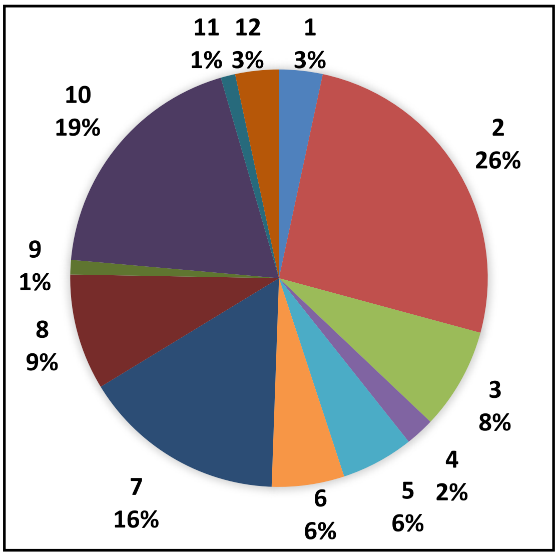
General description

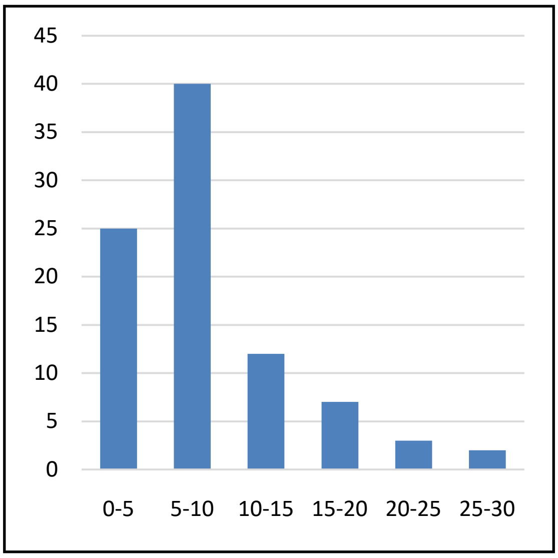
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	12
X	617805.994658	Stratum	1
Y	8664136.356259	Plot height (m)	1676

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	9.7	6.2	0.94	3	95
2	*Anisophyllea boehmii*	7.4	4.5	5.66	23	732
3	*Brachystegia tamarindoides*	9.7	6.1	1.89	7	223
4	*Brachystegia utilis*	6.0	5.0	0.23	2	64
5	*Isoberlinea angolensis*	8.9	4.4	1.58	5	159
6	*Jubernardia paniculata*	14.6	7.7	3.48	5	159
7	*Monotes* spp.	7.5	5.6	2.45	14	446
8	*Ocha schweinfurthiana*	6.4	4.1	1.07	8	255
9	*Rothmannia engleriana*	5.4	3.5	0.07	1	32
10	*Syzygium guineense*	8.2	4.3	3.34	17	541
11	*Terminalia brachystemma*	3.5	1.6	0.03	1	32
12	*Uapaca gosswoileri*	19.8	8.5	3.20	3	95

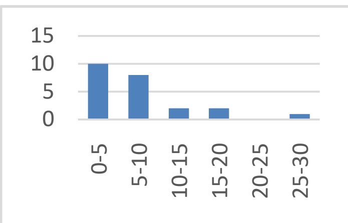
Density | **Total diameter distribution**

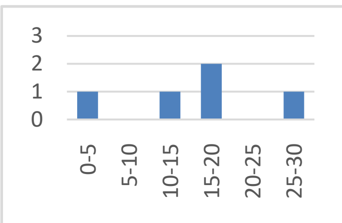


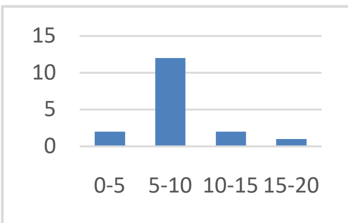


Diameter distribution main species

Anisophyllea boehmii	*Juberandia paniculata*	*Syzygium guineense*







Forest Inventory Huambo | Plot | 9

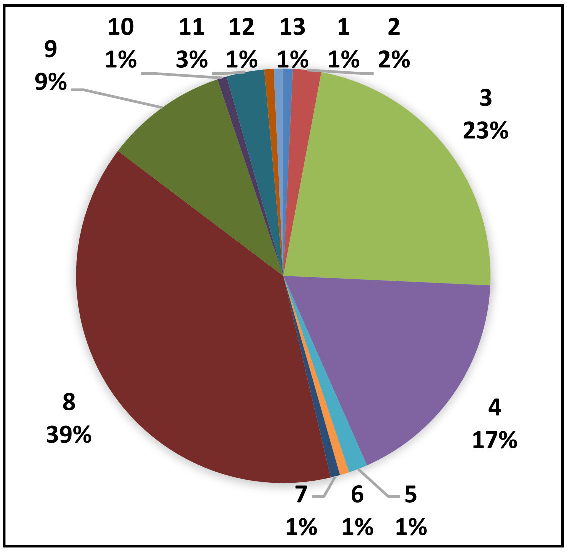
General description

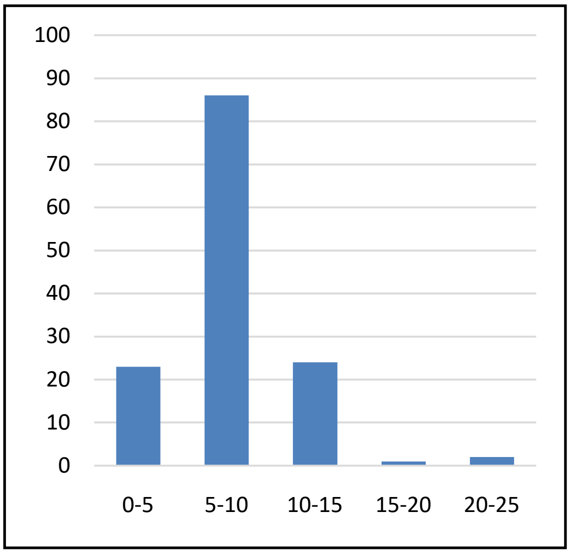
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	13
X	551952.408289	Stratum	2
Y	8627314.515359	Plot height (m)	1692

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	5.7	5.9	0.08	1	32
2	*Bobgunnia madagascariensis*	5.6	3.8	0.26	3	95
3	*Brachystegia spiciformis*	9.2	7.0	7.92	31	987
4	*Brachystegia tamarindoides*	7.6	5.8	4.49	24	764
5	*Euclea natalensis*	8.5	5.3	0.38	2	64
6	*Gardenia volkensii*	4.6	2.2	0.05	1	32
7	*Hymenocardia acida*	2.6	1.6	0.02	1	32
8	*Jubernardia paniculata*	7.3	6.7	7.64	53	1687
9	*Monotes* spp.	7.2	5.4	1.82	13	414
10	*Ocha schweinfurthiana*	6.7	6.0	0.11	1	32
11	*Pericopsis angolensis*	6.5	6.3	0.44	4	127
12	Syzygium guineense	4.6	6.5	0.05	1	32
13	*Uapaca kirkiana* Mull	8.3	3.5	0.18	1	32

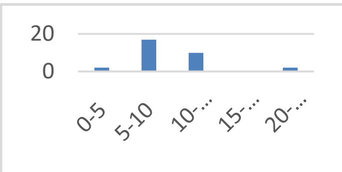
Density | **Total diameter distribution**

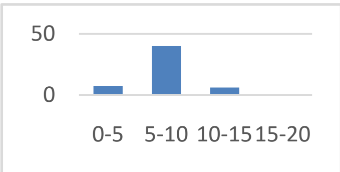


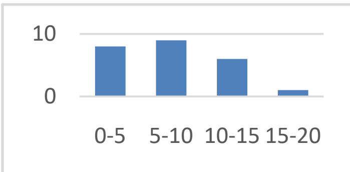


Diameter distribution main species

Brachystegia spiciformis	*Juberandia paniculata*	*Brachystegia tamarindoides*







Forest Inventory Huambo | Plot | 10

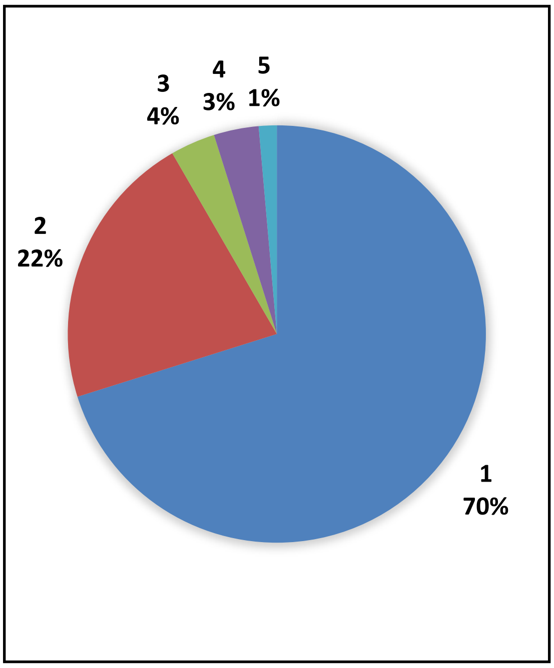
General description

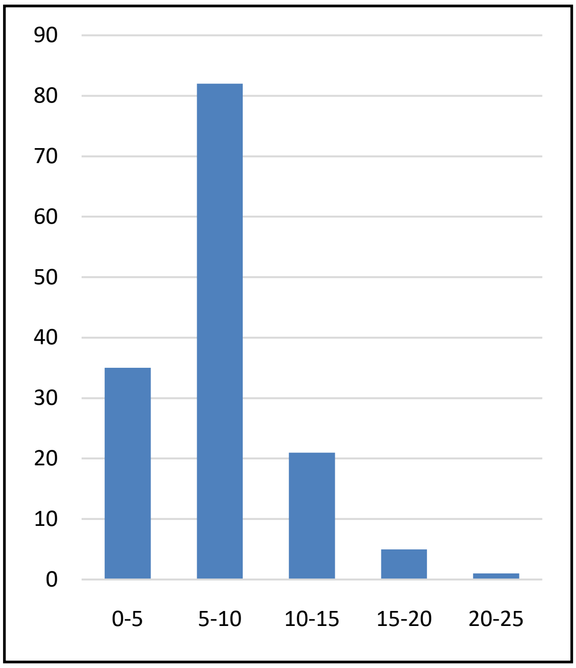
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	5
X	555046.380998	Stratum	3
Y	8520620.453691	Plot height (m)	1565

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	7.9	5.7	18.89	101	3215
2	*Brachystegia boehmii*	7.7	5.1	5.19	31	987
3	*Ehretia amoena*	2.9	3.0	0.12	5	159
4	*Euclea natalensis*	3.5	4.6	0.03	5	159
5	*Isoberlinea angolensis*	2.9	1.6	0.05	2	64

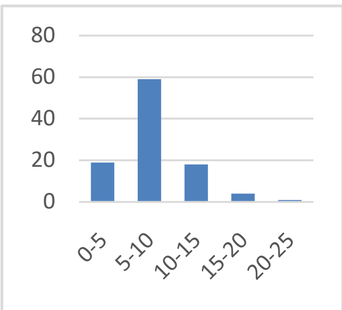
Density | **Total diameter distribution**

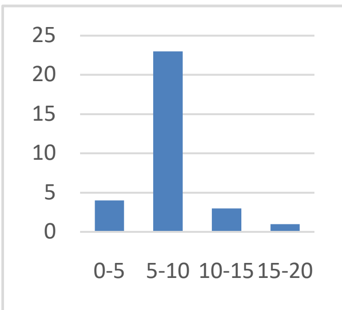


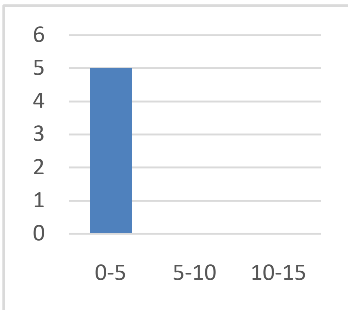


Diameter distribution main species

Albizia antunesiana	*Brachystegia boehmii*	*Ehretia amoena*







Forest Inventory Huambo | Plot | 12

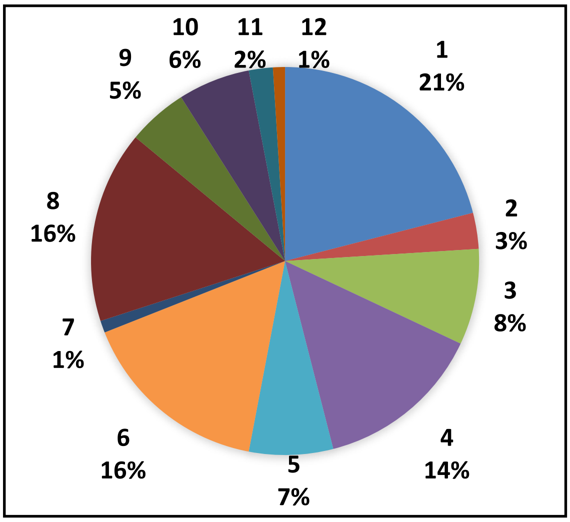
General description

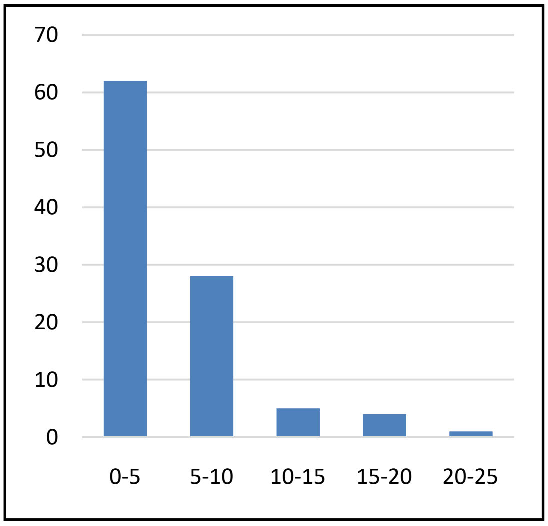
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	12
X	484926.081767	Stratum	2
Y	8579167.184426	Plot height (m)	1326

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Brachystegia boehmii*	4.5	3.0	1.26	21	668
2	*Brachystegia spiciformis*	14.1	4.8	2.00	3	95
3	*Brachystegia tamarindoides*	4.1	2.6	0.39	8	255
4	*Combretum collinum*	5.3	4.4	1.26	14	446
5	*Isoberlinea angolensis*	3.5	3.1	0.24	7	223
6	*Julbernardia paniculata*	5.8	4.1	1.95	16	509
7	*Ochna schweinfurthiana*	5.0	6.0	0.06	1	32
8	*Pericopsis angolensis*	7.8	5.0	3.36	16	509
9	*Pseudolachnostylis maprouneifolia*	3.5	3.6	0.19	5	159
10	*Pterocarpus angolensis*	5.0	5.0	0.46	6	191
11	*Rothmannia engleriana*	2.6	2.0	0.04	2	64
12	Upondandjamba	3.5	3.0	0.03	1	32

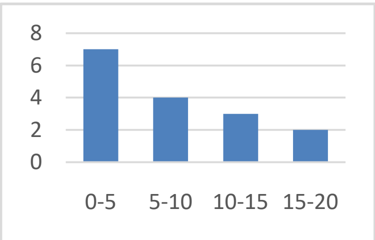
Density | **Total diameter distribution**

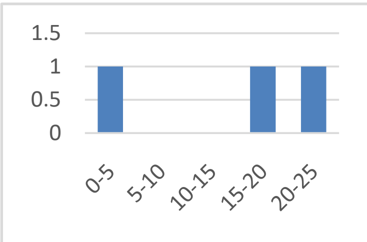


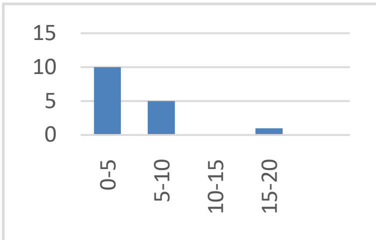


Diameter distribution main species

Pericopsis angolensis	*Brachystegia spiciformis*	*Julbernardia paniculata*







Forest Inventory Huambo | Plot | 13

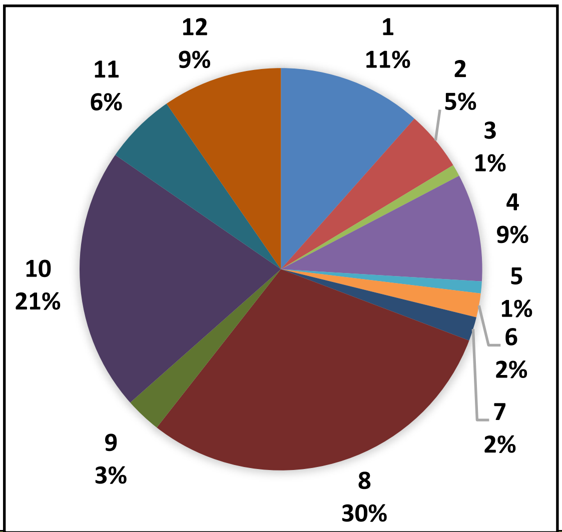
General description

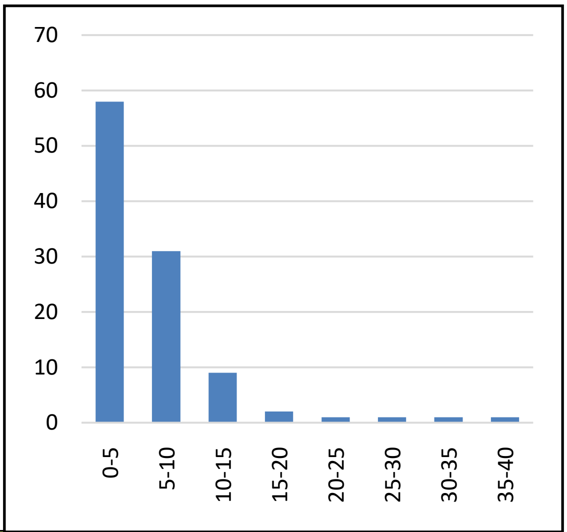
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	12
X	618206.527583	Stratum	1
Y	8659924.853461	Plot height (m)	1713

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	7.9	3.7	3.58	12	382
2	*Anisophyllea boehmii*	6.4	3.2	0.65	5	159
3	*Brachystegia utilis*	37.5	11.0	3.56	1	32
4	*Hymenocardia acida*	3.9	3.4	0.36	9	286
5	*Jubernardia paniculata*	12.5	6.0	0.40	1	32
6	*Monotes* spp.	7.8	3.8	0.31	2	64
7	*Ocha schweinfurthiana*	3.8	2.9	0.07	2	64
8	*Pseudolachnostylis maprouneifolia*	3.4	3.0	1.04	31	987
9	*Pterocarpus angolensis*	14.5	6.2	3.05	3	95
10	Syzygium guineense	7.8	4.5	3.79	22	700
11	*Terminalia brachystemma*	2.3	4.5	0.08	6	191
12	*Uapaca gosswoileri*	7.4	3.5	2.06	10	318

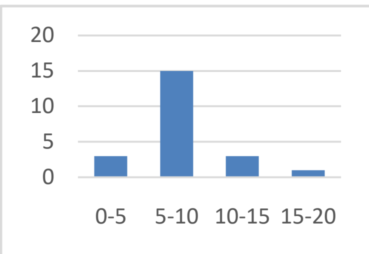
Density	Total diameter distribution

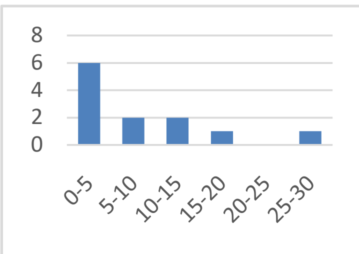


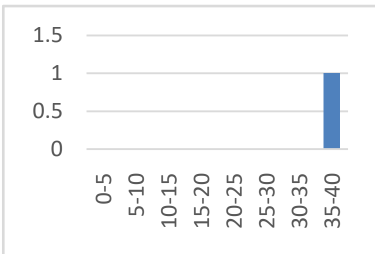


Diameter distribution main species

Syzygium guineense	*Albizia antunesiana*	*Brachystegia utilis*







Forest Inventory Huambo | Plot | 14

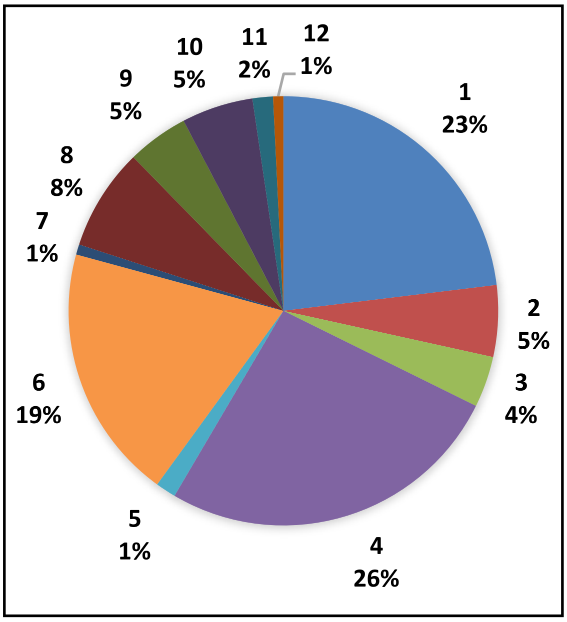
General description

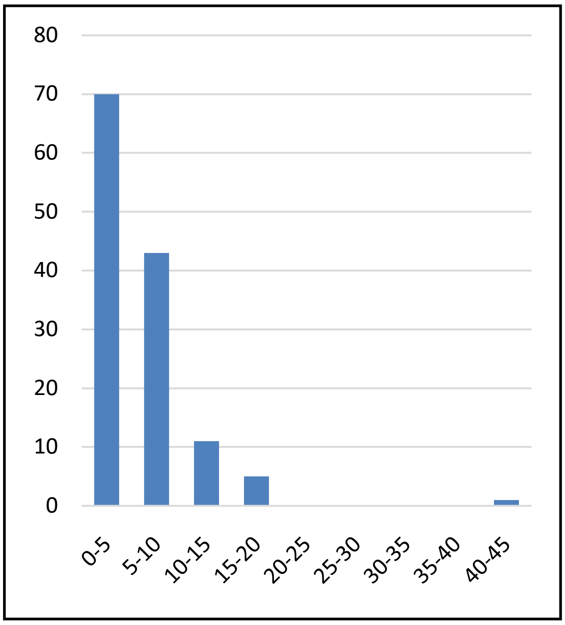
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	12
X	659270.30718	Stratum	0
Y	8544464.750976	Plot height (m)	1655

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	4.7	3.8	2.72	30	955
2	*Bobgunnia madagascariensis*	5.0	3.2	0.56	7	223
3	*Brachystegia boehmii*	16.6	6.4	6.31	5	159
4	*Brachystegia spiciformis*	5.9	5.6	4.15	34	1082
5	*Brachystegia utilis*	3.7	1.9	0.07	2	64
6	*Erythrophleum africanum*	4.3	4.2	1.38	25	796
7	*Hymenocardia acida*	2.5	4.5	0.02	1	32
8	*Isoberlinea angolensis*	7.5	6.9	1.68	10	318
9	*Jubernardia paniculata*	11.0	7.2	2.20	6	191
10	*Ocha schweinfurthiana*	4.7	4.3	0.42	7	223
11	*Parinari curatellifolia*	6.3	5.0	0.21	2	64
12	*Uapaca kirkiana*	9.0	8.0	0.21	1	32

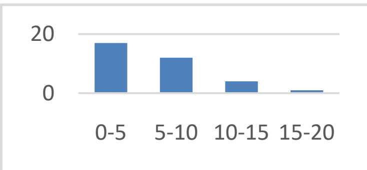
Density | **Total diameter distribution**

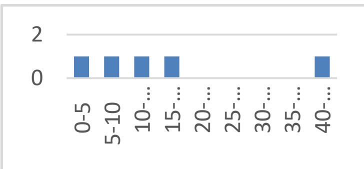


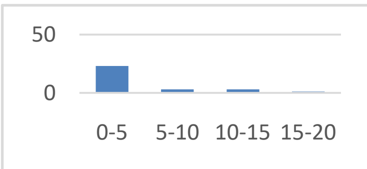


Diameter distribution main species

Brachystegia spiciformis	*Brachystegia boehmii*	*Anisophyllea boehmii*







Forest Inventory Huambo | Plot | 15

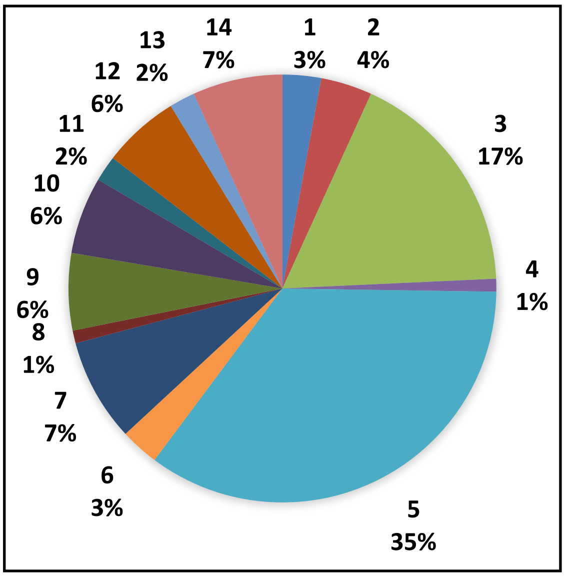
General description

Sistema de referencia	WGS84 UTM 36N	N. Total species plot	14
X	659451.600883	Stratum	0
Y	8544115.233558	Plot height (m)	1655

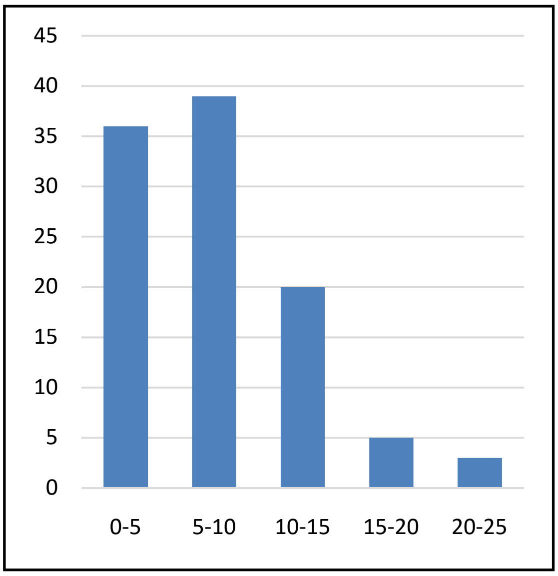
Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	5.3	4.2	0.22	3	95
2	*Brachystegia boehmii*	9.8	4.9	1.43	4	127
3	*Brachystegia spiciformis*	11.9	9.1	7.52	18	573
4	*Brachystegia utilis*	11.4	5.0	0.33	1	32
5	*Erythrophleum africanum*	5.5	3.9	3.77	36	1146
6	*Gardenia volkensii*	3.3	3.5	0.09	3	95
7	*Isoberlinea angolensis*	9.9	6.3	2.35	8	255
8	*Monotes* spp.	4.2	2.3	0.05	1	32
9	*Ocha schweinfurthiana*	4.6	4.1	0.37	6	191
10	*Parinari curatellifolia*	6.9	4.4	0.86	6	191
11	*Rothmannia engleriana*	3.5	3.5	0.06	2	64
12	*Terminalia brachystemma*	4.2	3.1	0.31	6	191
13	*Uapaca gosswoileri*	9.0	6.5	0.42	2	64
14	*Uapaca kirkiana*	9.7	6.9	1.73	7	223

Density

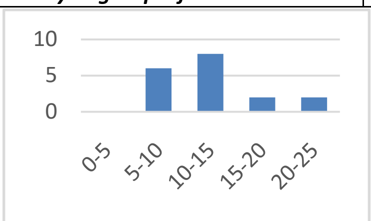


Total diameter distribution

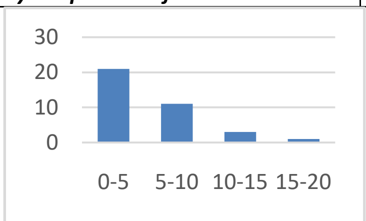


Diameter distribution main species

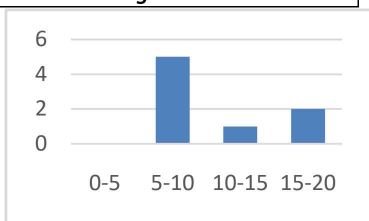
Brachystegia spiciformis



Erythrophleum africanum



Isoberlinea angolensis



Forest Inventory Huambo | Plot | 16

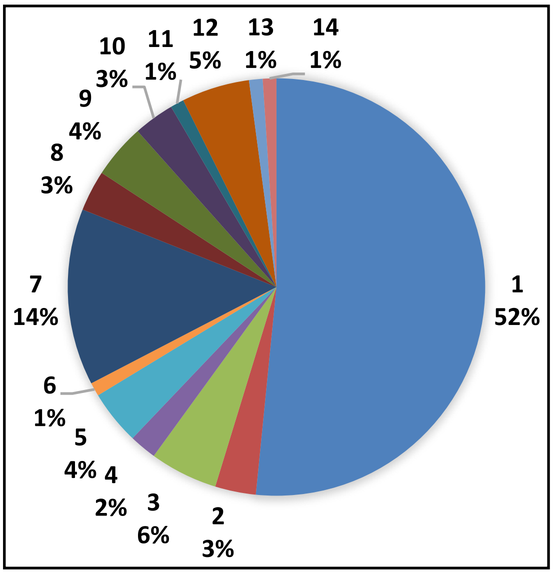
General description

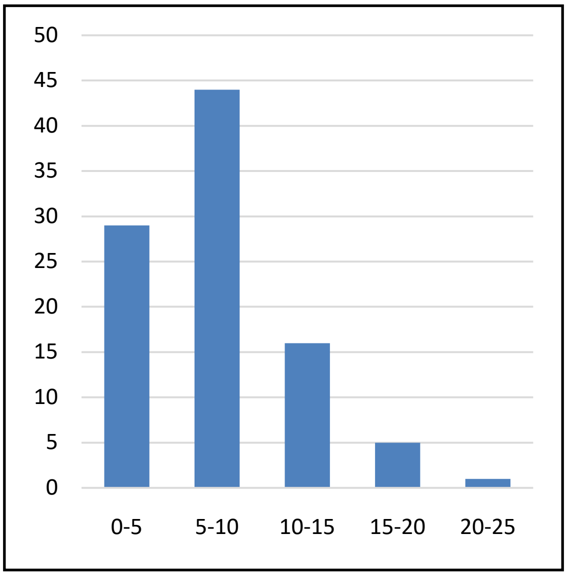
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	14
X	553961.353566	Stratum	1
Y	8515540.858868	Plot height (m)	1636

Stand composition

	*Species	D	H	G	Nplot	Nha
1	Albizia antunesiana	8.8	5.3	11.22	49	1560
2	*Anisophyllea boehmii*	5.4	4.1	0.39	3	95
3	*Anisophyllea boehmii*	12.8	6.7	2.49	5	159
4	*Brachystegia boehmii*	4.6	3.8	0.14	2	64
5	*Brachystegia utilis*	2.7	2.5	0.08	4	127
6	*Ehretia amoena*	5.0	4.2	0.06	1	32
7	*Isoberlinea angolensis*	6.1	4.3	1.53	13	414
8	*Ocha schweinfurthiana*	2.9	2.4	0.07	3	95
9	*Parinari curatellifolia*	5.0	4.4	0.32	4	127
10	*Rothmannia engleriana*	3.1	2.6	0.10	3	95
11	*Sterculia quinqueloba*	2.2	2.7	0.01	1	32
12	Syzygium guineense	5.2	3.0	0.39	5	159
13	*Uapaca kirkiana*	2.5	2.9	0.02	1	32
14	*SP5*	5.2	4.0	0.07	1	32

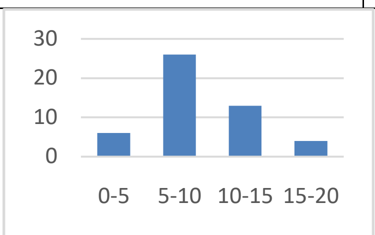
Density	Total diameter distribution

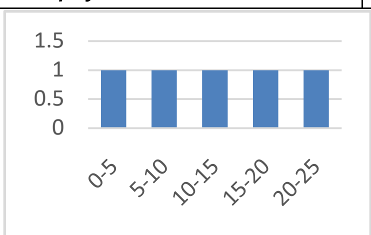


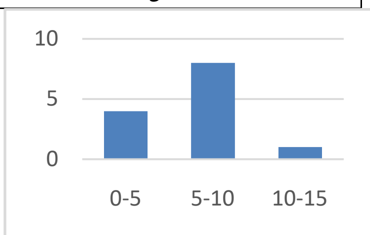


Diameter distribution main species

Albizia antunesiana	*Anisophyllea boehmii*	*Isoberlinea angolensis*







Forest Inventory Huambo | Plot | 17

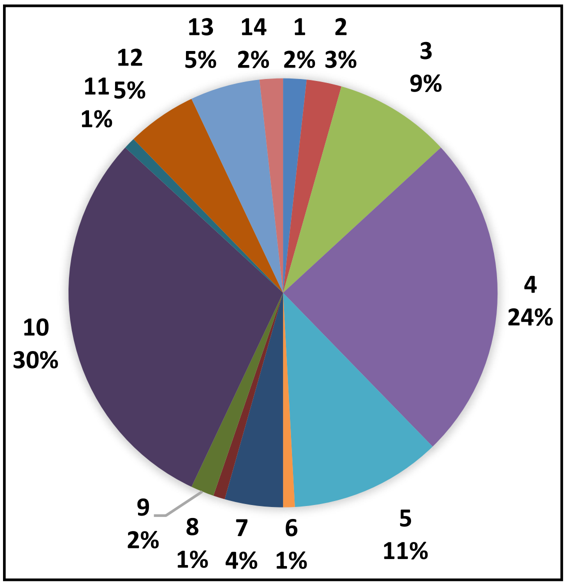
General description

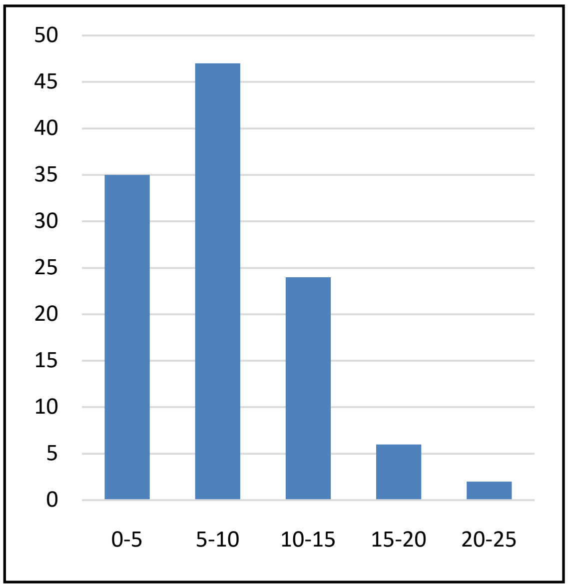
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	14
X	498606.386845	Stratum	2
Y	8580707.348931	Plot height (m)	1420

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	5.9	6.7	0.19	2	64
2	*Anisophyllea boehmii*	8.9	7.5	0.64	3	95
3	*Bobgunnia madagascariensis*	7.1	5.5	1.81	10	318
4	*Brachystegia boehmii*	6.5	5.9	3.80	28	891
5	*Brachystegia spiciformis*	12.3	8.5	5.44	13	414
6	*Combretum collinum*	11.0	9.5	0.31	1	32
7	*Diplorhynchus condylocarpon*	9.3	6.6	1.93	5	159
8	*Isoberlinea angolensis*	21.5	10.0	1.17	1	32
9	*Jubernardia paniculata*	11.0	7.6	0.63	2	64
10	*Monotes* spp.	7.9	6.4	6.66	34	1082
11	*Parinari curatellifolia*	4.7	1.6	0.06	1	32
12	*Pericopsis angolensis*	4.6	4.3	0.39	6	191
13	*Rothmannia engleriana*	3.8	3.3	0.29	6	191
14	Ondjassonde	8.8	5.4	0.39	2	64

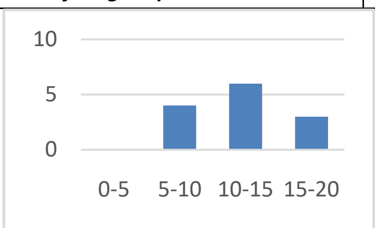
Density | **Total diameter distribution**



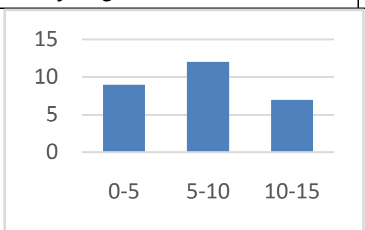


Diameter distribution main species

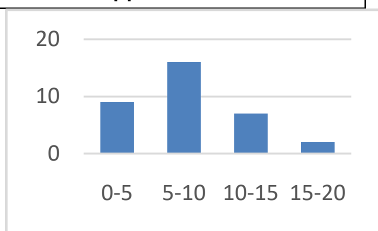
Brachystegia spiciformis



Brachystegia boehmii



Monotes spp.



Forest Inventory Huambo | Plot | 18

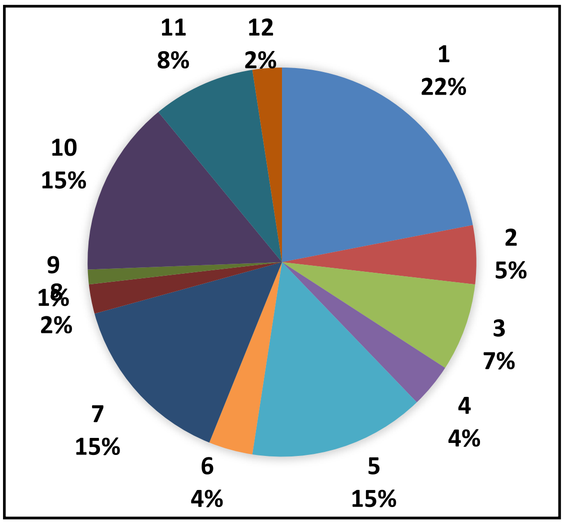
General description

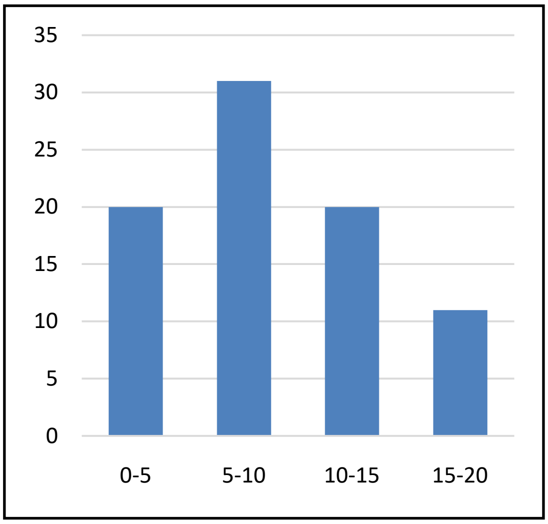
Sistema de referencia	WGS84 UTM 36N	**N. Total species plot**	12
X	570482.710056	**Stratum**	1
Y	8702318.617284	**Plot height (m)**	1551

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	8.6	5.7	4.29	18	573
2	*Bobgunnia madagascariensis*	10.6	6.3	1.53	4	127
3	*Brachystegia spiciformis*	10.5	3.6	1.84	6	191
4	*Dombeya rotundifolia*	3.9	2.5	0.12	3	95
5	*Hymenocardia acida*	6.6	4.7	1.71	12	382
6	*Isoberlinea angolensis*	15.2	8.0	1.77	3	95
7	*Jubernardia paniculata*	14.2	8.2	6.43	12	382
8	*Ochna schweinfurthiana*	4.0	1.9	0.09	2	64
9	*Rothmannia engleriana*	4.4	1.7	0.05	1	32
10	*Syzygium guineense*	10.0	5.9	3.31	12	382
11	*Terminalia brachystemma*	4.1	2.9	0.36	7	223
12	Tchikuniambambi	6.1	3.6	0.21	2	64

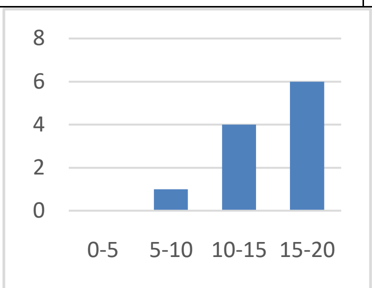
Density | **Total diameter distribution**

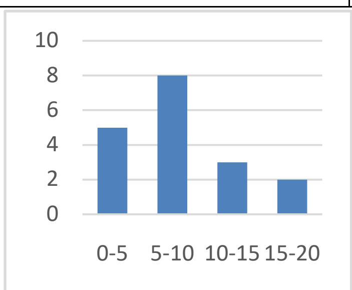


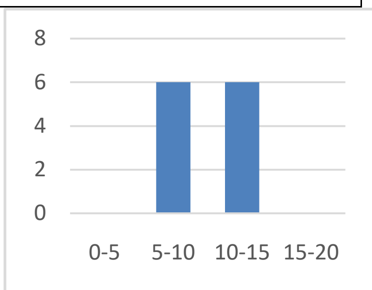


Diameter distribution main species

Jubernardia paniculata	*Anisophyllea boehmii*	*Syzygium guineense*







Forest Inventory Huambo | Plot | 19

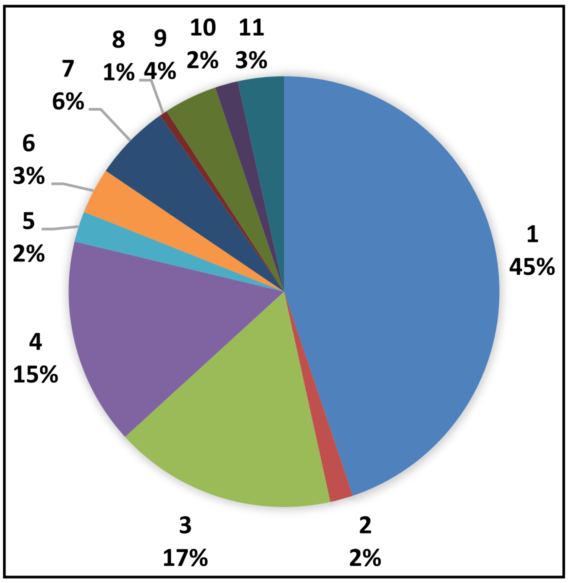
General description

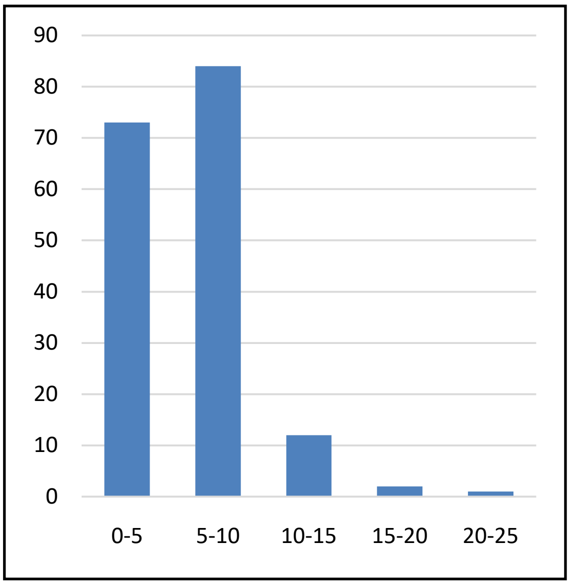
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	11
X	540942.999691	Stratum	0
Y	8515014.02235	Plot height (m)	1632

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	5.7	4.2	7.62	78	2483
2	*Bobgunnia madagascariensis*	11.0	4.7	1.51	3	95
3	*Brachystegia boehmii*	5.1	3.9	2.46	29	923
4	*Brachystegia spiciformis*	6.6	4.4	3.71	27	859
5	*Brachystegia utilis*	5.0	3.5	0.07	4	127
6	*Gardenia volkensii*	3.8	13.5	0.22	6	191
7	*Ocha schweinfurthiana*	5.2	3.7	0.77	10	318
8	*Ochna schweinfurthiana*	8.3	4.0	0.18	1	32
9	Parinari curatellifolia	9.0	4.1	1.97	7	223
10	*Uapaca gosswoileri*	5.5	3.7	0.25	3	95
11	*Uapaca kirkiana*	5.1	3.4	0.46	6	191

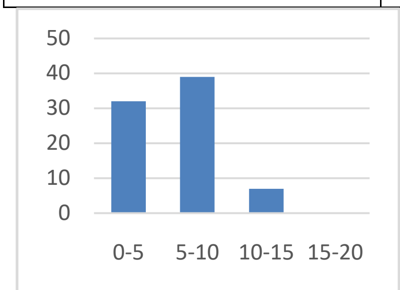
Density	Total diameter distribution

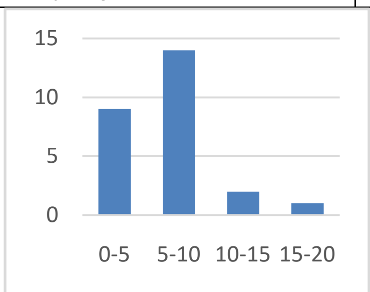


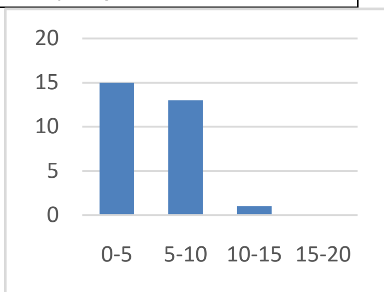


Diameter distribution main species

Albizia antunesiana	*Brachystegia spiciformis*	*Brachystegia boehmii*







Forest Inventory Huambo | Plot | 20

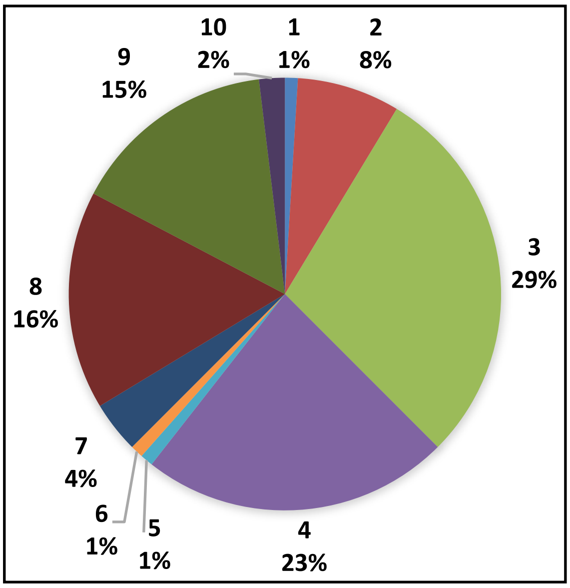
General description

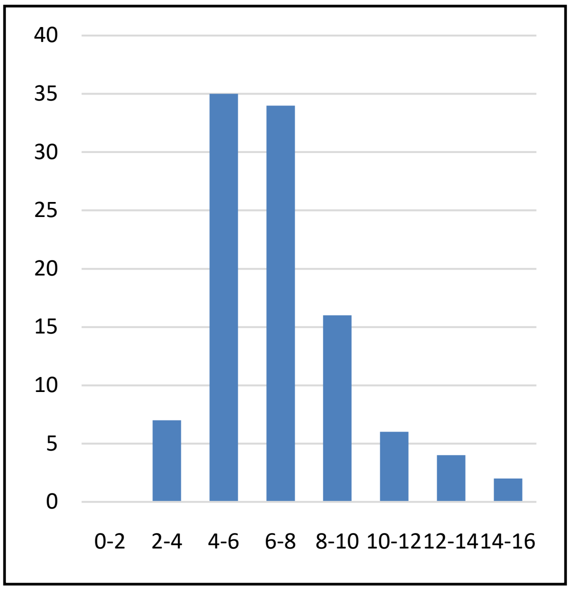
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	581334.49294	Stratum	0
Y	8685843.62925	Plot height (m)	1783

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	7.0	4.0	0.12	1	32
2	*Brachystegia spiciformis*	7.9	3.5	1.54	8	255
3	*Isoberlinea angolensis*	6.1	3.4	3.11	30	955
4	*Jubernardia paniculata*	6.1	3.3	2.51	24	764
5	*Parinari curatellifolia*	4.4	2.5	0.05	1	32
6	*Rothmannia engleriana*	4.2	1.7	0.05	1	32
7	Syzygium guineense	8.1	3.9	0.68	4	127
8	*Terminalia brachystemma*	6.0	3.5	1.82	17	541
9	*Uapaca kirkiana*	8.3	3.9	3.04	16	509
10	Upondandjamba	9.5	2.9	0.52	2	64

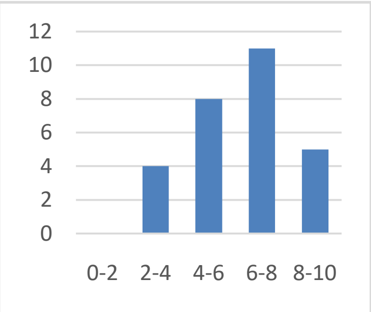
Density | **Total diameter distribution**

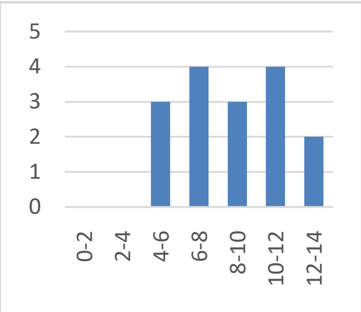


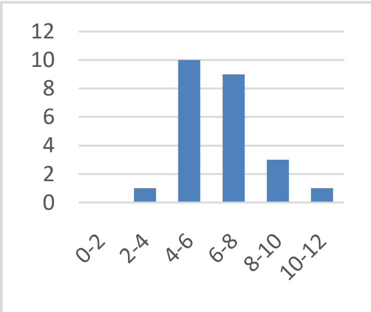


Diameter distribution main species

Isoberlinea angolensis | *Uapaca kirkiana* | *Jubernardia paniculata*







Forest Inventory Huambo | Plot | 21

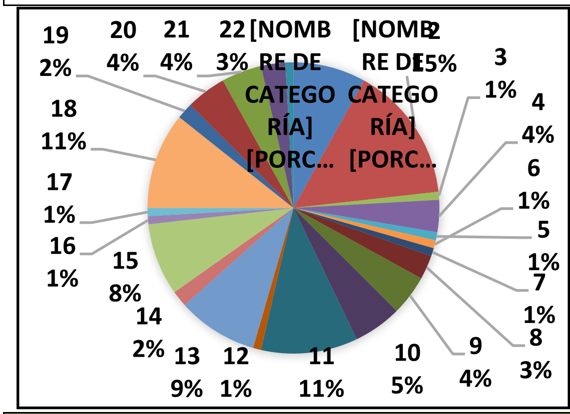
General description

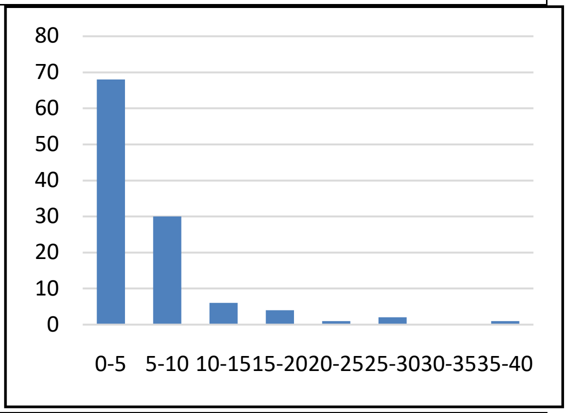
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	578720.764693	Stratum	1
Y	8724741.50623	Plot height (m)	1337

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	3.4	2.3	0.30	9	286
2	*Anisophyllea boehmii*	4.8	2.3	1.55	17	541
3	*Brachystegia tamarindoides*	2.2	1.6	0.01	1	32
4	*Brachystegia utilis*	4.9	4.3	0.32	4	127
5	*Combretum collinum*	1.5	3.0	0.01	1	32
6	*Diplorhynchus condylocarpon*	18.0	10.0	0.82	1	32
7	*Dombeya rotundifolia*	2.7	1.7	0.02	1	32
8	*Erythrophleum africanum*	5.3	3.0	0.25	3	95
9	*Euclea natalensis*	4.8	3.5	0.40	5	159
10	*Hymenocardia acida*	5.8	4.2	0.56	6	191
11	*Isoberlinea angolensis*	6.7	3.8	1.99	12	382
12	*Juberanrdia paniculata*	10.2	7.5	0.26	1	32
13	*Monotes spp.*	6.5	4.0	1.21	10	318
14	*Ochna schweinfurthiana*	2.3	2.2	0.03	2	64
15	*Parinari curatellifolia*	8.9	4.5	4.66	9	286
16	*Pseudolachnostylis maprouneifolia*	7.2	5.6	0.13	1	32
17	*Rothmannia engleriana*	3.1	1.6	0.02	1	32
18	*Syzygium guineense*	3.6	2.7	0.47	12	382
19	*Terminalia brachystemma*	3.1	2.6	0.05	2	64
20	*Terminalia brachystemma*	3.4	3.2	0.15	5	159
21	*Uapaca gosswoileri*	18.6	7.1	4.97	5	159
22	*Uapaca kirkiana*	12.3	3.8	2.13	3	95
23	*Upondanjamba*	2.5	2.0	0.02	1	32

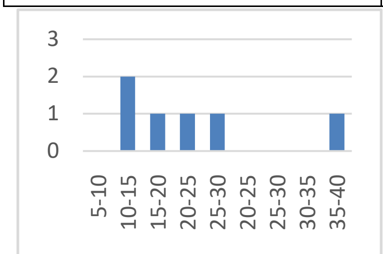
Density	Total diameter distribution

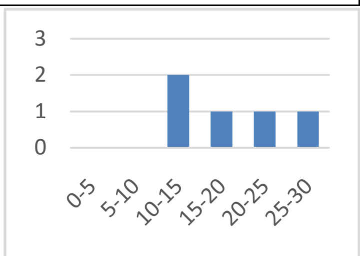


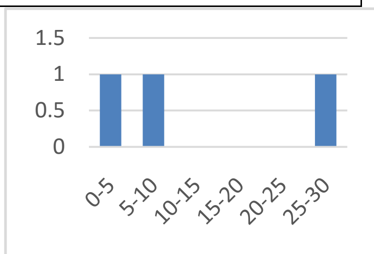


Diameter distribution main species

Parinari curatellifolia	*Uapaca gosswoileri*	*Uapaca kirkiana*







Forest Inventory Huambo | Plot | 22

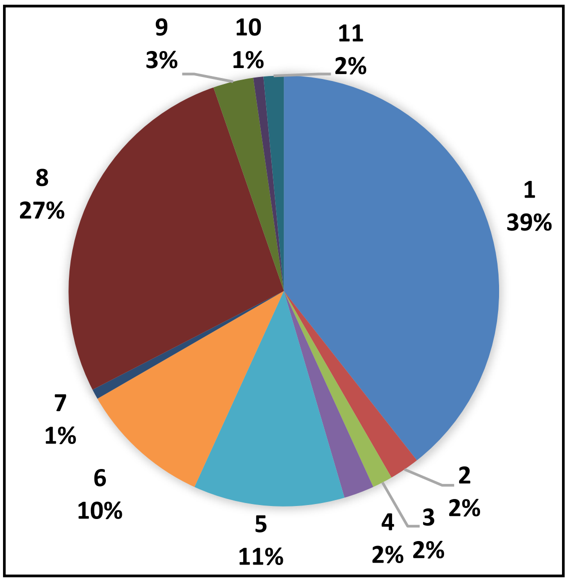
General description

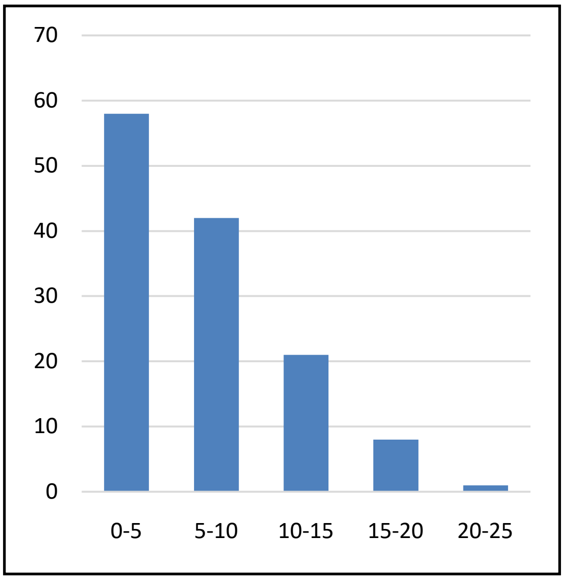
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	11
X	483221.490996	Stratum	2
Y	8579840.386806	Plot height (m)	1357

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	5.4	4.4	4.67	52	1655
2	*Bobgunnia madagascariensis*	7.1	4.9	0.52	3	95
3	*Brachystegia boehmii*	6.5	6.4	0.22	2	64
4	*Brachystegia spiciformis*	4.3	2.8	0.18	3	95
5	*Brachystegia tamarindoides*	6.1	3.8	2.03	15	477
6	*Combretum collinum*	5.7	5.5	1.74	13	414
7	*Gardenia volkensii*	4.5	1.7	0.05	1	32
8	*Jubernardia paniculata*	11.3	7.4	13.84	36	1146
9	*Monotes* spp.	5.8	3.1	0.43	4	127
10	*Ochna schweinfurthiana*	3.8	2.2	0.04	1	32
11	*Upandandjamba*	5.8	5.7	0.17	2	64

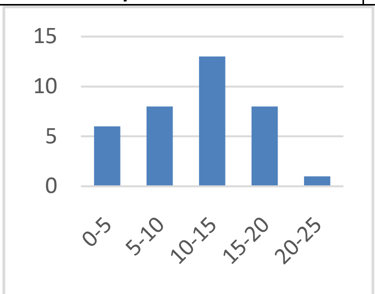
Density	Total diameter distribution

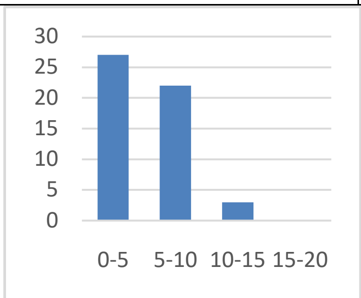


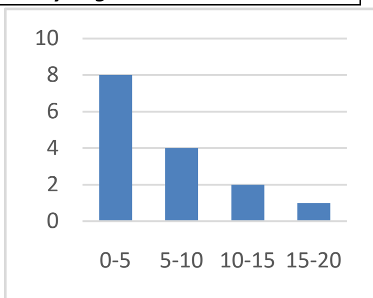


Diameter distribution main species

Jubernardia paniculata	*Albizia antunesiana*	*Brachystegia tamarindoides*







Forest Inventory Huambo | Plot | 23

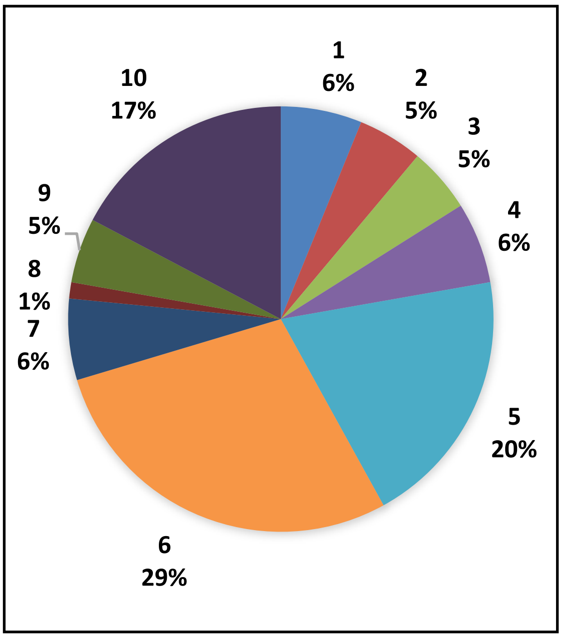
General description

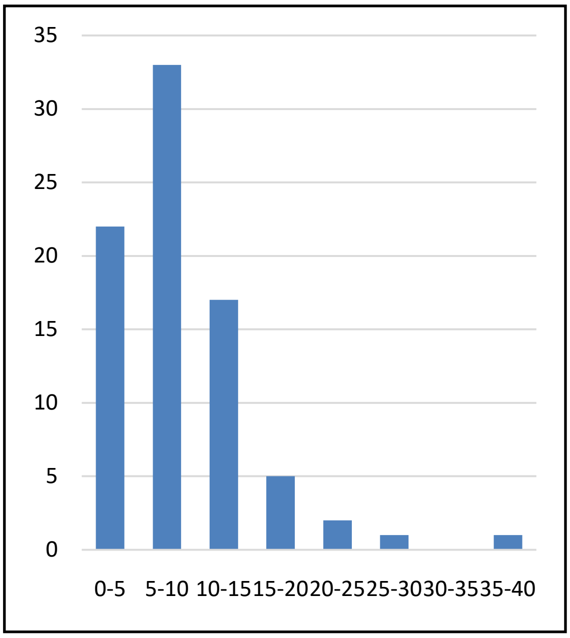
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	659394.781128	Stratum	0
Y	8542502.766478	Plot height (m)	1650

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	8.3	4.7	0.94	5	159
2	*Bobgunnia madagascariensis*	9.0	5.6	1.02	4	127
3	*Brachystegia boehmii*	14.1	5.2	2.54	4	127
4	*Brachystegia spiciformis*	12.1	6.3	2.15	5	159
5	*Erythrophleum africanum*	7.0	4.3	2.25	16	509
6	*Monotes* spp.	6.6	3.9	3.22	23	732
7	*Parinari curatellifolia*	15.1	6.6	4.73	5	159
8	*Terminalia brachystemma*	14.0	8.0	0.50	1	32
9	*Terminalia brachystemma*	8.6	4.6	1.34	4	127
10	*Uapaca gosswoileri*	9.9	5.7	4.27	14	446

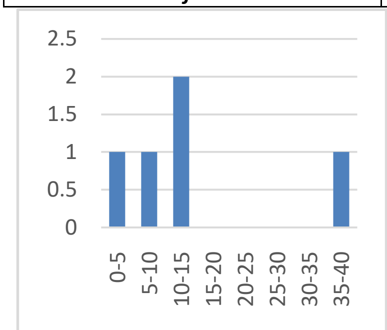
Density	Total diameter distribution

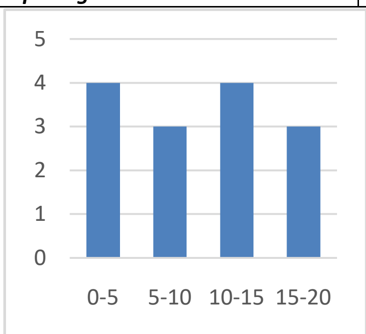


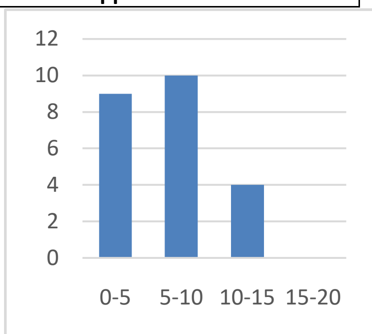


Diameter distribution main species

Parinari curatellifolia	*Uapaca gosswoileri*	*Monotes* spp.







Forest Inventory Huambo | Plot | 24

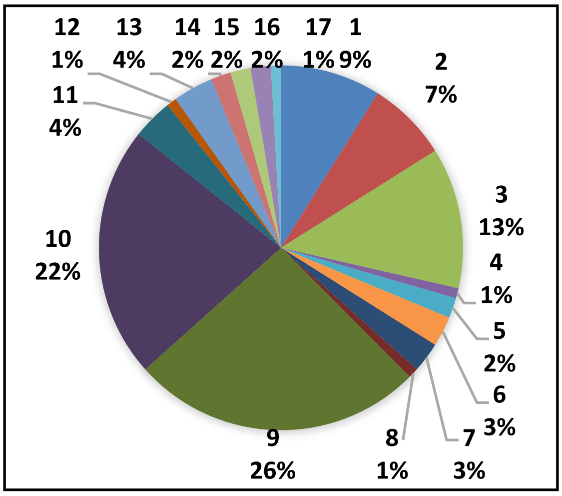
General description

Sistema de referencia	WGS84 UTM 36N	**N. Total species plot**	17
X	562145.46074	**Stratum**	2
Y	8624608.453962	**Plot height (m)**	1519

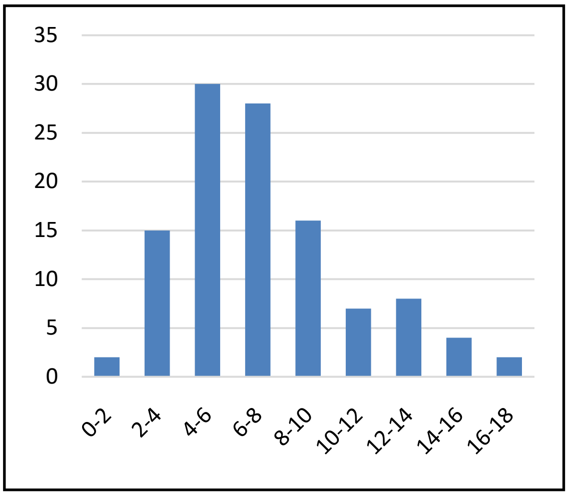
Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	4.9	3.9	0.66	10	318
2	*Bobgunnia madagascariensis*	6.4	3.2	0.90	8	255
3	*Brachystegia spiciformis*	9.3	6.5	3.37	14	446
4	*Brachystegia tamarindoides*	17.0	8.5	0.73	1	32
5	*Combretum collinum*	6.4	4.8	0.21	2	64
6	*Euclea natalensis*	8.3	3.8	0.53	3	95
7	*Hymenocardia acida*	3.8	3.0	0.13	3	95
8	*Isoberlinea angolensis*	5.2	3.5	0.07	1	32
9	*Jubernardia paniculata*	9.1	6.6	7.00	29	923
10	*Monotes* spp.	5.4	3.5	2.09	25	796
11	*Ocha schweinfurthiana*	5.5	4.0	0.31	4	127
12	*Parinari curatellifolia*	4.0	1.6	0.04	1	32
13	*Pericopsis angolensis*	6.2	4.5	0.41	4	127
14	Syzygium guineense	7.4	4.5	0.28	2	64
15	Terminalia brachystemma	4.9	3.1	0.17	2	64
16	*Uapaca benguellensis*	8.6	5.9	0.44	2	64
17	*Upandanjamba*	12.0	6.0	0.37	1	32

Density

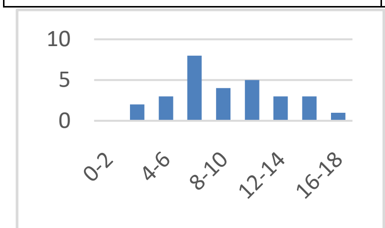


Total diameter distribution

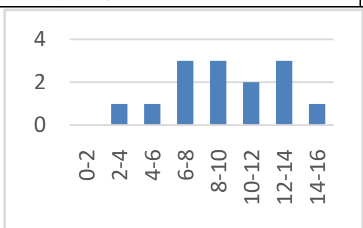


Diameter distribution main species

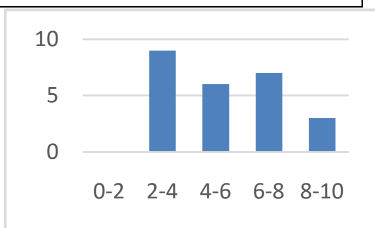
Jubernardia paniculata



Brachystegia spiciformis



Monotes spp.



Forest Inventory Huambo | Plot | 25

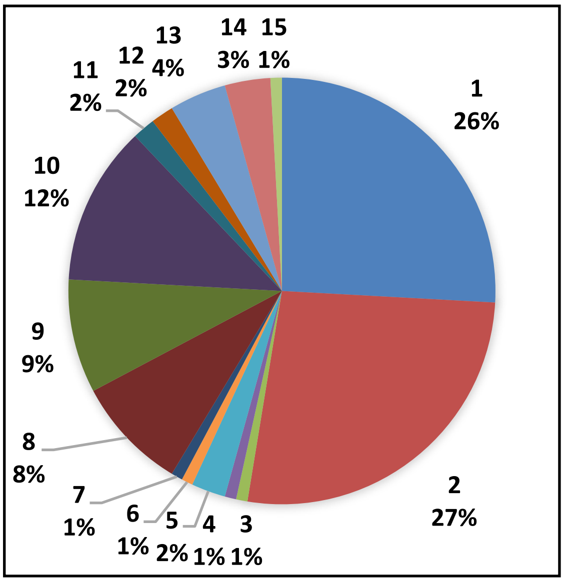
General description

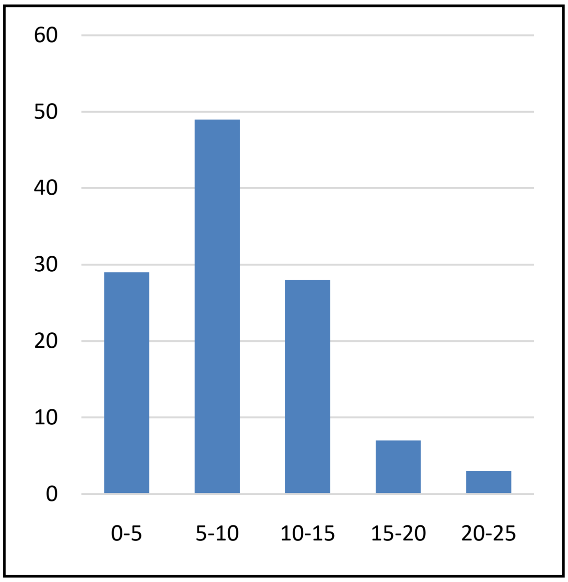
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	15
X	619867.515363	Stratum	0
Y	8657133.805715	Plot height (m)	1708

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	9.2	5.9	8.17	30	955
2	*Anisophyllea boehmii*	7.6	5.4	5.35	31	987
3	*Brachystegia boehmii*	5.7	5.0	0.08	1	32
4	*Brachystegia spiciformis*	7.8	9.5	0.15	1	32
5	*Gardenia volkensii*	3.6	2.5	0.10	3	95
6	*Hymenocardia acida*	2.3	1.8	0.01	1	32
7	*Isoberlinea angolensis*	3.0	1.7	0.02	1	32
8	*Jubernardia paniculata*	13.8	8.5	5.58	10	318
9	*Monotes* spp.	7.7	4.7	1.85	10	318
10	*Ocha schweinfurthiana*	5.4	3.4	1.21	14	446
11	*Rothmannia engleriana*	9.8	4.5	0.71	2	64
12	*Terminalia brachystemma*	6.2	4.3	0.19	2	64
13	*Uapaca gosswoileri*	10.8	6.3	1.53	5	159
14	*Uapaca kirkiana*	4.1	3.1	0.17	4	127
15	*Upondajamba*	11.0	6.0	0.31	1	32

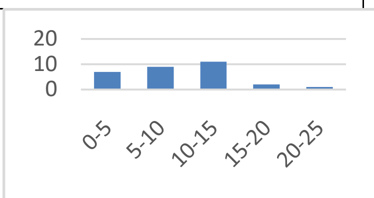
Density	Total diameter distribution

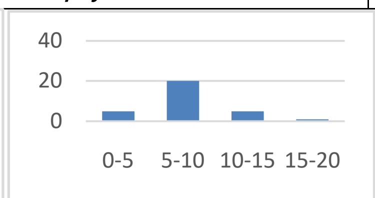


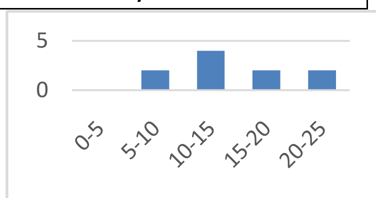


Diameter distribution main species

Albizia antunesiana	*Anisophyllea boehmii*	*Jubernardia paniculata*







Forest Inventory Huambo | Plot | 26

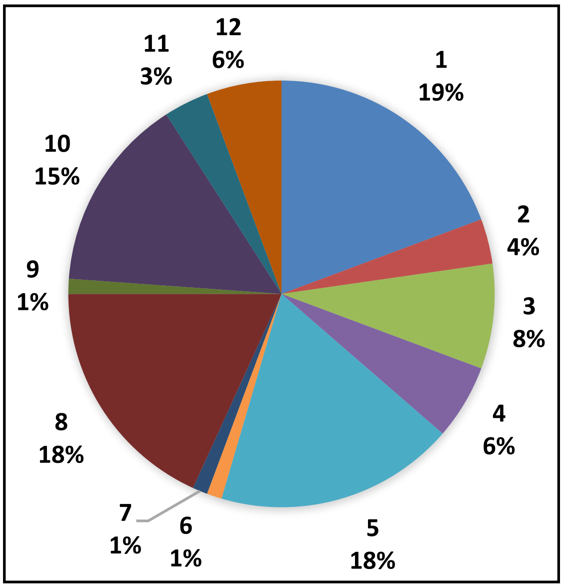
General description

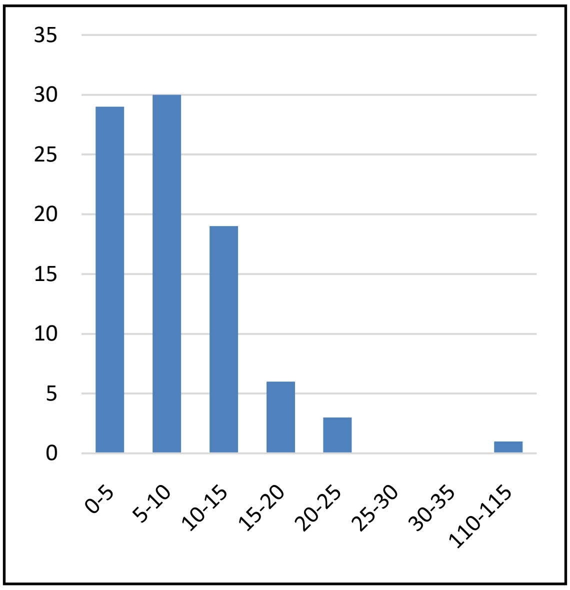
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	12
X	561875.227296	Stratum	1
Y	8525037.553579	Plot height (m)	1620

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	11.5	6.6	6.69	17	541
2	*Albizia antunesiana*	17.2	7.0	2.60	3	95
3	*Anisophyllea boehmii*	11.9	5.2	3.01	7	223
4	*Brachystegia boehmii*	8.6	5.2	1.04	5	159
5	*Brachystegia spiciformis*	15.3	7.2	36.19	16	509
6	*Brachystegia utilis*	7.5	6.5	0.14	1	32
7	*Dombeya rotundifolia*	4.5	1.6	0.05	1	32
8	*Hymenocardia acida*	2.9	2.6	0.39	16	509
9	*Isoberlinea angolensis*	4.1	2.4	0.04	1	32
10	*Monotes* spp.	6.8	6.0	1.71	13	414
11	*Ocha schweinfurthiana*	3.6	2.4	0.11	3	95
12	*Pericopsis angolensis*	8.3	6.2	1.16	5	159

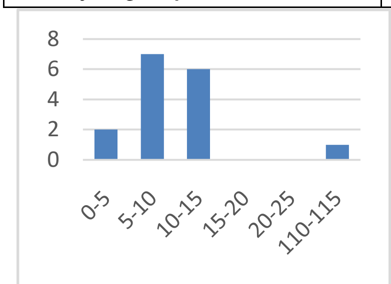
Density	Total diameter distribution

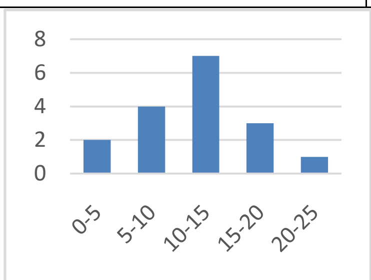


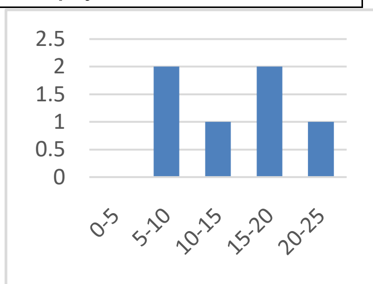


Diameter distribution main species

Brachystegia spiciformis	*Albizia antunesiana*	*Anisophyllea boehmii*







Forest Inventory Huambo | Plot | 27

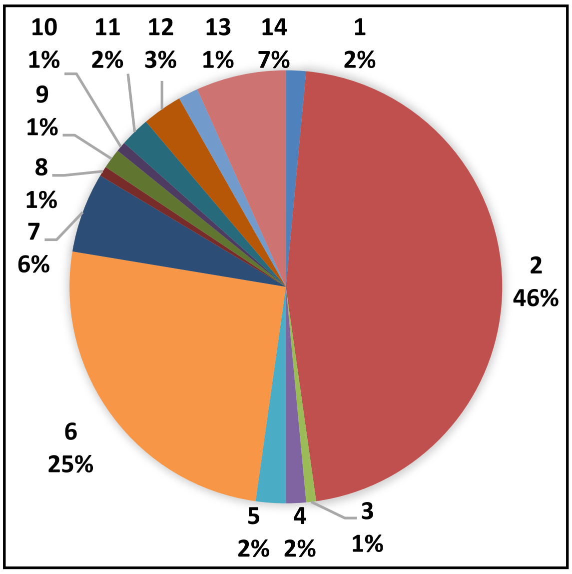
General description

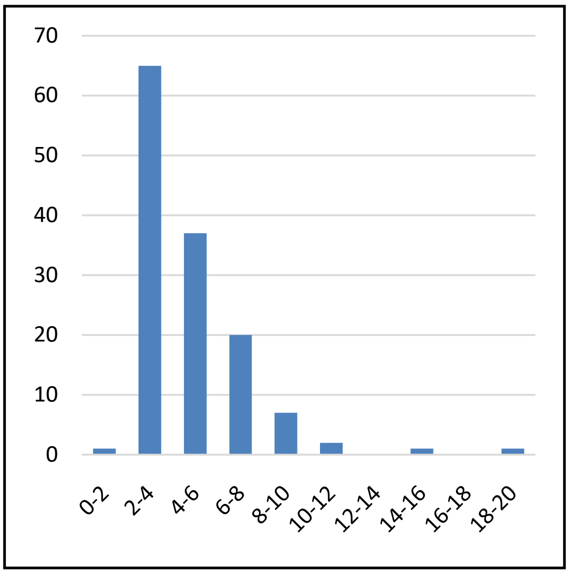
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	14
X	589765.503111	Stratum	0
Y	8689544.83843	Plot height (m)	1735

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Bobgunnia madagascariensis*	11.8	4.0	0.74	2	64
2	*Brachystegia spiciformis*	4.5	2.7	4.16	62	1974
3	*Brachystegia utilis*	5.9	4.0	0.09	1	32
4	*Diplorhynchus condylocarpon*	6.3	3.3	0.20	2	64
5	*Isoberlinea angolensis*	5.0	3.2	0.19	3	95
6	*Jubernardia paniculata*	3.9	2.4	1.68	34	1082
7	*Monotes* spp.	4.2	3.3	0.39	8	255
8	*Ocha schweinfurthiana*	6.4	4.2	0.10	1	32
9	*Parinari curatellifolia*	5.6	4.0	0.17	2	64
10	*Pericopsis angolensis*	6.0	3.0	0.09	1	32
11	Syzygium guineense	4.9	2.8	0.21	3	95
12	*Terminalia brachystemma*	5.7	3.7	0.36	4	127
13	*Uapaca gosswoileri*	8.3	7.3	0.36	2	64
14	*Uapaca kirkiana*	4.7	2.6	0.65	9	286

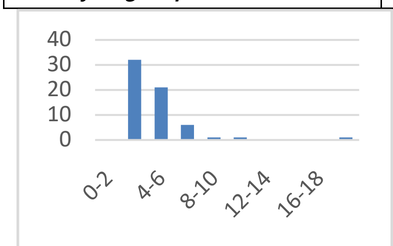
Density | **Total diameter distribution**

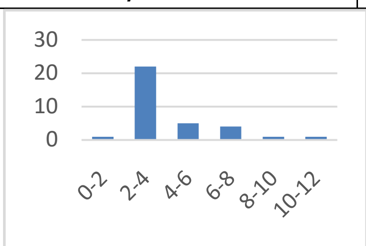


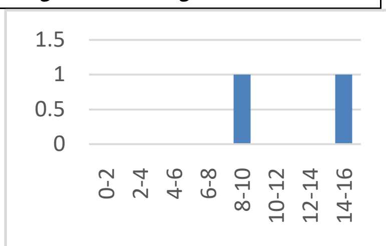


Diameter distribution main species

Brachystegia spiciformis | *Jubernardia paniculata* | *Bobgunnia madagascariensis*







Forest Inventory Huambo | Plot | 28

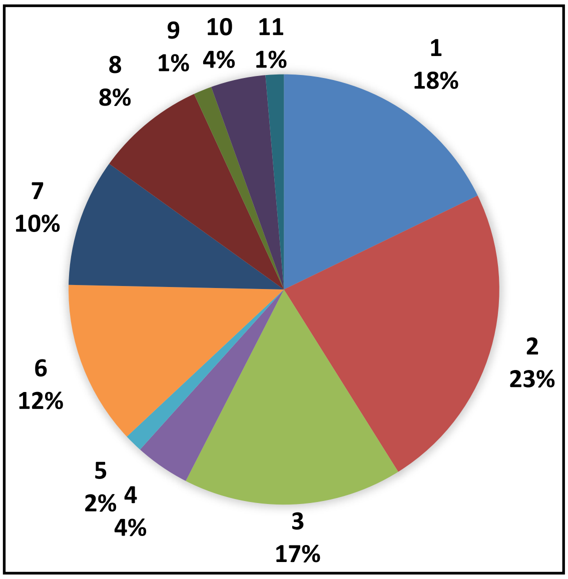
General description

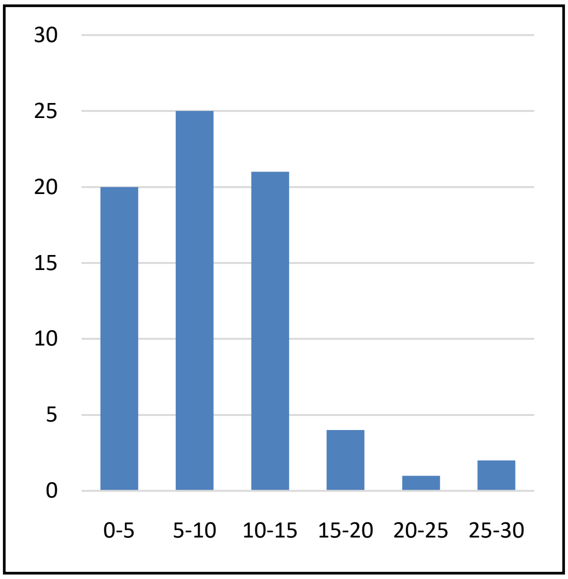
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	11
X	611368.794233	Stratum	0
Y	8527398.963663	Plot height (m)	1697

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	8.3	5.1	3.59	13	414
2	*Brachystegia boehmii*	11.0	7.4	5.35	17	541
3	*Brachystegia spiciformis*	11.7	7.5	5.38	12	382
4	*Brachystegia tamarindoides*	13.6	8.4	1.47	3	95
5	*Diplorhynchus condylocarpon*	4.4	7.0	0.05	1	32
6	*Isoberlinea angolensis*	5.0	4.1	0.75	9	286
7	*Kraussia floribunda*	3.6	2.8	0.30	7	223
8	*Ocha schweinfurthiana*	4.6	5.6	0.34	6	191
9	*Pterocarpus angolensis*	18.0	8.9	0.82	1	32
10	Syzygium guineense	7.2	6.3	0.42	3	95
11	*Uapaca kirkiana*	6.5	5.4	0.11	1	32

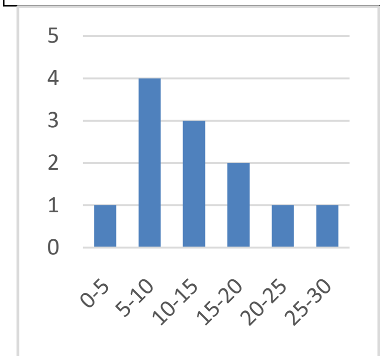
Density | **Total diameter distribution**

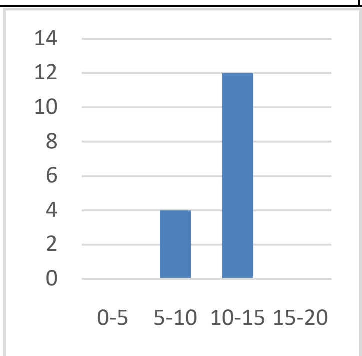


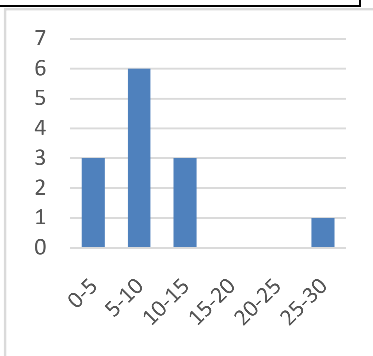


Diameter distribution main species

Brachystegia spiciformis | *Brachystegia boehmii* | *Anisophyllea boehmii*







Forest Inventory Huambo | Plot | 29

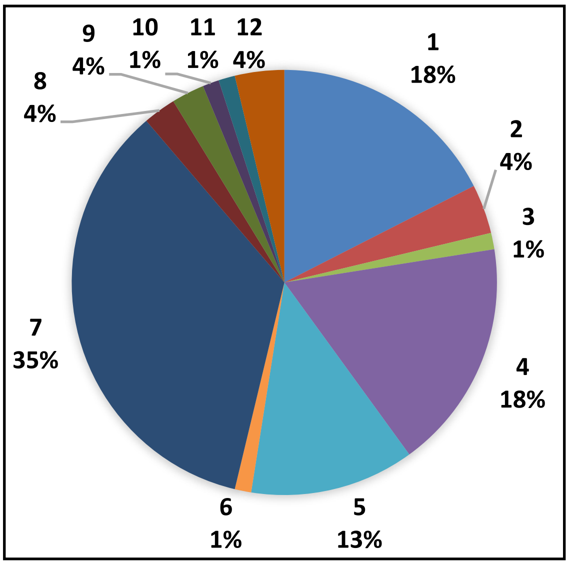
General description

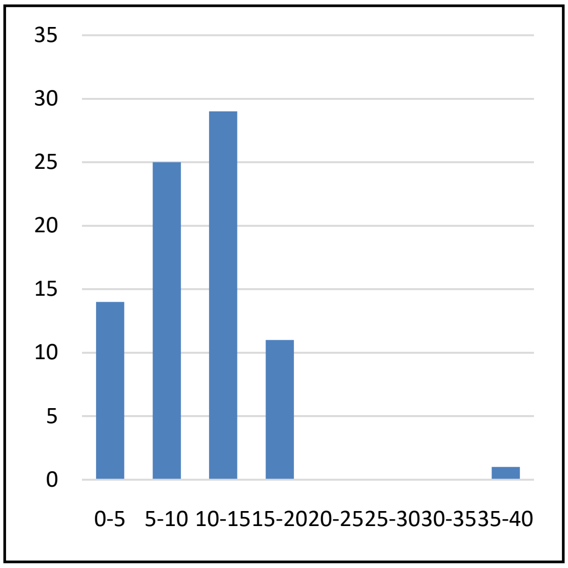
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	12
X	486387.590233	Stratum	0
Y	8590004.632013	Plot height (m)	1453

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	8.3	5.9	2.84	14	446
2	*Bobgunnia madagascariensis*	3.9	2.1	0.12	3	95
3	*Brachystegia bohemii*	12.5	11.0	0.40	1	32
4	*Brachystegia spiciformis*	9.9	8.6	4.05	14	446
5	*Brachystegia tamarindoides*	11.6	7.8	3.50	10	318
6	Isoberlinia angolensis	4.2	3.0	0.05	1	32
7	*Julbernardia paniculata*	12.5	9.1	14.62	28	891
8	*Ochna schweinfurthiana*	6.6	5.0	0.22	2	64
9	Parinari curatellifolia	7.0	2.8	0.32	2	64
10	*Pseudolachnostylis maprouneifolia*	6.6	5.5	0.11	1	32
11	*Rothmannia engleriana*	1.9	2.0	0.01	1	32
12	*Upondandjamba*	8.8	5.8	0.62	3	95

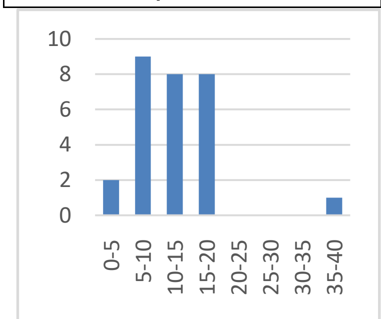
Density	Total diameter distribution

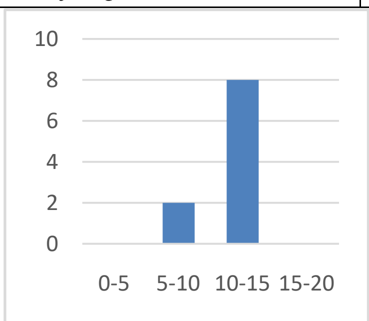


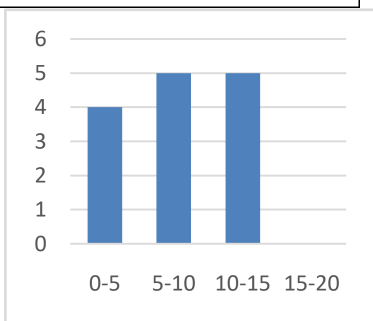


Diameter distribution main species

Julbernardia paniculata	*Brachystegia tamarindoides*	*Albizia antunesiana*







Forest Inventory Huambo | Plot | 30

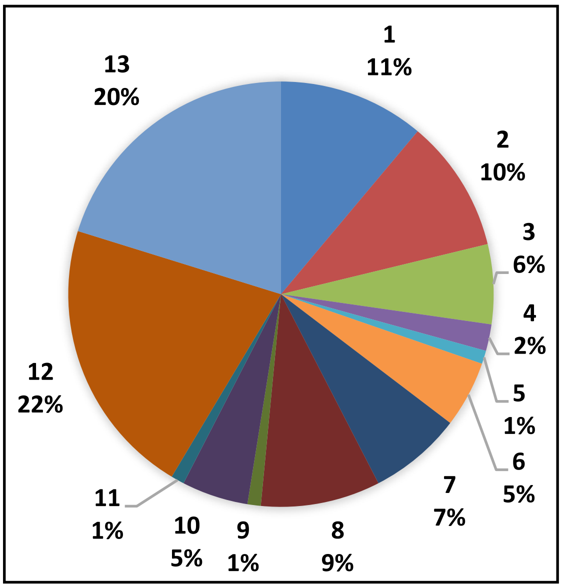
General description

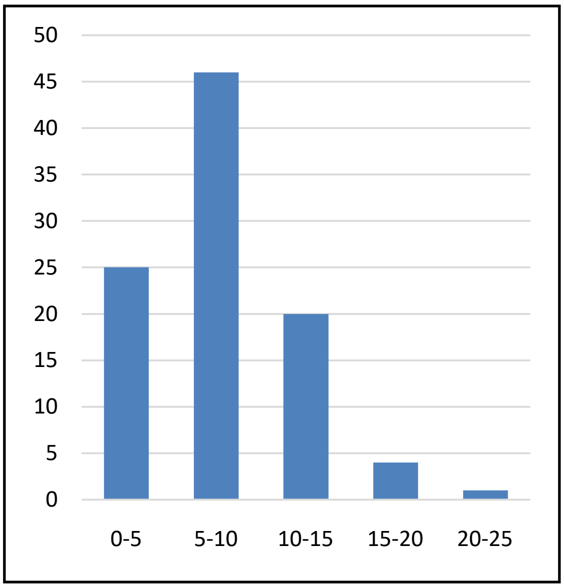
Sistema de referencia	WGS84 UTM 36N	**N. Total species plot**	13
X	539124.994339	**Stratum**	1
Y	8637551.024525	**Plot height (m)**	1630

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	10.3	4.7	3.02	11	350
2	*Anisophyllea boehmii*	7.2	5.1	1.49	10	318
3	*Brachystegia spiciformis*	11.7	4.4	2.65	6	191
4	*Brachystegia tamarindoides*	5.1	4.6	0.13	2	64
5	*Diplorhynchus condylocarpon*	9.0	6.5	0.21	1	32
6	*Hymenocardia acida*	4.2	2.7	0.23	5	159
7	*Isoberlinea angolensis*	10.7	6.3	2.27	7	223
8	*Jubernardia paniculata*	11.6	7.9	3.44	9	286
9	*Monotes* spp.	12.2	8.6	0.38	1	32
10	*Ocha schweinfurthiana*	10.1	6.9	1.43	5	159
11	*Parinari curatellifolia*	6.9	4.0	0.12	1	32
12	Syzygium guineense	5.3	3.0	1.60	21	668
13	*Terminalia brachystemma*	6.2	3.7	2.23	20	637

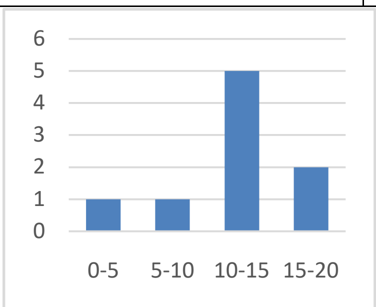
Density | **Total diameter distribution**

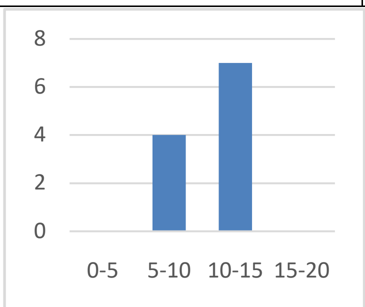


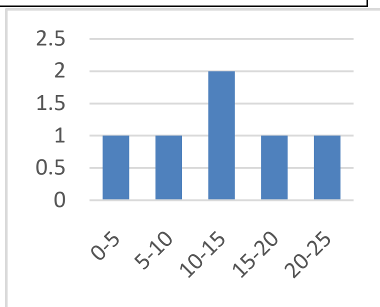


Diameter distribution main species

Julbernardia paniculata | *Albizia antunesiana* | *Brachystegia spiciformis*







Forest Inventory Huambo | Plot | 31

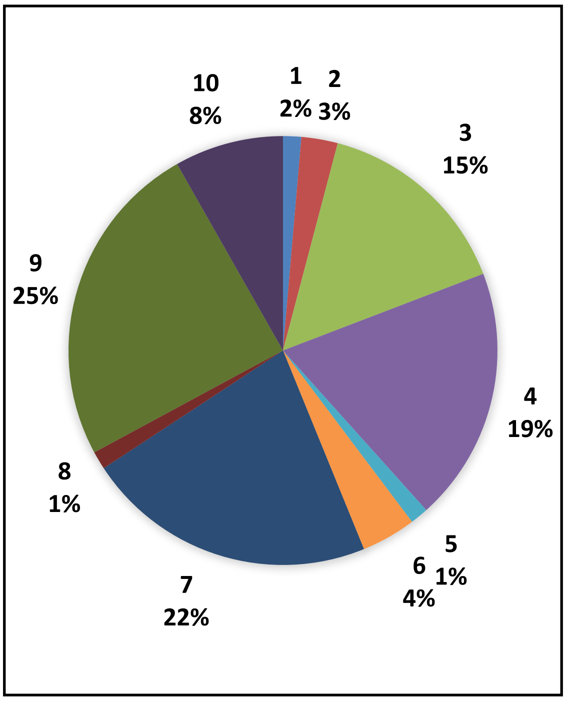
General description

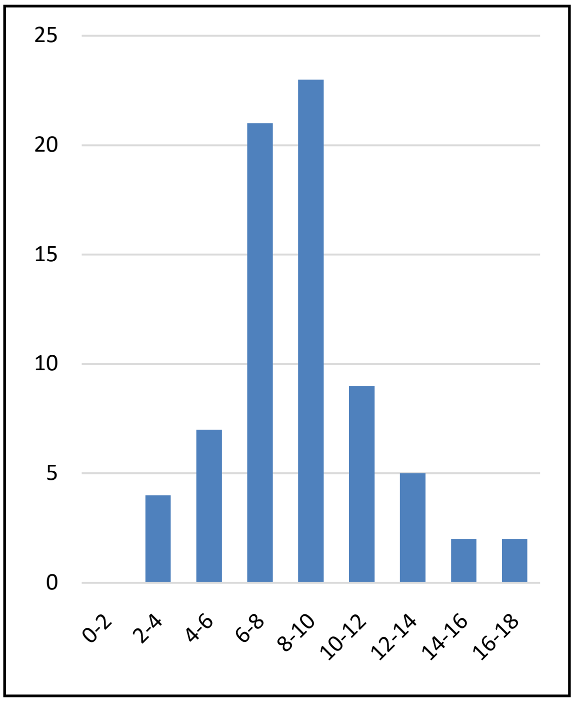
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	497386.525958	Stratum	2
Y	8580914.454502	Plot height (m)	1461

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	7.5	6.5	0.14	1	32
2	*Bobgunnia madagascariensis*	7.4	6.5	0.37	2	64
3	*Brachystegia boehmii*	9.2	6.5	2.61	11	350
4	*Brachystegia spiciformis*	10.4	7.5	4.32	14	446
5	*Combretum collinum*	6.4	3.4	0.10	1	32
6	*Erythrina abyssinica*	6.6	5.5	0.34	3	95
7	*Hymenocardia acida*	8.1	6.1	2.89	16	509
8	*Isoberlinea angolensis*	10.4	7.0	0.27	1	32
9	*Monotes* spp.	8.0	5.9	3.21	18	573
10	*Pterocarpus angolensis*	8.4	6.4	1.15	6	191

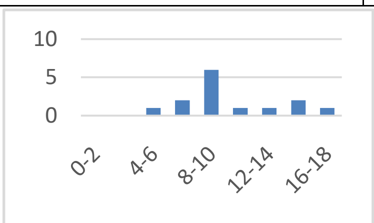
Density	Total diameter distribution

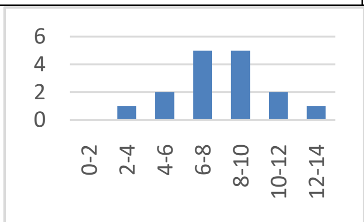


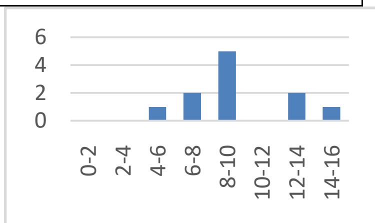


Diameter distribution main species

Brachystegia spiciformis	*Hymenocardia acida*	*Brachystegia boehmii*







Forest Inventory Huambo | Plot | 32

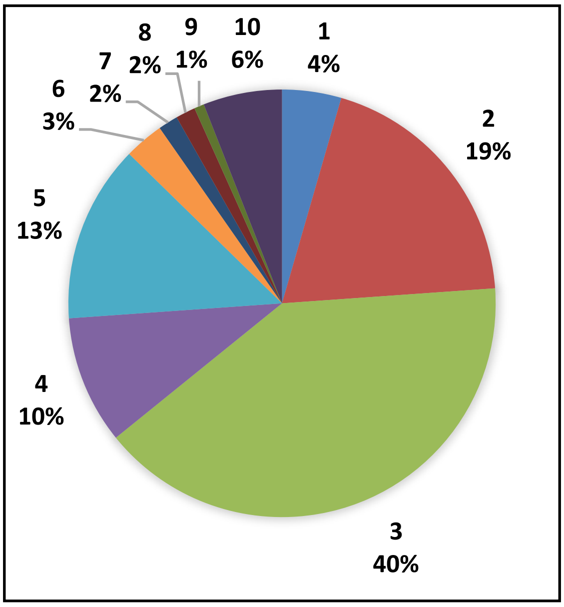
General description

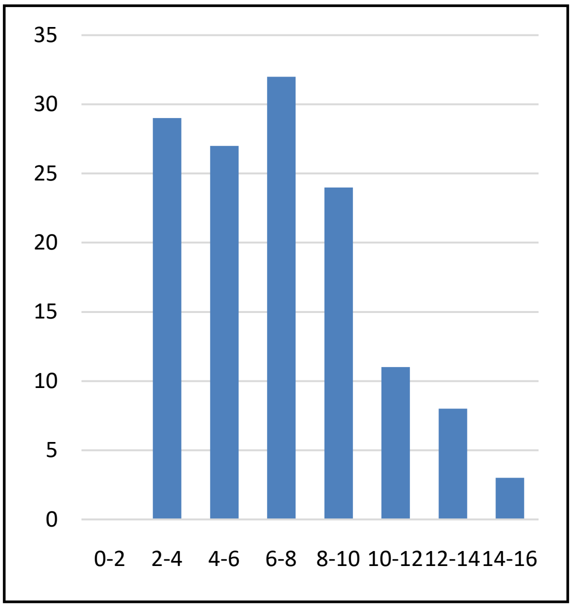
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	590020.996176	Stratum	0
Y	8614605.030098	Plot height (m)	1551

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	9.4	6.2	1.52	6	191
2	*Anisophyllea boehmii*	7.2	4.3	4.09	26	828
3	*Brachystegia spiciformis*	6.4	5.4	6.51	54	1719
4	*Isoberlinea angolensis*	9.7	5.8	3.45	13	414
5	*Monotes* spp.	4.2	3.0	0.94	18	573
6	*Ocha schweinfurthiana*	4.3	3.5	0.19	4	127
7	Parinari curatellifolia	7.7	6.5	0.30	2	64
8	*Pericopsis angolensis*	3.2	1.8	0.05	2	64
9	*Syzygium guineense*	3.0	2.3	0.02	1	32
10	*Upondajamba*	5.1	3.7	0.63	8	255

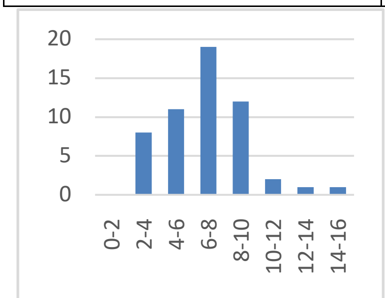
Density	Total diameter distribution

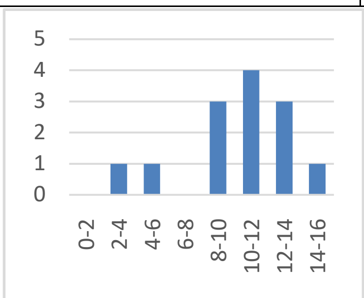


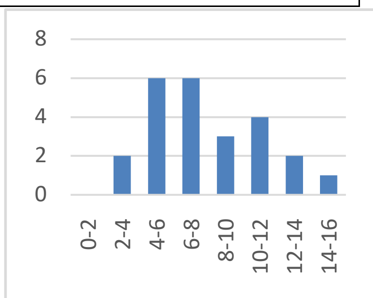


Diameter distribution main species

Brachystegia spiciformis	*Isoberlinea angolensis*	*Anisophyllea boehmii*







Forest Inventory Huambo | Plot | 33

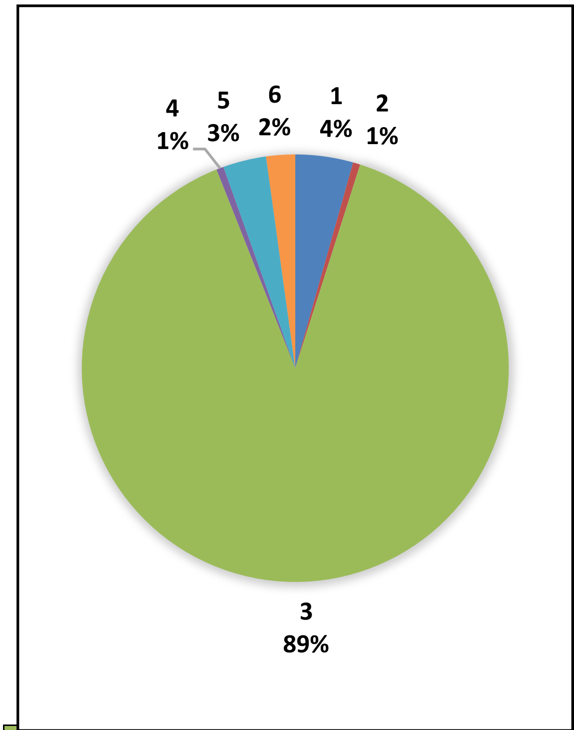
General description

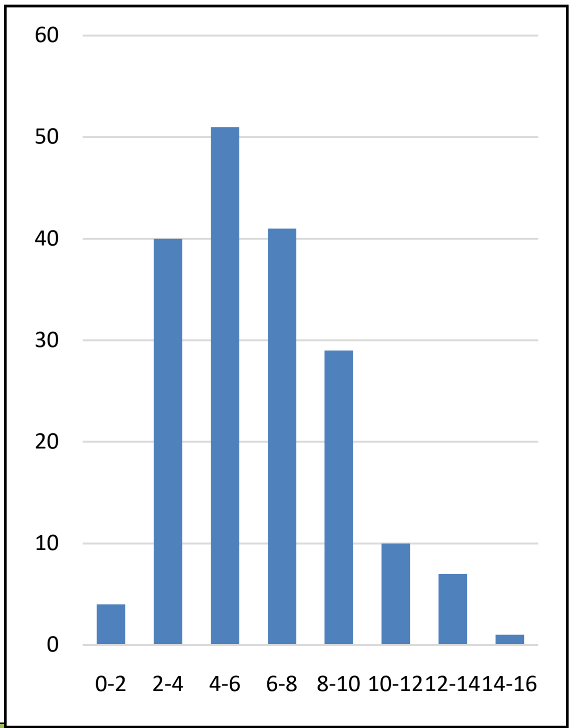
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	6
X	662089.354583	Stratum	3
Y	8525753.208548	Plot height (m)	1618

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	5.5	4.9	0.85	8	255
2	*Brachystegia utilis*	6.3	4.5	0.10	1	32
3	*Erythrophleum africanum*	6.3	4.8	19.69	163	5188
4	*Euclea natalensis*	2.1	1.8	0.01	1	32
5	*Parinari curatellifolia*	6.3	5.3	0.64	6	191
6	*Pseudolachnostylis maprouneifolia*	6.4	4.5	0.45	4	127

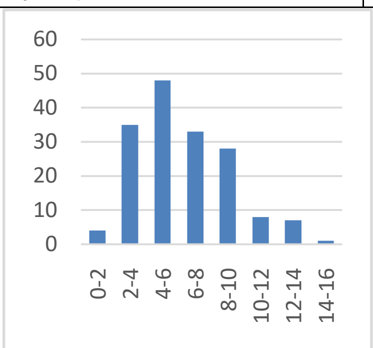
Density	Total diameter distribution

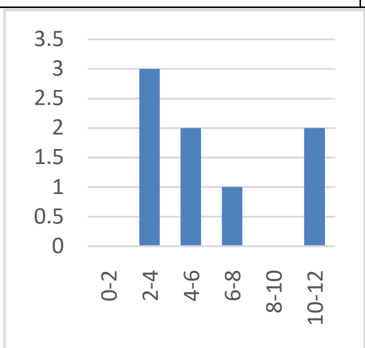


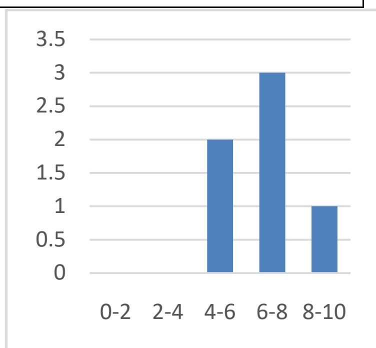


Diameter distribution main species

Erythrophleum africanum	*Albizia antunesiana*	*Parinari curatellifolia*







Forest Inventory Huambo | Plot | 34

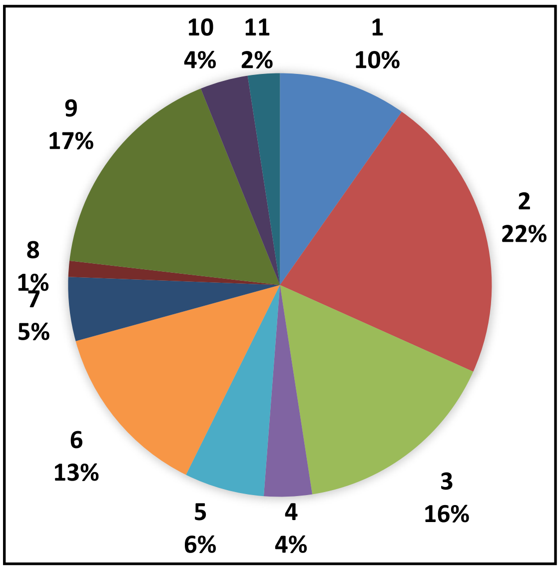
General description

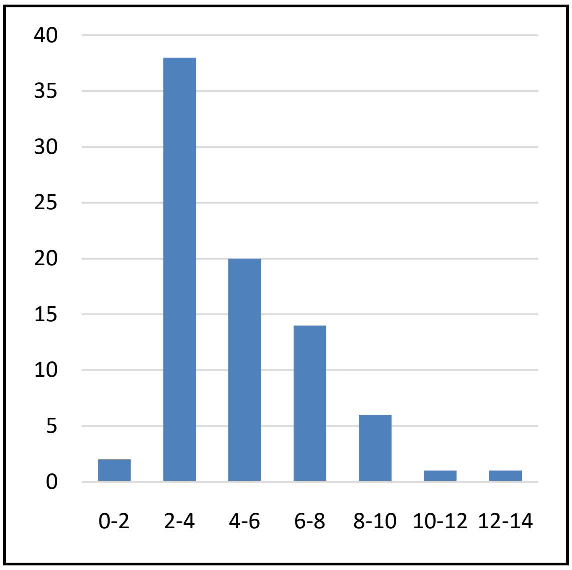
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	11
X	586199.022176	Stratum	0
Y	8600677.374767	Plot height (m)	1572

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	6.4	3.2	0.92	8	255
2	*Brachystegia boehmii*	3.7	2.0	0.97	18	573
3	*Brachystegia spiciformis*	3.2	2.0	0.35	13	414
4	*Brachystegia tamarindoides*	3.7	2.4	0.11	3	95
5	*Gardenia volkensii*	4.4	2.6	0.30	5	159
6	*Isoberlinea angolensis*	5.6	3.3	0.96	11	350
7	*Kraussia floribunda*	6.7	3.6	0.49	4	127
8	*Monotes* spp.	2.2	1.7	0.01	1	32
9	*Ocha schweinfurthiana*	4.0	2.2	0.64	14	446
10	*Pterocarpus angolensis*	6.9	3.0	0.37	3	95
11	*Terminalia brachystemma*	8.9	5.8	0.41	2	64

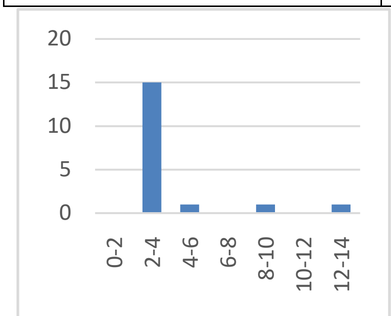
Density	Total diameter distribution

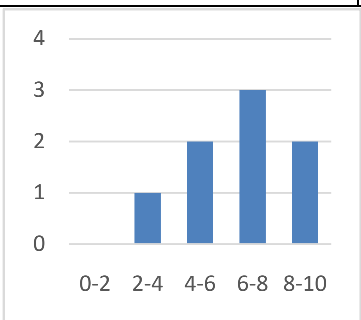


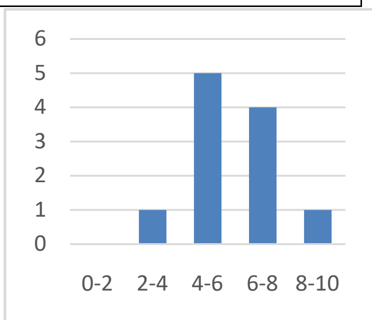


Diameter distribution main species

Brachystegia boehmii	*Albizia antunesiana*	*Isoberlinea angolensis*







Forest Inventory Huambo | Plot | 35

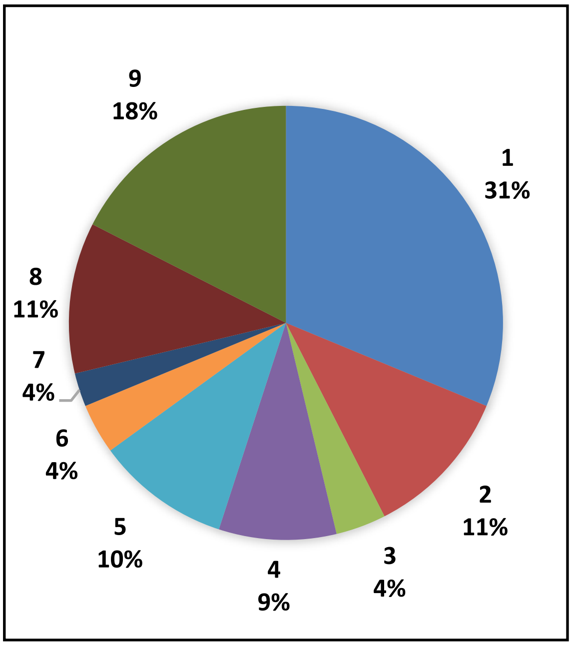
General description

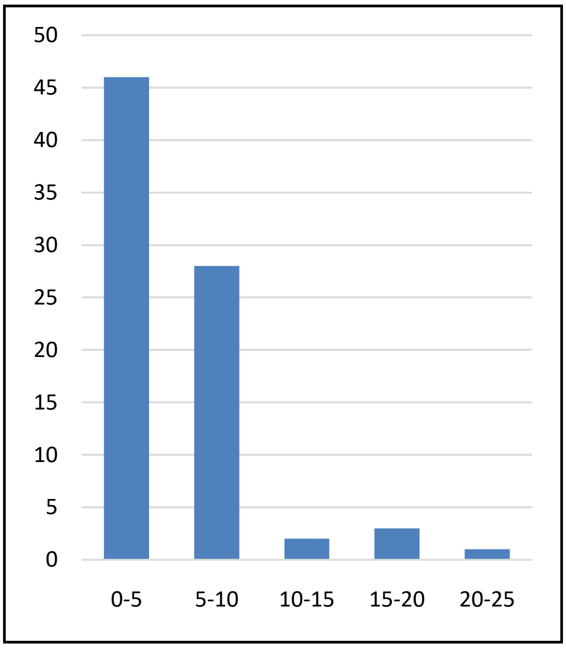
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	9
X	546585.106595	Stratum	0
Y	8575450.387515	Plot height (m)	1654

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Brachystegia boehmii*	4.7	3.7	1.56	25	796
2	*Brachystegia spiciformis*	3.0	2.1	0.25	9	286
3	*Diplorhynchus condylocarpon*	10.2	5.7	1.02	3	95
4	*Isoberlinea angolensis*	3.1	2.1	0.19	7	223
5	*Monotes* spp.	3.8	2.4	0.67	8	255
6	*Ocha schweinfurthiana*	5.6	3.6	0.24	3	95
7	*Parinari curatellifolia*	3.6	2.9	0.08	2	64
8	Syzygium guineense	7.6	3.7	2.14	9	286
9	*Uapaca kirkiana*	6.2	4.2	1.87	14	446

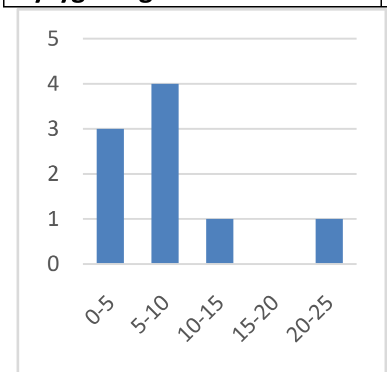
Density | **Total diameter distribution**

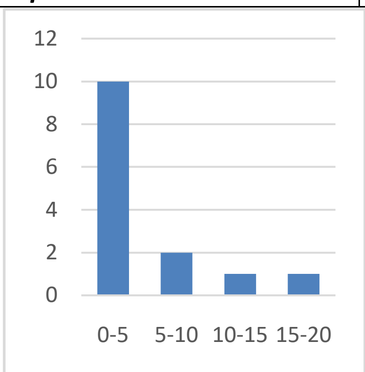


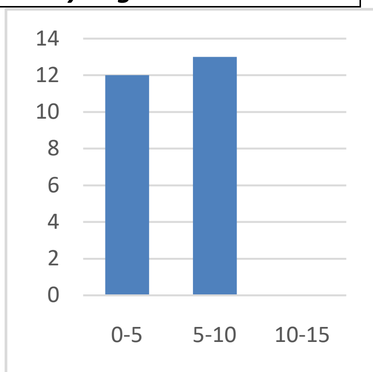


Diameter distribution main species

Syzygium guineense | ***Uapaca kirkiana*** | ***Brachystegia boehmii***







Forest Inventory Huambo | Plot | 36

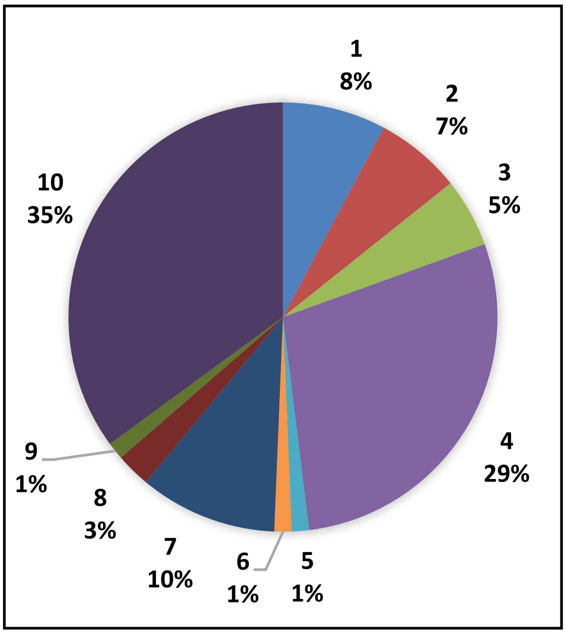
General description

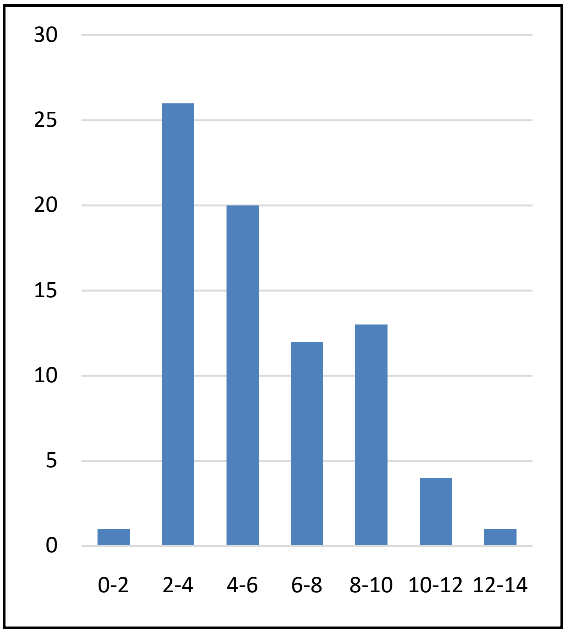
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	10
X	495394.298182	Stratum	2
Y	8581242.564931	Plot height (m)	1409

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	9.1	7.2	1.34	6	191
2	*Bobgunnia madagascariensis*	6.0	4.3	0.55	5	159
3	*Brachystegia boehmii*	5.0	4.1	0.38	4	127
4	*Brachystegia spiciformis*	3.9	2.9	0.95	22	700
5	*Erythrina abyssinica*	6.0	6.5	0.09	1	32
6	*Hymenocardia acida*	11.0	5.0	0.31	1	32
7	*Monotes* spp.	7.7	6.1	1.30	8	255
8	*Pericopsis angolensis*	2.5	2.3	0.03	2	64
9	*Rothmannia engleriana*	6.0	4.5	0.09	1	32
10	Syzygium guineense	5.4	4.0	2.33	27	859

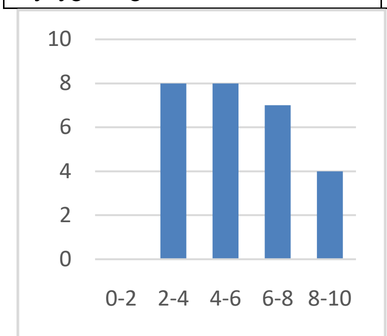
Density	Total diameter distribution

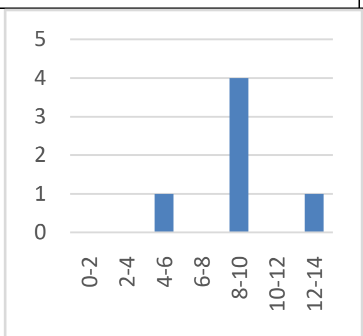


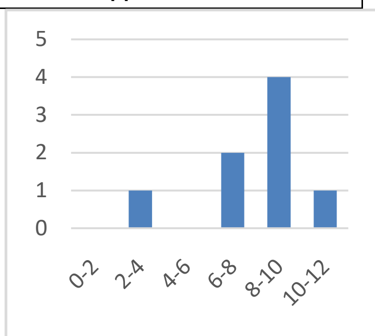


Diameter distribution main species

Syzygium guineense	*Albizia antunesiana*	*Monotes* spp.







Forest Inventory Huambo | Plot | 37

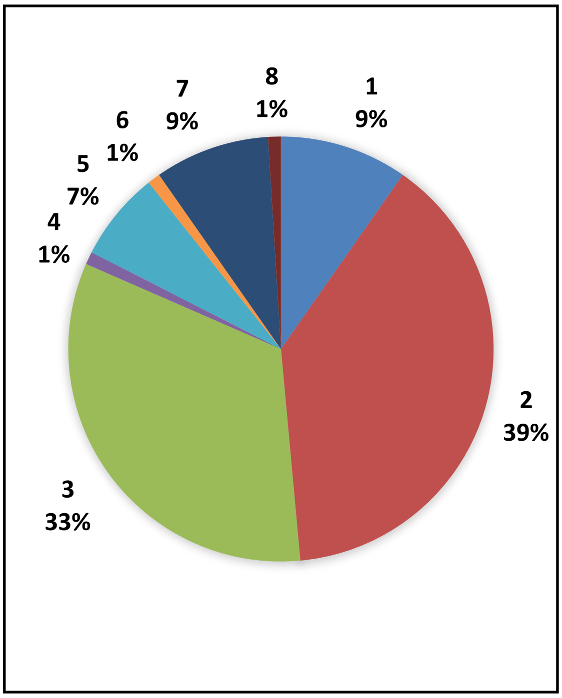
General description

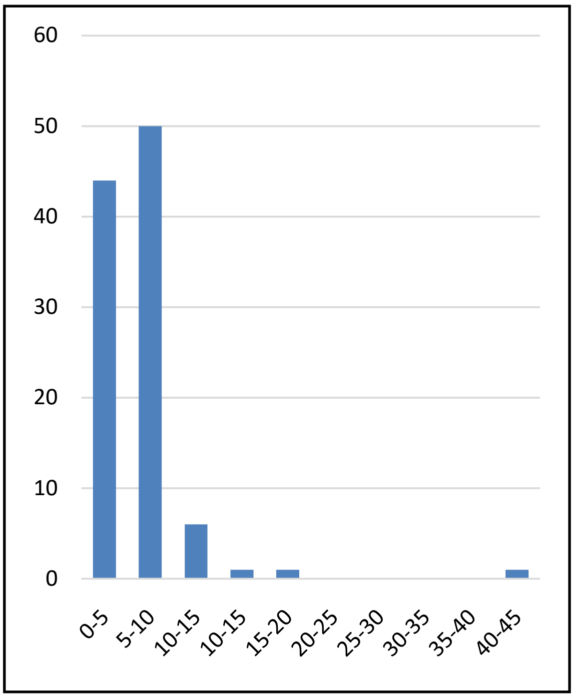
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	9
X	588610.992562	Stratum	0
Y	8567080.023783	Plot height (m)	1701

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Brachystegia boehmii*	3.6	2.8	0.36	10	318
2	*Brachystegia spiciformis*	7.3	5.3	9.23	40	1273
3	*Brachystegia tamarindoides*	5.5	4.3	3.02	34	1082
4	*Isoberlinea angolensis*	7.3	7.7	0.14	1	32
5	*Monotes* spp.	4.7	3.6	0.49	7	223
6	*Ochna schweinfurthiana*	3.4	2.9	0.03	1	32
7	Syzygium guineense	5.8	3.4	0.89	9	286
8	*Terminalia brachystemma*	23.5	6.2	1.40	1	32

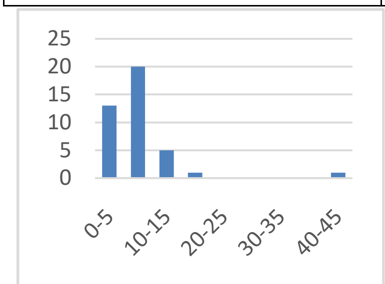
Density | **Total diameter distribution**



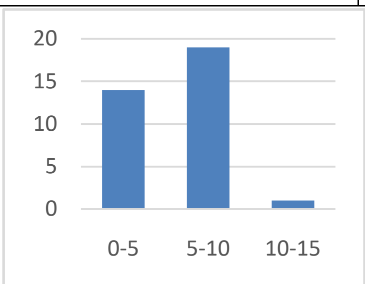


Diameter distribution main species

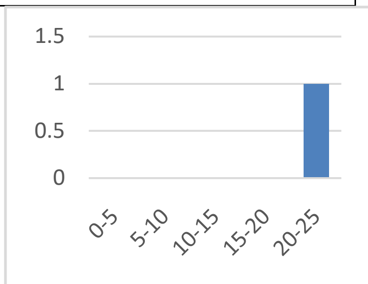
Brachystegia spiciformis



Brachystegia tamarindoides



Terminalia brachystemma



Forest Inventory Huambo | Plot | 38

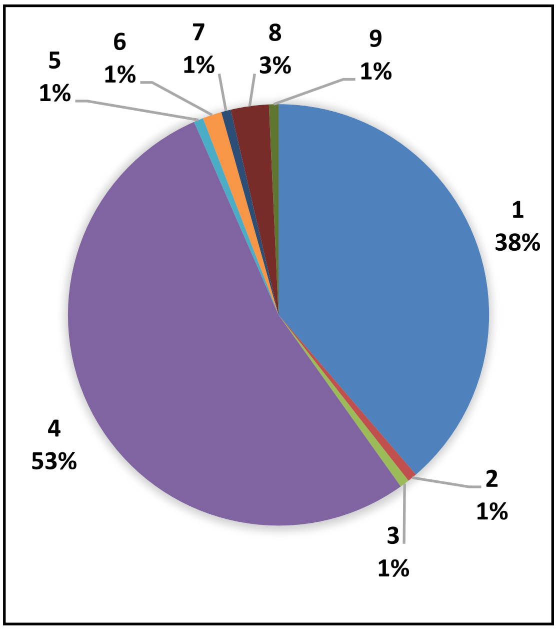
General description

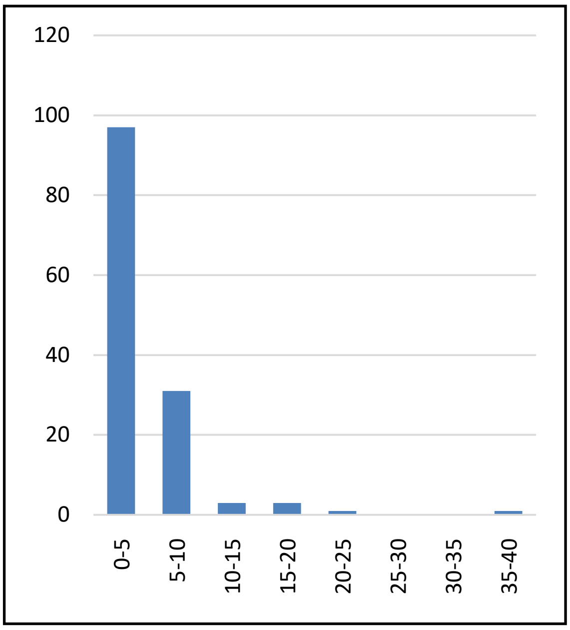
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	9
X	486719.766149	Stratum	0
Y	8589164.946999	Plot height (m)	1423

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Brachystegia boehmii*	5.1	3.6	5.01	53	1687
2	*Brachystegia bohemii*	1.9	1.8	0.01	1	32
3	*Diplorhynchus condylocarpon*	4.2	2.5	0.05	1	32
4	*Monotes* spp	4.2	3.6	4.65	73	2324
5	*Rothmannia engleriana*	36.4	3.0	3.36	1	32
6	Syzygium guineense	4.5	3.5	0.10	2	64
7	*Opondandjamba*	6.7	4.0	0.11	1	32
8	*Upandandjamba*	4.1	3.1	0.18	4	127
9	*Ungolo*	2.1	1.7	0.01	1	32

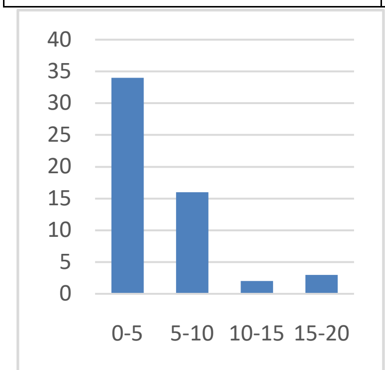
Density | **Total diameter distribution**

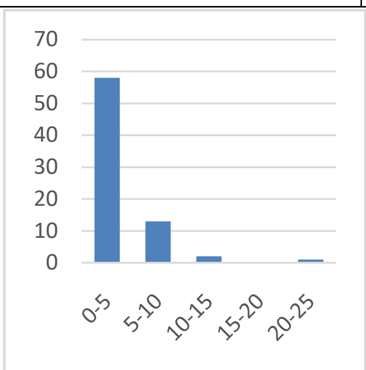


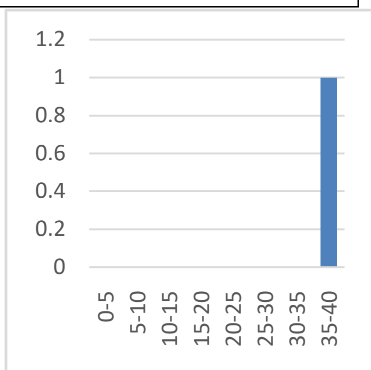


Diameter distribution main species

Brachystegia boehmii | *Monotes* spp | *Rothmannia engleriana*







Forest Inventory Huambo | Plot | 39

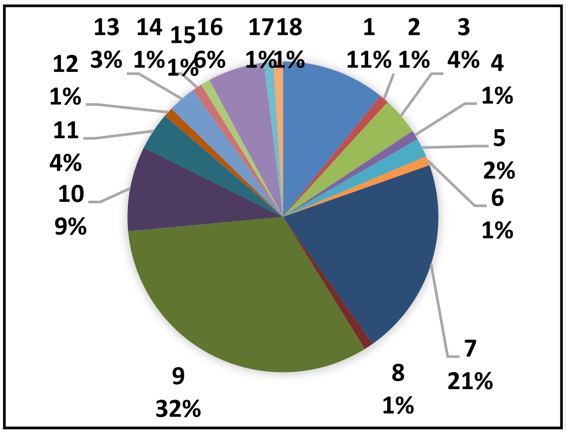
General description

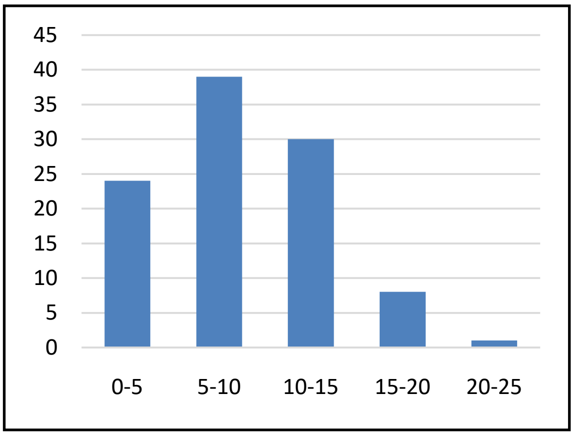
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	18
X	521443.499187	Stratum	2
Y	8602891.872166	Plot height (m)	1501

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	4.7	3.5	0.68	11	350
2	*Bobgunnia madagascariensis*	6.5	6.5	0.11	1	32
3	*Brachystegia boehmii*	6.0	4.7	0.64	4	127
4	*Brachystegia boehmii*	2.5	2.3	0.02	1	32
5	*Brachystegia spiciformis*	7.5	7.5	0.30	2	64
6	*Dombeya rotundifolia*	4.5	4.5	0.05	1	32
7	*Isoberlinea angolensis*	9.6	7.6	5.99	21	668
8	*Isoberlinia angolensis*	9.0	7.0	0.21	1	32
9	*Jubernardia paniculata*	11.2	8.5	11.37	33	1050
10	*Monotes* spp	3.6	3.7	0.31	9	286
11	*Ocha schweinfurthiana*	5.9	5.8	0.42	4	127
12	*Parinari curatellifolia*	14.4	10.0	0.53	1	32
13	*Pericopsis angolensis*	10.5	7.2	0.96	3	95
14	*Pterocarpus angolensis*	9.0	10.5	0.21	1	32
15	*Syzygium guineense*	4.9	3.0	0.06	1	32
16	*Uapaca benguellensis*	9.2	7.3	1.71	6	191
17	*Uapaca gossweileri*	9.0	10.0	0.21	1	32
18	*Upondojamba*	5.2	6.0	0.07	1	32

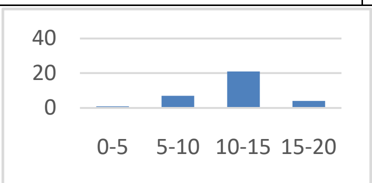
Density	Total diameter distribution

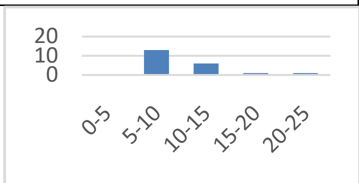


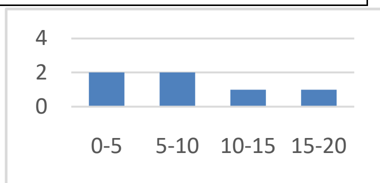


Diameter distribution main species

Jubernardia paniculata	*Isoberlinea angolensis*	*Uapaca benguellensis*







Forest Inventory Huambo | Plot | 40

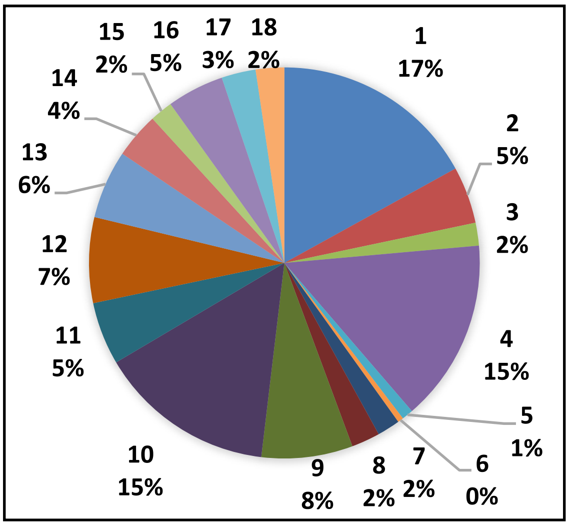
General description

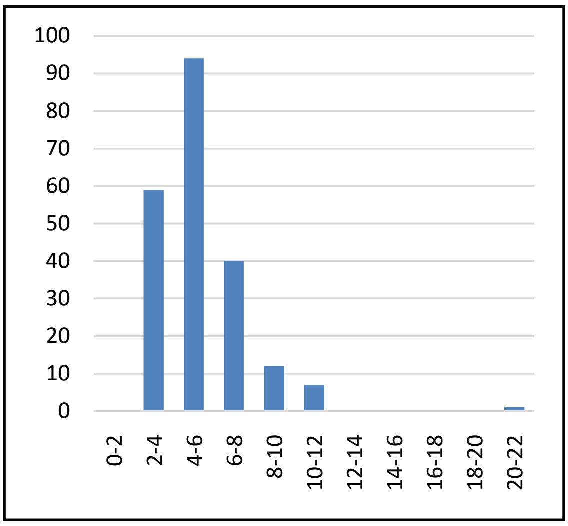
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	18
X	597200.128613	Stratum	2
Y	8625776.051604	Plot height (m)	1533

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	3.7	3.4	1.40	36	1146
2	*Anisophyllea boehmii*	5.5	3.7	0.80	10	318
3	*Brachystegia boehmii*	3.8	3.5	0.15	4	127
4	*Brachystegia spiciformis*	5.3	3.6	2.70	32	1019
5	*Euclea natalensis*	12.0	2.0	1.05	2	64
6	*Gardenia volkensii*	3.5	3.7	0.03	1	32
7	*Hymenocardia acida*	2.4	1.8	0.06	4	127
8	*Isoberlinea angolensis*	6.2	5.4	0.52	5	159
9	*Jubernardia paniculata*	6.2	5.1	1.69	16	509
10	*Monotes spp.*	4.7	3.7	1.87	31	987
11	*Ocha schweinfurthiana*	4.0	2.7	0.48	11	350
12	*Parinari curatellifolia*	5.7	3.6	1.41	15	477
13	*Pericopsis angolensis*	6.0	3.9	1.16	12	382
14	*Pterocarpus angolensis*	4.4	4.0	0.42	8	255
15	*Rothmannia engleriana*	2.4	1.8	0.06	5	159
16	Syzygium guineense	5.0	2.3	0.67	10	318
17	*Uapaca benguellensis*	7.6	4.7	1.02	6	191
18	*Uapaca kirkiana*	2.8	1.8	0.11	5	159

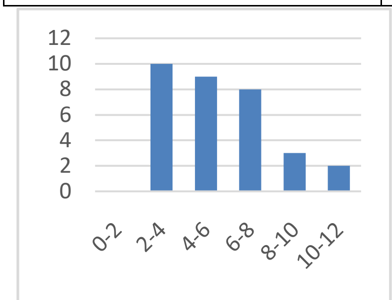
Density | **Total diameter distribution**

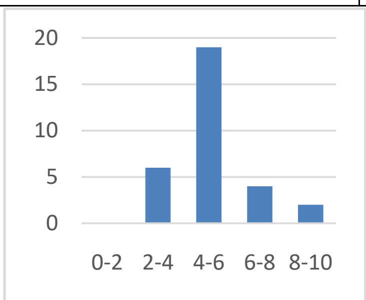


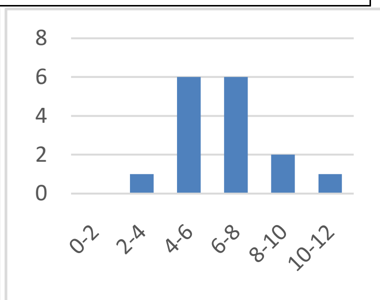


Diameter distribution main species

Brachystegia spiciformis	*Monotes* spp	*Jubernardia paniculata*







Forest Inventory Huambo	Plot	41

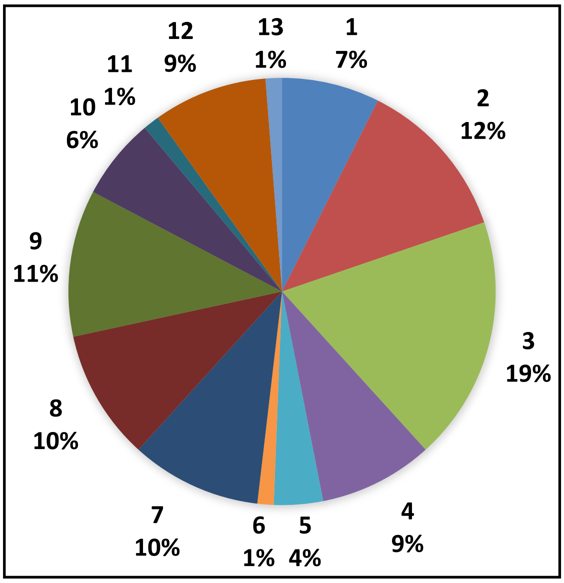
General description

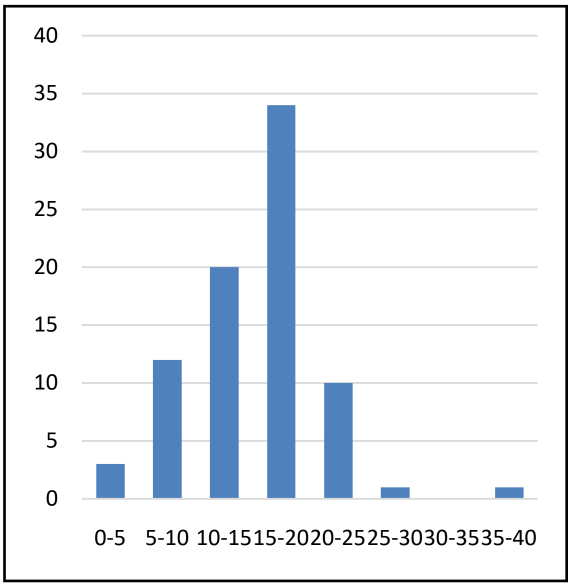
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	13
X	544217.667172	Stratum	2
Y	8688819.073545	Plot height (m)	1398

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	17.5	9.6	4.93	6	191
2	*Anisophyllea boehmii*	13.8	6.2	5.83	10	318
3	*Brachystegia spiciformis*	16.2	10.4	10.51	15	477
4	*Brachystegia tamarindoides*	14.3	8.6	3.96	7	223
5	*Diplorhynchus condylocarpon*	14.7	9.9	1.67	3	95
6	*Erythrina abyssinica*	37.5	14.6	3.56	1	32
7	*Hymenocardia acida*	11.5	6.9	3.30	8	255
8	*Isoberlinea angolensis*	15.9	10.3	5.43	8	255
9	*Monotes* spp.	9.0	7.5	2.09	9	286
10	*Ocha schweinfurthiana*	17.7	10.7	4.03	5	159
11	*Pericopsis angolensis*	13.0	11.4	0.43	1	32
12	*Pterocarpus angolensis*	17.2	11.1	5.38	7	223
13	Syzygium guineense	12.5	8.4	0.40	1	32

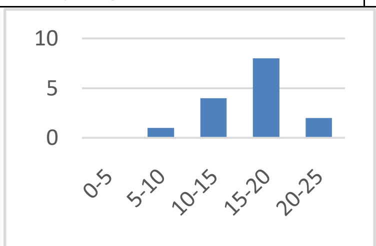
Density	Total diameter distribution

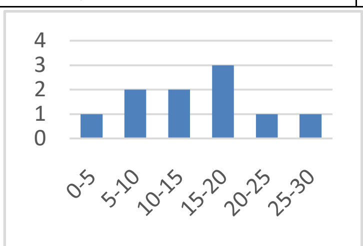


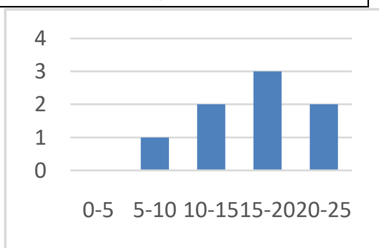


Diameter distribution main species

Brachystegia spiciformis	*Anisophyllea boehmii*	*Isoberlinea angolensis*







Forest Inventory Huambo | Plot | 42

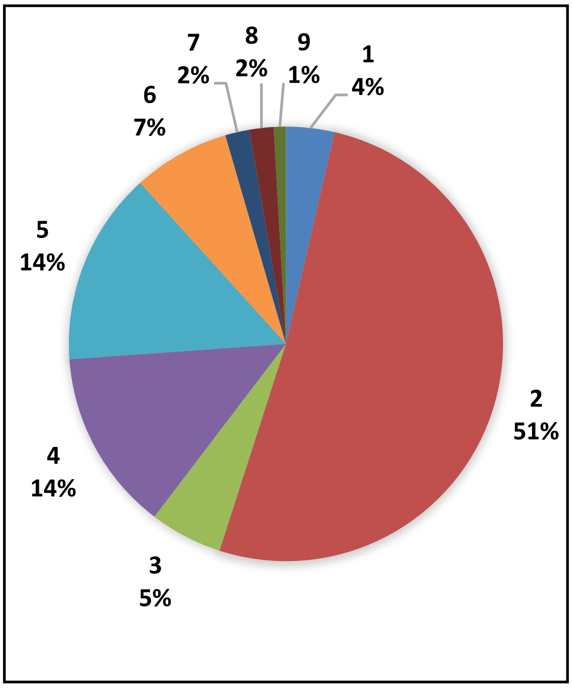
General description

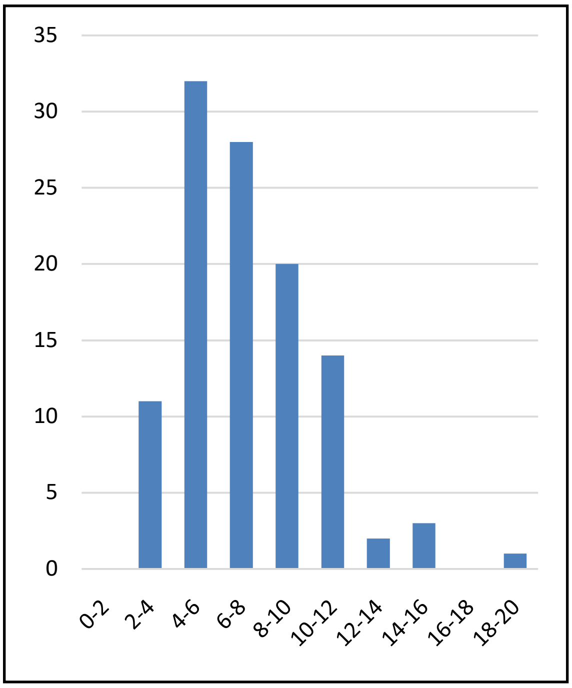
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	9
X	594724.992852	Stratum	2
Y	8621825.021667	Plot height (m)	1487

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	7.9	5.8	0.74	4	127
2	*Brachystegia spiciformis*	7.2	5.3	8.39	57	1814
3	*Hymenocardia acida*	3.3	2.3	0.22	6	191
4	*Julbernardia paniculata*	7.0	5.4	2.04	15	477
5	*Ochna schweinfurthiana*	6.0	4.0	1.71	16	509
6	*Pericopsis angolensis*	9.8	5.3	2.42	8	255
7	*Pterocarpus angolensis*	6.3	4.5	0.27	2	64
8	*Rothmannia engleriana*	5.0	4.0	0.13	2	64
9	*Uapaca kirkiana*	7.2	7.0	0.13	1	32

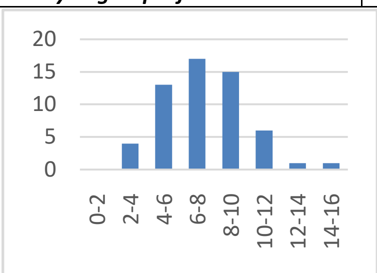
Density	Total diameter distribution

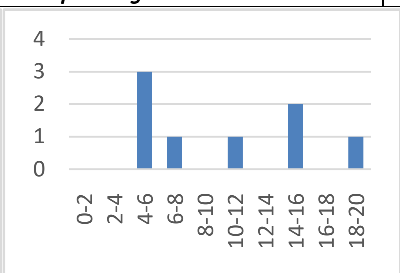


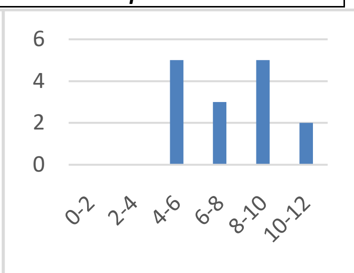


Diameter distribution main species

Brachystegia spiciformis	*Pericopsis angolensis*	*Julbernardia paniculata*







Forest Inventory Huambo | Plot | 43

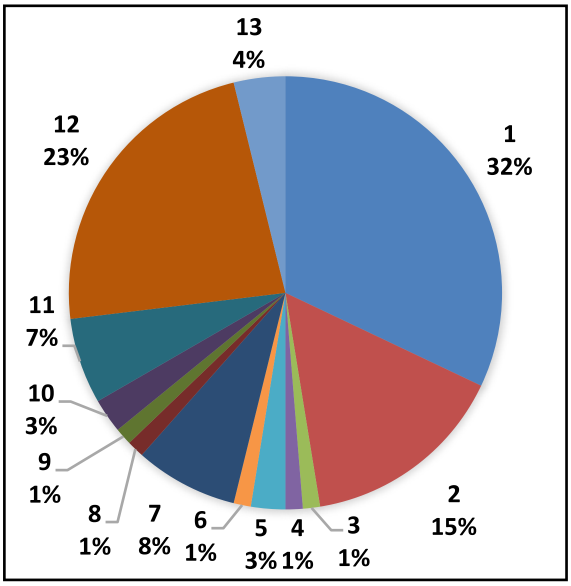
General description

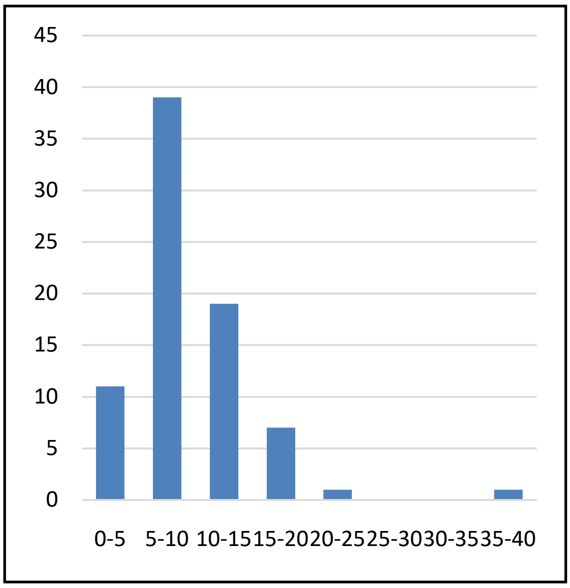
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	13
X	519504.777324	Stratum	0
Y	8595770.998555	Plot height (m)	1512

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	10.9	7.0	8.56	25	796
2	*Anisophyllea boehmii*	9.3	6.8	2.97	12	382
3	*Brachystegia bohemii*	13.6	8.0	0.47	1	32
4	*Brachystegia spiciformis* Benth	9.0	10.0	0.21	1	32
5	*Diplorhynchus condylocarpon*	23.4	11.2	4.01	2	64
6	*Hymenocardia acida*	7.0	7.0	0.12	1	32
7	*Isoberlinia angolensis*	13.0	9.1	2.78	6	191
8	*Jubernardia paniculata*	12.2	8.0	0.38	1	32
9	*Ochna schweinfurthiana*	4.5	3.0	0.05	1	32
10	*Parinari curatellifolia*	10.2	8.6	0.54	2	64
11	*Syzygium guineense*	6.4	3.6	0.55	5	159
12	*Uapaca benguellensis Muell.*	5.2	4.8	1.30	18	573
13	*Opondajamba*	7.0	6.7	0.39	3	95

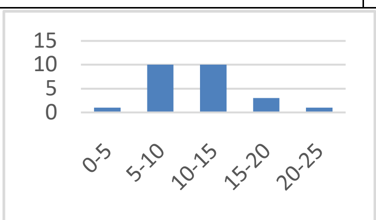
Density	Total diameter distribution

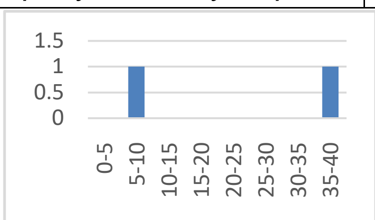


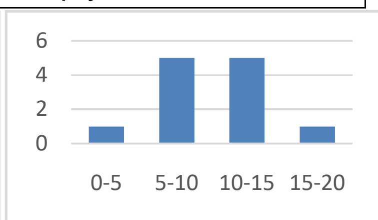


Diameter distribution main species

Albizia antunesiana	*Diplorhynchus condylocarpon*	*Anisophyllea boehmii*







Forest Inventory Huambo | Plot | 44

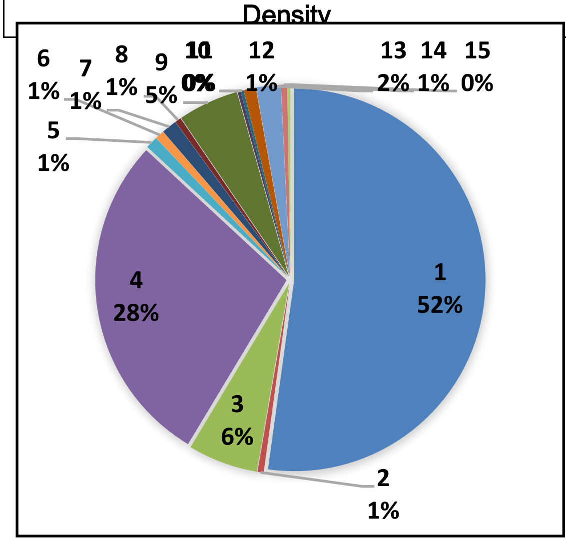
General description

Sistema de referencia	WGS84 UTM 36N	N. Total species plot	15
X	551471.260585	Stratum	0
Y	8519093.418636	Plot height (m)	1610

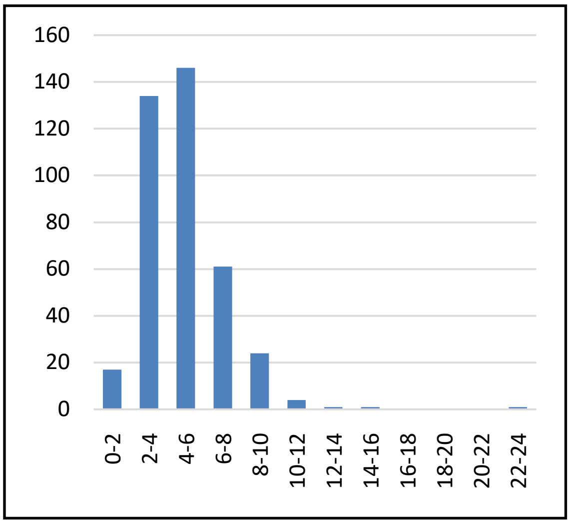
Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	4.6	5.1	12.57	203	6462
2	Anisophyllea boehmii	5.8	5.5	0.17	2	64
3	*Bobgunnia madagascariensis*	5.5	5.1	2.10	23	732
4	*Brachystegia boehmii*	5.3	4.9	9.50	110	3501
5	*Diplorhynchus condylocarpon*	3.7	5.4	0.15	4	127
6	*Dombeya rotundifolia*	3.1	4.5	0.07	3	95
7	*Monotes* spp.	2.8	3.6	0.12	5	159
8	*Ocha schweinfurthiana*	3.1	4.5	0.05	2	64
9	*Parinari curatellifolia*	4.5	4.6	1.22	20	637
10	*Pericopsis angolensis*	3.0	4.4	0.02	1	32
11	*Pterocarpus angolensis*	8.5	7.0	0.18	1	32
12	*Rothmannia engleriana*	5.9	5.3	0.39	4	127
13	Syzygium guineense	3.3	3.6	0.22	8	255
14	*Uapaca kirkiana*	9.9	4.5	0.67	2	64
15	*SP3*	2.4	1.6	0.02	1	32

Density

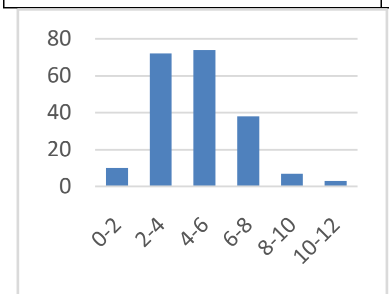


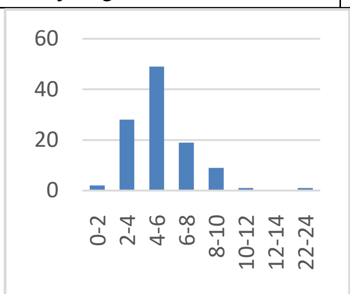
Total diameter distribution

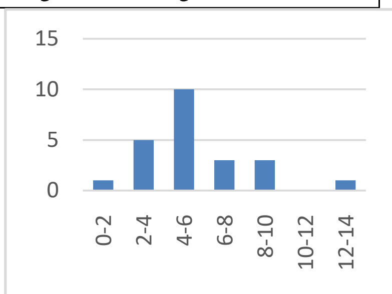


Diameter distribution main species

Albizia antunesiana	*Brachystegia boehmii*	*Bobgunnia madagascariensis*







Forest Inventory Huambo | Plot | 46

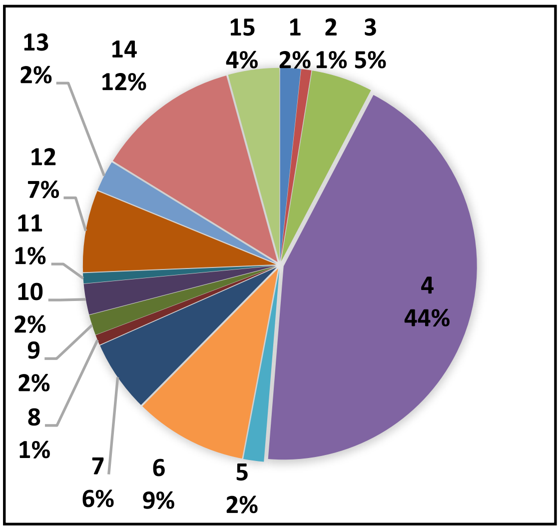
General description

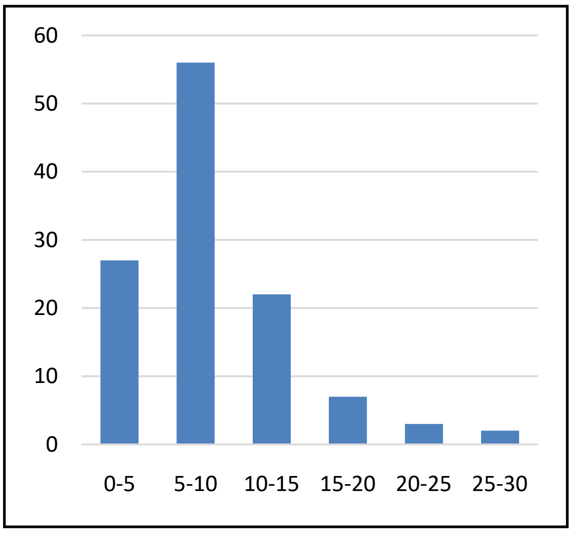
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	15
X	514534.834427	Stratum	2
Y	8592359.026868	Plot height (m)	1476

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	11.0	7.8	0.62	2	64
2	*Brachystegia bohemii*	3.5	3.0	0.03	1	32
3	*Brachystegia spiciformis*	14.0	9.3	3.39	6	191
4	*Combretum collinum*	7.5	6.4	8.92	51	1623
5	*Hymenocardia acida*	3.8	3.2	0.07	2	64
6	*Hymenocardia acida*	4.2	4.9	0.51	11	350
7	*Isoberlinia angolensis*	16.9	8.9	5.62	7	223
8	*Jubernardia paniculata*	15.0	10.7	0.57	1	32
9	*Ochna schweinfurthiana*	15.8	8.5	1.27	2	64
10	*Parinari curatellifolia*	5.7	4.8	0.28	3	95
11	*Pericopsis angolensis*	18.0	8.5	0.82	1	32
12	*Pterocarpus angolensis*	10.7	7.8	2.71	8	255
13	*Rothmannia engleriana*	7.0	5.3	0.42	3	95
14	*Syzygium guineense*	8.5	6.4	2.67	14	446
15	*Uapaca benguellensis*	5.1	7.0	0.47	5	159

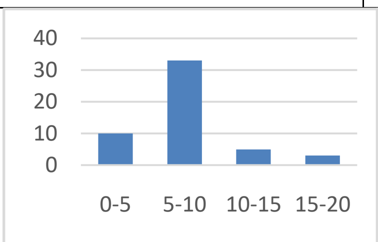
Density	Total diameter distribution

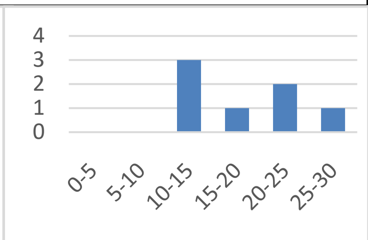


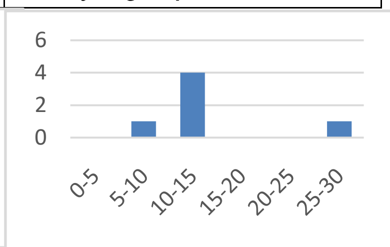


Diameter distribution main species

Combretum collinum	*Isoberlinia angolensis*	*Brachystegia spiciformis*







Forest Inventory Huambo | Plot | 47

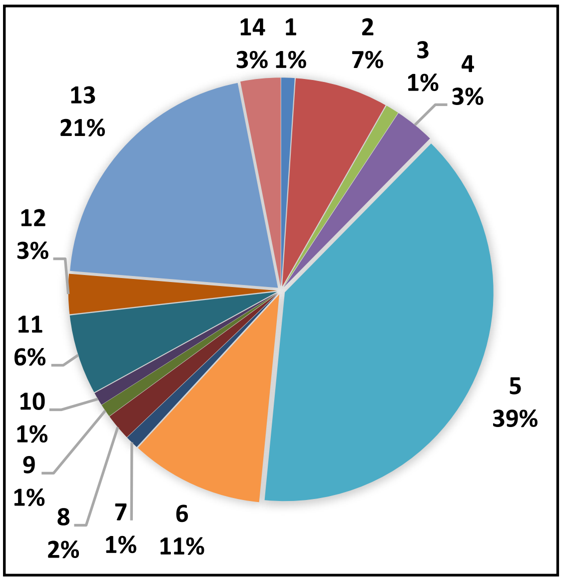
General description

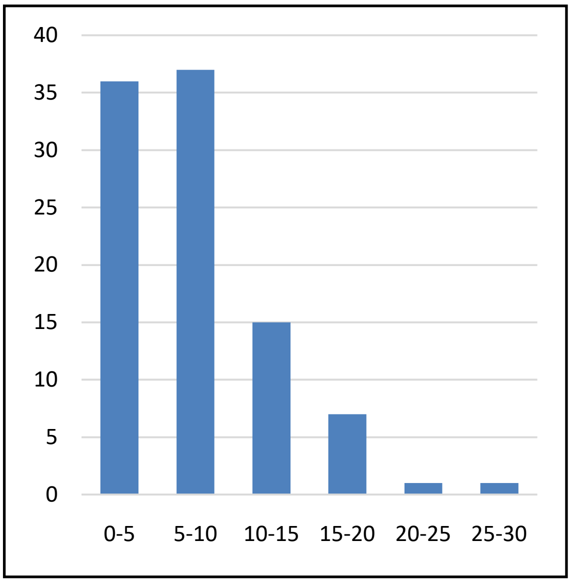
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	14
X	592084.620084	Stratum	0
Y	8693161.799875	Plot height (m)	1781

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Bobgunnia madagascariensis*	6.5	3.4	0.11	1	32
2	*Brachystegia spiciformis*	10.4	6.0	2.13	7	223
3	*Hymenocardia acida*	1.8	2.2	0.01	1	32
4	*Isoberlinea angolensis*	12.7	5.0	1.41	3	95
5	*Jubernardia paniculata*	6.6	4.8	5.62	38	1210
6	*Ocha schweinfurthiana*	5.6	3.6	1.10	10	318
7	*Parinari curatellifolia*	5.4	6.4	0.07	1	32
8	*Pericopsis angolensis*	5.8	5.3	0.17	2	64
9	*Pterocarpus angolensis*	26.7	9.0	1.81	1	32
10	*Sterculia quinqueloba*	7.4	7.4	0.14	1	32
11	*Terminalia brachystemma*	5.6	4.8	0.63	6	191
12	*Uapaca gosswoiler*	10.8	5.6	1.04	3	95
13	*Uapaca kirkiana*	7.4	4.5	3.66	20	637
14	*Upondanjamba*	9.1	5.4	0.77	3	95

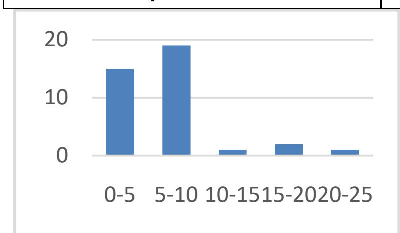
Density	Total diameter distribution

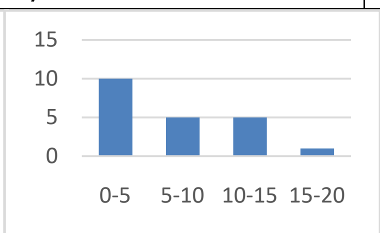


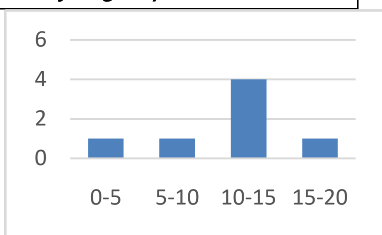


Diameter distribution main species

Jubernardia paniculata	*Uapaca kirkiana*	*Brachystegia spiciformis*







Forest Inventory Huambo | Plot | 48

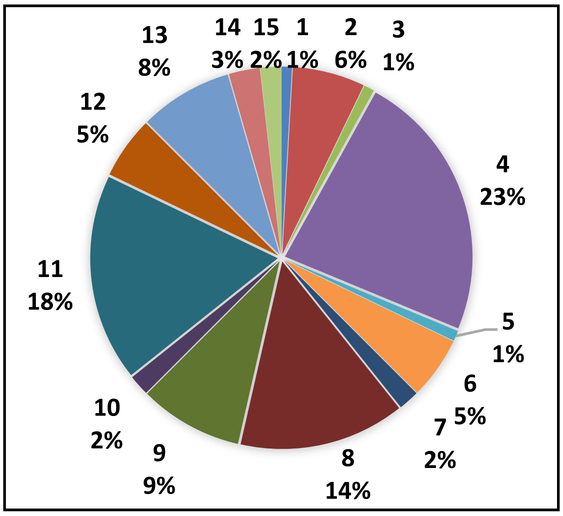
General description

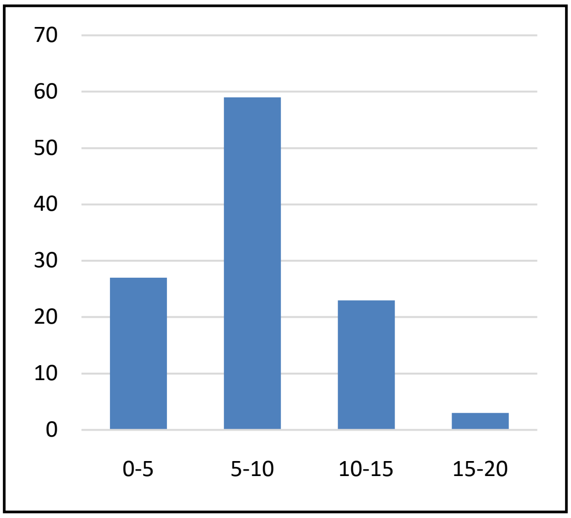
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	15
X	521055.460201	Stratum	0
Y	8664385.674524	Plot height (m)	1566

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Albizia antunesiana*	5.7	1.5	0.08	1	32
2	*Anisophyllea boehmii*	6.8	4.0	0.91	7	223
3	*Brachystegia boehmii*	4.6	2.6	0.05	1	32
4	*Brachystegia spiciformis*	9.7	7.7	6.74	26	828
5	*Brachystegia tamarindoides*	5.7	6.5	0.08	1	32
6	*Diplorhynchus condylocarpon*	6.3	4.2	0.65	6	191
7	*Hymenocardia acida*	4.9	2.6	0.13	2	64
8	*Isoberlinea angolensis*	8.9	7.3	3.44	16	509
9	*Jubernardia paniculata*	8.6	7.4	2.02	10	318
10	*Monotes* spp.	9.2	5.8	0.46	2	64
11	*Ocha schweinfurthiana*	4.3	2.4	1.03	20	637
12	*Parinari curatellifolia*	6.1	4.2	0.74	6	191
13	*Pericopsis angolensis*	8.8	6.3	2.22	9	286
14	*Terminalia brachystemma*	7.4	5.7	0.42	3	95
15	*Uapaca gosswoileri*	8.2	5.3	0.42	2	64

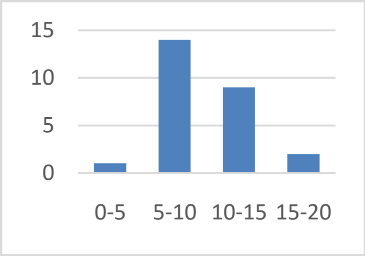
Density	Total diameter distribution

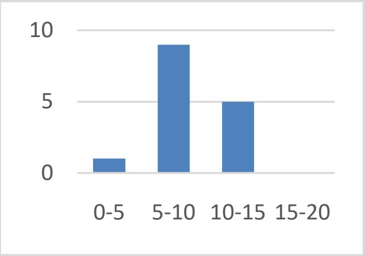


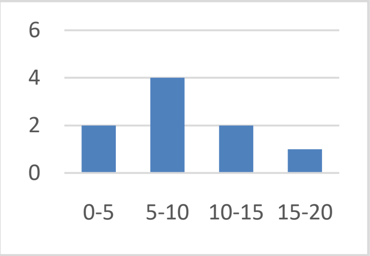


Diameter distribution main species

Brachystegia spiciformis	*Isoberlinea angolensis*	*Pericopsis angolensis*







Forest Inventory Huambo | Plot | 49

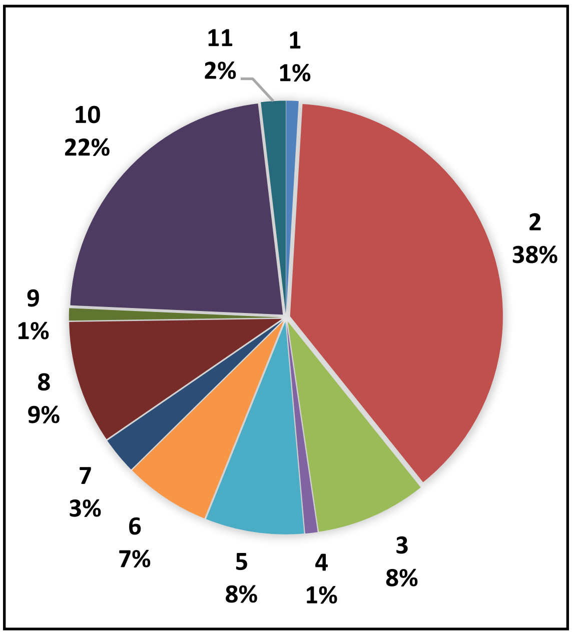
General description

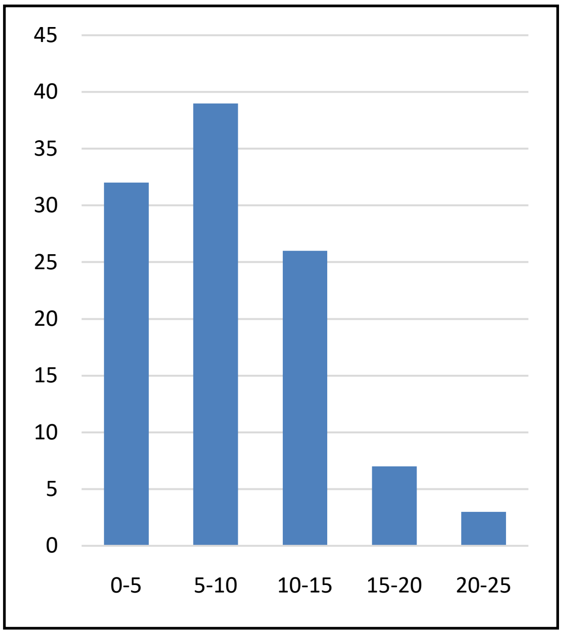
Sistema de referencia	WGS84 UTM 36N	N. Total species plot	11
X	562011.98859	Stratum	2
Y	8726247.486242	Plot height (m)	1367

Stand composition

	*Species	D	H	G	Nplot	Nha
1	*Anisophyllea boehmii*	10.4	1.7	0.27	1	32
2	*Brachystegia tamarindoides*	9.0	5.9	11.08	41	1305
3	*Combretum collinum*	4.7	3.5	0.58	9	286
4	*Diplorhynchus condylocarpon*	4.7	6.4	0.06	1	32
5	*Gardenia volkensii*	5.8	5.4	0.83	8	255
6	*Hymenocardia acida*	7.9	5.2	1.63	7	223
7	*Monotes* spp	10.1	7.7	0.82	3	95
8	*Pterocarpus angolensis*	11.2	7.9	3.50	10	318
9	*Rothmannia engleriana*	4.4	1.6	0.05	1	32
10	Syzygium guineense	7.0	4.6	3.49	24	764
11	*Uapaca gosswoileri*	17.0	9.5	1.65	2	64

Density	Total diameter distribution





Diameter distribution main species

Brachystegia tamarindoides	*Pterocarpus angolensis*	Syzygium guineense