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Potential Natural Vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia)

VOLUME 2

Description and Tree Species Composition for Forest Potential Natural Vegetation types

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Introduction

This book represents **Volume 2** in a seven-volume series that documents the potential natural vegetation map that was developed by the VECEA (Vegetation and Climate change in East Africa) project. The VECEA map was developed as a collaborative effort that included partners from each of the seven VECEA countries (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia).

- In **Volume 1**, we present the potential natural vegetation map that we developed for seven countries in eastern Africa. In Volume 1, we also introduce the concept of potential natural vegetation and give an overview of different application domains of the VECEA map.
- **Volumes 2** to **5** describe potential natural vegetation types, also including lists of the "useful tree species" that are expected to naturally occur in each vegetation type – and therefore also expected to be adapted to the environmental conditions where the vegetation types are depicted to occur on the map. **Volume 2** focuses on forest and scrub forest vegetation types. **Volume 3** focuses on woodland and wooded grassland vegetation types. **Volume 4** focuses on bushland and thicket vegetation types. In **Volume 5**, information is given for vegetation types that did not feature in Volumes 2 to 4.
- **Volume 6** gives details about the process that we followed in making the VECEA map.
- **Volume 7** shows the results of modelling the distribution of potential natural vegetation types for six potential future climates.

Acknowledgements

We are extremely grateful to the Rockefeller Foundation for having funded most of the work that has led to the development and publication of the VECEA map and its accompanying documentation.

We also greatly appreciate the comments and suggestions that were made by Paul Smith and Jonathan Timberlake (both of Royal Botanic Gardens Kew) when they reviewed early drafts of volumes 2, 3, 4 & 5.

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Thanks to Eugene Kayijamahe, Center for Geographic Information System and Remote Sensing at National University of Rwanda for sharing the digital map "Vegetation of Volcanoes National Park" that allowed us to classify in greater detail this part of the VECEA map.

Thanks to UNEP-GEF for funding the Carbon Benefits Project (CBP) through which information was compiled on indicator and characteristic species for The Vegetation Map of Africa (White 1983). (This work led to the publication in 2011 of an Africa-wide tree species selection tool that is available from: *http://www.worldagroforestrycentre.org/our_products/databases/ useful-tree-species-africa)* Thanks to BMZ for funding the ReACCT project in Tanzania through which funding was made available for field verification of the VECEA map around Morogoro (this was essential in preparing the VECEA map as the base map for Tanzania was essentially a physiognomic map.

Abbreviations

Abbreviation	Full
A	Afroalpine vegetation
B	Afromontane bamboo
Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Be	Evergreen and semi-evergreen bushland and thicket
bi (no capital)	Itigi thicket (edaphic vegetation type)
br (no capital)	Riverine thicket (edaphic vegetation type, mapped together with riverine forest and woodland)
C	In species composition tables: we have information that this species is a characteristic (typical) species in a national manifestation of the vegetation type
D	Desert
DBH	diameter at breast height (1.3 m)
E	Montane *Ericaceous* belt (easily identifiable type)
f (no capital)	In species composition tables: since this species is present in the focal country and since it was documented to occur in the same vegetation type in some other VECEA countries, this species potentially occurs in the national manifestation of the vegetation type
Fa	Afromontane rain forest
Fb	Afromontane undifferentiated forest (Fbu) mapped together with Afromontane single-dominant *Juniperus procera* forest (Fbj)
Fc	Afromontane single-dominant *Widdringtonia whytei* forest
fc (no capital)	Zanzibar-Inhambane scrub forest on coral rag (edaphic forest type)
Fd	Afromontane single-dominant *Hagenia abyssinica* forest
Fe	Afromontane moist transitional forest
fe (no capital)	Lake Victoria *Euphorbia dawei* scrub forest (edaphic forest type mapped together with evergreen and semi-evergreen bushland and thicket)
FeE	distinct subtype of Afromontane moist transitional forest in Ethiopia
FeK	distinct subtype of Afromontane moist transitional forest in Kenya
Ff	Lake Victoria transitional rain forest
Fg	Zanzibar-Inhambane transitional rain forest
Fh	Afromontane dry transitional forest
Fi	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest
FLD	Forest & Landscape (URL *http://sl.life.ku.dk/English.aspx)*
Fm	Zambezian dry evergreen forest
Fn	Zambezian dry deciduous forest and scrub forest
Fo	Zanzibar-Inhambane lowland rain forest
Fp	Zanzibar-Inhambane undifferentiated forest
Fq	Zanzibar-Inhambane scrub forest
fr (no capital)	Riverine forests (edaphic forest type mapped together with riverine woodland and thicket)
Fs	Somalia-Masai scrub forest (mapped together with evergreen and semi-evergreen bushland and thicket)
fs (no capital)	Swamp forest (edaphic forest type)
G	Grassland (excluding semi-desert grassland and edaphic grassland)
g (no capital)	Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type)
gv	Edaphic grassland on volcanic soils (edaphic subtype)
ICRAF	World Agroforestry Centre (URL *http://www.worldagroforestry.org/*)
L	Lowland bamboo
M	Mangrove
P	Palm wooded grassland (physiognomically easily recognized type)
PROTA	Plant Resources of Tropical Africa (URL *http://www.prota.org/*)
S	Somalia-Masai semi-desert grassland and shrubland

s (no capital)	Vegetation of sands (edaphic type)
T	*Termitaria* vegetation (easily identifiable and edaphic type, including bush groups around *termitaria* within grassy drainage zones)
UNEP	United Nations Environment Programme (URL *http://www.unep.org/*)
VECEA	Vegetation and Climate Change in Eastern Africa project (funded by the Rockefeller Foundation)
Wb	Vitellaria wooded grassland
Wc	Combretum wooded grassland
Wcd	dry *Combretum* wooded grassland subtype
Wcm	moist *Combretum* wooded grassland subtype
WCMC	World Conservation Monitoring Centre (URL *http://www.unep-wcmc.org/*)
wd (no capital)	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type)
We	Biotic *Acacia* wooded grassland
Wk	Kalahari woodland
Wm	Miombo woodland
Wmd	Drier miombo woodland subtype
Wmr	Miombo on hills and rocky outcrops subtype
Wmw	Wetter miombo woodland subtype
Wn	north Zambezian undifferentiated woodland and wooded grassland (abbreviation: undifferentiated woodland)
Wo	Mopane woodland and scrub woodland
wr (no capital)	Riverine woodland (edaphic vegetation type, mapped together with riverine forest and thicket)
Wt	*Terminalia sericea* woodland
Wvs	*Vitex - Phyllanthus - Shikariopsis (Sapium) - Terminalia* woodland (not described regionally)
Wvt	*Terminalia glaucescens* woodland (not described regionally)
Wy	Chipya woodland and wooded grassland
X	Fresh-water swamp
x (no capital)	In species composition tables: we have information that this species is present in a national manifestation of the vegetation type
Z	Halophytic vegetation
ZI	Zanzibar-Inhambane coastal mosaic (Kenya and Tanzania coast)

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1. Definition of forest

Forests are continuous stands of trees at least 10 m tall with interlocking crowns (White 1983 p. 46, Figure 1). This physiognomic type has similar height as **woodlands** (with height of at least 8 m), but woodlands never have densely interlocking crowns (although the crowns can be in contact). Woodlands can often also be distinguished from forests by the presence of heliophilous ('sun-loving') grasses in the field layer - a result from the light open canopy of woodlands. Forests have larger height than **bushlands** and **thickets** (both with maximum height of 7 m, the latter distinguished as an impenetrable community of densely interlaced bushes except along tracks made by animals).

Whereas forests are defined physiognomically to have 100% canopy cover, in reality vegetation types with canopy cover above 80% (not 100%) are likely to be classified as forest. A critical factor here is not just the physiognomy, but the species composition that indicates that the vegetation type is degraded forest (and hence the potential natural vegetation type is forest). As forest vegetation types have quite a different suite of species from woodland vegetation types, floristic information (i.e. information on species composition) allows classifying most vegetation types with canopy cover above 80% as forest potential natural vegetation types (J. Timberlake, pers. comm.).

White (1983 p. 46) distinguishes **scrub forests** as a physiognomic formation of local extend. Scrub forests are intermediate in structure between forest and bushland and thicket. They are usually 10 - 15 m high. Trees (woody plants with well-defined and upright boles) are usually present but do not form a closed canopy. Smaller woody plants (principally bushes and shrubs) contribute at least as much as the trees to the appearance of the vegetation and its phytomass. Within the VECEA classification system, four scrub forests were classified together with forests: Zanzibar-Inhambane scrub forest [Fq], Somalia-Masai scrub forest [Fs], Zanzibar-Inhambane scrub forest on coral rag [fc] and Lake Victoria *Euphorbia dawei* scrub forest [fe]). We made no distinction between forest and scrub forest subtypes for Zambezian dry deciduous forest and scrub forest (Fn).

In the VECEA map we follow White (1983 pp. 54 – 55) in not classifying mangroves (M, see volume 5) as a subtype of forests, but as a distinct physiognomic category.

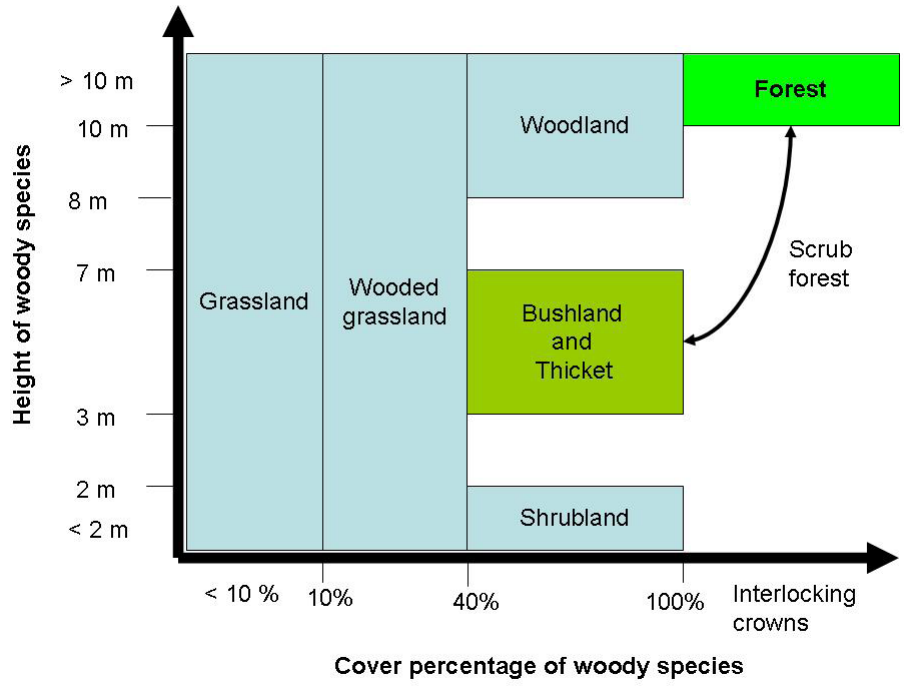


Figure 1. Height and cover percentage limits for major physiognomic types. Scrub forest is defined as a physiognomic mosaic of forest and bushland and thicket

2. Methodology

2.1. Main description of a forest type

In these sections, we relied heavily on *The Vegetation of Africa* (White 1983) - especially since this reference built on the extensive expertise that White (1983) and his co-authors obtained from literature (including 2400 references) and field work (including the experience from many reviewers [White 1983 p. 13]). By comparing species composition described at national (or subnational levels) with species composition described at a continental level, we were seeking to identify potential natural vegetation types of continental relevance that included the various national "manifestations" of these continental vegetation types. Moreover, we now expect to have set the stage for a potential further expansion of the VECEA map in other countries in Africa. **Within the structure of this volume, the first section ("description") within the description of a particular forest type refers to the "regional information" that was mainly obtained from "The Vegetation of Africa" (White 1983).**

2.2. Information for the VECEA region

Other than the key reference of The Vegetation of Africa (White 1983), we mainly consulted the references that were directly associated with the base maps that we used: Ethiopia, Kenya (two different maps, see volume 6), Rwanda (Bloesch *et al.* [2009] contains an updated version of the vegetation map prepared by Prioul [1981] (or possibly by Georges Troupin); the latter is the vegetation map that we digitized (see volume 6), Uganda and Zambia. For two countries, information was limited and we therefore reverted to various other references: Malawi and Tanzania. **Within the structure of this volume, the second section ("VECEA region") within the description of a particular forest type refers to information that was obtained from one of the national descriptions of the seven VECEA countries.**

The second section also explains the correspondence between the mapping units of the regional map (the VECEA map) and the national maps. For more details how the regional map was obtained from the national maps, see volume 6.

2.3. Information on species assemblages for a particular forest type

For each of the forest types, we obtained information on species assemblages (those tree species expected to occur in a particular forest) based on information that was provided in the national references. For each of the countries where we had information on the national "manifestation" of a forest type (for example, Afromontane rain forest as it was described for Ethiopia by Friis *et al.* 2010), we created a separate column within which we

gave an indication that a particular tree species was expected to occur within that forest type and within that country.

Where species were not listed in the national reference for a focal country, we checked with information on national lists of all the tree species that occur in the focal country[1] whether the species could **potentially** occur in the focal forest type and focal country **because the species was documented to occur in the same forest type in other countries**. For example, the species *Cyathea dregei* was documented to occur in Afromontane rain forest in Malawi, Rwanda and Zambia. From the UNEP-WCMC species database, there was information that this species also occurs in Ethiopia. This led us to indicate that there was information that the species **potentially** occurred in Afromontane rain forest in Ethiopia (we used the coding of "f" in the species assemblage table to indicate this). **Note that it is possible that species indicated with "f" for a particular country and forest type do NOT occur in that particular country and forest type in reality (meaning that, in reality, differences exist between species assemblages of the same forest type between countries – or possibly indicating errors in the obtained species assemblage for a particular country).**

We used a consistent naming system for all the species that were listed in this volume. Information on synonyms (see Appendix 2) was mainly obtained from the African Plants Database (URL *http://www.ville-ge.ch/musinfo/bd/cjb/africa*), whereas we generally attempted to use the same botanical names as adopted in the Plant Resources of Tropical Africa (PROTA) database (URL *http: //www.prota4u.org/*). Generally we did not differentiate below the species level. Even though the type species of the *Acacia* genus has recently been modified to be an Australian species (previously the type species was *Acacia nilotica*), we will continue to use the name of *Acacia* (in its widest sense, i.e. combining *Senegalia* and *Vachellia*) in Africa.

After compiling information on species assemblages, we selected a subset of tree species to feature in species composition tables. These were mainly "useful tree species", which are tree, bushland or liana species that were listed in at least one of the references that we consulted on tree species that are expected to be useful to farming or pastoral communities in the VECEA countries (see Appendix 1).

The regional information (*i.e.* mainly White 1983) was used to collate information on the "regional status" of a species. The regional status included regional information on "indicators", "characteristic species" and "species that are not characteristic". We defined these categories as:

- **Indicator**: A species that was **only listed for the focal forest type** among all the forest types described for the same floristic region as of the focal forest type. For example, *Chrysophyllum gorungosanum* is a (regional) indicator for Afromontane rain forest since this species was only listed for Afromontane rain forest (White 1983 p. 164) among all the forests described for the Afromontane floristic region.

1: These floristic references included the UNEP-WCMC species database, the Flora of Tropical East Africa (for Kenya, Tanzania and Uganda), the Flora Zambesiaca (for Malawi and Zambia), and some of the national references (Friis *et al.* 2010 for Ethiopia; Beentje (1994) for Kenya; Bloesch *et al.* 2009 for Rwanda; the Uganda Forest Department Biodiversity Database (Howard & Davenport [1996], Viskanic [1999]) for Uganda; and Burgess and Clarke (2000) for the coastal areas of Kenya and Tanzania)

- **Characteristic species**: A species that was listed **for more than one** of the forest types that were described for the same floristic region, **including the focal forest type**. For example, *Diospyros abyssinica* is a characteristic species for Afromontane rain forest since it is listed for Afromontane rain forest (White 1983 p. 164), but is also listed for Afromontane dry transitional forest (White 1983 p. 166).
- **Species that are not characteristic**: A species that was **listed once** among all the forest types described for the same floristic region as the focal forest type, but that was **not listed** for the focal forest type. For example, *Albizia gummifera* is a negative indicator for Afromontane rain forest since this species was only listed for Afromontane dry transitional forest (White 1983 p. 166) among all the forests described for the Afromontane floristic region (and thus not listed as a species for Afromontane rain forest).

Information on indicators was used to identify the VECEA forest type during the compilation of the VECEA map from information on national forest types. **For each of the national forest types, selected VECEA forest type was the forest type with the highest number of indicators (for this analysis, the complete species assemblages were investigated [i.e. not only the subset of species shown in the species composition tables in the 'sections 3']**).

We did not compile lists of indicators for riverine forests (fr) and swamp forests (fs) since these forest types can be easily recognized in the field. In other words, we did not find it necessary for these forest types to re-confirm the regional classification as riverine or swamp forest.

2.4. Information on the distribution of altitude, rainfall and temperature for each forest type

We obtained information on annual rainfall and annual mean temperature from Worldclim (Hijmans *et al.* 2005; resolution of 30 arc seconds [~ 925 m]). Information on altitude was obtained from CGIAR-CSI (2008; resolution of 3 arc seconds [~ 90 m]). We created a layer of sample points at a density of approximately one point per 5 km^2 and with a minimum distance of 900 m. In a next step, we sampled the environmental data layers at the sample point locations. All steps were carried out in the GRASS GIS software (GRASS Development Team 2010).

For histograms, we excluded sample points from vegetation mosaics (*i.e.* polygons that contained more than one vegetation type). In each histogram, we compare the distribution of altitude, temperature and rainfall of the focal forest type with the distributions for all vegetation types and for all forest types combined. The information for the combined vegetation types was also based on exclusion of sample points from vegetation mosaics.

3. Afromontane rain forest (Fa)

3.1. Description

Afromontane rain forest is very similar in structure (physiognomy) to certain types of Guineo-Congolian rain forest. Species composition, however, is almost entirely different (many tree genera have different species in Afromontane rain forest and Guineo-Congolian rain forest, on the other hand). Other physiognomic and floristic differentiation between Afromontane rain forest and Guineo-Congolian rain forest include the greater degree of bud protection, a lesser degree of drip tips of leaves development, the occurrence of tree ferns (*Cyathea*) and the occurrence of conifers (*Podocarpus*; especially *Podocarpus latifolius* as *Podocarpus falcatus* (synonym: *P. gracilior*) are more characteristic of Afromontane undifferentiated forest; White 1983 p. 164 - 165).

These forests occur mainly between 1200 and 2500 m on the slopes of certain mountains. However, the altitudinal limits vary greatly according to distance from the equator, proximity to the ocean, and size and configuration of the massif on which these forests occur (White 1983 p. 164). The observation that vegetation belts are scaled according to the size of the mountain on which they occur were first observed in the Alps, where this phenomenon is described as the 'Massenerhebung effect' (mass-elevation effect). The mean annual rainfall lies mostly between 1250 and 2500 mm. Mists that frequently occur during the dry season of one to five months may explain the fact that Afromontane rain forest is much less deciduous than lowland semi-evergreen forests that receive similar rainfall. Only a few of the larger tree species (*Entandophragma excelsum* and *Pouteria adolfi-friedericii*) lose their leaves - and then only for a few days (White 1983 p. 164).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Afromontane rain forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps include ***Chrysophyllum gorungosanum, Cola greenwayi, Cylicomorpha parviflora, Entandrophragma excelsum, Ficalhoa laurifolia, Hallea rubrostipulata, Myrianthus holstii, Ochna holstii, Ocotea usambarensis, Olea capensis, Parinari excelsa, Pouteria adolfi-friedericii, Strombosia scheffleri, Syzygium guineense*** **ssp.** ***afromontanum*** and ***Tabernaemontana stapfiana***.

Figure 3.1 View of canopy from Afromontane rain forest (synonym: moist evergreen Afromontane forest) north of Masha (Ethiopia). Altitude approximately 1950 m. Photograph by I. Friis and Sebsebe Demissew (September 2002). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25A. 2010.

Figure 3.2 Afromontane rain forest in Nyungwe National Park (Rwanda). Photograph by C. K. Ruffo (June 2008).

Figure 3.3 *Cyathea manniana* tree ferns in Lake Victoria transitional rain forest (Ff). The presence of tree ferns (*Cyathea* species) is typical for Afromontane rain forest (White 1983 p. 164). However, this species also occurs in other types of forests with admixture of Afromontane species. Photograph by F. Gachathi (2009).

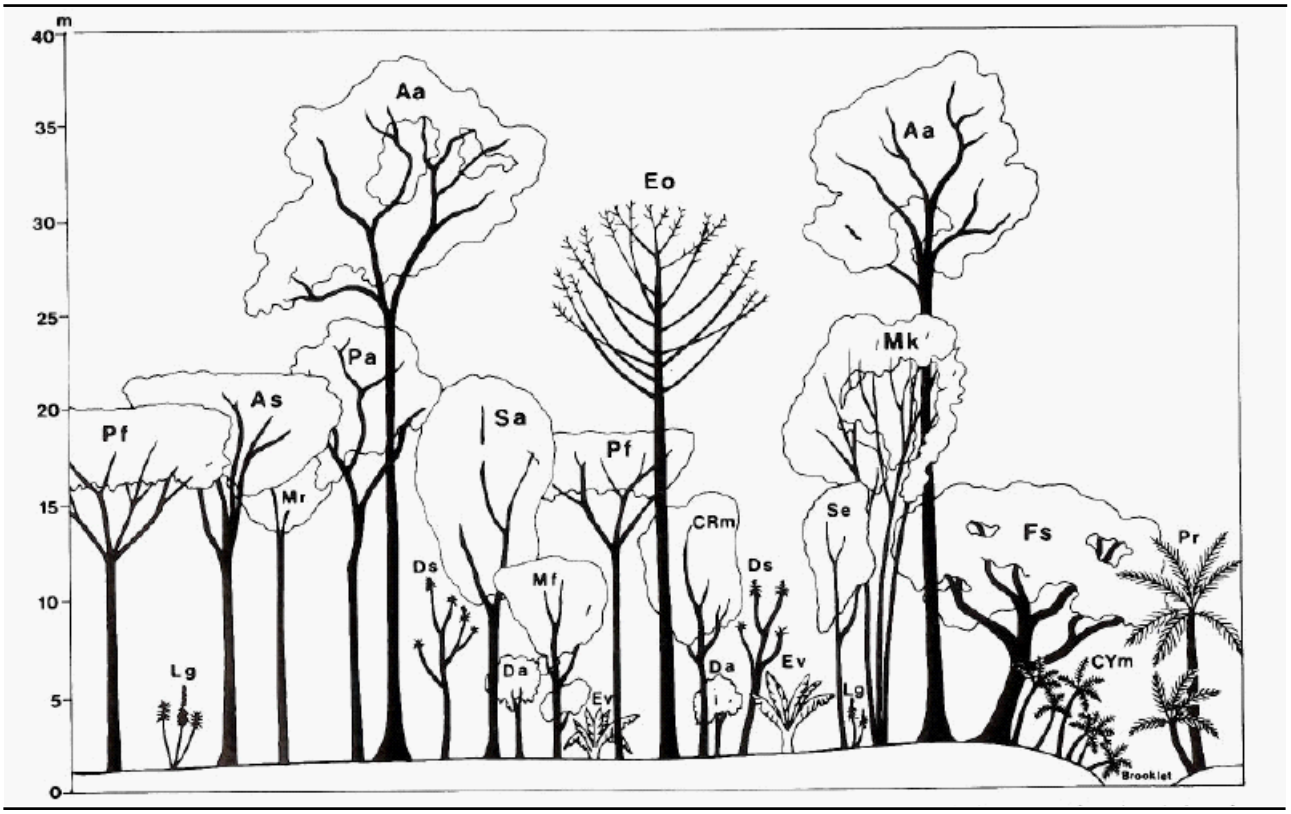


Figure 3.4 Transect of Primary or mature secondary moist evergreen Afromontane forest (classified in VECEA as Afromontane rain forest [Fa]). Generalised representation based on observations made in old secondary forest at approximately 1700 metres altitude south of Gore, IL floristic region. Although this locality is situated just below the altitudinal limit used for mapping (6) Moist evergreen Afromontane forest (Fa) no species restricted to (7) Transitional rain forest (mapped in VECEA as Afromontane moist transitional forest [Fe]) were observed, but a few species, for example *Hallea rubrostipulata*, are known from both vegetation types. The abbreviated names for the species stand for: Aa: *Pouteria (Aningeria) adolfi-friederici*. As: *Albizia schimperiana*. CRm: *Croton macrostachyus*. CYm: *Cyathea manniana*. Da: *Dracaena afromontana.* Ds: *Dracaena steudneri*. Eo: *Euphorbia ampliphylla*. Ev: *Enset ventricosum*. Fs: *Ficus sur*. Lg: *Lobelia giberroa*. Mf: *Millettia ferruginea.* Mk: *Macaranga capensis* var. *kilimandscharica*. Mr: *Hallea (Mitragyna) rubrostipulata*. Pa: *Prunus africana*. Pf: *Polyscias fulva*. Pr: *Phoenix reclinata*. Sa: *Schefflera abyssinica*. Sa: *Sapium ellipticum*. Drawn by Victoria C. Friis. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 24. 2010.

3.2. VECEA region

Within the VECEA region Afromontane rain forest occurs in all countries (see Figure 3.5, see also volume 6). However, the extent of this forest type in Zambia is very small.

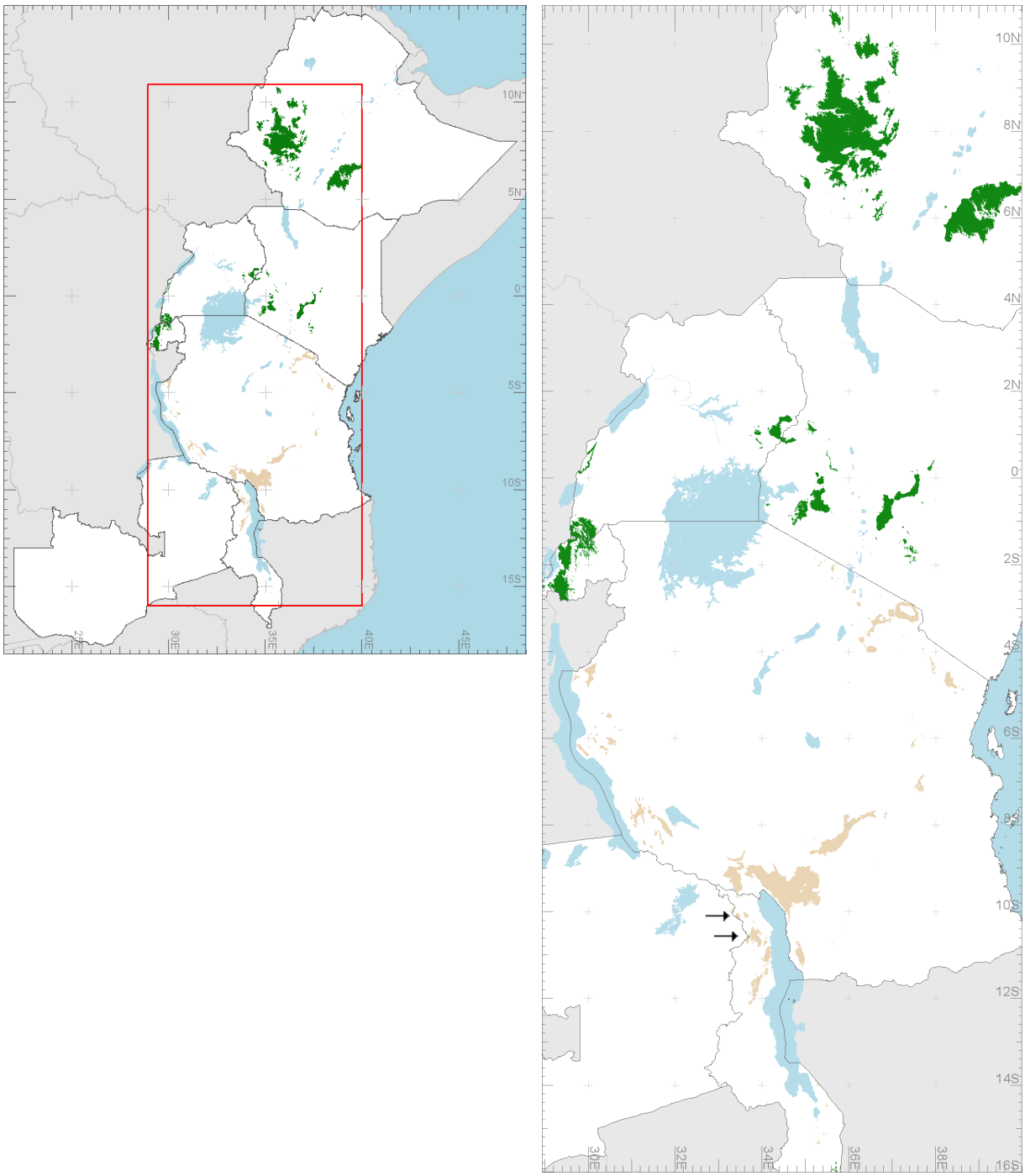


Figure 3.5. Mapped distribution of Afromontane rain forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. In Malawi and Tanzania, this vegetation type is mapped as part of different forest mosaics (shown in greyish-brown). In Zambia, this vegetation map was originally mapped together with Afromontane undifferentiated forest (Fbu) near the border with Malawi; since these vegetation mosaics (greyish-brown) are very small when depicted on small-scale distribution maps, we added arrows to indicate the position of these forest mosaics in Zambia.

In Ethiopia, Afromontane rain forest was originally described and mapped under the synonym of primary or mature secondary moist evergreen Afromontane forest (MAF-P). Friis *et al.* (2010, pp. 93, 98 and 99) mention that the absence of *Juniperus procera* and limited prominence of *Podocarpus falcatus* is a key criterion to distinguish Afromontane rain forest from Afromontane undifferentiated forest (Fbu).

The Ethiopian subtype of "Edges of moist evergreen Afromontane forest" (coded MAF-BW)" was not mapped separately. We consider this vegetation type to be one of the seral stages of forest regeneration. ***Acacia abyssinica*** is among the species that are often dominant (Friis *et al.* 2010 p. 103).

In Kenya, Afromontane rain forest was originally described and mapped under the synonym of moist montane forest.

In Malawi, Afromontane rain forest was orginally described and mapped under the synonym of Afromontane rain forest.

In Rwanda, Afromontane rain forest was orginally described and mapped under the synonym of "forêt ombrophile de montagne".

The Tanzanian types of "upper montane forest" and "montane forest" were both classified in the VECEA map as Afromontane rain forest, although Lovett (1993a) only treated "montane forest" (altitude 1200 - 1800 m, annual rainfall > 1200 mm) as a synonym of Afromontane rain forest sensu White (1983). Lovett (1993a) classified "upper montane forest" (altitude > 1800 m and annual rainfall > 1200 mm) as "wetter types of Afromontane undifferentiated forest sensu White (1983)". Lovett (1993a) had further reserved his classification of "dry montane forest" (altitude > 1500 m and annual rainfall 1000 - 1200 mm) to "drier types of Afromontane undifferentiated forest sensu White (1983)". Our interpretation of "upper montane forest sensu Lovett (1993a)" as a synonym of "Afromontane rain forest sensu White (1983)" was inspired on: (i) the absence of *Juniperus procera* and *Podocarpus falcatus*; (ii) the presence of the indicator species of *Ficalhoa laurifolia*, *Ochna holstii*, *Ocotea usambarensis*, *Olea capensis* and *Pouteria adolfi-friedericii*; (iii) the lower frequency (3 < 5) of species of *Ilex mitis*, *Nuxia congesta* and *Rapanea melanophloeos* that indicate Afromontane undifferentiated forest; (iv) not interpreting White's (1983 p. 165) description that Afromontane undifferentiated forest replaces Afromontane rain forest at higher altitudes on the wetter slopes as a dichotomy between moister and drier types of undifferentiated forest (lack of a drier-wetter dichotomy in Afromontane rain is also more conform with the other statement of White (1983) that Afromontane undifferentiated forest **usually**, but not always, receives a lower rainfall than Afromontane rain forest); and (v) not having seen other references that make the distinction between "moister" and "drier" variants of Afromontane undifferentiated forest.

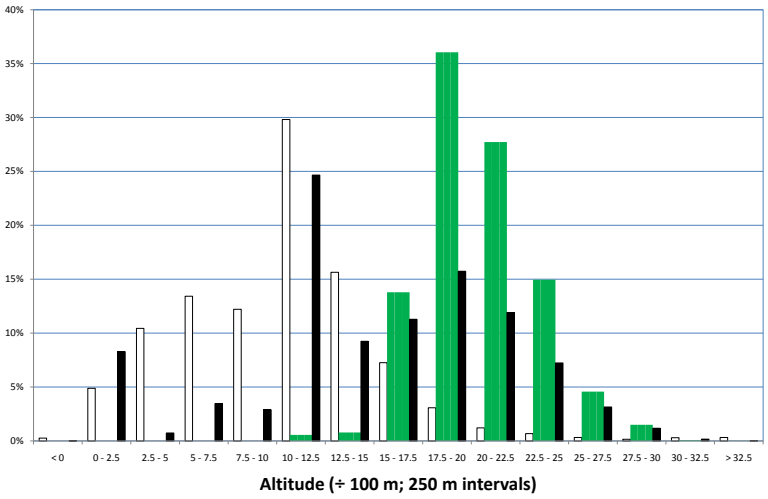
In Uganda, Afromontane rain forest was orginally described and mapped under the synonym of *Prunus* moist montane forest. Langdale-Brown *et al.* (1964 p. 42) used the name of *Prunus* (actually the synonym of *Pygeum*)

moist montane forest as the name for Afromontane rain forest, although they also mentioned that this species seldom forms pure stands and that the locally dominant species may not be *Prunus africana*. Moreover, *Prunus africana* is also a species that they listed to occur in Afromontane single-dominant *Hagenia abyssinica* forest (Fd) and various subtypes of Lake Victoria drier peripheral Guineo-Congolian rain forest (Fi).

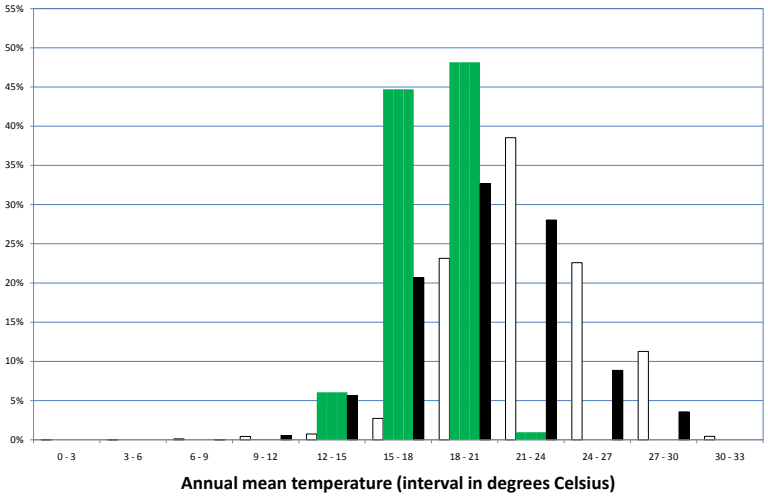
In Zambia, Afromontane rain forest was orginally described as moist montane forest. In the original vegetation map of Zambia, this vegetation type was mapped together with Afromontane undifferentiated forest (Fbu).

Investigation of environmental distribution of Afromontane rain forest in the VECEA region (Figure 3.6; limits are for areas of the VECEA map where this forest type is not mapped as mosaic) show similar distribution in altitude (with > 90% of the samples in an interval from 1500 – 2500 m) as reported by White (1983; also see section 3.1). Afromontane rain forest is among the forest types that occur at the highest altitudes. The altitude interval of 1750 – 2000 m contains the highest number of samples (36.0%); only Afromontane undifferentiated forest (Fbu and Fbj mapped together) and Afromontane single-dominant *Hagenia abyssinica* forest have most of their samples in higher altitude classes. Annual rainfall of Afromontane rain forest is mainly between 800 and 2000 mm (97.8% of samples). This interval includes lower rainfall than the interval of 1250 to 2500 mm reported by White (1983); see section 3.1). However, this forest type has the highest rainfall interval where most samples occur (34.9% in the 1800 – 2000 mm interval) of all forest types.

(a)



(b)



(c)

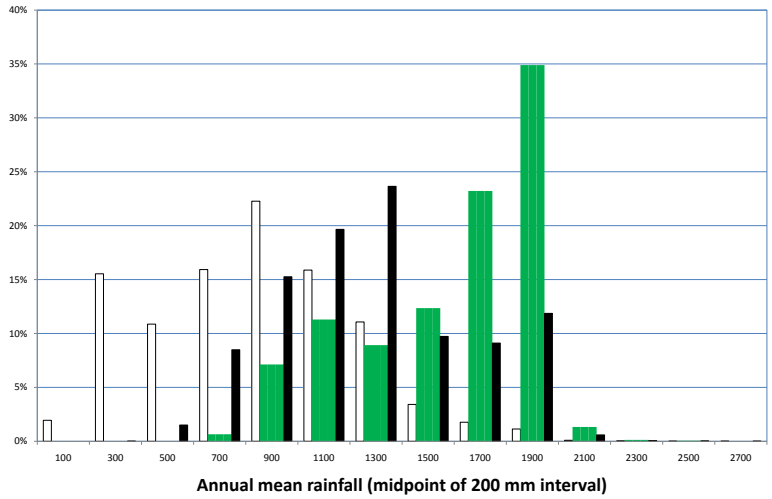


Figure 3.6. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Afromontane rain forest (Fa, *n* = 17,664). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,0013).

3.3. Species composition

Species assemblages were obtained from the following references:

- Ethiopia: Friis *et al.* 2010. Species mentioned in Appendix 3 for "Primary or mature secondary moist evergreen Afromontane forest" [MAF-P] were coded "x" (unless they were characteristic species). Species mentioned for "Edges of moist evergreen Afromontane forest, bushland, woodland and wooded grassland" [MAF/BW] were coded "e".
- Kenya: Trapnell (1997). Species listed in Annex 1 for "moist montane forest, west and east", "moist montane forest, east", "montane sclerophyll and/or moist montane forest", "moist montane and/or moist intermediate forest" and "of more general distribution" were coded "C". Suffix "b" indicates that species was listed to only occur marginally in the forest or in montane bamboo. Suffix "e" indicates that the species was listed for "moist montane forest, east". Suffix "g" indicates species of more general distribution. Suffix "i" indicates invasive species. Suffix "m" indicates that the species was also listed for Afromontane moist transitional forest (Fe; synonym: moist intermediate forest). Suffix "s" indicates secondary species. Suffix "r" indicates residual species after selective felling. Suffix "u" indicates that the species was also listed for Afromontane undifferentiated forest (Fb; synonym: montane sclerophyll forest). Numbers show the maximum height of the species provided in the Annex (Trapnell 1997). Species that were expected to occur in the forest type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x".
- Malawi: White *et al.* (2001). Species were included in species assemblages partially based on the interpretation of our Malawian co-author (C. Dudley) since species were not consistently allocated to forest types in the reference that was consulted. These species were coded "x" (unless they were characteristic species).
- Rwanda): Bloesch *et al.* (2009). All species that were mentioned to occur in floristic region 3 (montane forests of the Congo and Nile basin [3B] and forest remnants and secondary vegetation [3A]), that had part of their distribution range above 1900 m and where a reference was made to a forest habitat ('forêt') in the description of their ecology were coded "x" (unless they were characteristic species).
- Tanzania (columns "FarT" and "FawT"): Lovett (1993ab). Species that were mentioned for "montane forest" in Lovett (1993a; altitude 1200 - 1800 m; rainfall 1000 > 1200 mm) were coded "x" in column FarT. In a separate column (FawT), species that were mentioned for "upper montane forest" in Lovett (1993a; altitude > 1800 m; rainfall > 1200 mm) were coded "C" (since these were assumed to be characteristic species). Species that were only mentioned for "upper montane forest" in Lovett (1993b; altitude 1800 - 2900 m; annual rainfall > 1500 mm) were coded "x".
- Uganda (column "FaU"): Langdale-Brown *et al.* (1964). All spe-

cies that were listed to occur in "*Prunus* [synonym: *Pygeum*] moist montane forest" in the Appendix were coded "x" (unless they were characteristic species). Species listed in the Appendix for forest - wooded grassland mosaics of high altitudes[2] occurring on moister sites were coded "s1", whereas no new species were committed to the species assemblage.

- Zambia (column "FaZ"): Fanshawe (1971 pp. 28 - 31). Species that were listed to occur in the species composition table for "montane forest" were coded "fx" (Fanshawe did not distinguish between Afromontane rain forest and Afromontane undifferentiated forest in the species composition table for montane forest) in case that a species was also listed within the species assemblage of another country.

Characteristic species were determined as:

- Ethiopia: Those species that were mentioned in the description of the vegetation type in the main text were coded as "C".
- Kenya: Species that were listed by Trapnell (1997) were assumed to be characteristic species (these were coded "C").
- Malawi: Species identified to be present as emergent trees (30 - 45 m) or large trees (20 - 30 m, including stranglers) were coded as "C". Species recorded to have a marginal occurrence were not listed as characteristic species.
- Rwanda: Characteristic species were coded "C". These included: (i) species listed by Prioul (1981) to occur in forests at altitudes of 1900 - 2200 m and above 2200 m; (ii) species listed by Lebrun (1956) to occur in 'forêt ombrophile de montagne' or 'forêt de la dorsale du Ruanda'; and (iii) species listed by Habiyaremye (1997) to occur in *Parinari-Ocotea* forest, *Carapa-Strombosia* forest or *Carapa-Beilschmiedia* forest.
- Tanzania: species listed by Lovett (1993a) were coded "C".
- Uganda: Species characterized as large trees in the appendix or that were mentioned in the main text where the forest type was described were coded "C".
- Zambia: Species for which the genera were mentioned for moist types of montane forest that occur on the lower slopes and ravines were coded "C". Species or genera that were mentioned for secondary wet types around seepage heads were coded "Cs".

Within the information on assemblages, coding "f" indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

2: Langdale-Brown *et al.* (1964 p. 52) mention that trees mentioned in the appendix are from Mt. Elgon and are mostly remnants of a previous Afromontane rain forest (original mapping unit B1).

Table 3. Species composition of Afromontane rain forest (Fa)

Species	**Regional status** see section 2.3	**(Ethiopia)**	**(Kenya)**	**(Malawi)**	**(Rwanda)**	**FarT (Tanzania subtype)**	**FawT (Tanzania subtype)**	**(Uganda)**	**Zambia)**
Acacia abyssinica	(invasive)	e	Ci	x	f	f	f	f	
Acacia lahai	(invasive)	f	x			f	f	f	
Acacia mearnsii	(exotic)	f	f		x	f	f	f	f
Agauria salicifolia		f	x	x	x	f	x	f	Cs
Albizia grandibracteata		C	x		f	f	f	f	
Albizia gummifera	not characteristic (near streams in Afromontane dry transitional forest)	Ce	Cgs30	C	f	x	f	C s1	fx
Albizia schimperiana		Ce	f	C		f	f	f	f
Alchornea hirtella			x	x	x	f	f	f	f
Allophylus abyssinicus		xe	C21	x	x	f	f	x	f
Allophylus africanus		f	Cr	f	f	f	f	f	f
Allophylus rubifolius		f	x	f	f	f	f	f	f
Anthocleista grandiflora			C24	x		x	f	x	
Antidesma venosum		f	x	f		f	f	f	f
Apodytes dimidiata	not characteristic (characteristic for Afromontane undifferentiated forest and Afromontane dry transitional forest)	xe	Cu24	C	x	f	f	f	fx
Balthasaria schliebenii							C		
Berberis holstii		f	x	x		f	f	f	
Bersama abyssinica		xe	Cg15	x	x	x	x	C	fx
Blighia unijugata		x	x	f	f	f	f	f	fx
Bridelia brideliifolia				x	C	f	C	f	
Buddleja polystachya		f	x			f	f	f	
Caesalpinia decapetala			x	f	f	f	f	f	f
Caesalpinia volkensii			x			f	f	f	
Carapa procera					C	f	f	f	
Carissa spinarum		e	f	f	f	f	f	f	f
Casearia battiscombei			Cmr37	x		f	f	f	
Cassipourea malosana	not characteristic (Afromontane dry transitional forest)	C	Cg24	C		f	C	x	f
Cassipourea ruwensoriensis		f	f		C	f	f	f	
Catha edulis		f	Cs12	x	f	f	f	f	f
Celtis africana		C	Cu27	C	f	f	f	f	f
Celtis gomphophylla		f	x	x	f	f	f	f	fx

Species	Regional status see section 2.3	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	FarT (Tanzania subtype)	FawT (Tanzania subtype)	(Uganda)	Zambia)
Celtis mildbraedii			x			f	f	f	
Chrysophyllum gorungosanum	indicator		Ce27	C	x	x	f	C	f
Clausena anisata		xe	x	x	x	f	f	x	fx
Cola greenwayi	indicator		Ce30	C		x	f		C
Cordia africana		xe	x	f	f	f	f	f	fx
Cornus volkensii			Cbu24	C	x	x	f	f	
Craibia brownii			xh		f	f	f	f	
Crotalaria agatiflora		f	x	F	f	f	f	f	
Crotalaria grandibracteata						f	f		
Croton macrostachyus		Ce	Cgs24	C	x	f	f	x s1	f
Croton megalocarpus	not characteristic (ndicator for Afromontane dry transitional forest)		f	x	x	f	f	f	f
Croton sylvaticus		f	Cm24	x		f	f	f	f
Cussonia spicata			x	C		f	f	s1	fx
Cyathea dregei	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest	f	f	x	x	f	f		fx
Cyathea humilis	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest		x			f	f		
Cyathea manniana	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest	x	x	x	x	f	f	C	
Cylicomorpha parviflora	indicator		Ce21	x		f	f		
Diospyros abyssinica	characteristic	x	Cgr27	x	f	f	f	f	fx
Discopodium penninervium		f	x	x	x	f	f	f	
Dodonaea viscosa		f	fb	x	x	f	f	f	f
Dombeya torrida		xe	Cu24	x	x	f	C	x s1	
Dovyalis abyssinica		f	x	x		f	f	f	fx
Dovyalis macrocalyx			x	x	x	f	f	f	fx
Dracaena fragrans		x	f	x	f	f	f	f	
Dracaena steudneri		xe	Cg12	x	x	f	f	x	f
Ehretia cymosa		xe	Cg9	x	x			f	
Ekebergia capensis		Ce	Cg24	C	x	f	f	s1	fx
Elaeodendron buchananii		x	f	x	f	f	f	f	f
Embelia schimperi		f	x	x	x	f	f	f	fx
Englerophytum natalense			x	f		f	f	f	
Ensete ventricosum		xe	f	x	x	f	f	f	f

Species	Regional status see section 2.3	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	FarT (Tanzania subtype)	FawT (Tanzania subtype)	(Uganda)	Zambia)
Entandrophragma excelsum	indicator		I	C	C	x	f	C	fx
Erythrina brucei		xe							
Eugenia capensis		x	f	x	x	f	f	f	fx
Euphorbia abyssinica		f	Cu30	x		f	f	x	fx
Fagaropsis angolensis	not characteristic (indicator forAfromontane dry transitional forest)	x	f	x	x	f	f	f	f
Ficalhoa laurifolia	indicator		I	C	C	x	C	f	f
Ficus exasperata		f	x	f	x	f	f	f	fx
Ficus natalensis			x	x	x	f	f	f	fx
Ficus ovata		Ce	f	x	f	f	f	f	f
Ficus sur		C	Cg24	x	f	f	f	f	f
Ficus thonningii		Ce	Cg21	C	f	f	f	f	fx
Filicium decipiens		x	f	f		f	f		
Funtumia africana			x	f		f	f	f	
Galiniera saxifraga		x	Cu10	x	C	f	f	C	
Garcinia buchananii		x	x	f	f	f	f	s1	f
Hagenia abyssinica		f	Cbu15	C	C *	f	f	f	fx
Hallea rubrostipulata	indicator	Ce	x	x		x	f	f	
Harungana madagascariensis			Cms12	f	f	f	f	f	f
Hypericum quartinianum		f	f	x		f	f	f	f
Hypericum revolutum		f	f	x	x	f	f	f	f
Ilex mitis	not characteristic (indicator forAfromontane undifferentiated forest)	C	x	C	x	f	C	x	fx
Justicia schimperiana		e	f			f	f		
Kigelia moosa			Cm15			f	f	f	
Landolphia buchananii		x	f	x		f	f	f	fx
Lepidotrichilia volkensii		x	Cbu10	x	x	f	f	C	fx
Lovoa swynnertonii			x			f	f	f	
Macaranga capensis		f	Cs24	C	C	x	C	C	fx
Maesa lanceolata		e	C9	f	x	f	C	s1	Cs
Manilkara butugii		x	x					f	
Margaritaria discoidea		f	x	f		f	f	f	f
Maytenus acuminata			Ce9	C	x	f	C	x	fx
Maytenus undata		x	x	x	x	f	f	f	f

Species	Regional status see section 2.3	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	FarT (Tanzania subtype)	FawT (Tanzania subtype)	(Uganda)	Zambia)
Milicia excelsa		f	x	x	f	f	f	f	
Millettia dura			x	x	f	f	f	f	
Mimusops bagshawei			x		f	f	f	f	
Mimusops kummel		x	f	f		f	f	f	
Mondia whitei			x						
Myrianthus holstii	indicator		x	x	x	x	f	f	f
Myrsine africana		f	f	x	f	f	f	f	fx
Neoboutonia macrocalyx			Cms18	C	C	x	f	x	f
Newtonia buchananii	not characteristic (near streams in Afromontane dry transitional forest)		x	f	x	x	f	f	f
Nuxia congesta	not characteristic (indicator for Afromontane undifferentiated forest)	x	Cg21	x	x	f	C	f	fx
Nuxia floribunda	not characteristic (indicator for Afromontane undifferentiated forest)		f	x	x	f	f	f	fx
Ochna holstii	indicator	x	Ce21	x	x	x	C	f	fx
Ocotea kenyensis	not characteristic (indicator for Afromontane undifferentiated forest)	C	C30	x	x	f	f	f	
Ocotea usambarensis	indicator		Ce46	C	C	x	C	f	f
Olea capensis	indicator	C	Cm27	C	C	f	C	C s1	fx
Olea europaea	not characteristic (indicator for Afromontane dry transitional forest [Olea europaea ssp. cuspidata, synonym: Olea africana])	f	Cr	x	f	f	f	f	fx
Olinia rochetiana		f	f	x	x	f	x	f	fx
Parinari excelsa	indicator		I	C	C	x	f	f	C
Peddiea fischeri			x		x	f	f	f	fx
Phoenix reclinata	(palm species)	xe	x	x	f	f	f	f	f
Phytolacca dodecandra		f	x	x	f	f	f	f	f
Pittosporum viridiflorum		x	x	x	x	f	x	C	f
Plectranthus barbatus		f	x			f	f	f	
Pleiocarpa pycnantha			x		x	f	f	f	f

Species	Regional status see section 2.3	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	FarT (Tanzania subtype)	FawT (Tanzania subtype)	(Uganda)	Zambia)
Podocarpus falcatus	not characteristic (conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest)	x	x	x	C	x	f	f	
Podocarpus henkelii	conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest; species that is very localized north of the Limpopo river			C					
Podocarpus latifolius	characteristic (conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest)		Cu24	C	C	f	C	C	C
Podocarpus usambarensis	conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest		x			f	f	f	
Polyscias fulva		C	f	C	C	x	f	x s1	fx
Pouteria adolfi-friedericii	indicator	C	C46	C	x	C	C	C	C
Pouteria altissima		f	f		f	f	f	f	C
Prunus africana	characteristic	C	Cru37	C	C	f	x	C s1	fx
Pseudospondias microcarpa			f		x	f	f	f	f
Psychotria mahonii			C24	x	x	f	x	C	f
Psydrax parviflora		f	C	x	x	f	f	f	f
Pterolobium stellatum		f	x	x	f	f	f	f	fx
Rapanea melanophloeos	not characteristic (indicator forAfromontane undifferentiated forest)	f	Cu27	C	x	f	C	x	fx
Rauvolfia caffra			f	x		x	f	f	f
Rhamnus prinoides		x	x	x	x	f	f	x	fx
Rhamnus staddo		e	f		f	f	f	f	
Rhoicissus revoilii		f	x	f	f	f	f	f	f
Rinorea angustifolia			x		x	f	f	f	
Ritchiea albersii		x	x		x	f	f	f	f
Rothmannia urcelliformis		x	f	x		f	f	f	f
Rubus apetalus		f	x	x	x	f	f	f	f
Rubus volkensii		f	x			f	f	f	
Sambucus ebulus			x			f	f	f	
Schefflera abyssinica		C	C18	C		f	f	s1	f
Schefflera volkensii		x	Cu24			f	f	C	

Species	**Regional status** see section 2.3	**(Ethiopia)**	**(Kenya)**	**(Malawi)**	**(Rwanda)**	**FarT (Tanzania subtype)**	**FawT (Tanzania subtype)**	**(Uganda)**	**Zambia)**
Scutia myrtina		f	x	x	f	f	f	f	fx
Senna didymobotrya		f	x	f	f	f	f	s1	f
Senna septemtrionalis			x	f	f	f	f	f	f
Shirakiopsis elliptica		C	x	x	x	f	f	f	f
Sinarundinaria alpina	(Afromontane bamboo)	Ce	f	x	x	f	f	x	
Smilax anceps		x	x		x	f	f	f	fx
Solanecio mannii		xe	f	x	f	f	f	f	f
Solanum aculeastrum			x	x	x	f	f	f	
Strombosia scheffleri	indicator		Cm27	C	C	x	f	C	
Strychnos mitis		x	f	f		f	f	f	
Symphonia globulifera					C	f	C	C	f
Synsepalum brevipes			Ce25	f		f	f	f	fx
Syzygium cordatum							C		fx
Syzygium guineense	indicator (*Syzygium guineense* ssp. *afromontanum*)	C	Cru30	x	C	x	f	x s1	fx
Tabernaemontana pachysiphon			Cm10	f		f	f	f	f
Tabernaemontana stapfiana	indicator		C21	x	x	f	f	x	
Trema orientalis		x	x	f	x	f	f	f	f
Trichilia dregeana		x	x	f		f	f	f	fx
Trilepisium madagascariense		f	f	x		f	f	f	f
Vangueria apiculata		f	f	x	x	f	f	f	f
Vepris dainellii		x							
Vepris nobilis		x	Cg12	x	x	f	f	f	fx
Vernonia amygdalina		e	f	f	f	f	f	s1	f
Vernonia auriculifera		e	x		x	f	f	f	
Vernonia myriantha		e	x	x	x	f	f	f	f
Vitex keniensis			Ce49						
Xymalos monospora	characteristic		C15	x	C	x	C	x	fx
Zanthoxylum gilletii		f	Cm30		x	f	f	f	
Zanthoxylum rubescens			Cm24			f	f	f	

4. Afromontane undifferentiated forest (Fbu) and Afromontane single-dominant Juniperus procera forest (Fbj)

4.1. Description

Afromontane undifferentiated forest is usually shorter than Afromontane rain forest (Fa). Although there is some floristic overlap in species composition between these two forest types (for example, *Podocarpus latifolius*, *Prunus africana* and *Xymalos monospora* were listed as characteristic species both for Afromontane rain forest and Afromontane undifferentiated forest), species composition is distinctive (White 1983 p. 165). White (1983) reserved the term of "undifferentiated forests" to forests that undergo rapid and kaleidoscopic changes in structure and species composition over short distances (White 1983 p. 47).

Afromontane undifferentiated forest usually replaces Afromontane rain forest at comparable altitudes (usually between 1250 and 2500 m) on the drier slopes of mountains and at higher altitudes on the wetter slopes, and sometimes at lower altitudes. Afromontane undifferentiated forest usually receives lower rainfall (possibly as low as 850 mm, which is the upper rainfall limit of East African evergreen bushland [Be]) than Afromontane rain forest (White 1983 p. 165).

After fire, Afromontane undifferentiated forests are sometimes replaced by almost pure stands of Afromontane single-dominant *Juniperus procera* forest (Fbj), Afromontane single-dominant *Widdringtonia whytei* forest (Fc) or Afromontane single-dominant *Hagenia abyssinica* forest (Fd). Within the VECEA map, we mapped the latter two types of forests (Fc and Fd) separately but mapped Afromontane undifferentiated forest together with Afromontane single-dominant *Juniperus procera* forest (Fbj). We made this decision especially since most of the national maps only listed one of these two forests types, whereas our floristic and environmental analysis suggested that both these forests belonged to the same potential natural vegetation type.

Afromontane single-dominant *Juniperus procera* forest (Fbj) mostly occurs on the drier slopes of mountains between 1800 and 2900 m, although it sometimes descends to 1000 m. Annual rainfall is usually between 1000 and 1150 mm, but sometimes more than 1250 mm. *Juniperus procera* also occurs outside forests as in evergreen bushland (Be, see volume 5) where rainfall can be as low as 650 mm - this could be the original habitat of this species (for example, the species occurs in evergreen bushland [Be] at lower elevations on Mt. Kulal [Kenya] where it is 4 to 6 m tall [White 1983 p. 121]). *Juniperus procera* is a strong light-demander that does not regenerate in its own shade, so its presence as forest tree depends on fire. This species also seems to be intolerant of deep humus layers (White 1983 p. 165 - 166).

Besides the **potentially** dominant ***Juniperus procera***, regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Afromontane undifferentiated forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps include ***Halleria lucida, Ilex mitis, Kiggelaria africana*** (this species does not extend as far north as Ethiopia), ***Nuxia congesta, Nuxia floribunda*** (this species does not extend as far north as Ethiopia), ***Ocotea kenyensis, Podocarpus falcatus*** (synonym: ***Podocarpus gracilior***) and ***Rapanea melanophloeos***.

Figure 4.1 Afromontane undifferentiated forest with canopy of *Juniperus procera* and *Podocarpus falcatus i*n Chilimo forest (Ethiopia). Altitude approximately 2550 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 20A. 2010.

Figure 4.2 Afromontane single-dominant *Juniperus procera* forest with a tree of *Hagenia abyssinica* in the foreground near the upper edge of Chilimo forest (Ethiopia). Altitude approximately 3000 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 21B. 2010.

Figure 4.3. Climax stand of *Juniperus procera* (30 - 37 m) in Afromontane single-dominant *Juniperus procera* forest. Photographed in 1960 by unknown photographer at unknown location (presumably in Kenya). Photograph given to F. Gachachi by C.G. Trapnell (before his decease).

Figure 4.4 Afromontane single-dominant *Juniperus procera* forest in Maralal District (Kenya, leflt image, photograph taken in 2009) and Mt. Kenya (right image, photograph taken in 2011). Photographs by F. Gachathi.

Figure 4.5 A glade in Afromontane undifferentiated forest (synonym: montane sclerophyll forest) with *Juniperus procera* on the right and an unidentified *Podocarpus* species on the left. Afromontane bamboo (*Sinarundinaria alpina*, synonym: *Arundinaria alpina*) is portrayed behind the unidentified *Podocarpus* species. Western slopes of Mt. Kenya along the Sirimon track. Shell guide to East African birds (reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

4.2. VECEA region

Within the VECEA region Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest occurs in all countries, except Rwanda (see Figure 4.6, see also volume 6). The extent of this forest type is very limited in Zambia.

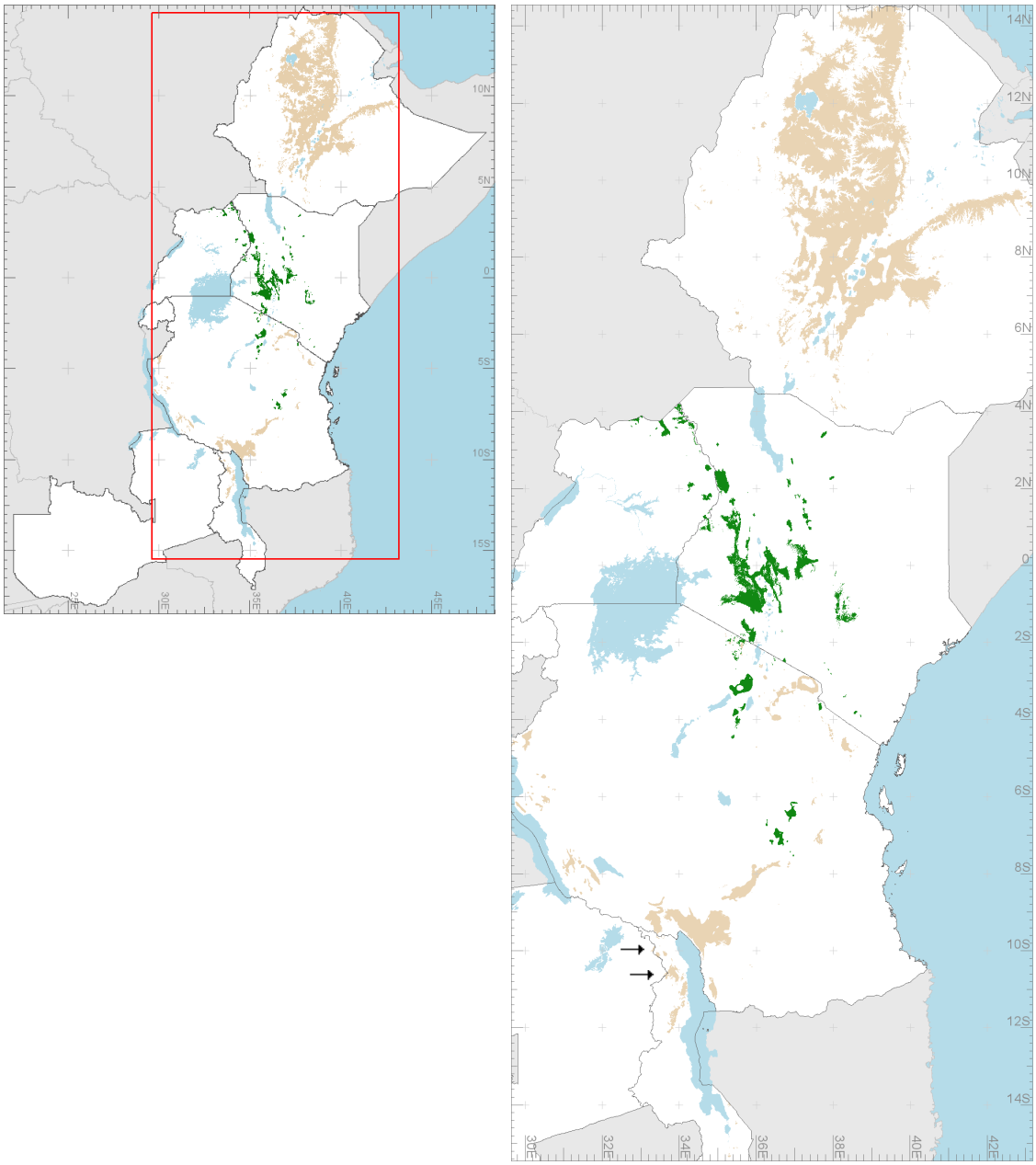


Figure 4.6. Mapped distribution of Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. In Ethiopia, these forest types are mapped together with evergreen and semi-evergreen bushland and thicket (Be, see volume 3) and are depicted by polygons in a greyish-brown colour. In Malawi and Tanzania, this vegetation type is mainly mapped as part of different forest mosaics (greyish-brown). In Zambia, this vegetation type was originally mapped together with Afromontane rain forest (Fa) next to border with Malawi; since these vegetation mosaics (greyish-brown) are very small when depicted on small-scale distribution maps, we added arrows to indicate the position of these mosaics

In Ethiopia, Afromontane undifferentiated forest was originally described as undifferentiated dry evergreen afromontane forest (DAF-U). In the same country, Afromontane single-dominant ***Juniperus procera*** forest was originally described as dry single-dominant Afromontane forest (DAF-SD). These forest types were mapped together with Evergreen bushland (Be, see volume 4) within the "Dry evergreen Afromontane forest and grassland complex" (DAF). In Afromontane single-dominant *Juniperus procera* forest, *Podocarpus falcatus* is absent from the canopy. Single-dominant Afromontane forest (original coding DAF-SD) occurs at higher altitudes or under lower rainfall than Afromontane undifferentiated forest (original coding DAF-U).

The Ethiopian vegetation subtype of "Afromontane woodland, wooded grassland and grassland" (DAF-WG) is described as a mixture of primary, secondary or edaphic vegetation types; these were all mapped together in the original Ethiopian map (also with Afromontane undifferentiated forest [Fbu], Afromontane single-dominant *Juniperus procera* forest [Fbj] and Evergreen bushland [Be]). The edaphic subtype is a type of edaphic grassland [mapped elsewhere in the VECEA region as "g" (see volume 5)]. The primary woodlands consist of *Acacia abyssinica, Acacia lahai* and five endemic *Acacia* species (Friis *et al.* 2010 p. 81). *Acacia abyssinica* and *Acacia lahai* are invasive species in residual and secondary Afromontane undifferentiated forest (Trapnell 1997). Trapnell and Langdale-Brown (1972 p. 132) describe that there are a few *Acacia* vegetation types which qualify locally as woodland, the main example being montane *Acacia* vegetation of *Acacia abyssinica* and *Acacia lahai* which is represented in the higher forests regions of Kenya, and which is probably secondary to forest. In an unfinished manuscript (available from F. Gachathi), Trapnell describes that *Acacia abyssinica* and *Acacia lahai* are common in secondary vegetation within the Afromontane undifferentiated forest zone, but that they also form distinct belts within this zone on specific types of soils. He mentions that these belts seem to occur under areas with impeded drainage such as fringes to valley grasslands, on tuff soils with seepage tendencies, on shallow brownish black or chocolate clay soils or in areas on recent ash and pumice (such as the Menengai area of ash and pumice soils north and west of Nakuru). We suspect, therefore, that the *Acacia* woodlands described in Ethiopia (DAF-WG) also occur in other countries either as secondary vegetation types or under specific edaphic conditions.

In Kenya, Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest were originally described and mapped as montane sclerophyll forest. Bussman (2002 [Table 2]) lists forest types for "islands in the desert". Based on a phytosociological survey based on 252 vegetation plots, most forests in northern Kenya were classified as the "Juniperetea" vegetation class, referring to ***Juniperus procera*** as the typical species. Bussman differentiated between four plant associations belonging to the "Juniperetea" class: (i) '*Juniperion procerae*' evergreen xeromorphic montane forest (A1.I); (ii) '*Cassipourion malosanae*' broadleaved montane forest (A1.II); (iii) '*Crotonion megalocarpi*' deciduous broad-leaved montane forests (A1.III); and (iv) '*Brachylaenion huillensis* - deciduous broad-leaved submontane forests (A1.IV).[3] Forest (areas) with the '*Juniperion procerae'* association included Imenti Forest, Mt. Kenya, Mt. Kulal, Loita Hills, Loroghi,

3: other plant associations that Bussman (2002) differentiated were the *Hagenio abyssinicae - Hypericion revoluti* evergreen subalpine Kosso forests (B1.I; Mt. Kenya, Gakoe Forest [Aberdares], Harenna, Mt. Nyiro, Ndoto Mts.); the *Sinarundinarion alpinae* (C1.I; Mt. Kenya, Gakoe Forest [Aberdares], Ngaia Forest, Imenti Forest, Nyambeni Hills, Harenna); the *Cyathion mannianae* (D1.I; Mt. Kenya, Gakoe Forest [Aberdares], Ngaia Forest, Imenti Forest, Nyambeni Hills); the *Zanthoxyllion gilettii* (D1.II; Mt. Kenya, Gakoe Foret [Aberdares], Ngaia Forest, Imenti Forest, Nyambeni Hills) and the *Lovoion swynnertonii* (D1.III, Ngaia Forest, Imenti Forest, Nyambeni Hills).

Mt. Marsabit, the Mathews Range, Mukogodo, Ndare Ngare, the Ndoto Mts., Ngaia Forest, Nguruman, Nyambeni Hills, Mt. Nyiro and Mt. Porror. Forest (areas) with the '*Cassipourion malosanae*' association included Gakoe Forest (Aberdares), Harenna, Mt. Kenya, Mt. Kulal, Loita Hills, Loroghi, Mt. Marsabit, Nguruman. The Mathews Range was the only area where the '*Crotonion megalocarpi*' association occurred. Nairobi was the only area where the '*Brachylaenion huillensis*' formation occurred. Based on this analysis (especially the occurrence of the 'Juniperetea' class), we classified most of the forests in northern Kenya as Afromontane undifferentiated forest but not differentiating between Afromontane undifferentiated forest (Fbu) or Afromontane single-dominant *Juniperus procera* forest (Fbj).

In Malawi, Afromontane single-dominant ***Juniperus procera*** forest was originally described as ***Juniperus procera*** forest. This forest type is too small to be mapped separately from Afromontane single-dominant ***Hagenia abyssinica*** forest [Fd]; C. Dudley, personal communication).

In Tanzania, Afromontane undifferentiated forest was originally described as "dry montane forest". One of the synonyms listed by Lovett (1993a) for dry montane forest is "drier types of Afromontane undifferentiated forest" (but see discussion for the Tanzanian manifestations of Afromontane rain forest). ***Juniperus procera*** rarely occurs as a single-dominant, but occurs in places where Afromontane undifferentiated forest regeneration appears to be associated with fire or in Evergreen bushland (Be, Lovett 1990 p. 291).

In Uganda, Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest were originally described and mapped as *Juniperus - Podocarpus* dry montane forest (original mapping unit B3).

In Zambia, Afromontane undifferentiated forest was originally described as dry montane forest. In this country, it was originally mapped together with Afromontane rain forest (see volume 6).

Investigation of environmental distribution of Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest in the VECEA region (Figure 4.6; limits are for areas of the VECEA map where these forests (Fa) are only mapped as mosaic of these two forest types) show a wider distribution in altitude for these forest types (with > 90% of the samples in an interval from 1000 – 3000 m) than for Afromontane rain forest, confirming the information given by White (1983; also see section 3.1). Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest are among the forest types that occur at the highest altitudes. The altitude interval of 2000 – 2250 m contains the highest number of samples (22.7%) for this forest type; only Afromontane single-dominant *Hagenia abyssinica* forest has most of its samples in a higher altitude class. Annual rainfall of Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest is mainly between 600 and 1400 mm (94.4% of samples). Afromontane undifferentiated forest and Afromontane single-dominant *Juniperus procera* forest are among the forest types that occur at locations with the lowest rainfall. The rainfall interval

of 800 – 1000 mm contains the highest number of samples (36.0%) for this forest type; only Zambezian dry deciduous forest and scrub forest (Fn) and Zanzibar-Inhambane scrub forest (Fq) have most of their samples in a smaller rainfall class.

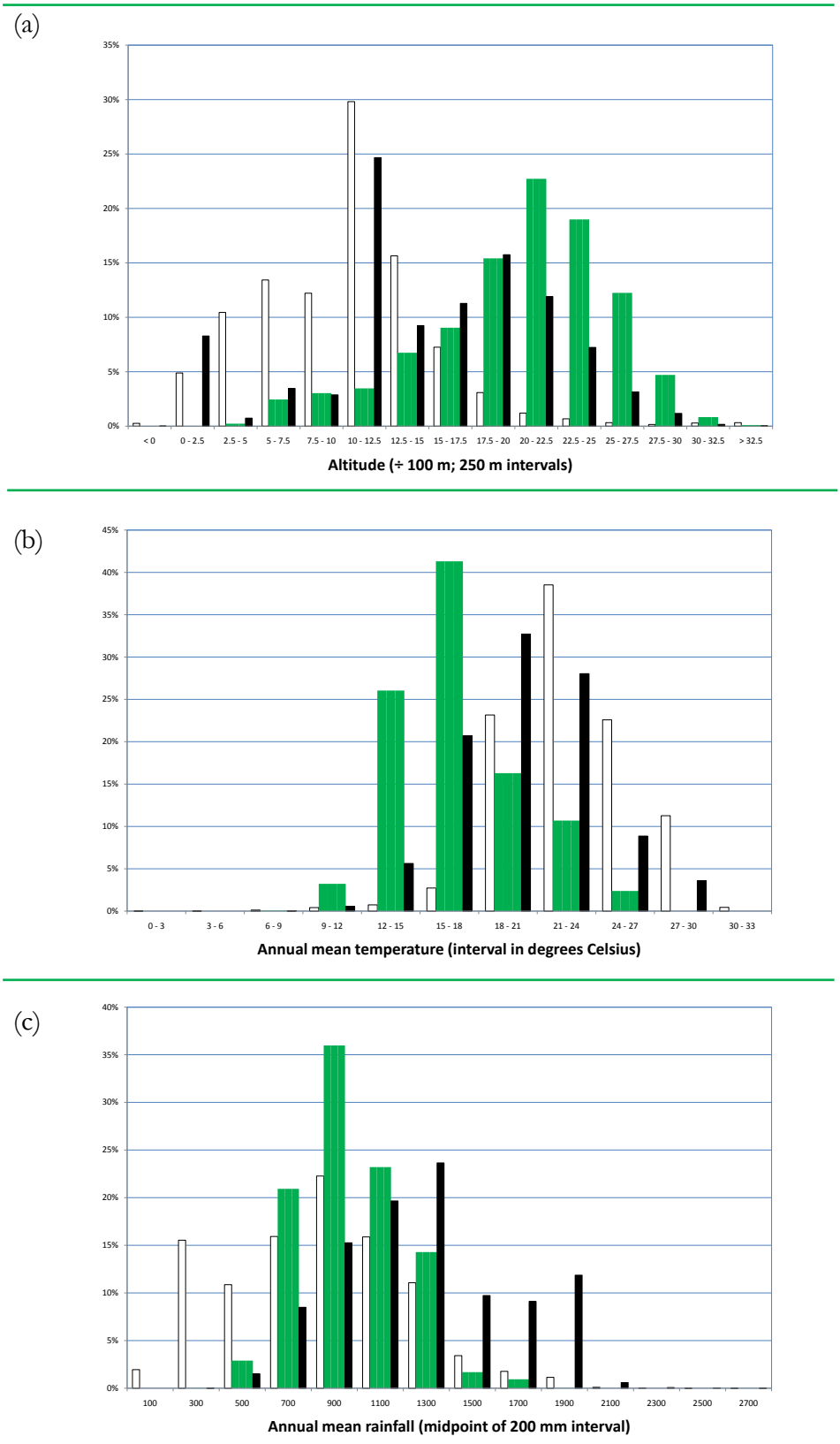


Figure 4.7. Histograms of the distribution of altitude (a), mean annual temperature (b)and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples (*n* = 8,572) within Afromontane undifferentiated forests (Fbu) or Afromontane single-dominant *Juniperus procera* forest (Fbj). Bars on left (open) show the overall percentage of samples (n = 740,047). Bars on the right (black) show the percentages of samples within forests (n =59,013).

4.3. Species composition

Species composition was obtained from the following references:

- Ethiopia: Friis *et al.* 2010. Species mentioned in Appendix 3 for "Undifferentiated Dry evergreen afromontane forest" [DAF-U] were coded "x" (unless they were characteristic species) in column FbuE.. Species mentioned in Appendix 3 for "Dry single-dominant Afromontane forest of the Ethiopian highlands" [DAF-SD] were coded "x" (unless they were characteristic species) in column FbjE. Species that were mentioned in Appendix 3 for "Edges of moist evergreen Afromontane forest, bushland, woodland and wooded grassland" [DAF-WG] **and** within one of the species assemblages for any country were coded "w" .
- Kenya: Trapnell (1997). Species listed in Annex 1 for "montane sclerophyll forest", "montane sclerophyll and/or moist montane forest" and "of more general distribution" were coded "C". Suffix "a" indicates that the species was also listed for Afromontane rain forest (Fa; synonym: moist montane forest). Suffix "b" indicates that species was listed to only occur marginally in the forest or in montane bamboo. Suffix "g" indicates species of more general distribution. Suffix "i" indicates invasive species. Suffix "s" indicates secondary species. Suffix "r" indicates residual species after selective felling. Numbers show the maximum height of the species provided in the Annex (Trapnell 1997). Species that were expected to occur in the forest type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x".
- Malawi: Dowsett-Lemaire (1985), Palgrave (2002) and White *et al.* (2001). Species were included in species assemblages partially based on the interpretation of our Malawian co-author (C. Dudley) since species were not consistently allocated to forest types in White *et al.* (2001). These species were coded "x" (unless they were characteristic species).
- Tanzania: Species that were mentioned for "dry montane forest" in Lovett (1993a; altitude > 1500 m; rainfall 1000 - 1200 mm) were coded "C" (since these were assumed to be characteristic species). Species that were only listed as "trees in lower altitude dry montane forest" were excluded. Species that were only mentioned for "dry montane forest" in Lovett (1993b; altitude 1250 - 2900 m; annual rainfall 900 - 1500 mm) were coded "x".
- Uganda: Langdale-Brown *et al.* (1964) and Howard & Davenport (1996). All species that were listed to occur in "*Juniperus-Podocarpus* dry montane forest" (original mapping unit B3) in the Appendix were coded "x" (unless they were characteristic species). Species listed to occur in Moroto or Napak forests (forests indicated on page 107 to only contain the primary forest type "B3") in the Uganda Foret Department Biodiversity Database (Howard & Davenport [1996]) were coded "xb". Species listed in the Appendix for forest - wooded grassland mosaics of high altitudes[4] occurring on drier sites were coded "s1", whereas no new species were committed to the species assemblage.

4: Langdale-Brown *et al.* (1964 p. 51) mention that forest remnants that occur especially in valleys within the forest - wooded grassland mosaics of high altitudes (F1) are mainly Afromontane undifferentiated forest (original mapping unit B3) although there may also be some Afromontane single-dominant *Hagenia abyssinica* forest (original mapping unit B2) or some Ericaceous belt vegetation (original mapping unit A2).

- Zambia: Fanshawe (1971 pp. 28 - 31). Species that were listed to occur in the species composition table for "montane forest" were coded "fx" (Fanshawe did not distinguish between Afromontane rain forest and Afromontane undifferentiated forest in the species composition table for montane forest) in case that a species was also listed within the species assemblage of another country. Characteristic species were coded "C".

Characteristic species were determined as:

- Ethiopia: species mentioned in the main description of the vegetation type were coded "C", unless they were described as being dominant (coded "D").
- Kenya: Species that were listed by Trapnell (1997) were assumed to be characteristic species (these were coded "C").
- Malawi: Species identified to be present as emergent trees (30 - 45 m) or large trees (20 - 30 m, including stranglers) were coded as "C", unless they were dominant species (coded "D") or co-dominant species (coded "Cd").
- Tanzania: Species listed in Lovett (1993a) were coded "C".
- Uganda: Species characterized as large trees in the appendix or that were mentioned in the main text where the forest type was described were coded "C".
- Zambia: Species for which the genera were mentioned for dry types of montane forest that occur on upper slopes and in watersheds were coded "C".

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

Table 4. Species composition of Afromontane undifferentiated forest (Fbu) and Afromontane single-dominant *Juniperus procera* forest (Fbj)

Species	**Regional status** (see section 2.3)	**FbuE (Ethiopia subtype)**	**FbjE (Ethiopia subtype)**	**(Kenya)**	**(Malawi)**	**(Tanzania)**	**(Uganda)**	**(Zambia)**
Juniperus procera	dominant in single-dominant *Juniperus procera* forest	C	D	C37	D	C	C	
Acacia abyssinica	(invasive)	w	w	Ci	f	f	x	
Acacia drepanolobium		f	f	x		f	f	
Acacia gerrardii		f	f	x	f	f	f	f
Acacia lahai	(invasive)	w	w	Ci		f	f	
Acacia seyal		w	w	x	f	f	f	f
Acokanthera schimperi		w	Cw	fh		f	f	
Agauria salicifolia		xw	w	x	x	C	f	fx
Albizia glaberrima				f	f	f	xb	f
Albizia grandibracteata		f	f	f		f	xb	
Albizia gummifera	not characteristic (indicator for Afromontane dry transitional forest)	xw	w	Cg30	f	C	xb	fx
Albizia schimperiana		xw	w	f	f	f	f	f
Allophylus abyssinicus		C	f	x	f	f	xb	f
Allophylus rubifolius		w	w	x	f	f	f	f
Anthocleista grandiflora				f	f	f	f	
Antiaris toxicaria		f	f	f		f	f	fx
Apodytes dimidiata	characteristic	Cw	w	Ca24	x	C	f	fx
Berberis holstii		f	f	x	x	f	C	
Bersama abyssinica		Cw	xw	Cg15	x	C	xb	fx
Blighia unijugata		f	f	x	f	f	xb	fx
Brachylaena huillensis				f		x	f	
Bridelia micrantha		f	f	f	f	x	f	f
Buddleja polystachya		w	Cw	x		f	f	
Caesalpinia decapetala				x	f	f	f	f
Caesalpinia volkensii				x		f	f	
Carissa spinarum		xw	Cw	f	f	f	f	f
Casearia battiscombei				f	f	f	f	
Cassipourea malosana	not characteristic (indicator for Afromontane dry transitional forest)	C	f	Cgr24	C	C	x	f
Catha edulis		f	f	f	f	C	C	f

Species	Regional status (see section 2.3)	FbuE (Ethiopia subtype)	FbjE (Ethiopia subtype)	(Kenya)	(Malawi)	(Tanzania)	(Uganda)	(Zambia)
Celtis africana		C	f	Ca27	x	f	x	f
Celtis gomphophylla		f	f	f	f	f	f	fx
Clausena anisata		xw	Cw	x	x	f	x	fx
Clerodendrum myricoides		xw	Cw	f		f	f	
Cordia africana		x	f	f	f	f	xb	fx
Cordia monoica		w	w	f		f	xb	
Cornus volkensii				Cab24	f	f	f	
Craibia brownii				f		f	xb	
Crotalaria agatiflora		w	w	x	f	f	f	
Crotalaria grandibracteata						f		
Croton macrostachyus		Cw	w	Cgs24	f	C	xb	f
Croton megalocarpus	not characteristic (indicator for Afromontane dry transitional forest)			f	f	x	xb	f
Croton sylvaticus		f	f	f	f	x	f	f
Cussonia holstii		xw	w	C15		x	xb	
Cussonia spicata				C12	C	C	xb	fx
Diospyros abyssinica	not characteristic (characteristic for Afromontane rain forest and Afromontane Afromontane dry transitional forest)	x	f	Cgr27	f	x	x	fx
Discopodium penninervium		xw	Cw	f	f	f	xb	
Dodonaea viscosa		xw	Cw	Cs	f	f	xb	f
Dombeya torrida		xw	w	Cas24	x	x	x	
Dovyalis abyssinica		C	x	C9	f	f	xb	fx
Dovyalis macrocalyx				x	x	f	xb	fx
Dracaena steudneri		Cw	w	Cg12	f	f	xb	f
Ehretia cymosa		xw	Cw	Cg9	f		f	
Ekebergia capensis		C	x	Cg24	x	C	C	fx
Elaeodendron buchananii		f	f	f	f	f	xb	f
Embelia schimperi		x	f	f	f	f	f	fx
Ensete ventricosum		xw	w	f	f	f	f	f
Erica arborea		x	C	f		f	s1	
Erythrina abyssinica		f	f	f	f	C	xb	f

Species	Regional status (see section 2.3)	FbuE (Ethiopia subtype)	FbjE (Ethiopia subtype)	(Kenya)	(Malawi)	(Tanzania)	(Uganda)	(Zambia)
Erythrina brucei		C	f					
Euclea divinorum	not characteristic (indicator for Afromontane dry transitional forest)	xw	xw	Cs9	x	C	C	f
Euclea racemosa		w	Cw	f	f	f	x	fx
Eugenia capensis		f	f	f	x	f	f	f
Euphorbia abyssinica		w	Cw	Ca30	f	f	f	fx
Euphorbia tirucalli		f	C	f	f	f	f	f
Fagaropsis angolensis	not characteristic (indicator for Afromontane dry transitional forest)	x	f	f	f	x	xb	f
Faurea saligna				C24	f	x	xb s1	fx
Ficus mucuso		f	f	f		f	xb	
Ficus natalensis				f	f	f	xb	fx
Ficus ovata		Cw	w	f	f	f	f	f
Ficus sur		C	f	Cg24	f	f	xb	f
Ficus sycomorus		w	w	f	f	f	xb	f
Ficus thonningii		C	f	Cg21	x	f	xb	fx
Flacourtia indica		xw	w	f	f	f	f	f
Flueggea virosa		f	f	f	f	f	xb	f
Galiniera saxifraga		xw	Cw	Ca10	f	f	f	
Garcinia buchananii		f	f	f	f	f	xb	f
Grewia ferruginea		xw	Cw					
Hagenia abyssinica		xw	xw	Cab15	x	C	f	fx
Halleria lucida	indicator	x	x	x	x	C	f	fx
Harrisonia abyssinica		f	f	f	f	f	xb	f
Hypericum quartinianum		xw	w	f	f	f	f	f
Hypericum revolutum		x	f	Cb12	f	f	xb	f
Hypericum roeperanum		x	x	f		f	x s1	f
Ilex mitis	indicator	x	f	C24	C	x	C	fx
Kigelia africana		f	f	f	f	f	xb	f
Kiggelaria africana	indicator (species does not extend as far north as Ethiopia)				x	f		
Lannea barteri		f	f				xb	
Lannea fulva				f		f	xb	
Lannea schweinfurthii		f	f	f	f	f	xb	f

Species	Regional status (see section 2.3)	FbuE (Ethiopia subtype)	FbjE (Ethiopia subtype)	(Kenya)	(Malawi)	(Tanzania)	(Uganda)	(Zambia)
Lepidotrichilia volkensii		C	f	Ca10	x	f	f	fx
Maesa lanceolata		xw	Cw	f	x	x	xb	fx
Margaritaria discoidea		xw	w	f	f	C	xb	f
Maytenus acuminata				f	x	x	f	fx
Maytenus arbutifolia		xw	w	f		f	f	
Maytenus undata		C	x	C12	f	f	C	f
Mimusops kummel		x	f	f	f	f	xb	
Morella salicifolia		xw	w					
Myrsine africana		x	f	x	x	f	x	fx
Nuxia congesta	indicator	xw	Cw	Cg21	C	C	x s1	C
Nuxia floribunda	indicator (species does not extend as far north as Ethiopia)			f	x	x	x	C
Ocotea kenyensis	indicator	f	f	f	f	f	f	
Olea capensis	not characteristic (indicator for Afromontane rain forest)	x	f	C24	Cd	C	x	fx
Olea europaea	not characteristic (indicator for Afromontane dry transitional forest[*Olea europaea* ssp. *cuspidata,* synonym: *Olea africana*])	Cw	Cw	Cs24	x	f	C	fx
Olinia rochetiana		C	f	C12	C	C	C	C
Oncoba spinosa		w	w	f	f	f	xb	f
Osyris lanceolata		xw	w	f		f	xb s1	
Ozoroa insignis		w	w	f	f	f	xb	f
Parinari excelsa	not characteristic (indicator for Afromontane rain forest)				f	C	f	fx
Pavetta crassipes		f	f	f		f	xb	
Pavetta oliveriana		w	w	f		f	xb	
Phoenix reclinata	(palm species)	w	w	x	f	x	f	f
Phytolacca dodecandra		xw	w	x	f	f	xb	f
Pistacia aethiopica		f	f	x		f	f	
Pittosporum viridiflorum		x	f	C15	C	x	xb	f
Podocarpus falcatus	indicator (conifer species that is absent from Guineo-Congolian rain forest and less characteristic of Afromontane rain forest)	C	f	C30	f	f	C	

Species	Regional status (see section 2.3)	FbuE (Ethiopia subtype)	FbjE (Ethiopia subtype)	(Kenya)	(Malawi)	(Tanzania)	(Uganda)	(Zambia)
Podocarpus latifolius	characteristic (conifer species that is absent from Guineo-Congolian rain forest and less characteristic of Afromontane rain forest; species does not extend as far north as Ethiopia)			Ca24	C	f	xb	fx
Polyscias fulva		f	f	f	x	f	f	f
Pouteria adolfi-friedericii	not characteristic (indicator for Afromontane rain forest)	f	f	f	f	f	xb	fx
Prunus africana	characteristic	C	f	Ca37	C	C	xb	fx
Psychotria mahonii				f	f	x	f	f
Psydrax parviflora		f	f	f	f	f	xb	f
Psydrax schimperiana		w	w	x	f	f	xb	fx
Pterolobium stellatum		w	Cw	x	f	f	f	fx
Rapanea melanophloeos	indicator	x	C	C15	C	C	x	C
Rhamnus prinoides		xw	Cw	x	x	f	xb	fx
Rhamnus staddo		w	w	x		f	f	
Rhoicissus revoilii		f	f	x	f	f	f	f
Rhoicissus tridentata		w	Cw	f	x	f	f	f
Rhus longipes		f	f	f	x	f	xb	fx
Rhus natalensis		w	Cw	x	f	f	xb	f
Rhus vulgaris		w	w	x	f	f	xb	f
Ritchiea albersii		x	f	C9		x	xb	f
Rosa abyssinica		xw	Cw					
Rothmannia urcelliformis		x	f	f	f	f	xb	f
Rubus apetalus		xw	w	x	f	f	xb	f
Rubus volkensii		xw	w	x		f	f	
Schefflera abyssinica		x	f	f	x	f	x	f
Schefflera volkensii		x	f	Ca24		f	x	
Schrebera alata	not characteristic (indicator for Afromontane dry transitional forest)	xw	Cw	x	f	C	xb	fx
Scutia myrtina		xw	w	x	f	f	f	fx
Senecio hadiensis		w	w	x		f	f	
Senna didymobotrya		f	C	x	f	f	f	f
Senna septemtrionalis				x	f	f	f	f

Species	Regional status (see section 2.3)	FbuE (Ethiopia subtype)	FbjE (Ethiopia subtype)	(Kenya)	(Malawi)	(Tanzania)	(Uganda)	(Zambia)
Shirakiopsis elliptica		f	f	x	f	x	f	f
Sinarundinaria alpina	(Afromontane bamboo)	x	C	f	x	f	f	
Solanecio mannii		w	w	x	f	f	xb	f
Solanum aculeastrum				x	f	f	f	
Strychnos henningsii		f	f	f	f	f	x	f
Strychnos mitis		f	f	f	f	f	xb	
Syzygium cordatum				f	x	x	f	fx
Syzygium guineense	not characteristic (indicator for Afromontane rain forest [*Syzygium guineense* ssp. *afromontanum*])	xw	w	Car30	x	x	xb	fx
Trema orientalis		xw	w	x	f	f	xb	f
Trichilia dregeana		f	f	f	f	f	xb	fx
Vangueria apiculata		xw	w	f	f	f	xb	f
Vangueria madagas-cariensis		f	C	f	f	f	xb	
Vepris dainellii		C	f					
Vepris nobilis		C	C	Cgr12	x	f	C	fx
Vernonia amygdalina		xw	Cw	f	f	f	xb	f
Vernonia myriantha		w	w	f	x	f	x	f
Warburgia ugandensis	not characteristic (indicator for Afromontane dry transitional forest)	f	f	f	f	f	xb	
Xymalos monospora	characteristic (species does not extend as far north as Ethiopia)			x	C	f	f	fx
Zanha golungensis		f	f	f	f	f	xb	f
Zanthoxylum chalybeum		f	f	x	f	f	f	f
Zanthoxylum usambarense		w	Cw	C15		x		

5. Afromontane single-dominant *Widdringtonia whytei* forest (Fc)

5.1. Description

The only location where ***Widdringtonia whytei*** (synonym *Widdringtonia nodiflora* subsp. *whytei*) naturally occurs is on Mt. Mulanje (Malawi; 15º 55' S, 35º 37' E) . *Widdringtonia whytei* has a similar relationship to fire as *Juniperus procera* (a species that forms Afromontane single-dominant forests that replace Afromontane undifferentiated forest [Fbu] after fire and that requires fire for regeneration; White 1983 p. 166).

Afromontane single-dominant ***Widdringtonia whytei*** forest occurs between 1525 and 2135 m (White 1983 p. 166).

Figure 5.2 *Widdringtonia whytei* forest on Mt. Mulanje (Malawi). Photograph obtained from the archive of the Mulanje Mountain Conservation Trust by C. Dudley.

Figure 5.1 *Widdringtonia whytei* forest on Mt. Mulanje (Malawi). Photograph obtained from the archive of the Mulanje Mountain Conservation Trust by C. Dudley.

5.2. VECEA region

Within the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia), Afromontane single-dominant ***Widdringtonia whytei*** forest only occurs in Malawi.

In Malawi, Afromontane single-dominant ***Widdringtonia whytei*** forest was mapped together with the montane Ericaceous belt (E, see volume 6) and figure 5.3.

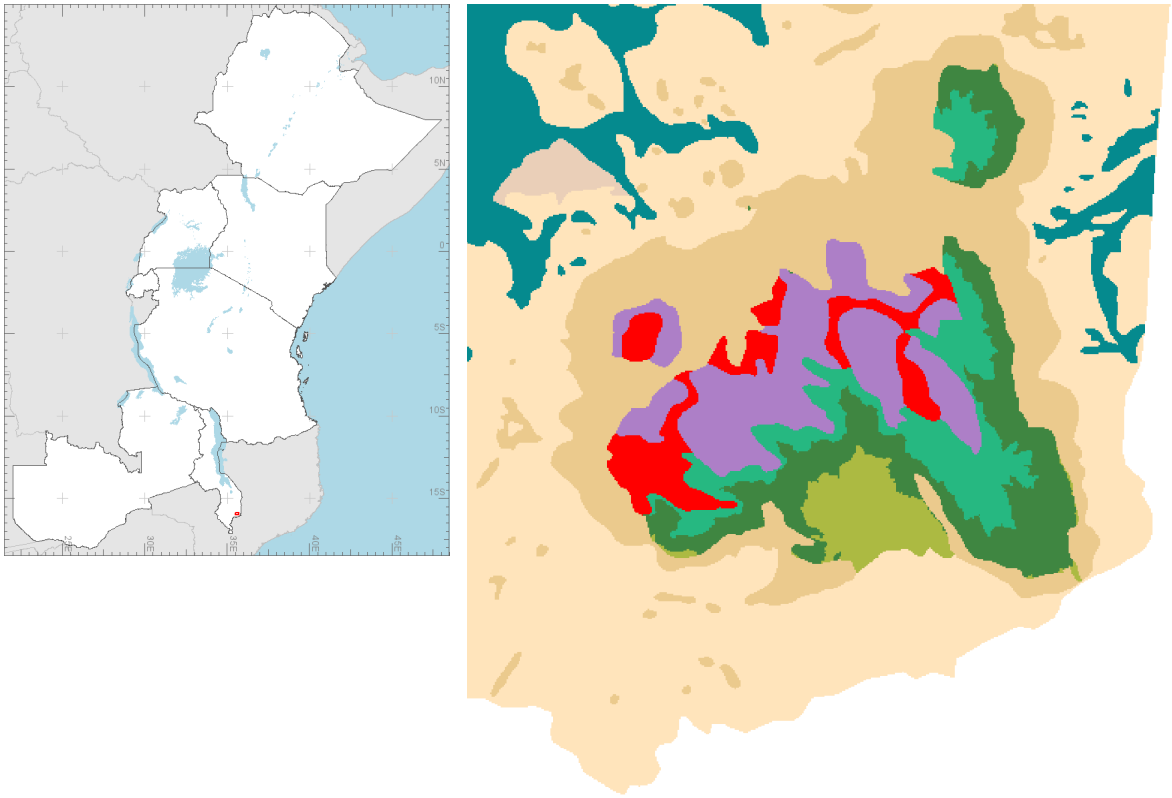


Figure 5.3. Mapped distribution of Afromontane single-dominant *Widdringtonia whytei* forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). This forest type only occurs on Mt. Mulanje, in the south of Malawi. It was mapped in mosaic with the Montane Ericaceous belt (E, see Volume 4). These vegetation mosaics are depicted in red (see also Figure 4.4 of Volume 6). Purple areas correspond to the montane Ericaceous belt (E), light-green areas to Afromontane rain forest (Fa), dark-green areas to dark green to Zanzibar-Inhambane transitional rain forest (Fg) and brownish areas to Miombo woodland on hills and rocky outcrops (Wmr; including patches of Zanzibar-Inhambane transitional rain forest [Fg] or Zanzibar-Inhambane lowland rain forest [Fo]).

5.3. Species composition

Species composition was obtained from the following references:

- Malawi: Chapman and White (1970), Dowset-Lemaire (1988) and White *et al.* (2001). Species were included in species assemblages partially based on the interpretation of our Malawian co-author (C. Dudley) since species were not consistently allocated to forest types in Dowsett-Lemaire (1988) and White *et al.* (2001). These species were coded "x" (unless they were characteristic species).

Characteristic species were determined as:

- Malawi: Species identified to be large trees (20 - 30 m) were coded as "C". Dominant species were coded "D". Species of marginal occurrence were not listed as characteristic species.

Table 5. Afromontane single-dominant *Widdringtonia whytei* forest (Fc)

Species	**Regional status (see section 2.3)**	**(Malawi)**
Widdringtonia whytei	dominant (species that extends from Table Mountain in the south to Mt. Mulanje in the north)	D
Agauria salicifolia		x
Bersama abyssinica		x
Cassipourea malosana	not characteristic (indicator for Afromontane dry transitional forest)	C
Clausena anisata		x
Cornus volkensii		x
Cussonia spicata		C
Ekebergia capensis		x
Hypericum revolutum		x
Ilex mitis	indicator (for Afromontane undifferentiated forest)	C
Kiggelaria africana	indicator (for Afromontane undifferentiatedforest)	x
Maesa lanceolata		x
Maytenus acuminata		x
Nuxia congesta	indicator (for Afromontane undifferentiated forest)	x
Nuxia floribunda	indicator (for Afromontane undifferentiated forest)	x
Olea capensis	not characteristic (indicator for Afromontane rain forest)	C
Olinia rochetiana		C
Pittosporum viridiflorum		C
Podocarpus latifolius	characteristic (for Afromontane undifferentiated forest)	C
Polyscias fulva		x
Prunus africana	characteristic (for Afromontane undifferentiated forest)	C
Rapanea melanophloeos	indicator (for Afromontane undifferentiated forest)	C
Rhamnus prinoides		x
Sinarundinaria alpina	(Afromontane bamboo)	x
Xymalos monospora	characteristic (for Afromontane undifferentiated forest)	x

6. Afromontane single-dominant *Hagenia abyssinica* forest (Fd)

6.1. Description

Hagenia abyssinica is found on most of the higher mountains between Ethiopia and northern Malawi, including Mt. Kenya, Mt. Meru (Tanzania), the Nyika Plateau (Malawi) and the Virunga mountains (Rwanda). Characteristically, ***Hagenia abyssinica*** forms almost pure stands of 9 to 15 m tall in a narrow and often interrupted zone between the montane Ericaceous belt (E) and taller types of Afromontane rain forest (Fa) or Afromontane undifferentiated forest (Fbu). The best-developed stands are clearly forest, but other stands have a structure that is better described as woodland or scrub forest (White 1983 p. 166).

Some authors have suggested that Afromontane single-dominant ***Hagenia abyssinica*** forest is a climax vegetation type where low night temperatures exclude other trees. However, even at high altitudes the dominance of ***Hagenia abyssinica*** is probably still the result from disturbance. The altitudinal range of this species is between 1800 and 3400 m. The abundance of this species does not seem to be related to moisture conditions, although the species is usually absent from Afromontane rain forest (Fa) and taller types of Afromontane undifferentiated forest (White 1983 p. 166).

Figure 6.1 Afromontane single-dominant *Hagenia abyssinica* forest between the Gisoke and Sabyinoyo volcanoes in the Volcanoes National Park (Rwanda). Photograph by V. Minani (July 2008)

Figure 6.2 Flowering *Hagenia abyssinica* tree against a background of Afromontane bamboo *(Sinarundinaria alpina*, synonym: *Arundinaria alpina*) in Volcanoes National Park (Rwanda). *Hagenia abyssinica* is also present in other types of Afromontane forest such as Afromontane single-dominant *Juniperus procera* forest (Fbj). Photograph by V. Minani (July 2008).

6.2. VECEA region

Within the VECEA region, Afromontane single-dominant ***Hagenia abyssinica*** forest occurs in all countries except Zambia (see Figure 6.3 and volume 6).

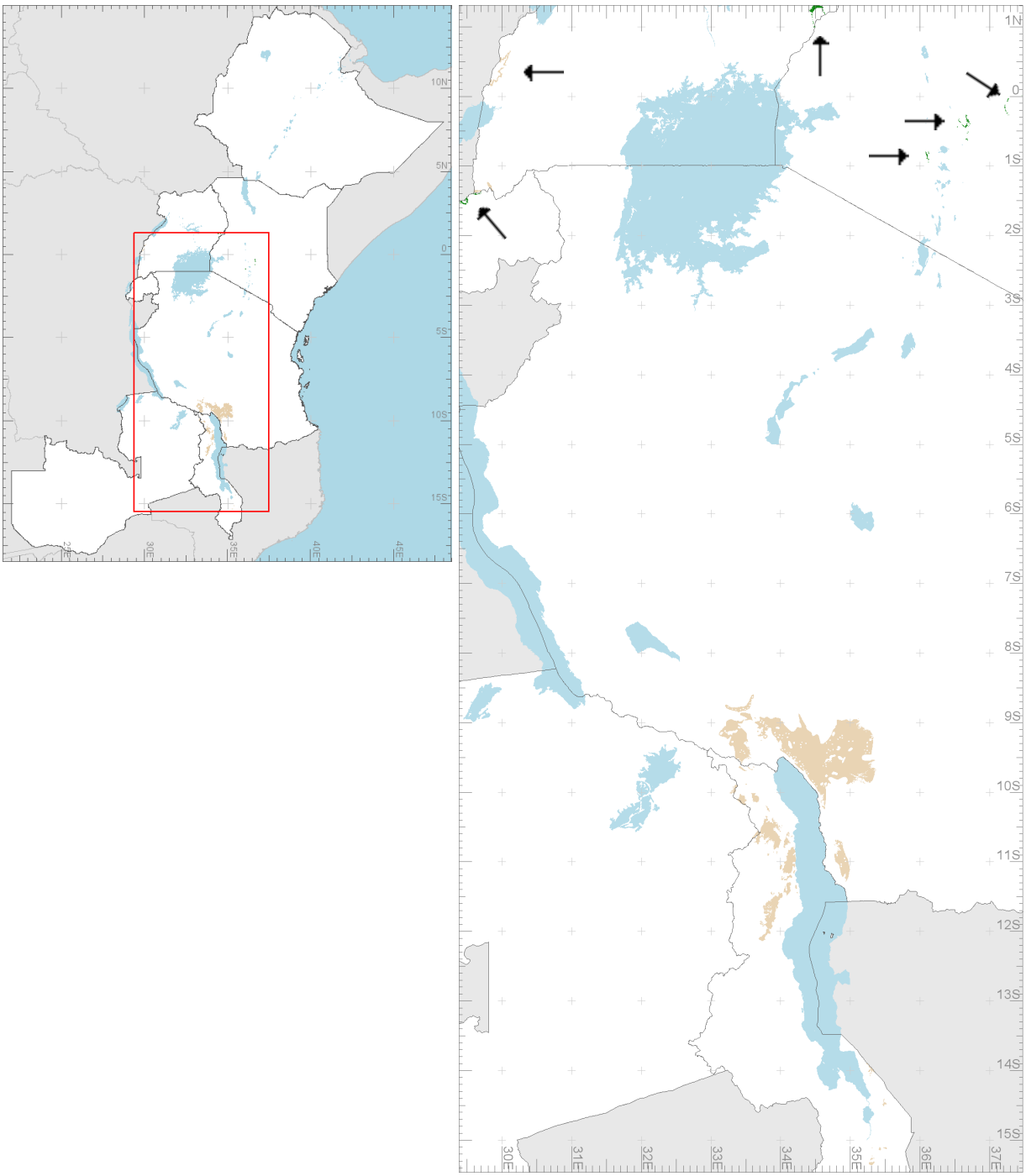


Figure 6.3. Mapped distribution of Afromontane single-dominant ***Hagenia abyssinica*** forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). This forest type occurs in all VECEA countries except Zambia. However, it could not be mapped everywhere as in Ethiopia. Where this vegetation type does not occur in mosaic, it is depicted by green polygons. Where this vegetation type occurs in vegetation mosaics, it is depicted by greyish-brown polygons. In some of the areas that are mapped as mosaics (like the high plateaus in southern Tanzania and northern Malawi), this forest type does occurs albeit in small and widely scattered patches only. Arrows show some places in the map where small polygons occur (as in Rwanda).

The atlas of the potential vegetation of Ethiopia did not classify Afromontane single-dominant ***Hagenia abyssinica*** forest as a separate forest type, but mentioned that "the mixture between *Juniperus-Podocarpus* dominated forest and ***Hagenia abyssinica - Hypericum revolutum*** woodland or scrub near the upper limit of Afromontane undifferentiated woodland seems to be characteristic of the Ethiopian mountains" (Friis *et al.* 2010 p. 77).

Maps for the highlands of Kenya (Trapnell *et al.* [1966, 1969, 1976, 1986]) listed *Hagenia - Hypericum* woodland and scrub (mapping unit 48a).

In Malawi, Afromontane single-dominant ***Hagenia abyssinica*** forest is distinguishable in the field, but patches are too small to be mapped separately (C. Dudley, personal observations). This forest type was therefore mapped together with Afromontane single-dominant ***Juniperus procera*** forest (Fbj). where the forest type occurs in widely scattered patches. Afromontane single-dominant ***Hagenia abyssinica*** forest also occurs as a narrow fringe above Afromontane rain forest (Fa; C. Dudley, personal observations).

In Rwanda, Afromontane single-dominant ***Hagenia abyssinica*** forest was described in the national classification system as "forêt-parcs à *Hagenia*".

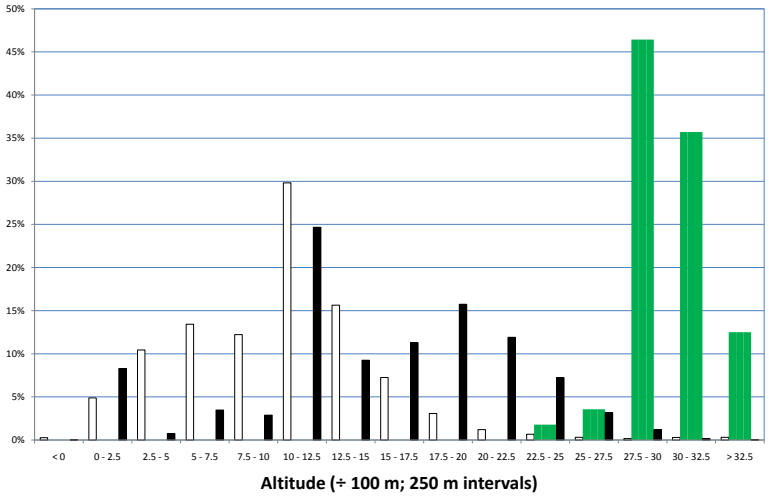
Lovett (1990 p. 291) writes that ***Hagenia abyssinica*** occurs as a single-dominant in Tanzania on Luhombero. However, White (1983) listed ***Hagenia abyssinica*** to occur on Mt. Meru.

In Uganda, Afromontane single-dominant ***Hagenia abyssinica*** forest was described in the national classification system as *Hagenia-Rapanea* moist montane forest. Langdale-Brown (1964 p. 43) mention that ***Hagenia abyssinica*** is a large tree that is only locally dominant in Uganda, typically in colonizing forest. ***Rapanea melanophloeos*** (a " indicator" of Afromontane undifferentiated forest) is a species that is more abundant and is more frequently dominant in these forests. The main reason that they retained a reference to ***Hagenia abyssinica*** in the name of this vegetation type was to provide uniformity with the work from other authors.

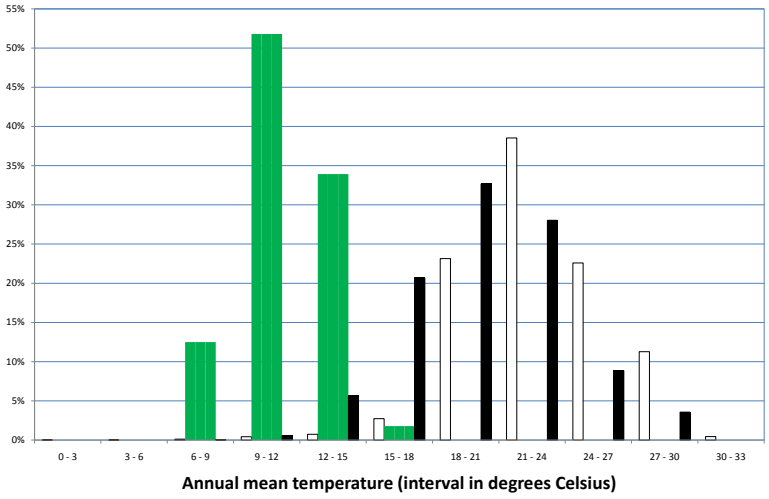
Fanshawe (1971 p. 29) mentions that *Hagenia abyssinica* is one of the species of secondary montane forest, but does not list it in the species composition table for Montane forest (Table 8 in Fanshawe 1971). Based on altitude limits (see below), we assume that typical Afromontane single-dominant *Hagenia abyssinica* forest does not occur in Zambia. However, probably *Hagenia abyssinica* has a similar patchy distribution as described above for Malawi.

Investigation of environmental distribution of Afromontane single-dominant ***Hagenia abyssinica*** forest in the VECEA region (Figure 6.4; limits are for areas of the VECEA map where this forest is not mapped as mosaic) shows that this forest type occurs at the highests altitudes of all forest types (94.6% of samples occur > 2750 m). However, there were only a small number of samples where this forest type did not occur as a mosaic. Annual rainfall of Afromontane single-dominant ***Hagenia abyssinica*** forest is mainly between 800 and 2000 mm (96.4% of samples), which is a similar range as for Afromontane rain forest (Fa).

(a)



(b)



(c)

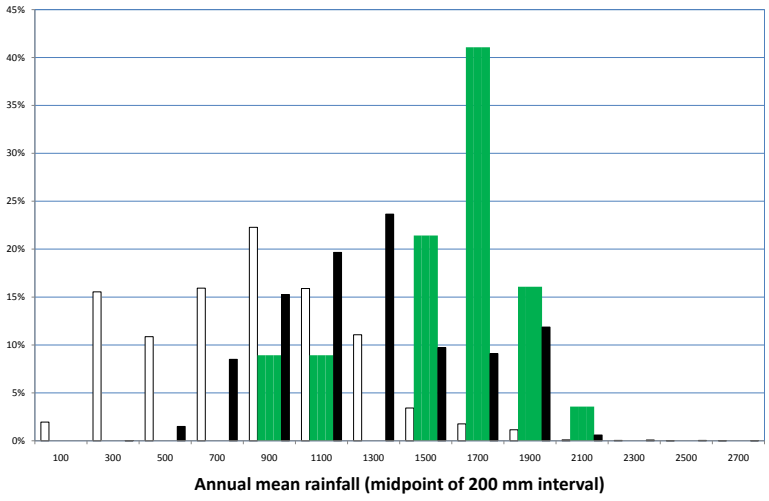


Figure 6.4 Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Afromontane single-dominant *Hagenia abyssinica* forest (Fd, *n* = 56). Bars on left (open) show the overall percentage of samples (n = 740,047). Bars on the right (black) show the percentages of samples within forests (n =59,013).

6.3. Species composition

Species composition was obtained from the following references:

- Kenya: Trapnell (1997). Species listed in Annex 1 to only occur marginally in the forest or in montane bamboo at high altitudes for "montane sclerophyll forest" or "montane sclerophyll and/or moist montane forest" were coded "C". Numbers show the maximum height of the species provided in the Annex (Trapnell 1997).
- Malawi: Dowset-Lemaire (1985) and White *et al.* (2001). Species were included in species assemblages partially based on the interpretation of our Malawian co-author (C. Dudley) since species were not consistently allocated to forest types in the references. These species were coded "x" (unless they were characteristic species).
- Rwanda: Bloesch *et al.* (2009). All species that were mentioned to occur in floristic region 4 (volcano zone) and where a reference was made to 'forêt-parcs à *Hagenia*' in the description of their ecology were coded "x" (unless they were characteristic species).
- Uganda: Langdale-Brown *et al.* (1964). All species that were listed to occur in "*Hagenia - Rapanea* moist montane forest" in the Appendix were coded "x" (unless they were characteristic species).

Characteristic species were determined as:

- Kenya: The species referred by the name of mapping unit 48a (*Hagenia - Hypericum* woodland and scrub) were coded as "C".
- Malawi: Species identified to be present as large trees (20 - 30 m) were coded as "C". Dominant species were coded as "D".
- Rwanda: ***Hagenia abyssinica*** was identified as the dominant species (coded "D"). *Hypericum revolutum* (listed as an associate species for the Virunga mountains by White (1983) [1983 p. 166] and Bloesch *et al.* [1999 p. 649] was identified as a characteristic species (coded "C").
- Uganda. Species characterized as large trees in the appendix or that were mentioned in the main text where the forest type was described were coded "C".

Within the information on assemblages, coding "f " indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

Table 6. Species composition of Afromontane single-dominant ***Hagenia abyssinica*** forest (Fd)

Species	regional status	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	(Uganda)
Hagenia abyssinica	dominant	D	C15	D	D	D	C
Agauria salicifolia		f	f	x	f	f	f
Apodytes dimidiata	characteristic (for Afromontane undifferentiated forest)	f	f	x	f	f	f
Bersama abyssinica		f	f	x	f	f	f
Casearia battiscombei			f	x		f	f
Cassipourea malosana	not characteristic (indicator forAfromontane dry transitional forest)	f	f	C		f	f
Catha edulis		f	f	x	f	f	f
Clausena anisata		f	f	x	f	f	f
Cornus volkensii			C24	f	f	f	C
Cussonia spicata			f	C		f	f
Dombeya torrida		f	f	x	f	f	f
Dovyalis macrocalyx			f	x	f	f	f
Ekebergia capensis		f	f	x	f	f	f
Hypericum revolutum	indicator	f	C12	f	C	f	x
Ilex mitis	indicator (for Afromontane undifferentiated forest)	f	f	C	f	f	f
Kiggelaria africana	indicator (for Afromontane undifferentiated forest, species that does not extend as far north as Ethiopia)			C		f	
Lepidotrichilia volkensii		f	C10	x	f	f	f
Maesa lanceolata		f	f	x	f	f	f
Maytenus acuminata			f	x	f	f	f
Nuxia congesta	indicator (for Afromontane undifferentiated forest)	f	f	x	f	f	f
Nuxia floribunda	indicator (for Afromontane undifferentiated forest)		f	x	f	f	f
Olea capensis	not characteristic (indicator forAfromontane rain forest)	f	f	C	f	f	f
Olinia rochetiana		f	f	C	f	f	f
Pittosporum viridiflorum		f	f	C	f	f	f
Podocarpus latifolius	characteristic (species that does not extend as far north as Ethiopia)		f	C	f	f	f
Polyscias fulva		f	f	x	f	f	f
Prunus africana	characteristic	f	f	C	f	f	x
Rapanea melanophloeos	indicator (for Afromontane undifferentiated forest)	f	f	C	f	f	x
Schefflera volkensii		f	C24			f	f
Syzygium guineense	not characteristic (indicator for Afromontane rain forest [Syzygium guineense ssp. afromontanum])	f	f	x	f	f	f
Xymalos monospora	characteristic (species that does not extend as far north as Ethiopia)		f	x	f	f	f

7. Afromontane moist transitional forest (Fe)

7.1. Description

Afromontane moist transitional forest was the only VECEA forest vegetation type that could not be directly related to forest types listed for the Vegetation Map of Africa (White 1983). However, in the description of Afromontane dry transitional forest, White listed two characteristic species that occur near streams (White 1983 pp. 166 - 167). We hypothesize that these two species, ***Albizia gummifera*** and ***Newtonia buchananii***, could be potential indicators of Afromontane moist transitional forest. ***Albizia gummifera*** is also a characteristic species of Lake Victoria transitional rain forest (Ff; White 1983 p. 181). ***Newtonia buchanani***i was also listed as characteristic species for Lake Victoria transitional rain forest (Ff; White 1983 p. 181), Zanzibar-Inhambane lowland rain forest (Fo; White 1983 p. 186), Zanzibar-Inhambane transitional rain forest (Fg; White 1983 p. 187) and evergreen and semi-evergreen Zambezian riparian forest (fr; White 1983 p. 91). However, since these two indicator species are not listed for Ethiopia, they are effectively indicators for the Kenyan manifestation of this vegetation type (FeK).

Figure 7.1 Canopy and forest margins of Afromontane moist transitional rain forest (synonym transitional rain forest) in Ethiopia. Approximate altitude of 1200 m. Photograph by I. Friis and Sebsebe Demissew (January 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 28A. 2010.

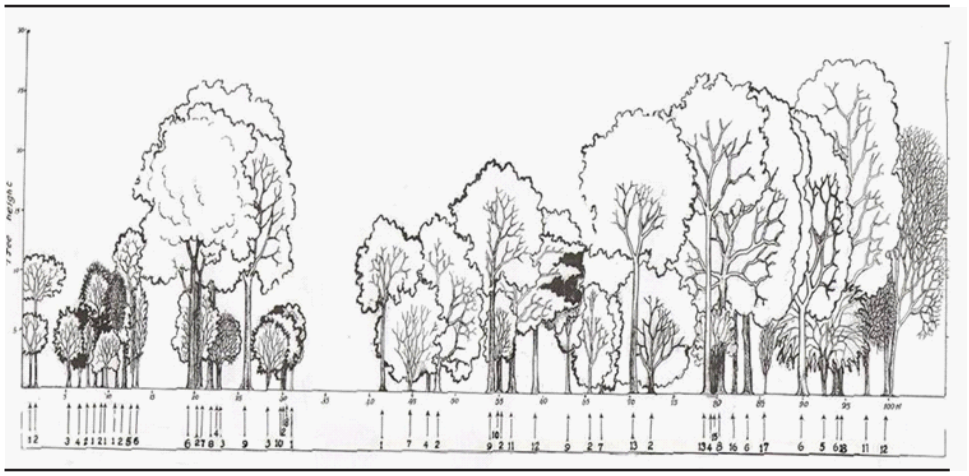


Figure 7.2 Profile diagram of Afromontane moist transitional forest in the Kambakia area north-east of Mt. Kenya (0° 04.498′ N; 37° 37.671′ E). Altitude 1612 m. This forest was classified by Trapnell *et al.* (1966, 1969, 1976, 1986)) as moist intermediate forest. Species shown are: *Bersama abyssinica* (15); *Casearia battiscombei* (13); *Celtis africana* (8); *Celtis gomphophylla* (12); *Cordia africana* (6); *Croton sylvaticus* (9); *Diospyros abyssinica* (10); *Ehretia cymosa* (5); *Erythrococca bongensis* (3); *Flacourtia indica* (7); *Olea capensis* (16); *Pittosporum viridiflorum* (11); *Ritchiea albersii* (14); *Rothmannia urcelliformis* (1); *Trilepisium madagascariense* (4) and *Xymalos monospora* (2). Obtained from Matingi (2011).

7.2. VECEA region

Within the VECEA region, Afromontane moist transitional forest was only mapped in Ethiopia and Kenya (originally mapped as "moist intermediate forest, east").

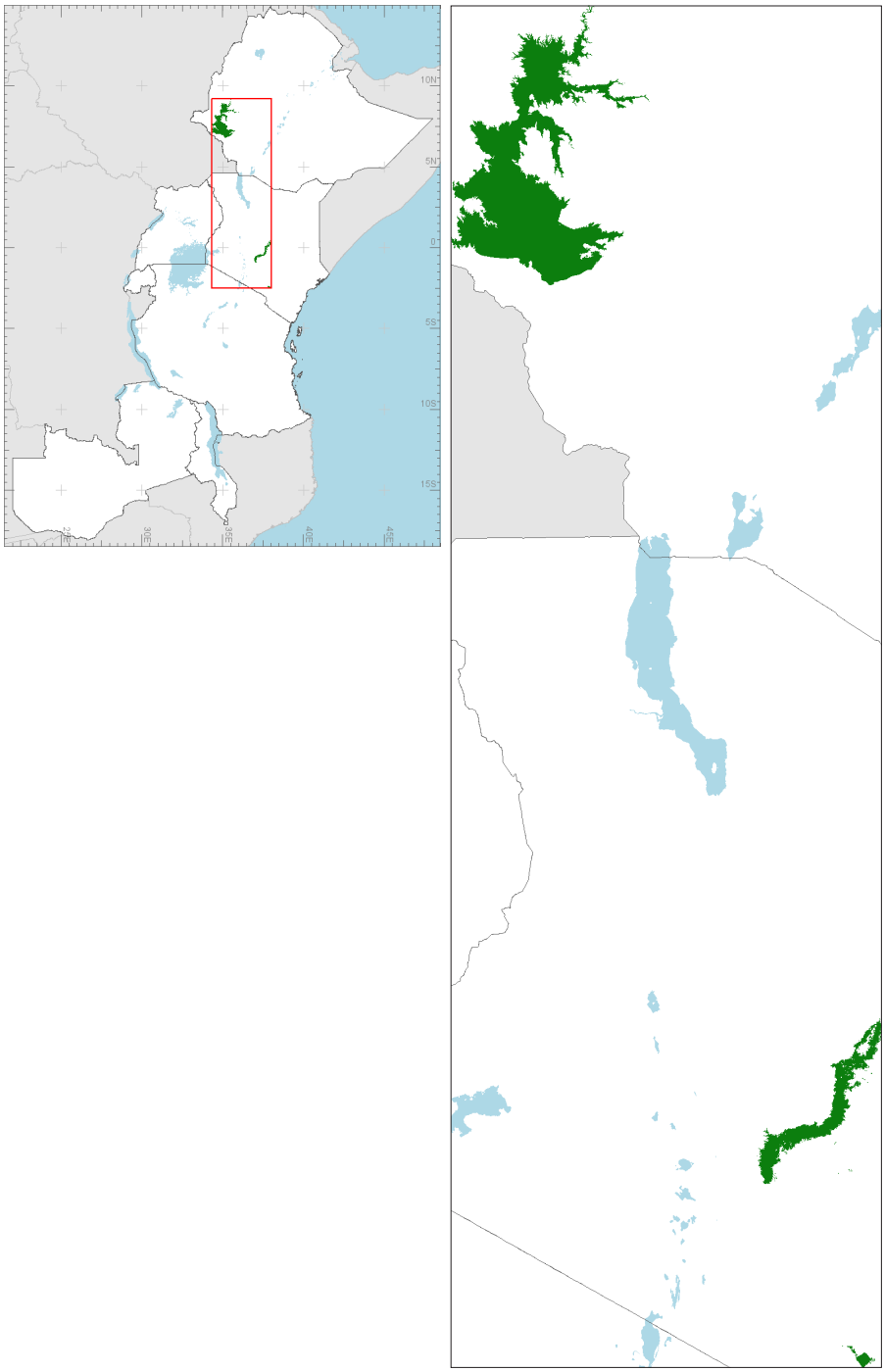


Figure 7.3. Mapped distribution of Afromontane moist transitional forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). The locations where this forest type occurs are depicted by green polygons. Note that species composition and environmental distribution is considerably different between the Ethiopian and Kenyan manifestations of this forest type. In Kenya, we used modelling to estimate the wider distribution of this forest type beyond the base maps (see Volume 6).

In Ethiopia, Afromontane moist transitional forest was originally mapped as Transitional Rain Forest (TRF). One of the synonyms used for the transitional rain forest of Ethiopia (coded TRF) is "dry peripheral semi-deciduous Guineo-Congolian forest" (Friis 1992 cited in Friis *et al.* 2010 p. 106), a name that suggests similarity with "drier peripheral semi-evergreen Guineo-Congolian forests and similar forests in the transition zones" (with the subtype of "Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest" mapped in Kenya and Uganda within the VECEA map [Fi]). Although there could be some arguments to classify Ethiopian transitional rain forest as "Ethiopian drier peripheral semi-evergreen Guineo-Congolian rain forest", we included it under the general heading of "Afromontane moist transitional forest" for four reasons:

(i) in accordance to White (1983), to restrict the classification of "drier peripheral semi-evergreen Guineo-Congolian rain forest" to the Guineo-Congolian floristic region, the Guineo-Congolia to Zambezia and Guineo-Congolia to Sudania regional transitional zones and the Lake Victoria regional mosaic;
(ii) to highlight a similarity between the Ethiopian and Kenyan manifestations of "Afromontane moist transitional forest" in occurring in areas that are adjacent to blocks of Afromontane rain forest (Fa);
(iii) to show that both these forests could not be re-classified as one of the forest types listed in the Vegetation of Africa (White 1983); and
(iv) to indicate that both the Ethiopian and Kenyan areas where these forest types occur are highly suitable for the cultivation of coffee and tea (*i.e.* they can be classified as the same agro-ecological zone) - and are highly threatened by conversion to plantations for these reasons.

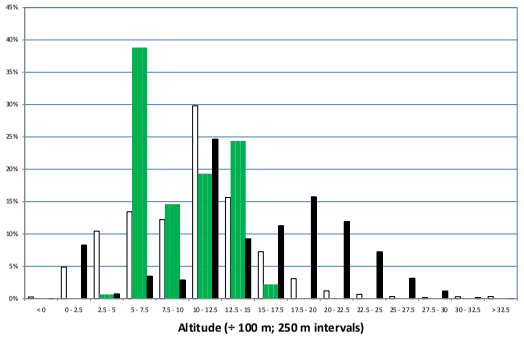
Another choice could have been to classify the Ethiopian transitional rain forest as an "Ethiopian variant of Lake Victoria transitional rain forest", where an argument could have been the occurrence of the characteristic species of *Pouteria altissima* in both forests.

In Kenya, Afromontane moist transitional forest was originally mapped as "moist intermediate forest, east". We used environmental modelling to estimate the wider distribution of this forest type beyond the base maps (see Volume 6).

In Ethiopia, Afromontane moist transitional forest occurs at lower altitudes (the 500 – 750 m interval has the highest percentage of samples [38.8%]), although there is also a considerable percentage of samples at higher altitudes (samples mainly cover an altitude interval of 500 – 1750 m; Figure w1). In Kenya, more than 95% of samples are in an altitude interval of 1000 – 1750 m. Most samples in Ethiopia are in the rainfall interval of 1200 – 1400 mm (70.7%), whereas in Kenya the rainfall has a wider distribution with almost 80% of samples in the 1000 – 1800 mm interval (Figure 7.5).

We strongly emphasize that there are clear floristic and environmental differences between the Ethiopian and Kenyan Afromontane moist transitional forests. Both vegetation types can therefore be regarded as having a unique value.

(a)



(b)

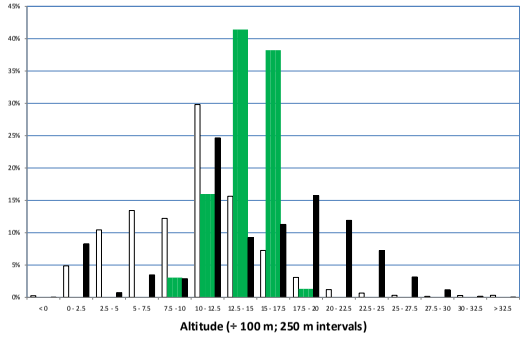
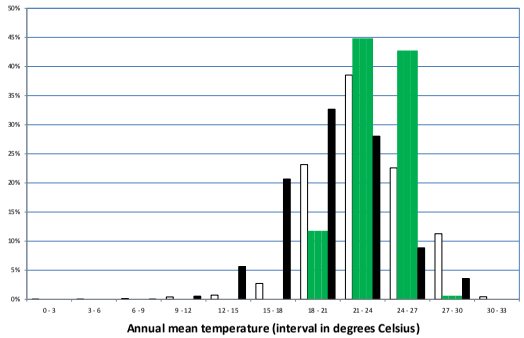


Figure 7.5.1. Histograms of the distribution of altitude. Bars at the centre of each interval show the percentage of samples within the Ethiopian manifestation (a, FeE, *n* = 3,813) and Kenyan manifestation (b, FeK, *n* = 751) of Afromontane moist transitional forest. Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

(a)



(b)

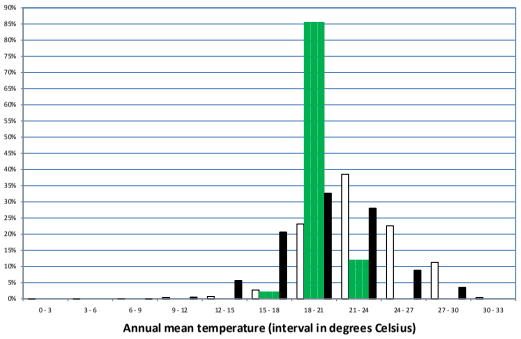
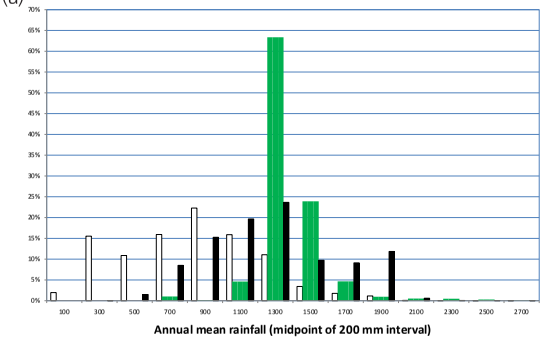


Figure 7.5.2. Histograms of the distribution of mean annual temperature. Bars at the centre of each interval show the percentage of samples within the Ethiopian manifestation (a, FeE, *n* = 3,813) and Kenyan manifestation (b, FeK, *n* = 751) of Afromontane moist transitional forest. Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

(a)



(b)

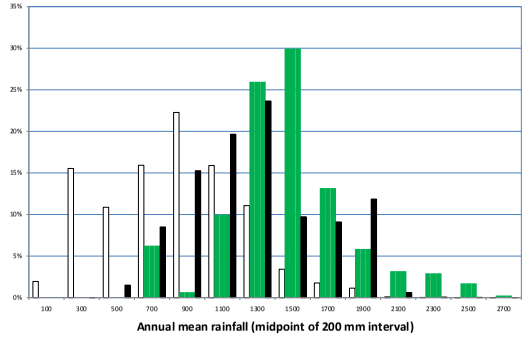


Figure 7.5.3. Histograms of the distribution of mean annual rainfall. Bars at the centre of each interval show the percentage of samples within the Ethiopian manifestation (a, FeE, *n* = 3,813) and Kenyan manifestation (b, FeK, *n* = 751) of Afromontane moist transitional forest. Bars on left (open) show the overall percentage of samples *(n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

7.3. Species composition

Species composition was obtained from the following references:

- Ethiopia: Friis *et al.* 2010. Species mentioned in Appendix 3 for "Transitional rainforest" (TRF) were coded as "x" (unless they were characteristic species).
- Kenya: Trapnell (1997). Species listed in Annex 1 for "moist intermediate forest, east", "moist montane and/or moist intermediate forest", "moist intermediate forest, west and east", "moist intermediate and dry intermediate forest" and "of more general distribution" were coded "C". Suffix "a" indicates that the species was also listed for Afromontane rain forest (Fa; synonym: moist montane forest). Suffix "f" indicates that the species was also listed for Lake Victoria transitional rain forest (Ff; synonym: moist intermediate forest, west). Suffix "g" indicates species of more general distribution. Suffix "h" indicates that the species was also listed for Afromontane dry transitional forest (Fh; synonym: dry intermediate forest). Suffix "s" indicates secondary species. Numbers show the maximum height of the species provided in the Annex (Trapnell 1997). Species that were expected to occur in the forest type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x".

Characteristic species were determined as:

- Ethiopia: species mentioned in the main description of the vegetation type were coded as "C".
- Kenya: Species that were listed by Trapnell (1997) were assumed to be characteristic species (these were coded "C").

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

Table 7. Species composition of Afromontane moist transitional forest (Fe)

Species	Regional status (see section 2.3)	(Ethiopia)	(Kenya)
Acacia abyssinica		f	x
Albizia coriaria		x	f
Albizia grandibracteata		x	f
Albizia gummifera	probable indicator as near streams in Afromontane dry transitional forest	f	Cg30
Albizia schimperiana		C	f
Allophylus abyssinicus		f	x
Allophylus rubifolius		f	x
Alstonia boonei		C	
Anthocleista grandiflora			Cf24
Antiaris toxicaria		C	f
Antidesma venosum		f	x
Aphania senegalensis		x	f
Apodytes dimidiata	not characteristic (indicator for Afromontane dry transitional forest)	f	x
Baphia abyssinica		x	
Bersama abyssinica		f	Cg15
Blighia unijugata		x	Cf30
Bridelia micrantha		f	Cfhs12
Buddleja polystachya		f	x
Caesalpinia decapetala			x
Caesalpinia volkensii			x
Casearia battiscombei			Caf37
Cassipourea malosana	not characteristic (indicator for Afromontane dry transitional forest)	f	Cg24
Catha edulis		f	x
Ceiba pentandra		x	
Celtis africana		f	x
Celtis gomphophylla		C	Cf27
Celtis mildbraedii			x
Celtis toka		C	
Clausena anisata		f	x
Cordia africana		x	Cfr24
Craibia brownii			x
Crateva adansonii		x	f
Crotalaria agatiflora		f	x
Croton macrostachyus		f	Cgs24
Croton megalocarpus	not characteristic (indicator for Afromontane dry transitional forest)		Cfhs37
Croton sylvaticus		C	Caf24
Diospyros abyssinica	not characteristic (indicator for Afromontane dry transitional forest)	C	Cg27
Dombeya torrida		f	x
Dovyalis abyssinica		f	x
Dovyalis macrocalyx			x
Dracaena fragrans		x	f
Dracaena steudneri		x	Cg12
Ehretia cymosa		f	Cg9
Ekebergia capensis		f	Cg24
Elaeodendron buchananii		x	f

Species	Regional status (see section 2.3)	(Ethiopia)	(Kenya)
Embelia schimperi		f	x
Englerophytum natalense			x
Erythroxylum fischeri		x	f
Eugenia capensis		x	f
Fagaropsis angolensis	not characteristic (indicator for Afromontane dry transitional forest)	x	Cfh21
Ficus exasperata		C	Cf27
Ficus mucuso		C	f
Ficus natalensis			x
Ficus platyphylla		x	
Ficus sur		x	Cg24
Ficus thonningii		f	Cg21
Funtumia africana			x
Hagenia abyssinica		f	x
Harungana madagascariensis			Caf12
Kigelia moosa			Caf15
Lannea welwitschii		x	f
Lecaniodiscus fraxinifolius		C	f
Lepidotrichilia volkensii		f	x
Lovoa swynnertonii			C46
Macaranga capensis		f	x
Maesa lanceolata		f	x
Manilkara butugii		C	Cf27
Margaritaria discoidea		x	x
Markhamia lutea	not characteristic (indicator for Afromontane dry transitional forest)		Cfh18
Maytenus undata		f	x
Milicia excelsa		C	Cf49
Mimusops bagshawei			Cfh40
Mimusops kummel		f	Cfh27
Morus mesozygia		C	f
Myrianthus holstii	not characteristic (indicator for Afromontane rain forest)		Cs15
Neoboutonia macrocalyx			Caf18
Newtonia buchananii	probable indicator as near streams in Afro-montanedry transitional forest		C46
Nuxia congesta	not characteristic (indicator for Afromontane undifferentiated forest)	f	Cg21
Olea capensis	not characteristic (indicator for Afromontane rain forest)	f	Caf27
Olyra latifolia		x	f
Oncoba spinosa		x	f
Phoenix reclinata	(palm species)	f	x
Phytolacca dodecandra		f	x
Pittosporum viridiflorum		f	xb
Plectranthus barbatus		f	x
Polyscias fulva		x	faf
Pouteria adolfi-friedericii	not characteristic (indicator for Afromontane rain forest)	f	xa
Pouteria altissima		C	ff
Premna maxima			C30

Species	Regional status (see section 2.3)	(Ethiopia)	(Kenya)
Prunus africana	not characteristic (characteristic for Afromontane rain forest and Afromontane undifferentiated forest)	f	x
Psychotria mahonii			x
Psydrax parviflora		f	Caf24
Pterolobium stellatum		f	x
Rapanea melanophloeos	not characteristic (indicator for Afromontane undifferentiated forest)	f	xab
Rauvolfia caffra			C24
Rhamnus prinoides		f	x
Rhoicissus revoilii		f	x
Ritchiea albersii		x	f
Rothmannia urcelliformis		x	Cfh9
Rubus apetalus		f	x
Rubus volkensii		f	x
Schefflera abyssinica		f	x
Schefflera volkensii		f	x
Scutia myrtina		f	x
Senna didymobotrya		f	x
Senna septemtrionalis			x
Shirakiopsis elliptica		x	Cfh15
Smilax anceps		x	f
Solanum aculeastrum			x
Strombosia scheffleri	not characteristic (indicator for Afromontane rain forest)		Caf27
Strychnos mitis		C	f
Syzygium guineense	not characteristic (indicator for Afromontane rain forest [*Syzygium guineense* ssp. *afromontanum*])	f	x
Tabernaemontana pachysiphon			Caf10
Tabernaemontana stapfiana	not characteristic (indicator for Afromontane rain forest)		x
Trema orientalis		f	Cfh12
Trichilia dregeana		C	f
Trichilia emetica		f	Cf27
Trilepisium madagascariense		C	f
Vepris dainellii		x	
Vepris nobilis		f	Cg12
Vernonia auriculifera		f	x
Vernonia myriantha		f	x
Warburgia ugandensis	not characteristic (indicator for Afromontane dry transitional forest)	f	Cfh30
Xylopia parviflora		x	f
Xymalos monospora	not characteristic (characteristic for Afromontane rain forest and Afromontane undifferentiated forest)		x
Zanha golungensis		C	f
Zanthoxylum gilletii		x	Caf30
Zanthoxylum rubescens			Caf24
Ziziphus pubescens		x	f

8. Lake Victoria transitional rain forest (Ff)

8.1. Description

White describes two types of Lake Victoria transitional rain forest: (i) transitional rain forests occurring between 1600 and 1900 m in western Burundi, western Rwanda and eastern Kivu (DRC); and (ii) Kakamega forest in Kenya (1520 to 1680 m). Kakamega forest is described as containing a mixture of Guineo-Congolian lowland rain forest species (that reach their easternmost limits in distribution in Kakamega forest) and Afromontane species, but containing fewer Afromontane species than the other Lake Victoria transitional rain forests (White 1983 p. 181).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Lake Victoria transitional rain forest and no other Lake Victoria forest types) that were listed as characteristic species for one or several national maps include ***Alangium chinense*** (Afromontane species, also a indicator for Zanzibar-Inhambane transitional rain forest [Ff]), ***Anthonotha pynaertii, Apodytes dimidiata*** (Afromontane species, also characteristic of Afromontane undifferentiated forest [Fbu] and Afromontane dry transitional forest [Fh]), ***Carapa procera, Chrysophyllum gorungosanum*** (also a indicator of Afromontane rain forest [Fa]), ***Cordia millenii*** (Guineo-Congolian lowland rain forest species), ***Diospyros gabunensis, Macaranga capensis (***synonym: ***Macaranga kilimandscharica; Afromontane species), Monodora myristica*** (Guineo-Congolian lowland rain forest species), ***Neoboutonia macrocalyx*** (Afromontane species), ***Newtonia buchananii*** (also a characteristic species of Afromontane moist transitional forest [FeK], Afromontane dry transitional forest [Fh; near streams], Zanzibar-Inhambane lowland rain forest [Fo] and Zanzibar-Inhambane transitional rain forest [Fg; upland species]), ***Parinari excelsa*** (also an indicator of Afromontane rain forest [Fa]), ***Prunus africana*** (Afromontane species, also characteristic of Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]), ***Strombosia scheffleri*** (Afromontane species, also a indicator of Afromontane rain forest [Fa]), ***Symphonia globulifera, Syzygium guineense*** (also an indicator of Afromontane rain forest [Fa]), ***Turraea holstii*** (Afromontane species) and ***Xymalos monospora*** (also characteristic of Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]).

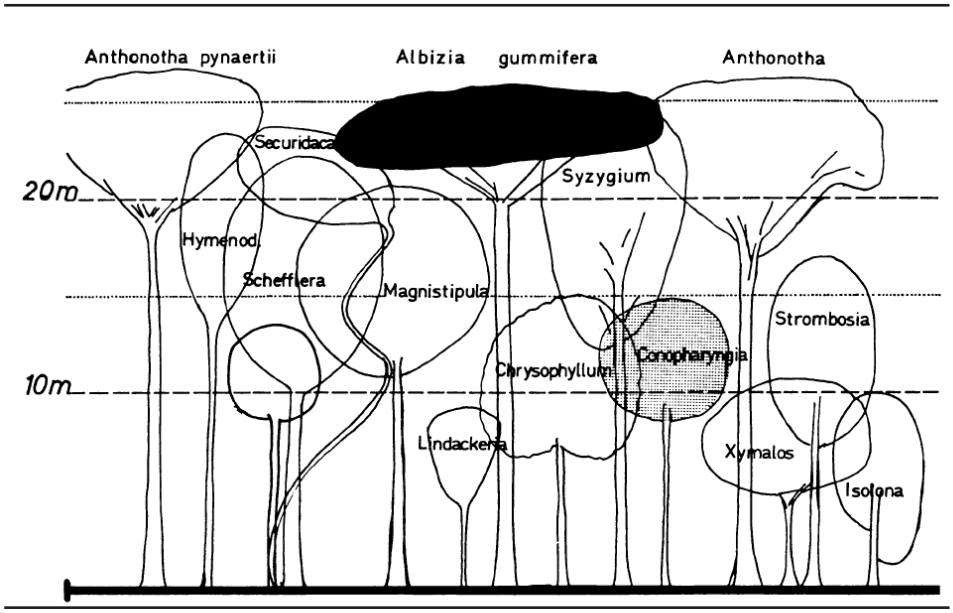


Figure 8.1 Profile diagram of Lake Victoria transitional rain forest in Burundi. Although White (1983 p. 164) listed this profile diagram for the description of Afromontane rain forest (Fa), the altitude range for this forest type of 1600 – 1900 m were described by White (1983 p. 181) for Lake Victoria transitional rain forest (Ff) and also corresponded to the altitude range of the "horizon inférieur" mentioned with the original publication of this profile diagram (Lewalle 1972). Figure obtained from URL: *http://www.jstor.org/stable/3667406*.

Figure 8.2 Lake Victoria transitional rain forest in South Nandi forest. Photograph by F. Gachathi.

8.2. VECEA region

Within the VECEA region, Lake Victoria transitional rain forest only occurs in Kenya and Rwanda.

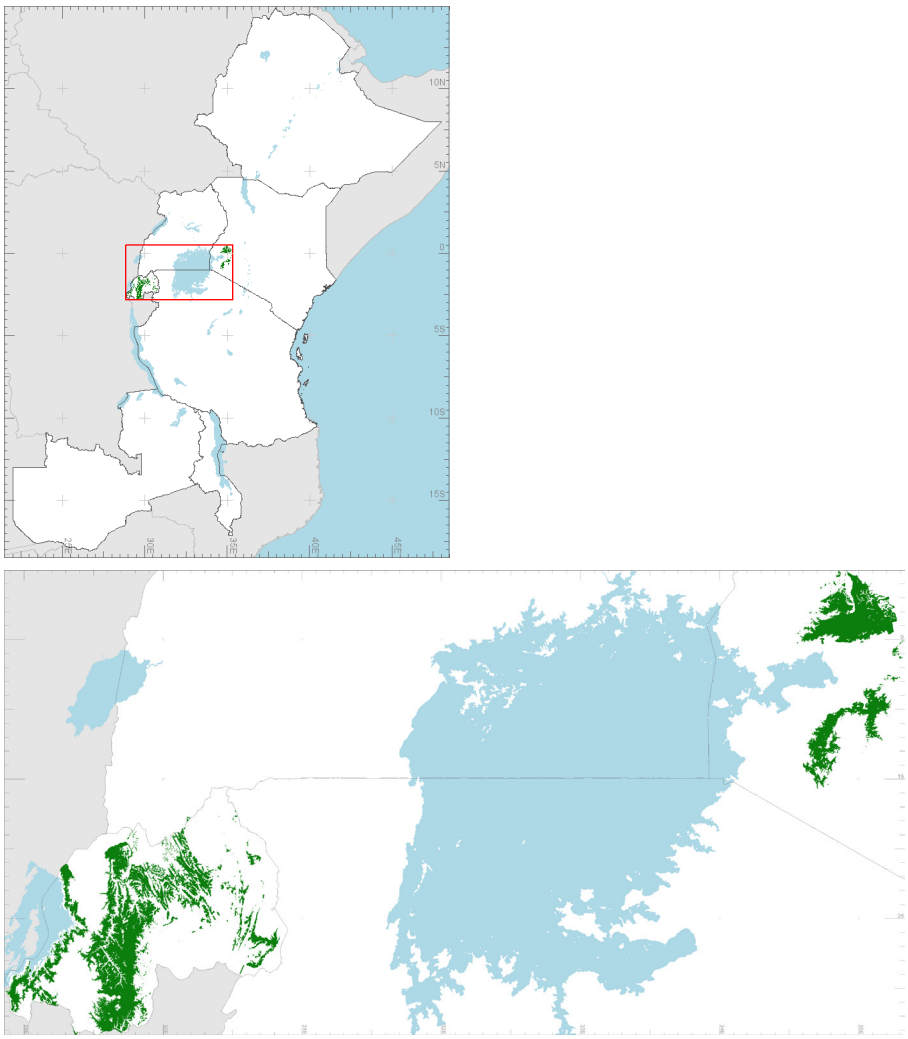


Figure 8.3. Mapped distribution of Lake Victoria transitional rain forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). The locations where this forest type occurs are depicted by green polygons.

In Kenya, Trapnell *et al.* (1966, 1969, 1976, 1986; see also Trapnell and Brunt [1987]) did not differentiate between Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (mapped in VECEA as Fi) and Lake Victoria transitional rain forest (Ff) and mapped both forests as "moist intermediate forest, west". We used an altitude limit of 1520 m (*i.e.* the lower altitude limit mentioned by White [1983 p. 181]) to infer the boundary between these forests (see volume 6).

In Rwanda, Lake Victoria transitional rain forest was originally described as "forêts mésophiles de montagne". The Rwandan manifestation of Lake Victoria transitional rain forest only exists as small remnants now. More than 50 years ago, Lebrun (1956) mentioned that he did not know any typical examples from these forests to occur in Rwanda and Burundi (he inferred the previous presence of these forests from isolated relicts). Gasana (1975 cited in Combe 1975) mentions that the inferior horizon of Nyungwe forests (1600 - 1900 m) contains following dominant species: *Albizia gummifera*, *Entandrophragma excelsum*, ***Parinari excelsa, Newtonia buchananii*** and ***Symphonia globulifera. Carapa procera*** was dominant in the shrub layer. Therefore, this forest may still exist in Rwanda (though only marginally).

Investigation of environmental distribution of Lake Victoria transitional rain forest in the VECEA region (Figure 8.4) shows that most of this forest occurs between 1500 and 2000 m (with > 95% of the samples in this interval). The rainfall interval where most of samples occur is the same for this vegetation type (1200 – 1400 mm; 29.6% of samples) as for all forests combined (23.7%).

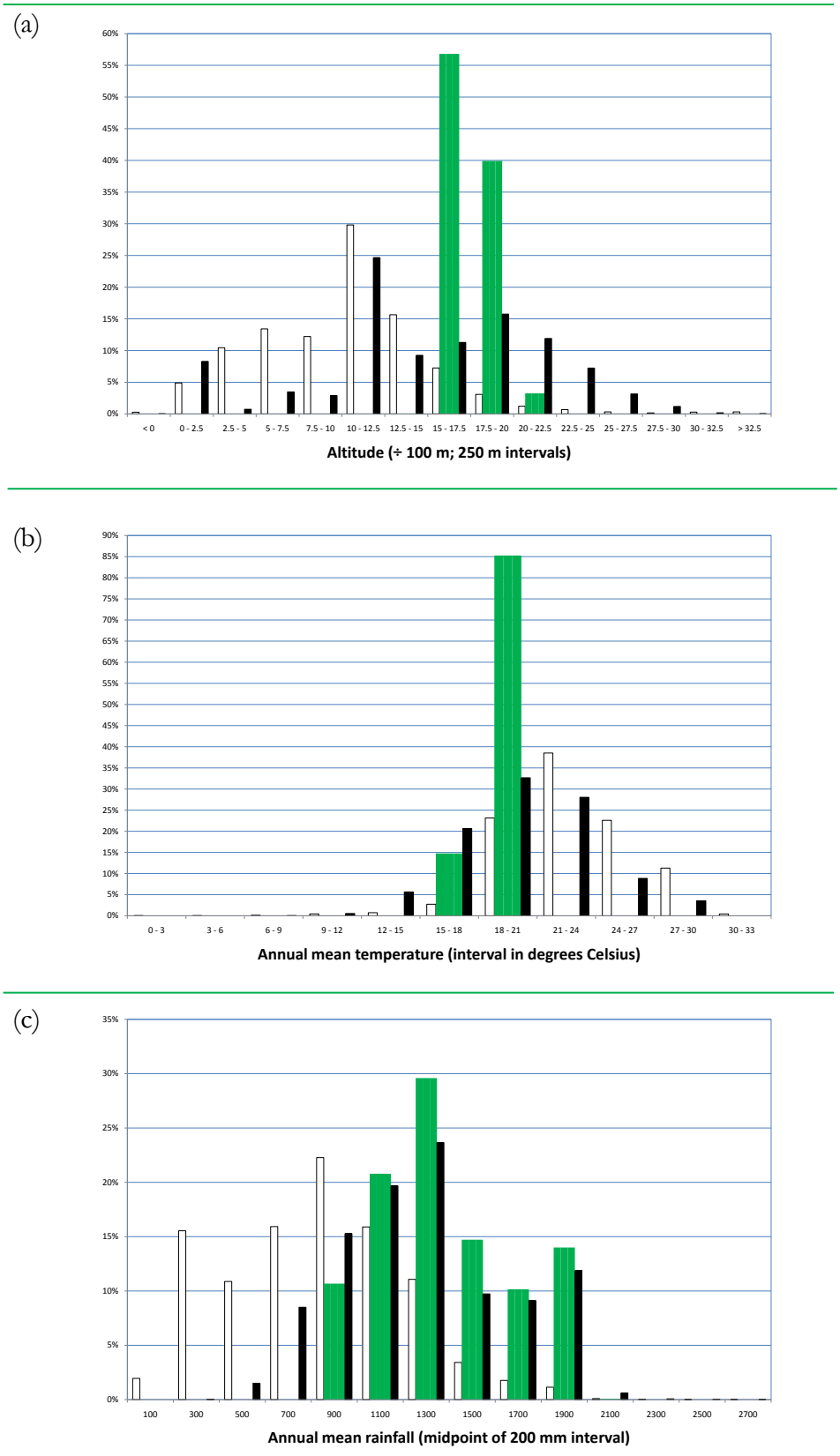


Figure 8.4. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Lake Victoria transitional rain forest (Ff, n = 2,521). Bars on left (open) show the overall percentage of samples (n = 740,047). Bars on the right (black) show the percentages of samples within forests (n =59,013).

8.3. Species composition

Species assemblages were obtained from the following references:

- Kenya: Trapnell (1997). Species listed in Annex 1 of for "moist intermediate forest, west", "moist montane and/or moist intermediate forest", "moist intermediate forest, west and east", "moist intermediate and dry intermediate forest" and "of more general distribution" were coded "C". Suffix "a" indicates that the species was also listed for Afromontane rain forest (Fa; synonym: moist montane forest). Suffix "e" indicates that the species was also listed for Afromontane moist transitional forest (Fe; synonym: moist intermediate forest, east). Suffix "g" indicates species of more general distribution. Suffix "h" indicates that the species was also listed for Afromontane dry transitonal forest (Fh; synonym: dry intermediate forest). Suffix "s" indicates secondary species. Numbers show the maximum height of the species provided in the Annex (Trapnell 1997). Species that were expected to occur in the forest type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x".
- Rwanda: Bloesch *et al.* (2009). All species that were mentioned to occur in floristic region 3 (forest remnants and secondary vegetation [3A]; montane forests of the Congo and Nile basins [3B]), that had part of their distribution range below 1900 m and where a reference was made to a forest habitat ('forêt') in the description of their ecology were coded "x" (unless they were characteristic species). To these species we added species listed by White (1983) (1983 p. 181) to occur at altitudes of 1600 - 1900 m in western Rwanda.

Characteristic species were determined as:

- Kenya: Species that were listed by Trapnell (1997) were assumed to be characteristic species (these were coded "C").
- Rwanda: Characteristic species were coded "C". These included: (i) species listed by Prioul (1981) to occur in forests at altitudes of 1600 - 1900 m; (ii) species listed by Lebrun (1956) to occur in 'forêts mésophiles de montagne'; and (iii) species listed by Gasana (1975 cited in Combe 1975) to occur in Nyungwe forest at altitudes of 1600 - 1900 m.

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

Table 8. Species composition of Lake Victoria transitional rain forest (Ff)

Species	**Regional status** (see section 2.3)	**(Kenya)**	**(Rwanda)**
Acacia abyssinica		x	f
Acacia lahai		x	
Acacia mearnsii		f	x
Agauria salicifolia		f	x
Alangium chinense	indicator (Afromontane species)	x	f
Albizia grandibracteata		C19	f
Albizia gummifera	characteristic	Cgs30	C
Albizia zygia		C30	
Alchornea hirtella		x	x
Allophylus abyssinicus		x	x
Allophylus rubifolius		x	f
Anthocleista grandiflora		Ce24	
Anthonotha pynaertii	indicator		x
Antiaris toxicaria	not characteristic (indicator for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest)	C46	f
Antidesma venosum		x	
Apodytes dimidiata	indicator (afromontane species)	x	x
Beilschmiedia ugandensis		x	
Bersama abyssinica		Cg15	f
Blighia unijugata		Ce30	f
Bridelia brideliifolia			x
Bridelia micrantha		Ceh12	f
Buddleja polystachya		x	
Caesalpinia decapetala		x	f
Caesalpinia volkensii		x	
Carapa procera	indicator		C
Casearia battiscombei		Cae37	
Cassipourea malosana		Cg24	
Cassipourea ruwensoriensis		C12	x
Celtis africana		x	f
Celtis gomphophylla		Ce27	C
Celtis mildbraedii		C30	
Chrysophyllum albidum	not characteristic (indicator forLake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest)	C37	
Chrysophyllum gorungosa-num	indicator (afromontane species)	f	C
Clausena anisata		x	C
Cordia africana		Ce24	f
Cordia millenii	indicator (Guineo-Congolian species)	C30	
Craibia brownii		x	f
Crotalaria agatiflora		x	f
Croton macrostachyus		Cgs24	x
Croton megalocarpus		Ceh37	x
Croton sylvaticus		Cae24	
Cyathea manniana		x	x
Diospyros abyssinica		Cg27	f
Diospyros gabunensis	indicator		x
Dodonaea viscosa		x	x
Dombeya torrida		x	x
Dovyalis abyssinica		x	

Species	Regional status (see section 2.3)	(Kenya)	(Rwanda)
Dovyalis macrocalyx		x	x
Dracaena fragrans		x	f
Dracaena steudneri		Cg12	x
Ehretia cymosa		Cg9	C
Ekebergia capensis		Cgs24	x
Embelia schimperi		x	x
Ensete ventricosum		f	x
Entada abyssinica		x	f
Entandrophragma angolense	characteristic (Guineo-Congolian species)	C49	
Entandrophragma excelsum			C
Eugenia capensis		f	x
Fagaropsis angolensis		Ceh21	x
Ficalhoa laurifolia			x
Ficus exasperata		Ce27	x
Ficus natalensis		x	f
Ficus sur		Cg24	x
Ficus thonningii		Cg21	f
Funtumia africana		C24	
Galiniera saxifraga		x	x
Garcinia buchananii		C12	f
Hagenia abyssinica		x	x
Harungana madagascariensis		Cae12	C
Hypericum revolutum		f	x
Ilex mitis		f	x
Kigelia africana		f	x
Kigelia moosa		Cae15	
Lecaniodiscus fraxinifolius		C18	
Lepidotrichilia volkensii		x	x
Lovoa trichilioides			x
Macaranga capensis	indicator (Afromontane species)	x	x
Maesa lanceolata		x	x
Maesopsis eminii	characteristic (Guineo-Congolian species)	Cs27	f
Manilkara butugii		C27	
Margaritaria discoidea		x	
Markhamia lutea		Cehs18	f
Maytenus acuminata		f	x
Maytenus undata		xb	x
Milicia excelsa	not characteristic (indicator for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest)	Ce49	f
Mimusops bagshawei		Ceh40	f
Mimusops kummel		Ceh27	
Mondia whitei		x	
Monodora myristica	indicator (Guineo-Congolian species)	C24	
Morus mesozygia	not characteristic (indicator for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest)	C24	
Neoboutonia macrocalyx	indicator (Afromontane species)	Cae18	C
Newtonia buchananii	indicator	f	C
Nuxia congesta		Cg21	x
Nuxia floribunda		f	x
Ocotea kenyensis		f	x

Species	Regional status (see section 2.3)	(Kenya)	(Rwanda)
Ocotea usambarensis		f	x
Olea capensis		Cae27	f
Olinia rochetiana		f	x
Parinari excelsa	indicator (afromontane species)		C
Peddiea fischeri		f	x
Phoenix reclinata	(palm species)	x	f
Phytolacca dodecandra		x	f
Pittosporum viridiflorum		x	x
Plectranthus barbatus		x	
Pleiocarpa pycnantha		f	x
Podocarpus falcatus		f	x
Podocarpus latifolius		f	x
Polyscias fulva		C24	x
Pouteria adolfi-friedericii		x	f
Pouteria altissima	characteristic (Guineo-Congolian species)	C46	x
Prunus africana	indicator (Afromontane species)	x	x
Pseudospondias microcarpa		C30	x
Psychotria mahonii		x	x
Psydrax parviflora		Cae24	f
Pterolobium stellatum		x	f
Rapanea melanophloeos		x	x
Rhamnus prinoides		x	x
Rinorea angustifolia		f	x
Ritchiea albersii		x	x
Rothmannia urcelliformis		Ceh9	
Rubus apetalus		x	x
Rubus volkensii		x	
Schefflera abyssinica		x	
Schefflera volkensii		x	
Schrebera alata		f	x
Scutia myrtina		x	f
Senna didymobotrya		x	f
Senna septemtrionalis		x	f
Shirakiopsis elliptica		Ceh15	C
Smilax anceps		f	x
Solanum aculeastrum		x	x
Spathodea campanulata		C18	f
Sterculia dawei		x	
Strombosia scheffleri	indicator (Afromontane species)	Cae27	x
Symphonia globulifera	indicator		C
Syzygium guineense	indicator (Afromontane species [*Syzygium guineense* ssp. *afromontanum*])	x	x
Tabernaemontana pachysiphon		Cae10	
Tabernaemontana stapfiana		x	x
Trema orientalis		Ceh12	x
Trichilia dregeana		C30	
Trichilia emetica		Ce27	
Trilepisium madagascariense		C30	
Turraea holstii	indicator (afromontane species)	Cae12	

Species	Regional status (see section 2.3)	(Kenya)	(Rwanda)
Vangueria apiculata		f	x
Vepris nobilis		Cg12	x
Vernonia amygdalina		x	f
Vernonia auriculifera		x	f
Vernonia myriantha		x	x
Warburgia ugandensis		Ceh30	
Xymalos monospora	indicator (afromontane species)	xa	x
Zanthoxylum gilletii		Cae30	x
Zanthoxylum rubescens		Cae24	

9. Zanzibar-Inhambane transitional rain forest (Fg)

9.1. Description

White describes the summits of the transitional rain forests of the East Usambara mountains as a typical example of Zanzibar-Inhambane transitional rain forest. The East Usambara mountains are not high enough for the occurrence of Afromontane rain forest (Fa), but several Afromontane species occur at altitudes that are much lower than their normal limits on other mountains. Other examples of Zanzibar-Inhambane transitional rain forest, although floristically poorer, occur in Malawi (Misuku Hills [1370 m], Machemba Hill, Mt. Nchisi, Lisau Saddle and Chaone Hill) and Zimbabwe (Chirinda forest, White 1983 p. 187).

More than 40 percent of the species are endemic to the East Usambara mountains. Most of these endemic species are floristically related to species that occur in the lowland rain forests of the Guineo-Congolian regional centre of endemism. The pattern that many species are separated by a wide interval with their congeneric species suggests that the East Usambara mountains is a refugium for a flora that was previously distributed over a much larger area. Almost 30 percent the species are either Afromontane or upland ('**lower** transitional rain forest') species. Most of the remaining species also occur in the Guineo-Congolian regional centre of endemism (White 1983 p. 187). Lovett (1990 p. 292) suggests that in the future, Zanzibar-Inhambane transitional rain forest should be regarded as an Afromontane forest type rather than a Zanzibar-Inhambane forest type since the proportion of Afromontane species is greater.

Regional indicator species (characteristic species listed by White (1983) that were only provided for Zanzibar-Inhambane transitional forest and no other Zanzibar-Inhambane forest types) that were listed as characteristic species for one or several national maps can be further classified into endemic species, Afromontane species, upland species ('lower transitional rain forest') and Guineo-Congolian species (White 1983 p. 187):

- Endemic species include ***Anonidium usambarense, Cephalosphaera usambarensis*** (endemic genus), ***Enantia kummeriae***, ***Englerodendron usambarense*** (endemic genus), ***Isolona heinsenii*** and ***Polyceratocarpus scheffleri***
- Afromontane species include ***Alangium chinense*** (also a indicator for Lake Victoria transitional rain forest [Ff]), ***Allanblackia stuhlmannii, Cylicomorpha parviflora*** (also an indicator for Afromontane rain forest [Fa]), ***Isoberlinia scheffleri, Myrianthus holstii*** (also a indicator for Afromontane rain forest [Fa]), ***Ocotea usambarensis*** (also a indicator for Afromontane rain forest [Fa]), ***Pouteria adolfi-friedericii*** (also an indicator for Afromontane rain forest [Fa]), ***Strombosia scheffleri*** (also an indicator for Afromontane rain forest [Fa]), ***Syzygium sclerophyllum, Xymalos monospora*** (a characteristic species both of Afromontane rain

forest [Fa] and Afromontane undifferentiated forest [Fbu]) and ***Zenkerella capparidacea***.

- Upland species include ***Morinda asteroscepa, Strychnos mitis*** and ***Trichilia dregeana***
- Guineo-Congolian species include ***Chrysophyllum perpulchrum, Cleistanthus polystachyus, Ficus sur, Funtumia africana, Greenwayodendron suaveolens*** (an endemic subspecies), ***Magnistipula butayei*** (an endemic subspecies), ***Pterocarpus mildbraedii*** (an endemic subspecies), ***Rauvolfia caffra, Schefflerodendron usambarense, Synsepalum cerasiferum, Synsepalum msolo*** and ***Treculia africana***.

Figure 9.1 View from a gap inside Zanzibar-Inhambane transitional rain forest at Mbomole Hill (Amani Nature Reserve, Tanzania). Altitude approximately 970 m. Photograph by H. N. Moshi (2009).

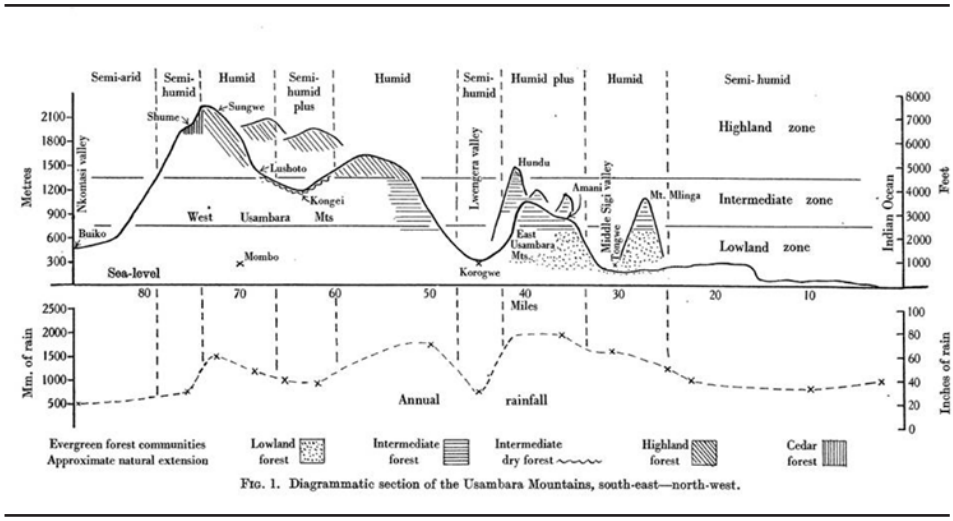


FIG. 1. Diagrammatic section of the Usambara Mountains, south-east—north-west.

Figure 9.2 Zanzibar-Inhambane transitional rain forest (synonym: intermediate forest) forest occurs at lower altitudes than Afromontane forests (Fa and Fb; the figure gives the synonyms of "highland forest" and "Cedar forest") and at higher altitudes than Zanzibar-Inhambane lowland rain forest (Fo; the figure gives the synonym of "lowland forest"). Moreau (1935). Figure obtained from URL: *http://www.jstor.org/stable/2256144*

9.2. VECEA region

Within the VECEA region, Zanzibar-Inhambane transitional rain forest occurs in Malawi, Tanzania and probably also in Kenya (Figure 9.3, see also Volume 6).

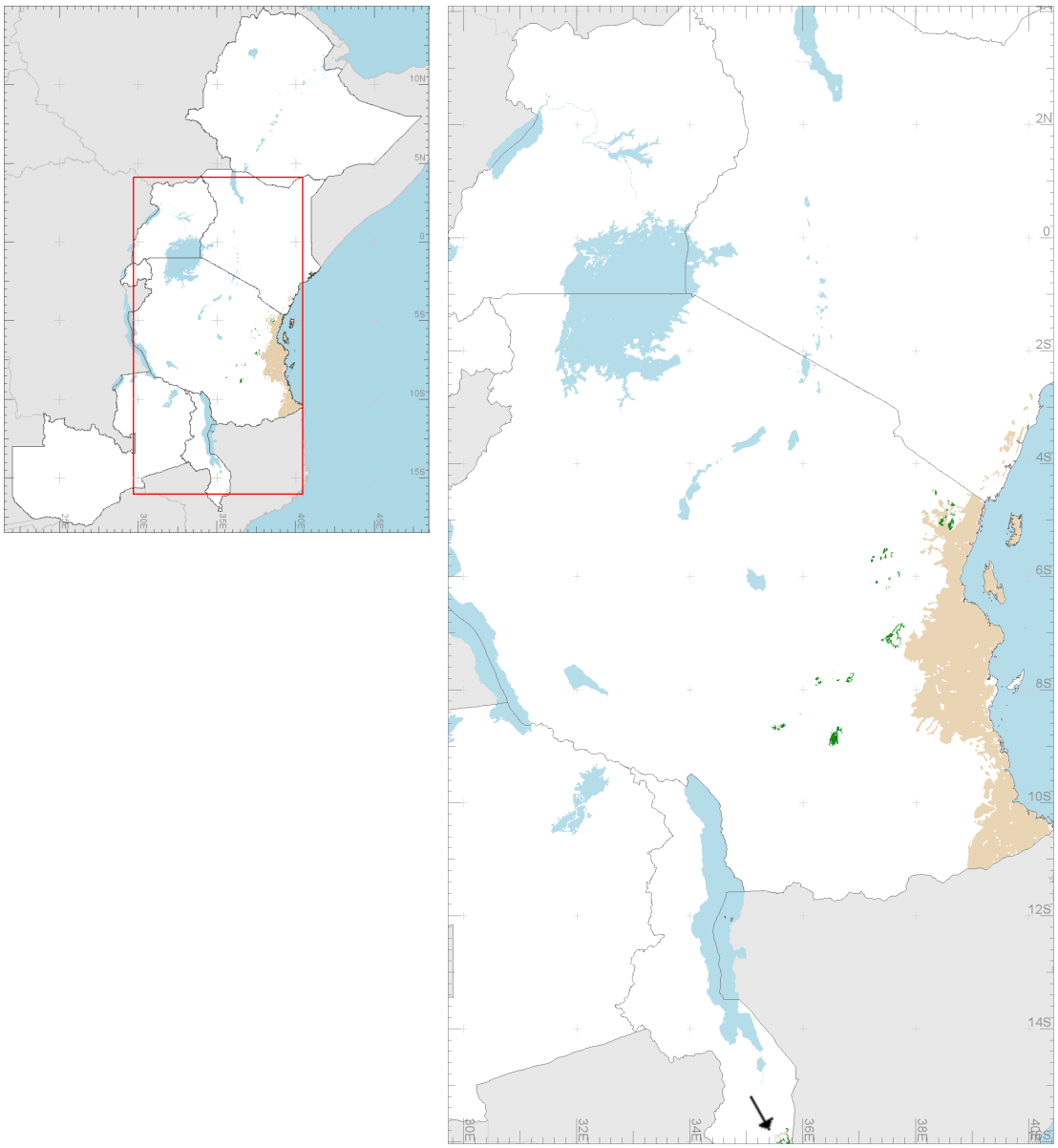


Figure 9.3. Mapped distribution of Zanzibar-Inhambane transitional rain forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. In Malawi and Tanzania, it is also mapped as part of different mosaics (shown in greyish-brown, see the arrow for Malawi). We expect that this forest type also occurs in Taita Hills (Kenya), although we did not map this forest in the VECEA map in that location (this was a consequence of not having forest in that location in a Kenyan base map and a consequence of the long-term fragmented distribution of the forest in that location).

In Malawi, Zanzibar-Inhambane transitional rain forest was originally classified as mid-altitude rain forest. It was mapped by expanding original mapping unit 46d with the contour lines of 800 and 1500 m on Mt. Mulanje (see Volume 6).

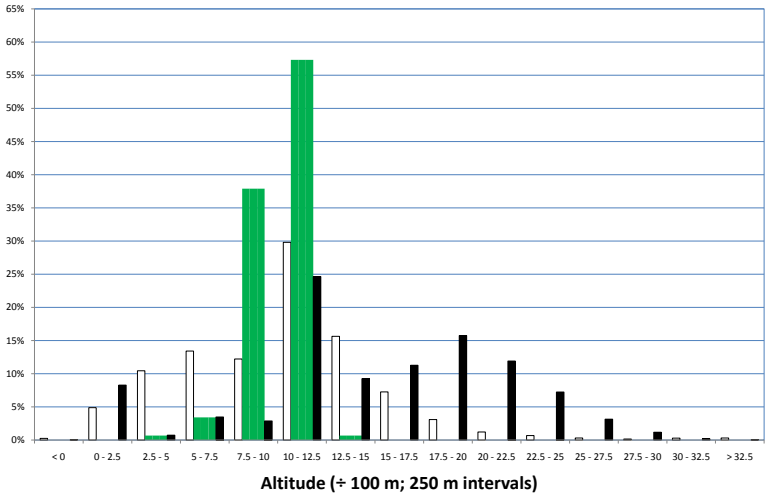
In Tanzania, Zanzibar-Inhambane transitional rain forest was described originally as submontane forest. One of the synonyms listed by Lovett (1993a) for submontane forest is "Zanzibar-Inhambane transitional rain forest". In the VECEA map, we combined altitude limits of 900 and 1250 m with the Gillman (1949) physiognomic map to infer the distribution of this forest type in Tanzania (see Volume 6).

We expect that Zanzibar-Inhambane transitional rain forest also occurs in Taita Hills in Kenya. Lovett (1998) gives the northern limit of the eastern arc as Taita and Shimba Hills (*see also URL http://www.easternarc.org/html/map.html* [last accessed July 2011]). Dale (1939) mentions that "upper montane evergreen rain-forest" is limited to the Bura and Sagalla Hills (Teita Hills [sic]) above 4500 ft (~ 1500 m). He describes that there were only a few patches of forest remnants with a total acreage not more than two square miles (~ 5 km^2). These forests are of the "*Ocotea usambarensis* type" (an indicator for Zanzibar-Inhambane transitional rain forest in the Zanzibar-Inhambane floristic region; this species is also a indicator for Afromontane rain forest in the Afromontane floristic region). Other trees found in the "high forest" include *Albizia gummifera* (near streams in Afromontane dry transitional forest [White 1983] and **potentially** an indicator of Afromontane moist transitional forest [Fe]), *Allophylus abyssinicus, Ekebergia capensis, Garcinia volkensii, Macaranga capensis* (Afromontane species in the Lake Victoria transitional rain forest [Ff]), *Neoboutonia macrocalyx, Newtonia buchananii* (a characteristic species of Zanzibar-Inhambane lower transitional rain forest, but also near streams in Afromontane dry transitional forest, in Zanzibar-Inhambane lowland rain forest (near Tavetta) and **potentially** an indicator of Afromontane moist transitional forest [Fe]), *Nuxia floribunda* (an indicator for Afromontane undifferentiated forest), *Polyscias kikuyuensis, Prunus africana* (Afromontane rain forest [Fa], Afromontane undifferentiated forest [Fb] and Afromontane species in Lake Victoria transitional rain forest [Ff]), *Rapanea melanophloeos* (an indicator for Afromontane undifferentiated forest [Fb]), *Tabernaemontana pachysiphon* and *Xymalos monospora* (a indicator for Zanzibar-Inhambane transitional rain forest in the Zanzibar-Inhambane region; this species is also characteristic for Afromontane rain forest, Afromontane undifferentiated forest and is furthermore a indicator for Lake Victoria transitional rain forest in the Lake Victoria region).

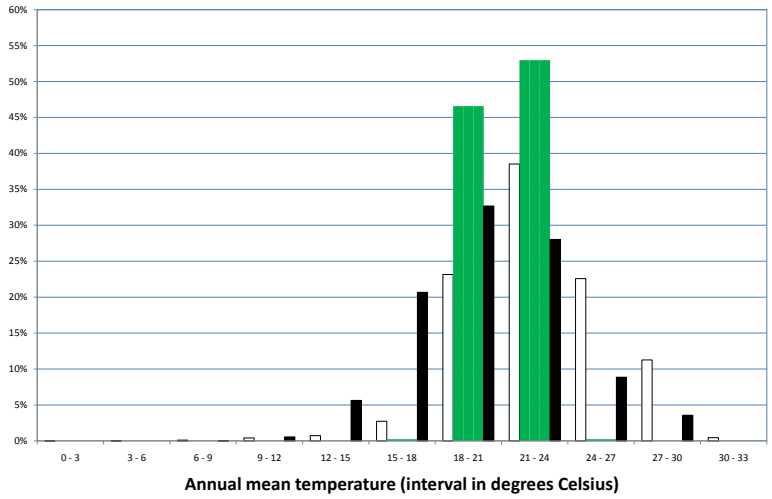
Investigation of environmental distribution of Zanzibar-Inhambane transitional rain forest in the VECEA region (Figure 9.4; limits are for areas of the VECEA map where this forest is not mapped as mosaic) suggests that, with the exception of the Ethiopian manifestation of Afromontane moist transitional rain forest (FeE), this is the transitional forest that occurs at the lowest altitudes (> 95% of samples occur at altitudes of 750 – 1250 m). The altitude interval where most of samples occur is the same for this vegetation type (1000 – 1250 m; 57.3% of samples) as for all forests combined

(24.7%). Rainfall conditions are somewhat above those for other transitional rain forests (with highest number of samples in the 1600 – 1800 mm interval; 24.4%). However, there were only a limited number of samples in this forest type.

(a)



(b)



(c)

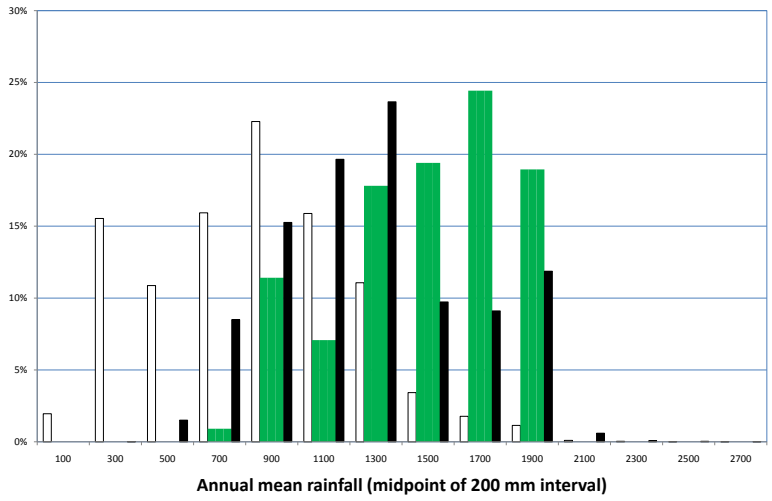


Figure 9.4. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Zanzibar-Inhambane transitional rain forest (Fg, *n* = 438). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

9.3. Species composition

Species assemblages were obtained from the following references:

- Malawi: White *et al.* (2001). Only species that were clearly stated as occurring in "mid-altitude rain forest" were included. These species were coded "x" (unless they were characteristic species).
- Tanzania: Lovett (1993a). Species that were mentioned for "sub-montane forest" in Lovett (1993a; altitude 800 - 1400 m; annual rainfall > 1500 mm [5 and 6] were coded "C" (since these species were interpreted as characteristic species). Species that were listed as Eastern Arc endemic species that occur in "lowland forest" in Lovett (1998) were coded "e").

Characteristic species were determined as:

- Malawi: Species identified to be present as emergent trees (30 - 45 m) or large trees (20 - 30 m, including stranglers) were coded as "C". Liana species or species of marginal occurrence were not listed as characteristic species.
- Tanzania: Species listed by Lovett (1993a) were coded "C".

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

All species listed by White (1983) for Zanzibar-Inhambane transitional rain forest were listed, even if their presence was not listed in the national references that we consulted (these species only had entries of "f").

5: Lovett defines the Eastern Arc as "those forests occurring on crystalline mountains in south-east Kenya and eastern Tanzania under the direct climatic influence of the Indian Ocean" (Lovett 1990 p. 292). Whereas the volcanoes of Mt. Meru and Mt. Kilimanjaro have been formed in the last million years, the crystalline block-faulted mountains of the Eastern Arc were created 7 million years ago. The moist forests on the eastern slopes have probably been under a stable high rainfall throughout the Pleistocene and possibly before the end of the Miocene (Lovett 1993a). See also URL *http://www.easternarc.org/html/map.html*

6: Lovett (1993b) gives different limits for Zanzibar-Inhambane transitional rain forest of altitude 800 - 1250 m and rainfall 2000 - 3000 m (with "Afromontane rain forest sensu Lovett 1990" occurring at altitudes of 1200 - 2500 m under rainfalls of 1250 - 2500 mm).

Table 9. Species composition of Zanzibar-Inhambane transitional rain forest (Fg)

Species	Regional status	(Malawi)	(Tanzania)
Alangium chinense	indicator (Afromontane species)		f
Albizia gummifera		C	f
Albizia schimperiana		C	f
Allanblackia stuhlmannii	indicator (Afromontane species)		C
Anonidium usambarense	indicator (endemic species)		e
Anthocleista grandiflora		C	f
Antiaris toxicaria	characteristic (Guineo-Congolian species)		f
Blighia unijugata		x	f
Cassipourea malosana		C	f
Celtis africana		C	f
Celtis gomphophylla		C	f
Cephalosphaera usambarensis	indicator (endemic genus)		C
Chrysophyllum gorungosanum		C	f
Chrysophyllum perpulchrum	indicator (Guineo-Congolian species)		f
Cleistanthus polystachyus	indicator (Guineo-Congolian species)	x	f
Cordia africana		x	f
Croton macrostachyus		C	f
Croton sylvaticus		C	f
Cussonia spicata		x	f
Cylicomorpha parviflora	indicator (Afromontane species)	C	C
Diospyros abyssinica	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest [very rare])	C	f
Dovyalis macrocalyx		x	f
Ekebergia capensis		C	f
Embelia schimperi		C	f
Enantia kummeriae	indicator (endemic species)		e
Englerodendron usambarense	indicator (endemic genus)		C
Ensete ventricosum		x	f
Ficalhoa laurifolia		C	f
Ficus sur	indicator (Guineo-Congolian species)	C	f
Ficus thonningii		C	f
Ficus vallis-choudae	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	C	f
Funtumia africana	indicator (Guineo-Congolian species)	C	f
Greenwayodendron suaveolens	indicator (Guineo-Congolian species, endemic subspecies)		e
Harrisonia abyssinica		x	f
Harungana madagascariensis		x	C
Ilex mitis		C	f
Isoberlinia scheffleri	indicator (Afromontane species)		C
Isolona heinsenii	indicator (endemic species)		e
Khaya anthotheca	not characteristic (indicator for Zanzibar-Inhambane lowland rain forest)	C	f
Landolphia buchananii		x	f
Macaranga capensis	characteristic (upland species)	C	C

Species	Regional status	(Malawi)	(Tanzania)
Maesopsis eminii			C
Magnistipula butayei	indicator (Guineo-Congolian species, endemic subspecies)	x	f
Maranthes goetzeniana	characteristic (upland species)		f
Maytenus acuminata		C	f
Milicia excelsa	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane undifferentiated forest)	f	C
Morinda asteroscepa	indicator (upland species)	x	f
Myrianthus holstii	indicator (Afromontane species)	x	C
Newtonia buchananii	characteristic (upland species)	C	C
Ocotea usambarensis	indicator (Afromontane species)	f	f
Olea capensis		x	f
Oreobambos buchwaldii	(bamboo species indigenous to Africa)	x	f
Parinari excelsa		C	C
Parkia filicoidea	characteristic (Guineo-Congolian species)	f	C
Polyceratocarpus scheffleri	indicator (endemic species)		e
Polyscias fulva		x	f
Pouteria adolfi-friedericii	indicator (Afromontane species)	f	f
Prunus africana		C	f
Pterocarpus mildbraedii	indicator (Guineo-Congolian species, endemic subspecies)		f
Pterocarpus tinctorius		C	f
Rapanea melanophloeos		x	f
Rauvolfia caffra	indicator (Guineo-Congolian species)	C	f
Ricinodendron heudelotii	characteristic (Guineo-Congolian species)		f
Schefflera abyssinica		C	f
Scheffl erodendron usambarense	indicator (Guineo-Congolian species)		f
Shirakiopsis elliptica		x	C
Strombosia scheffleri	indicator (Afromontane species)	x	C
Strychnos mitis	indicator (upland species)	x	f
Synsepalum cerasiferum	indicator (Guineo-Congolian species)	C	C
Synsepalum msolo	indicator (Guineo-Congolian species)		C
Syzygium guineense		C	f
Syzygium sclerophyllum	indicator (Afromontane species)		e
Treculia africana	indicator (Guineo-Congolian species)	f	f
Trema orientalis		x	C
Trichilia dregeana	indicator (upland species)	C	C
Trilepisium madagascariense	characteristic (Guineo-Congolian species)	C	C
Xymalos monospora	indicator (Afromontane species)	x	f
Zanha golungensis		C	f
Zenkerella capparidacea	indicator (Afromontane species)		e

10. Afromontane dry transitional forest (Fh)

10.1. Description

Afromontane dry transitional forest occurs on the drier lower slopes of those East African mountains and uplands which rise from the plains covered with Somalia-Masai bushlands (Bd and Be, volume 4). Afromontane and non-afromontane species occur together within these forests. Only small fragments remain and there is little published information (White 1983 p. 166).

Remnants of Afromontane dry transitional forest occur near Nairobi at altitudes between 1650 and 1800 m and annual rainfall around 800 mm (White 1983 p. 166).

Regional indicator species (characteristic species listed by White (1983) that were only provided for Afromontane dry transitional rain forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps (' indicators', see section 3.2) include ***Calodendrum capense*** (a species that also occurs as stunted individuals at higher altitudes in evergreen bushland [Be]), ***Cassipourea malosana, Chaetacme aristata, Chrysophyllum viridifolium, Croton megalocarpus, Euclea divinorum, Fagaropsis angolensis, Markhamia lutea, Olea europaea* ssp. *cuspidata***, (synonym: *Olea africana*), ***Schrebera alata*** (a species that also occurs as stunted individuals at higher altitudes in evergreen bushland [Be]), ***Strychnos usambarensis, Suregada procera, Trichocladus ellipticus, Uvariodendron anisatum*** and ***Warburgia ugandensis. Albizia gummifera and Newtonia buchananii*** were listed as characteristic species that occur near streams. We hypothesize that these can therefore be categorized as indicator species for Afromontane moist transitional forest (FeK).

White (1983 p. 129) also describes rain-fed dry evergreen forest that occurs as relicts within the greater Serengeti region. The main canopy of this forest consists of *Diospyros abyssinica* (also characteristic of Afromontane dry transitional forest near Nairobi), *Drypetes gerrardii* (also characteristic of Afromontane dry transitional forest near Nairobi), *Elaeodendron buchananii*, *Lecaniodiscus fraxinifolius*, ***Suregada procera*** (an indicator for Afromontane dry transitional forest near Nairobi), and *Vepris nobilis* (White mentions that *Vepris* [syn. *Teclea*] species are characteristic of Afromontane dry transitional forest near Nairobi). Less frequent constituents of the main canopy include ***Chaetacme anisata*** (an indicator of Afromontane dry transitional forest near Nairobi), ***Euclea divinorum*** (an indicator of Afromontane dry transitional forest near Nairobi), ***Olea europaea*** ssp. ***cuspidata*** (synonym: *Olea africana*, an indicator of Afromontane dry transitional forest near Nairobi) and ***Schrebera alata*** (an indicator of Afromontane dry transitional forest near Nairobi). *Capparis erythrocarpos*, *Croton dichogamus* and *Vepris trichocarpa* are the most common species of the understorey. This similarity in species composition and environmental conditions lead us to include this forest into Afromontane dry transitional forests.

Figure 10.1 Profile diagram of Afromontane dry transitional forest in the Kithoka area north-east of Mt. Kenya (0° 08.065′ N; 37° 39.564′ E). Altitude 1514 m. This forest was classified by Trapnell *et al*. (1966, 1969, 1976, 1986) as dry intermediate forest. Species shown are: *Calodendrum capense* (4); *Celtis africana* (1); *Croton megalocarpus* (8); *Ehretia cymosa* (11); unidentified *Ficus sp* (9); *Olea europaea* (10, B); *Pittosporum viridiflorum* (3, A); *Ritchiea albersii* (5); *Strychnos henningsii* (12); *Uvariodendron anisatum* (2); *Vepris simplicifolia* (7) and *Vepris trichocarpa* (6). Obtained from Matingi (2011).

10.2. VECEA region

Within the VECEA region, Afromontane dry transitional forest is only mapped for Kenya and Tanzania (Figure 10.2, see also Volume 6).

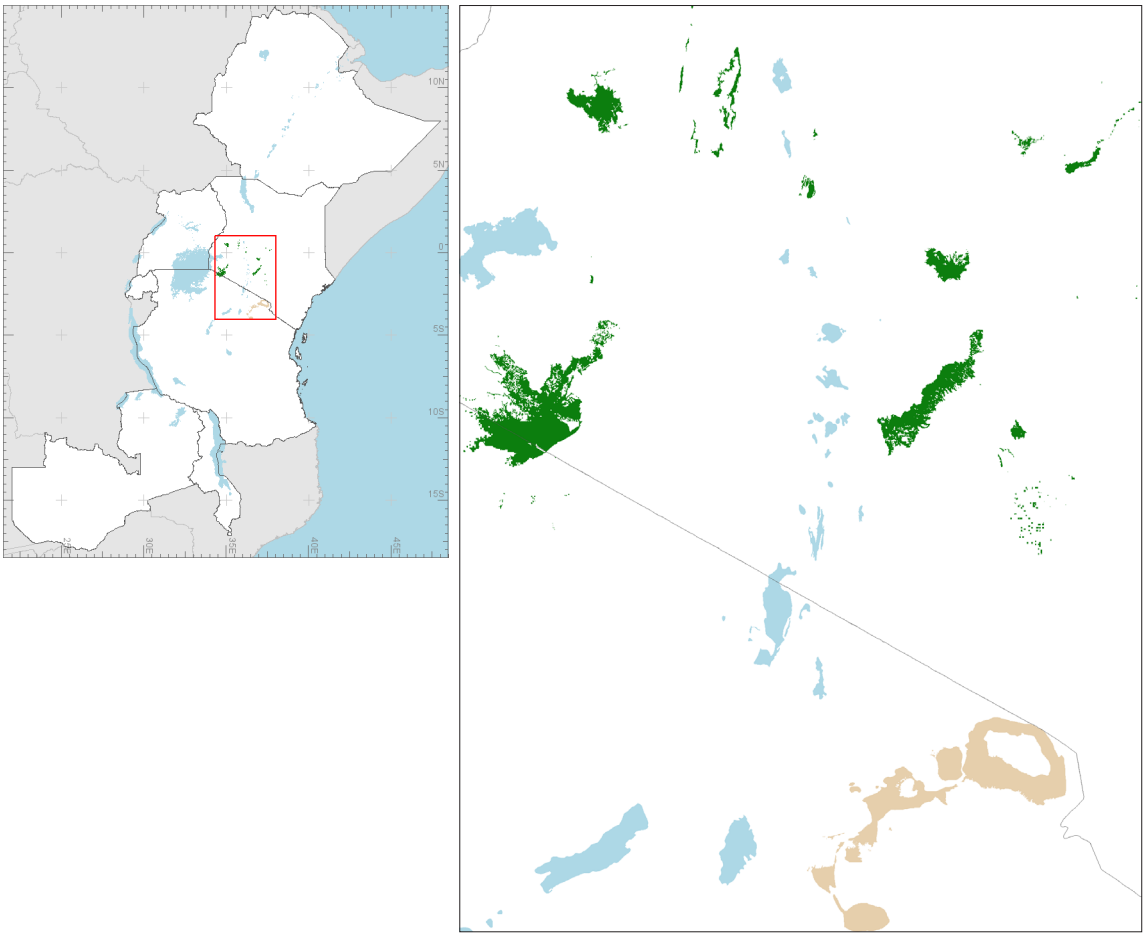


Figure 10.2. Mapped distribution of Afromontane dry transitional forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. In Tanzania, it is also mapped as part of different forest mosaics (shown in greyish-brown), as on Mt. Kilimanjaro and Mt. Meru. We further expect that this forest type is distributed more widely than depicted here.

In Kenya, some of the Afromontane dry transitional forest was originally mapped as dry intermediate forest. The Trapnell *et al.* (1966, 1969, 1976, 1986) maps for central and south-western Kenya contained "intermediate *Diospyros - Olea* forest" (original mapping unit 18) in vegetation sheets 2 and 3. This forest type was not classified together with "dry intermediate forest types" (*i.e.* Afromontane dry transitional forest) and was placed in different "decline zones" than "dry intermediate forest" .[7] (Trapnell and Brunt [1987 p. 7] further mention that *Diospyros - Olea* forest may have extended further south towards the Menangai crater on vegetation sheet 2.) Since we expect that this is the same type of forest that was described for the greater Serengeti region (see section 10.1), we also mapped this forest as Afromontane dry transitional forest in the VECEA map. Unfortunately, Trapnell [1997] did not give species composition for intermediate *Diospyros - Olea* forest (see section 10.3). However, Beentje (1990) described a forest type of *Diospyros abyssinica – Olea europaea* forest with species composition of *Diospyros abyssinica* (also mentioned in section 10.1), ***Olea europaea*** (also mentioned in section 10.1), *Drypetes gerrardii* (also mentioned in section 10.1), ***Euclea divinorum*** (also mentioned in section 10.1), *Strychnos mitis* (a characteristic species of "dry intermediate forest" according to Trapnell [1997]), *Olea capensis* (listed in section 10.3) and *Aphania senegalensis* (synonym: *Lepisanthes senegalensis*, listed in section 10.3). Based on this correspondence in species composition between the *Diospyros abyssinica – Olea europaea* forest and Afromontane dry transitional forest, we hypothesize that *Diospyros abyssinica – Olea europaea* forest is a subtype of Afromontane dry transitional forest.

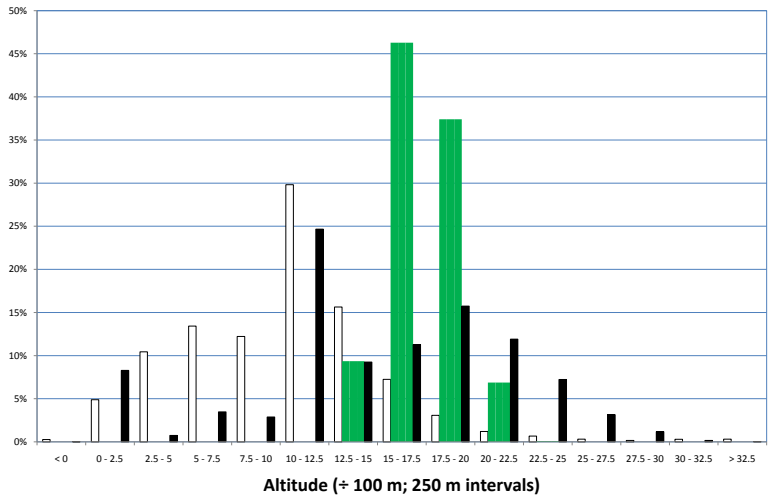
In Tanzania, Afromontane dry transitional forest was originally described as lower altitude dry montane forest. Lovett (1993a) lists two synonyms for "dry montane forest": (i) drier types of Afromontane undifferentiated forest sensu White (1983); and (ii) dry transitional montane forest sensu White (1983). However, Lovett (1993a) does not provide information in differences in altitude between these two synonyms. Moreover, although Lovett (1990; this is the main reference that we used to allocate forest types to the physiognomic map of Gillman [1949]) lists Afromontane dry transitional forest among forest types that occur in Tanzania, he does not list it for any specific Tanzanian forest area. As a consequence, we treated "dry montane forest" sensu Lovett (1993a) only as a synonym of Afromontane undifferentiated forest (Fbu) for most of the VECEA map. Various areas that were mapped as (mosaics containing) Afromontane undifferentiated forest (Fb) in Tanzania could thus also contain some Afromontane dry transitional forest (Fh). Further evidence for a wider distribution of Afromontane undifferentiated forest includes the mapping by Moreau (1935) of "intermediate dry forest" on the West Usambara Mts. see Figure 9.2, the mention of a "dry evergreen forest" zone between 1500 and 1700 m on Mt. Meru by Beesley (1972) and the differentiation of a "relatively dry submontane *Croton – Calodendrum* forest" by Hemp (2006) on Mt. Kilimanjaro (this forest is dominated by *Croton megalocarpus*, *Calodendrum capense*, *Olea europaea* ssp. *cuspidata* [synonym: *Olea africana*] and *Diospyros abyssinica* and occurs on the western slopes below 1600 m and on the northern slopes below 2000 m). In response, we mapped Afromontane dry transitional forest to occur in forest mosaics on Mt. Kilimanjaro and Mt. Meru.

7: in between montane bamboo (B) and deciduous bushland (Bd, synonym: lowland *Acacia* and *Commiphora* bushland), Trapnell and Brunt (1987) described three "decline zones": (i) the eastern decline zones from upper eastern moist forest (i.e. Afromontane rain forest), eastern moist intermediate forest (i.e. Afromontane moist transitional forest), eastern dry intermediate forest (i.e. Afromontane dry transitional forest) to eastern *Combretum* wooded grassland (Wc); (ii) the western decline zones from western moist forests (i.e. Afromontane rain forest and Afromontane moist transitional forest), western *Diospyros* forest, western *Combretum* wooded grassland (Wc) to western semi-evergreen thicket (Be); and (iii) the Rift Valley decline zones from montane sclerophyll forest (i.e. Afromontane undifferentiated forest), *Diospyros* forest (local, coded RD), upland evergreen bushland (Be) to upland *Acacia* bushland (We).

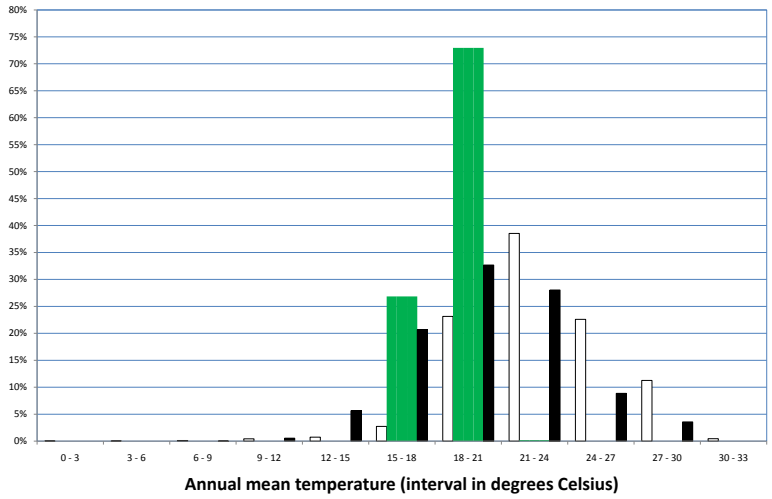
It is possible that this forest type previously existed in Ethiopia, but it is not obvious what distinguishes the presence of Afromontane dry transitional forest or the alternative vegetation type of evergreen bushland (Be) in areas that are located between deciduous bushland (Bd) and Afromontane undifferentiated forest (Fbu).

Investigation of environmental distribution of Afromontane dry transitional forest in the VECEA region (Figure 10.3; limits are for areas of the VECEA map where this forest is not mapped as mosaic) shows a slightly higher distribution in altitude than the Kenyan Afromontane moist transitional rain forest (FeK). The altitude range where most of this forest type occurs (with > 90% of samples occurring at altitudes from 1250 – 2000 m) includes the altitude range for forests near Nairobi mentioned by White (1983, see previous section). Although the rainfall was somewhat lower than for Kenyan Afromontane moist transitional rain forest (FeK), it was similar to rainfall for several transitional forests: the 1200 – 1400 mm contained the highest number of samples for Afromontane dry transitional forest (32.7%), Ethiopian moist transitional rain forest (70.7%), Lake Victoria transitional rain forest (29.6%) and all forests combined (23.7%). All samples had rainfall above 800 mm (this was the rainfall mentioned by White [1983] for this forest type, see previous section). We hypothesize that this could be in part a consequence of White (1983) describing manifestations of the forest type near the lower end of its rainfall range (*i.e.* near Nairobi).

(a)



(b)



(c)

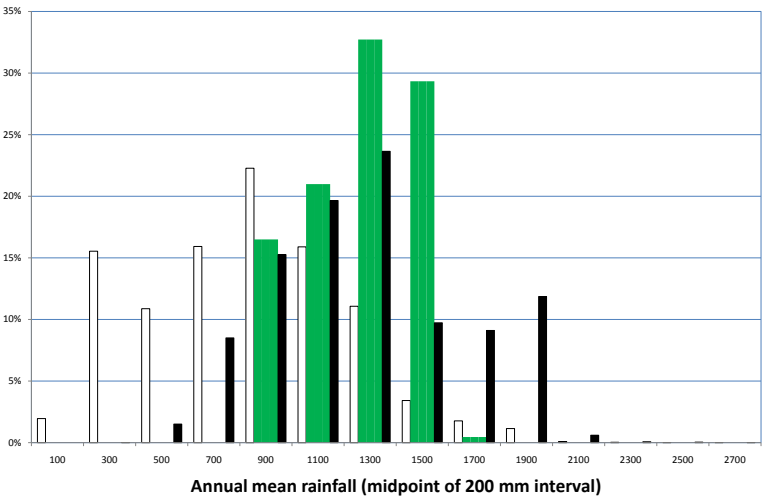


Figure 10.3. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Afromontane dry transitional forest (Fh, *n* = 1,091). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

Table 10. Species composition of Afromontane dry transitional forest (Fh)

Species	**regional status** (see section 2.3)	**(Kenya)**	**(Tanzania)**
Acacia brevispica		x	f
Acokanthera oppositifolia		x	
Acokanthera schimperi		Cs12	f
Albizia gummifera	indicator (but near streams)	Cg30	x
Albizia schimperiana		Cs	f
Allophylus abyssinicus		x	f
Allophylus rubifolius		x	f
Antidesma venosum		x	f
Aphania senegalensis		x	f
Apodytes dimidiata	characteristic	x	f
Bersama abyssinica		Cg15	x
Blighia unijugata		x	f
Brachylaena huillensis		C24	f
Bridelia micrantha		Cefs12	f
Bridelia scleroneura		x	f
Caesalpinia decapetala		x	f
Caesalpinia volkensii		x	f
Calodendrum capense	indicator	Cs15	f
Carissa spinarum		x	f
Cassipourea malosana	indicator (but near streams)	Cg24	f
Catha edulis		x	f
Celtis africana		x	f
Chaetacme aristata	indicator	x	f
Chrysophyllum viridifolium	indicator	C18	
Clausena anisata		x	f
Clerodendrum myricoides		x	f
Combretum schumannii		x	f
Commiphora eminii		x	f
Cordia africana		x	f
Cornus volkensii		x	f
Craibia brownii		C12	f
Crateva adansonii		x	f
Crotalaria agatiflora		x	f
Croton macrostachyus		Cgs24	f
Croton megalocarpus	indicator	Cefs37	f
Cussonia spicata		x	f
Diospyros abyssinica	characteristic	Cg27	f
Dodonaea viscosa		x	f
Dombeya kirkii		x	f
Dovyalis abyssinica		x	f
Dovyalis macrocalyx		x	f
Dracaena steudneri		Cg12	f
Drypetes gerrardii	characteristic	Cef12	x
Ehretia cymosa		Cg9	

Species	**regional status** (see section 2.3)	**(Kenya)**	**(Tanzania)**
Ekebergia benguelensis		x	f
Ekebergia capensis		Cg24	f
Elaeodendron buchananii	characteristic (greater Serengeti region)	C24	f
Englerophytum natalense		x	f
Euclea divinorum	indicator	Cs	f
Euclea racemosa		x	f
Euphorbia abyssinica		x	f
Euphorbia candelabrum		x	f
Fagaropsis angolensis	indicator	Cef21	f
Ficus natalensis		x	f
Ficus sur		Cg24	f
Ficus thonningii		C12	f
Filicium decipiens		x	f
Flacourtia indica		x	f
Flueggea virosa		x	f
Grewia similis		x	f
Ilex mitis	not characteristic (indicator for Afro-montane undifferentiated forest)	x	f
Indigofera swaziensis		x	f
Juniperus procera		x	f
Kigelia moosa		x	f
Lannea schweinfurthii		x	f
Lepidotrichilia volkensii		x	f
Manilkara sulcata		x	f
Margaritaria discoidea		C15	x
Markhamia lutea	indicator	Cef18	f
Maytenus arbutifolia		x	f
Maytenus undata		x	f
Meyna tetraphylla		x	f
Mimusops bagshawei		Cef40	f
Mimusops kummel		Cef27	f
Myrsine africana		x	f
Newtonia buchananii	indicator (but near streams)	x	f
Nuxia congesta	not characteristic (indicator for Afro-montane undifferentiated forest)	Cg21	f
Nuxia floribunda	not characteristic (indicator for Afro-montane undifferentiated forest)	x	f
Olea capensis	not characteristic (indicator for Afromontane rain forest)	x	f
Olea europaea	indicator [*Olea europaea* ssp. *cuspidata*, synonym: *Olea africana*]	Cs	f
Olinia rochetiana		x	f
Osyris lanceolata		x	f
Pappea capensis		x	f
Pavetta oliveriana		x	f
Phoenix reclinata	(palm species)	x	f

Species	**regional status** (see section 2.3)	**(Kenya)**	**(Tanzania)**
Phytolacca dodecandra		x	f
Pistacia aethiopica		x	f
Pittosporum viridiflorum		x	f
Plectranthus barbatus		x	f
Podocarpus falcatus	not characteristic (indicator for Afromontane undifferentiated forest)	x	f
Podocarpus latifolius	not characteristic (characteristic for Afromontane rain forest and Afromontane undifferentiated forest)	x	f
Podocarpus usambarensis		x	f
Psydrax schimperiana		C12	f
Pterolobium stellatum		x	f
Rapanea melanophloeos	not characteristic (indicator for Afromontane undifferentiated forest)	x	f
Rhamnus staddo		x	f
Rhoicissus revoilii		x	f
Rhus natalensis		x	f
Rhus vulgaris		x	f
Ritchiea albersii		x	f
Rothmannia urcelliformis		Cef9	f
Rubus apetalus		x	f
Rubus volkensii		x	f
Schefflera volkensii		x	f
Schrebera alata	indicator	C24	f
Scutia myrtina		x	f
Senecio hadiensis		x	f
Senna didymobotrya		x	f
Senna septemtrionalis		x	f
Shirakiopsis elliptica		Cef15	f
Solanecio cydoniifolius		x	f
Solanecio mannii		x	f
Solanum aculeastrum		x	f
Sorindeia madagascariensis		x	f
Stereospermum kunthianum		x	f
Strychnos henningsii		C9	f
Strychnos innocua		x	f
Strychnos mitis		C18	x
Strychnos usambarensis	indicator	x	f
Suregada procera	indicator	x	f
Synsepalum brevipes		x	f
Syzygium guineense	not characteristic (indicator for Afromontane rain forest [*Syzygium guineense* ssp. *afromontanum*])	x	f
Tarenna graveolens		x	f
Trema orientalis		Cefs12	f
Trichocladus ellipticus	indicator	x	f
Uvaria scheffleri		x	f
Uvariodendron anisatum	indicator	C9	

Species	**regional status** (see section 2.3)	**(Kenya)**	**(Tanzania)**
Vangueria apiculata		x	f
Vangueria infausta		x	f
Vangueria madagascariensis		x	f
Vepris nobilis	characteristic genus, characteristic species in greater Serengeti region	Cg12	f
Vepris simplicifolia		C9	f
Vepris trichocarpa	characteristic in greater Serengeti region	C10	f
Vernonia auriculifera		x	f
Warburgia ugandensis	indicator	Cef30	f
Zanthoxylum chalybeum		x	f
Zanthoxylum usambarense		x	f

10.3. Species composition

Species assemblages were obtained from the following references:

- Kenya: Species listed in Annex 1 of Trapnell (1997) for "dry intermediate forest", moist intermediate and dry intermediate forest" and "of more general distribution" were coded "C". Suffix "e" indicates that the species was also listed for Afromontane moist transitional forest (Fe; synonym: moist intermediate forest, east). Suffix "f" indicates that the species was also listed for Lake Victoria transitional rain forest (Ff; synonym: moist intermediate forest, west). Suffix "g" indicates species of more general distribution. Suffix "s" indicates secondary species. Numbers show the maximum height of the species provided in the Annex (Trapnell 1997). Species that were expected to occur in the forest type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x".
- Tanzania: Lovett (1993a). Species that were mentioned for "lower altitude dry montane forest" were coded "x" (these species were mentioned in a description of "dry montane forest" [altitude > 1500 m, annual rainfall: 1000 - 1200 mm], but altitude limits for the "lower altitude dry montane forest" were not given).

Characteristic species were determined as:

- Kenya: Species that were listed by Trapnell (1997) were assumed to be characteristic species (these were coded "C").
- Tanzania: Characteristic species were not identified.

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

11. Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)

11.1. Description

White (1983 p. 46) restricted semi-evergreen forests to forests where some canopy species are briefly deciduous, but not necessarily at the same time, and most members of the understorey are evergreen.

The Lake Victoria regional mosaic consists of floristically impoverished variants of the characteristic vegetation types of the Guineo-Congolian, Sudanian, Zambezian and Somalia-Masai regional centres of endemism, sometimes with an admixture from Afromontane species (White 1983 p. 181). Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest is therefore expected to be a floristically impoverished variant of drier peripheral semi-evergreen Guineo-Congolian rain forests described for the Guineo-Congolian region (White 1983 p. 79). Most of the species of secondary grassland and wooded grassland in the Lake Victoria region also occur in Guineo-Congolian secondary grassland (White 1983 p. 181).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest and no other Lake Victoria forest type) that were listed as characteristic species for one or several national maps include ***Alstonia boonei, Antiaris toxicaria, Chrysophyllum albidum, Entandrophragma cylindricum, Entandrophragma utile, Holoptelea grandis, Khaya anthotheca, Khaya grandifoliola, Mildbraediodendron excelsum, Milicia excelsa, Morus mesozygia, Piptadeniastrum africanum*** and ***Pycnanthus angolensis.***

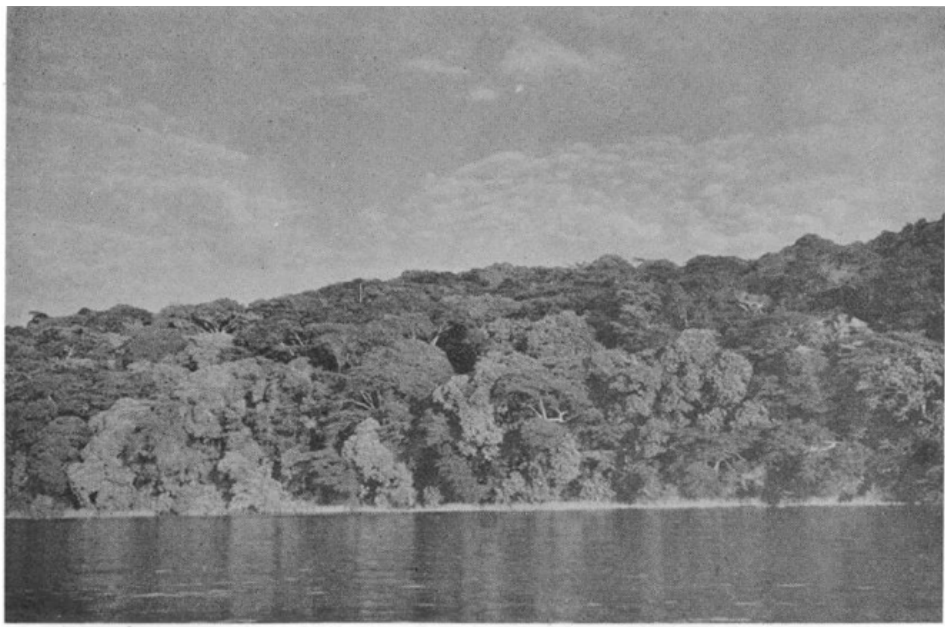


Figure 11.1 Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest on Bukasa Island (Ssese Islands, Uganda). Species shown include *Newtonia buchananii* and *Uapaca guineensis*. In the Uganda national map, this forest type was classified as *Piptadeniastrum - Uapaca* forests (C1). Thomas 1941. Image obtained from URL: *http://www.jstor.org/stable/2256396*

Figure 11.2 Profile diagram of Ironwood forest in Budongo (Uganda). This forest type was classified as Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest in the VECEA map and as *Cynometra - Celtis* forest (D2) in the Uganda national map. Characteristic species include *Cynometra alexandri* ("Cyn" in the figure; ironwood) and *Celtis zenkeri* ("Cz" in the figure). Eggeling 1947. Image obtained from URL: *http://www.jstor.org/stable/2256760*

Figure 11.3 Profile diagram of mixed forest in Budongo (Uganda). This forest type may represent a successional stage towards *Cynometra - Celtis* forest (D2; see Figure 11.2). Emergent species include: *Alstonia congensis* ("Ac"), *Khaya anthotheca* ("Kh") and *Mildbraediodendron excelsum* ("Ml"). Eggeling 1947. Image obtained from URL: *http://www.jstor.org/stable/2256760.*

11.2. VECEA region

Within the VECEA region, Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest is only mapped for Kenya, Tanzania and Uganda (Figure 11.4, see also Volume 6).

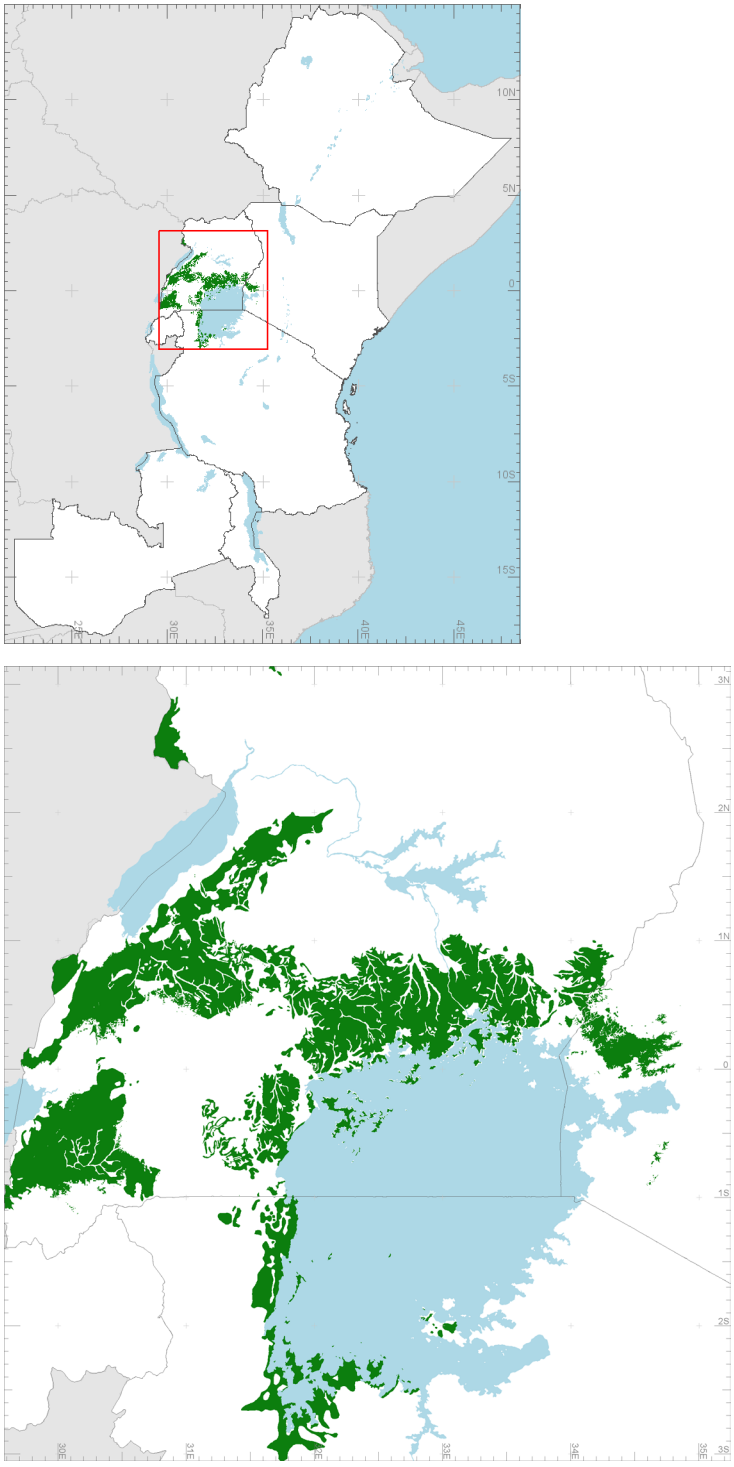


Figure 11.4. Mapped distribution of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Green polygons depict where this forest type is mapped by the VECEA project.

In Kenya, Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest corresponds partially to the area mapped by Trapnell *et al.* (1966, 1969, 1976, 1986) as "moist intermediate forest, west"). We assume that no remnants of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest existed when Trapnell *et al.* (1966, 1969, 1976, 1986) produced their maps for south-western Kenya. They did not differentiate between Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest and Lake Victoria transitional rain forest (Ff) and mapped both forests as "moist intermediate forest, west". We used an altitude limit of 1520 m to infer the boundary between these forest types (see volume 6).

Lovett (1990) described that Guineo-Congolian drier peripheral semi-evergreen rain forest occurred in Tanzania in Rubondo, but did not provide species composition.

In Uganda, Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest was originally mapped as 3 subtypes of medium-altitude moist evergreen forest (original mapping units C1 - C3) and 4 subtypes of medium-altitude moist semi-deciduous forest (original mapping units D1 - D4). We did not distinguish between the different Ugandan subtypes for the VECEA map, but maintained a floristic discrimination between these types in section 11.3. White (1983 p. 181) completely ignored the division between the two types despite making an explicit reference to page numbers 44 to 51 in the Langdale-Brown *et al.* (1964) text (*i.e.* the distinct description of both C- and D-types of forests) when describing Lake Victoria drier peripheral semi-evergreen Guineo-Congolian forest. Although Langdale-Brown *et al.* (1964) discriminated between moist evergreen "C" and moist semi-deciduous "D" types, they also mentioned that there is no sharp distinction between these forests types, but rather a gradual increase in the number of species that shed all their leaves and a gradual increase in the period for which these species are leafless. They further mention that no quantitative data were available to support their subdivision in the two categories - and that most features are similar in the various forests.

Medium-altitude moist evergreen forests contain a large number of genera whereby many genera are only represented by one species in any particular forest. Buttressed trees and large woody lianas are common. Strangling figs (that start their life epiphytically but eventually become huge self-supporting trees) and large antler ferns are the most conspicuous species of an abundant epiphytic flora (Langdale-Brown *et al.* 1964 pp. 44 -45). Langdale-Brown *et al.* (1964) discriminate the medium altitude moist evergreen forests in three subtypes:

- *Piptadeniastrum - Uapaca* forests (C1) occur on the Ssese Islands in Lake Victoria. They are characterized by *Uapaca guineensis*, a species that is ubiquitous (even on beach sands) on these islands but that also is a typical swamp forest tree in mainland Uganda. It is possible that this species was dominant because these forests became established when the islands were evacuated between 1902 and 1906 (following sleeping sickness epidemics) and that it would be mainly restricted to swamp forests if forest succession continues.

- *Piptadeniastrum - Albizia - Celtis* forests (C2) are characterized by a young stage in which various *Albizia* spp. (see section 11.3) and ***Piptadeniastrum africanum*** (sometimes forming nearly pure stands; this is also a characteristic species of the C1 forest subtype) are abundant and ***Antiaris toxicaria*** and *Maesopsis eminii* are also common. The more mature stages are dominated by *Celtis mildbraedii* (White [1983 p. 181] listed unspecified *Celtis* species as characteristic for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian forest), *Celtis zenkeri* (not classified by VECEA as a useful tree species), various *Chrysophyllum* species (see section 11.2), ***Pouteria altissima*** and ***Pycnanthus angolensis.*** This is probably the forest climax as fossil records suggest that this forest occurred on Rusinga Island in the Miocene. *Parinari excelsa* occurs in some C2 forests, which is a characteristic species of forests of higher locations (*e.g.* C3 forests).
- *Parinari excelsa* forest (C3). *Parinari excelsa* is not fast growing, so it seems to be characteristic of the climax vegetation (White 1983 [p. 181] listed it as characteristic of Lake Victoria transitional rain forest [Ff] and not as characteristic of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian forest; this species is also an indicator of Afromontane rain forest [Fa]). The presence in mud below volcanic tuffs of fruits and leaves that are thousands of years old further suggest that this species has been present in these forests for a long time. These forests are appreciable more moist than C2 forests as a result of their greater altitude and reduced evapotranspiration.

The four subtypes of medium-altitude moist semi-deciduous forests that Langdale-Brown *et al.* (1964) discriminate are:

- *Celtis - Chrysophyllum* forest (D1). This forest is floristically similar to the C2 forest. *Celtis* and *Chrysophyllum* species occur in both C2 and D1 forests, but these species are more abundant and more clearly a part of the climax vegetation in D1 forests.
- *Cynometra - Celtis* forest (D2). Langdale-Brown *et al.* (1964 p. 49) speculate whether ***Cynometra alexandri*** (ironwood) could be the climax on poor soils or soils with impeded drainage, whereas *Celtis* and *Chrysophyllum* species could replace this species on better soils. It is also possible that ***Cynometra alexandri*** particularly benefits from large elephant populations and their daily movements to and from waterholes (Langdale-Brown *et al.* 1964 p. 50). ***Cynometra alexandri*** is also a characteristic species of some Lake Victoria scrub forests (see fe).
- *Albizia - Markhamia* forest (D3). Most of these forests were formed relatively recently (during the first half of the 20th century). *Markhamia lutea* (synonym *Markhamia platycalyx*) forms an almost pure stand in many places where the forests are more narrowly confined to valley bottoms. The ultimate stage may be a form of *Celtis* forest (Langdale-Brown *et al.* 1964; in the VECEA project, we assume particularly a D1 or D2 forest).
- *Albizia - Chlorophora* (now: *Milicia*) forest (D4). The area where this

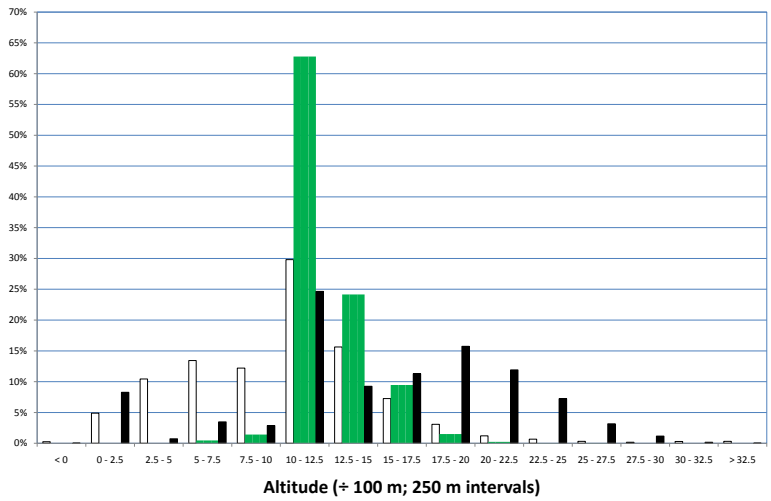
forest occurred was densely populated at the end of the 19th century until the sleeping sickness endemics of 1902 - 1906 killed over 100,000 people and the remainder of the population was evacuated. ***Milicia excelsa*** (Mvule, synonym: *Chlorophora excelsa*) grew within banana gardens as it was protected by locals customs and was probably a remnant from a previous forest type. It is possible but not certain that these forests could **potentially** develop into a *Celtis - Chrysophyllum* forest (D1; Langdale-Brown *et al.* 1964). Investigations by means of geographical information systems of the D1 and D4 vegetation types concluded that it is likely that D4 forests are transitional to D1 forests (P. van Breughel, personal investigations).

Lovett (1990 p. 292) describes that Lake Victoria dried up during the last glacial maximum (18,000 years ago) and that forests supported by convectional rains from this lake subsequently disappeared. The species occurring in Lake Victoria drier peripheral semi-evergreen rain forest and Lake Victoria swamp forest in Tanzania (and elsewhere in the Lake Victoria region) therefore dispersed in the area relatively recently.

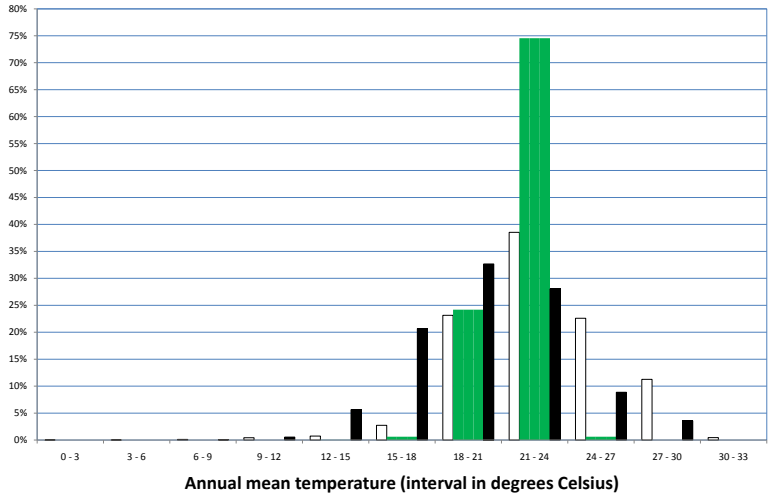
White (1983 p. 90) briefly describes a semi-evergreen variant of Zambezian dry evergreen forest (Fm) that occurs in Mbala district of Zambia. This forest is characterized by Guineo-Congolian species including *Celtis gomphophylla* (synonym *Celtis durandii*), *Pouteria altissima* and *Trichilia prieuriana.* These are characteristic species for Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest, so possibly this forest should be classified as one of the variants of drier peripheral semi-evergreen Guineo-Congolian rain forest.

Investigation of environmental distribution of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest in the VECEA region (Figure 11.5) shows that most of this forest occurs between 1000 and 1750 m (with > 95% of the samples in this interval). The altitude interval where most of samples occur is the same for this vegetation type (1000 – 1250 m; 62.8% of samples) as for all forests combined (24.7%). Similarly, the rainfall interval that contains the highest number of samples is the same (1200 – 1400 mm) for this forest type (49.3%) as for all forests combined (23.6%).

(a)



(b)



(c)

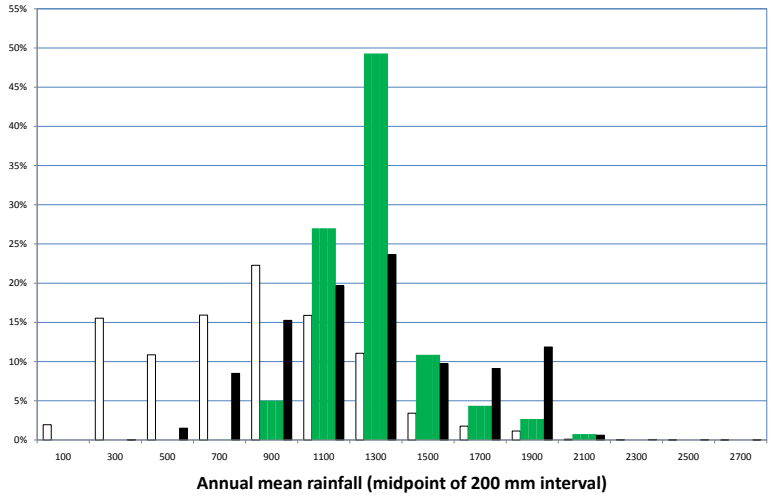


Figure 11.5 Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi, *n* = 11,967). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

11.3. Species composition

White (1983 p. 181) did not distinguish *Albizia* species. We identified 5 *Albizia* species as potential indicators as only one Albizia species (*Albizia gummifera*) was listed for Lake Victoria transitional rain forest (Ff).

Species composition was obtained from the following references:

- Kenya: Information was only available from floristic references and were coded "f". Species that were listed as characteristic species in Kenya for "Lake Victoria transitional rain forest" were coded "fK". Species listed within assemblages of "Lake Victoria transitional rain forest" were coded "fk". Species that were only available from the UNEP-WCMC database were coded "fw".
- Tanzania: Information was only available from floristic references and were coded "f". Species that were only available from the UNEP-WCMC database were coded "fw".
- Uganda: Langdale-Brown *et al.* (1964) and Howard & Davenport (1996). All species that were listed to occur in one of the C1 - C2 or D1 - D4 forests in the Appendix were coded "x" (unless they were characteristic species). Forests indicated on page 107 to only contain only one primary forest type were coded "xb": these referred to the Mpanga forest (C2) and Budongo, Bugoma, Semliki and Zoka forests (D2). A suffix of "s" indicated that the species were listed for "forest - savanna mosaic at medium altitudes [F2].[8]

Characteristic species were determined as:

- Kenya: characteristic species were not determined
- Tanzania: characteristic species were not determined
- Uganda. Species characterized as large trees ("trees" for the D3 and D4 forests) in the appendix or that were mentioned in the main text where the forest type was described were coded "C".

Floristics:

- Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).
- fK = species characteristic in Kakamega forest; fk = species occurs in Kakamega forest; fw = floristic evidence only from UNEP-WCMC
- fc = species occurs in forests that contain mixtures of C forests
- fd = species occurs in forests that contain mixtures of D forests

8: the only two species that were only listed in forest - savanna mosaics were *Acacia polyacantha* and *Mangifera indica* (exotic). We added *Acacia polyacantha* to the species assemblages (coded "s").

Table 11. Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Acacia polyacantha		f	f	s	s	s	s	s	s	s
Albizia adianthifolia	potential indicator (genus)	f	f	f	f	f	fd	xb	fd	fd
Albizia coriaria	potential indicator (genus)	f	f	fs	fs	fs	Cs	fds	Cs	Cs
Albizia glaberrima	potential indicator (genus)	f	f	fc	C	fc	C	xb	fd	C
Albizia grandibracteata	potential indicator (genus)	fK	f	fcs	Cs	fcs	Cs	Cs	Cs	Cs
Albizia gummifera		fK	f	fc	C	C	fd	xb	C	fd
Albizia zygia	potential indicator (genus)	fK	f	fcs	Cs	fcs	Cs	xbs	fds	Cs
Alchornea hirtella		f	f	fc	fc	fc	fd	xb	fd	fd
Allophylus abyssinicus		fk	f	fc	fc	fc	fd	xb	fd	fd
Allophylus africanus		f	f	f	f	f	x	fd	fd	fd
Alstonia boonei	indicator			fc	fc	fc	C	C	fd	C
Antiaris toxicaria	indicator	fK	f	Cs	Cs	fcs	Cs	xbs	Cs	Cs
Antidesma venosum		f	f	fc	fc	fc	fd	xb	fd	fd
Apodytes dimidiata		fk	f	fc	fc	fc	fd	xb	fd	fd
Baikiaea insignis			f	fcs	fcs	fcs	fds	xbs	fds	fds
Balanites wilsoniana		f	f	fc	xb	fc	fd	C	fd	fd
Beilschmiedia ugandensis			f	fc	x	fc	fd	xb	fd	fd
Bersama abyssinica		fK	f	fc	xb	fc	fd	xb	fd	fd
Blighia unijugata		fK	f	fc	xb	fc	x	xb	C	fd
Bombax buonopozense				f	f	f	fd	C	fd	fd
Bridelia brideliifolia			f	f	f	f	fd	xb	fd	fd
Bridelia micrantha		fK	f	fc	xb	fc	fd	xb	fd	fd
Canarium schweinfurthii			f	Cs	xbs	fcs	fs	xbs	fds	Cs
Carapa procera			f	fc	fc	x	f	f	f	f
Cassipourea malosana		fK	f	fc	xb	fc	fd	xb	fd	fd
Cassipourea ruwensoriensis		fK	f	fc	fc	x	fd	xb	fd	fd
Celtis adolfi-fridericii	characteristic genus			fc	fc	fc	x	C	fd	fd

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Celtis africana	characteristic genus	fk	f	fc	C	fc	C	C	C	C
Celtis gomphophylla	characteristic genus	fK	f	fc	C	fc	C	xb	fd	fd
Celtis mildbraedii	characteristic genus	fK	f	fc	C	fc	C	C	fd	fd
Celtis philippensis	characteristic genus	f	f	f	f	f	C	x	fd	fd
Celtis zenkeri	characteristic genus		f	fc	C	fc	C	C	fd	C
Chrysophyllum albidum	indicator	fK		fc	C	C	C	xb	fd	fd
Chrysophyllum gorungosanum		f	f	fc	fc	C	f	f	f	f
Clausena anisata		fk	f	fc	xb	fc	x	x	x	x
Cordia africana		fK	f	fc	fc	fc	fd	xb	fd	fd
Cordia millenii		fK	f	fc	xb	fc	fd	xb	fd	fd
Cordia monoica		f	f	f	f	f	fd	xb	fd	fd
Craibia brownii		fk	f	fc	fc	fc	fd	xb	fd	fd
Croton macrostachyus		fK	f	fc	xb	fc	fd	xb	C	C
Croton megalocarpus		fK	f	fc	fc	C	fd	xb	fd	fd
Croton sylvaticus		fK	f	fc	xb	fc	fd	xb	fd	fd
Cussonia holstii		f	f	f	f	f	fd	xb	fd	fd
Cyathea manniana		fk	f	fc	fc	x	fd	fd	fd	fd
Cynometra alexandri	characteristic		f	f	f	f	fd	C	fd	fd
Diospyros abyssinica		fK	f	fc	xb	x	C	x	fd	x
Discopodium penninervium		f	f	f	f	f	fd	xb	fd	fd
Dombeya kirkii		f	f	f	f	x	x	xb	fd	fd
Dovyalis abyssinica		fk	f	f	f	f	fd	xb	fd	fd
Dovyalis macrocalyx		f	f	fc	fc	fc	fd	xb	fd	fd
Dracaena fragrans		fk	f	x	x	fc	x	fd	fd	fd
Dracaena steudneri		fK	f	fc	xb	fc	fd	xb	fd	fd
Ehretia cymosa		fK		fc	xb	fc	fd	xb	fd	fd
Ekebergia capensis		fK	f	fc	xb	fc	fd	xb	fd	fd
Elaeis guineensis	(palm species)	f	f	fc	fc	fc	fd	xb	fd	fd
Elaeodendron buchananii		f	f	f	f	f	fd	xb	fd	fd

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Entandrophragma angolense	characteristic	fK	fw	fc	C	fc	C	C	fd	fd
Entandrophragma cylindricum	indicator			fc	C	fc	fd	C	fd	fd
Entandrophragma excelsum			f	fc	xb	C	fd	fd	fd	fd
Entandrophragma utile	indicator			fc	C	fc	C	C	fd	fd
Erythrina abyssinica		f	f	fcs	xbs	fcs	fds	xbs	fds	fds
Erythrina excelsa		f	f	fc	x	fc	fd	xb	fd	fd
Erythrophleum suaveolens		f	f	fc	fc	fc	C	C	fd	fd
Erythroxylum fischeri		f	f	f	f	f	fd	xb	fd	fd
Euclea divinorum		f	f	f	f	f	fd	fd	fd	x
Euclea racemosa		f	f	f	f	f	fd	xb	fd	fd
Fagaropsis angolensis		fK	f	fc	xb	fc	fd	xb	C	C
Ficus exasperata		fK	f	fc	xb	fc	fd	xb	fd	fd
Ficus mucuso		fk	f	fc	C	fc	fd	xb	fd	fd
Ficus natalensis		fk	f	fc	xb	fc	fd	xb	fd	fd
Ficus sur		fK	f	fc	xb	fc	fd	xb	fd	fd
Ficus sycomorus		f	f	f	f	f	fd	xb	fd	fd
Ficus thonningii		fK	f	fc	fc	fc	fd	xb	fd	fd
Flueggea virosa		f	f	fc	xb	fc	fd	xb	fd	x
Funtumia africana		fK	f	xs	xs	xs	Cs	xs	fds	fds
Funtumia elastica				f	f	f	C	x	fd	fd
Galiniera saxifraga		fk	f	f	f	f	fd	xb	fd	fd
Garcinia buchananii		fK	f	fc	fc	fc	fd	xb	fd	fd
Guarea cedrata				f	f	f	fd	xb	fd	fd
Hallea stipulosa				fc	x	fc	fd	xb	fd	fd
Harrisonia abyssinica		f	f	f	f	f	fd	xb	fd	x
Harungana madagascariensis		fK	f	fc	xb	fc	fd	xb	fd	fd
Hexalobus monopetalus			f	f	f	f	fd	xb	fd	fd
Holoptelea grandis	indicator			fc	xb	fc	C	C	fd	fd

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Khaya anthotheca	indicator		f	fc	fc	fc	fd	C	fd	fd
Khaya grandifoliola	indicator			f	f	f	fd	C	fd	fd
Kigelia africana		fk	f	fc	fc	fc	fd	xb	fd	fd
Lannea barteri				fc	fc	fc	fd	xb	fd	fd
Lannea welwitschii		f	fw	fc	x	fc	fd	xb	fd	fd
Lepidotrichilia volkensii		fk	f	fc	xb	fc	fd	xb	fd	fd
Lovoa swynnertonii		f	f	fc	xb	C	fd	xb	fd	fd
Lovoa trichilioides			f	Cs	Cs	fcs	fds	xbs	fds	fds
Maesa lanceolata		fk	f	fc	xb	x	fd	xb	fd	fd
Maesopsis eminii	characteristic	fK	f	Cs	Cs	Cs	Cs	Cs	fds	fds
Manilkara butugii		fK		f	f	f	fd	xb	fd	fd
Manilkara dawei			f	fc	x	fc	fd	xb	fd	fd
Margaritaria discoidea		fk	f	fc	x	fc	fd	C	C	C
Markhamia lutea		fK	f	fcs	xbs	fcs	xs	xbs	Cs	Cs
Maytenus undata		fk	f	fc	xb	fc	fd	xb	fd	fd
Mildbraediodendron excelsum	indicator			f	f	f	C	C	fd	fd
Milicia excelsa	indicator	fK	f	fcs	xbs	fcs	fds	xbs	fds	Cs
Millettia dura		f	f	f	f	f	fd	xb	fd	fd
Mimusops bagshawei		fK	f	C	C	fc	C	xb	fd	C
Mimusops kummel		fK	f	f	f	f	fd	xb	fd	fd
Monodora myristica		fK	f	fc	xb	fc	fd	x	fd	fd
Morinda lucida			f	fc	x	fc	fd	xb	fd	fd
Morus mesozygia	indicator	fK	f	fc	C	fc	fd	xb	fd	fd
Myrianthus arboreus			f	fc	fc	fc	fd	xb	fd	fd
Myrianthus holstii		f	f	fc	fc	fc	fd	xb	fd	fd
Nauclea diderrichii				fc	fc	fc	fd	xb	fd	fd
Neoboutonia macrocalyx		fK	f	fc	xb	fc	fd	xb	fd	fd
Newtonia buchananii		f	f	Cs	fcs	Cs	fds	xbs	fds	fds

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Nuxia congesta		fK	f	f	f	f	fd	xb	fd	fd
Olea capensis		fK	f	fc	fc	C	fd	C	C	fd
Oncoba spinosa		f	f	fc	fc	fc	fd	xb	fd	fd
Oreobambos buchwaldii	(bamboo species indigenous to Africa)	f	f	fc	fc	fc	fd	xb	fd	fd
Ozoroa insignis		f	f	f	f	f	fd	xb	fd	fd
Parinari excelsa			f	fc	C	C	fd	xb	fd	fd
Parkia filicoidea		f	f	fc	xb	fc	fd	xb	fd	fd
Pavetta crassipes		f	f	fc	fc	fc	fd	xb	fd	fd
Pavetta oliveriana		f	f	fc	fc	fc	fd	xb	fd	fd
Peddiea fischeri		f	f	fc	fc	fc	fd	xb	fd	fd
Phoenix reclinata	(palm species)	fk	f	fcs	xs	fcs	fs	fs	fs	fs
Phytolacca dodecandra		fk	f	fc	xb	fc	fd	xb	fd	fd
Piptadeniastrum africanum	indicator			Cs	Cs	fcs	fds	xbs	fds	fds
Pleiocarpa pycnantha		f	f	fc	xb	x	fd	xb	fd	fd
Polyscias fulva		fK	f	x	xb	x	fd	xb	C	fd
Pouteria adolfi-friedericii		fk	f	f		f	fd	xb	fd	fd
Pouteria altissima	characteristic	fK	f	fc	C	C	fd	xb	fd	fd
Prunus africana		fk	f	fc	x	C	fd	xb	C	C
Pseudospondias microcarpa		fK	f	Cs	xbs	fcs	fds	xbs	fds	Cs
Psychotria mahonii		fk	f	fc	xb	fc	fd	xb	fd	fd
Psydrax parviflora		fK	f	fc	xb	fc	fd	xb	fd	fd
Pterolobium stellatum		fk	f	fc	xb	fc	x	xb	fd	fd
Pterygota mildbraedii			fw	f	f	f	fd	C	fd	fd
Pycnanthus angolensis	indicator		f	Cs	Cs	fcs	fds	xbs	fds	fds
Raphia farinifera	(palm species)	f	f	fc	x	fc	fd	xb	fd	fd
Rauvolfia caffra		f	f	f	f	f	fd	xb	fd	fd
Rauvolfia vomitoria			f	fc	x	fc	fd	xb	fd	fd
Rhus natalensis		f	f	fc	fc	fc	fd	xb	fd	fd

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Rhus vulgaris		f	f	fc	xb	fc	fd	xb	fd	fd
Ricinodendron heudelotii		f	f	fc	fc	fc	fd	xb	fd	fd
Rinorea angustifolia		f	f	f	f	f	fd	x	fd	fd
Ritchiea albersii		fk	f	fc	fc	fc	fd	xb	fd	fd
Rothmannia urcelliformis		fK	f	fc	xb	fc	fd	x	fd	fd
Schefflera volkensii		fk	f	fc	xb	fc	f	f	f	f
Schrebera arborea		fw		f	f	f	C	C	fd	fd
Scutia myrtina		fk	f	fc	fc	fc	x	xb	fd	x
Senna didymobotrya		fk	f	f	f	f	fd	xb	fd	fd
Shirakiopsis elliptica		fK	f	fc	x	C	fd	x	C	C
Spathodea campanulata		fK	f	fcs	xbs	fcs	fds	xbs	fds	fds
Sterculia dawei				fc	fc	fc	fd	xb	fd	fd
Strombosia scheffleri		fK	f	fc	xb	C	fd	xb	fd	fd
Strychnos mitis		f	f	fc	xb	fc	C	C	fd	fd
Symphonia globulifera			f	C	xb	C	fd	xb	fd	fd
Synsepalum brevipes		f	f	C	xb	fc	x	xb	fd	fd
Syzygium guineense		fk	f	fc	xb	fc	fd	xb	fd	fd
Tabernaemontana pachysiphon		fK	f	x	xb	fc	fd	x	fd	fd
Treculia africana			f	fc	xb	fc	fd	xb	fd	fd

Species	Regional status (see section 2.3)	(Kenya)	(Tanzania)	LC1U (Uganda subtype)	LC2U (Uganda subtype)	LC3U (Uganda subtype)	LD1U (Uganda subtype)	LD2U (Uganda subtype)	LD3U (Uganda subtype)	LD4U (Uganda subtype)
Trema orientalis		fK	f	fc	xb	x	fd	xb	fd	fd
Trichilia dregeana		fK	f	C	xb	fc	fd	C	fd	fd
Trilepisium madagascariense		fK	f	x	x	fc	C	x	fd	fd
Uapaca guineensis	Lake Victoria swamp forest		f	C	fc	fc	f	f	f	f
Uvaria scheffleri		f	f	f	f	f	fd	xb	fd	fd
Vangueria apiculata		f	f	fc	fc	fc	fd	xb	fd	fd
Vangueria madagascariensis		f	f	fc	xb	fc	fd	xb	fd	fd
Vepris nobilis		fK	f	fc	x	fc	C	x	x	C
Vernonia amygdalina		fk	f	fc	xb	fc	fd	xb	x	fd
Vernonia auriculifera		fk	f	f	f	f	fd	fd	x	C
Vitex ferruginea		f	f	f	f	f	fd	xb	fd	fd
Warburgia ugandensis		fK	f	f	f	f	C	xb	fd	fd
Xylopia aethiopica		f	f	x	fc	fc	fd	xb	fd	fd
Xylopia parviflora		f	f	f	f	f	fd	xb	fd	fd
Xymalos monospora		fk	f	fc	xb	fc	fd	fd	fd	fd
Zanha golungensis		f	f	fc	fc	fc	fd	xb	fd	fd
Zanthoxylum gilletii		fK	f	fc	x	fc	fd	xb	fd	fd
Zanthoxylum rubescens		fK	f	fc	xb	fc	fd	xb	fd	fd

12. Zambezian dry evergreen forest (Fm)

12.1. Description

Zambezian dry evergreen forest rarely exceeds 25 m in height except for a few emergents. This forest represents a physiognomic and floristic transition from Guineo-Congolian rain forest to Zambezian woodland (*e.g.*, Miombo woodland [Wm]), but also contains Afromontane species. Zambezian dry evergreen forest is simpler in structure than Guineo-Congolian rain forest, the leaves of the dominant trees are more coriaceous ('leathery') and have few drip-tips (White 1983 p. 89).

White (1983 p. 46) restricted dry forests to those forests that experience a dry season lasting several months and during which atmospheric humidity is low. Dry forests are shorter than rain forests and also simpler in structure and floristics (White 1983 p. 46)

Compared to Guineo-Congolian rain forest, Zambezian dry evergreen forest is floristically relatively poor. Floristic composition varies greatly from place to place. There are eight dominant and emergent tree species that overlap considerably with each other, although no species occurs throughout: ***Berlinia giorgii, Cryptosepalum exfoliatum* ssp. *pseudotaxus, Daniellia alsteeniana, Entandrophragma delevoyi, Marquesia acuminata, Marquesia macroura, Parinari excelsa*** and ***Syzygium guineense* ssp. *afromontanum. Cryptosepalum exfoliatum* ssp. *pseudotaxus*** dominates the most distinct type of Zambezian dry evergreen forest which occurs on Kalahari Sand [9] (White 1983 pp. 89 - 90).

In the Zambezian region, Zambezian dry evergreen forest is confined to the wetter northern parts where the mean annual rainfall is more than 1200 mm. On Kalahari Sand, however, Zambezian dry evergreen forest extends into regions where mean annual rainfall is more than 900 mm. Fire exclusion experiments suggest that Zambezian dry evergreen forest is confined to areas with deeper soils, whereas Miombo woodland (Wm) occurs on shallower soils[10]. Zambezian transition woodland (not included in the VECEA classification system) forms an ecotone between Zambezian dry evergreen forest and Miombo woodland on soils of intermediate depth; forest shrubs and climbers exist in dynamic equilibrium with miombo species in this ecotone (White 1983 pp. 89 - 92).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zambezian dry evergreen forest and no other Zambezian forest type) that were listed as characteristic species for the national map include ***Cryptosepalum exfoliatum*** ssp. ***pseudotaxus, Entandrophragma delevoyi, Marquesia acuminata, Marquesia macroura, Parinari excelsa*** (also an indicator of Afromontane rain forest [Fa] and Lake Victoria transitional rain forest [Ff]) and ***Syzygium guineense*** ssp. ***afromontanum*** (also an indicator of Afromontane rain forest [Fa] and Lake Victoria transitional rain forest [Ff]).

9: Kalahari Sand is a Pleistocene lacustrine deposit and possibly the erosion product from the weak Upper Karroo sandstones. The soil is deep, well drained and moderately acid (pH 5 -5.5). These soils are able to support dry evergreen forest because high rainfall compensates for the rapid drainage of the sands. (Fanshawe pp. 7, 11 and 16).

10: The interpretation that areas within the Zambezian floristic region that have deeper soils would only have Zambezian dry evergreen forest as the climax vegetation type - and not miombo woodland - is not generally accepted. It is known that miombo woodland occurs in areas with deeper soils, and it is not certain that all these areas with deeper soils previously supported Zambezian dry evergreen forest (P. Smith and J. Timberlake, pers. comm.; see also comments for miombo woodland in Volume 3).

Figure 12.1 *Cryptosepalum exfoliatum* forest on Kalahari Sand (Zambia). Right: *Cryptosepalum exfoliatum*. Left: *Brachystegia spiciformis* (dominant in miombo woodland). Photograph by M. Bingham.

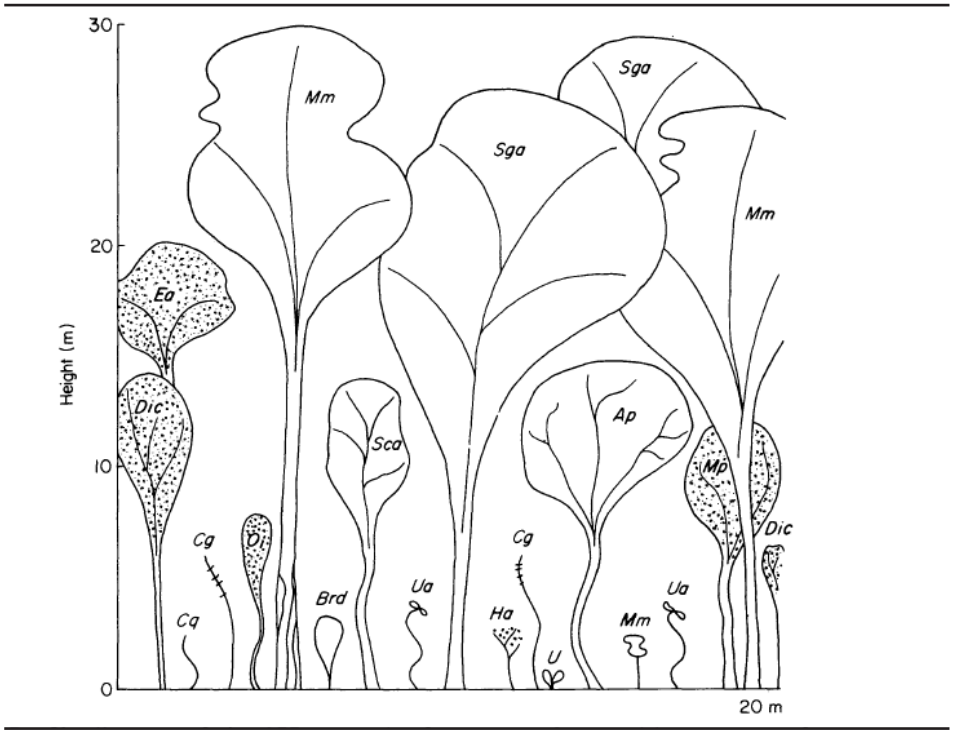


Figure 12.2 Profile diagram of a patch of Zambezian dry evergreen forest. Dominant species in the canopy are *Marquesia macroura* (Mm) and *Syzygium guineense* ssp. *afromontanum* (Sga). Species that are typical in Chipya woodland (Wy; see Volume 3) are stippled, including *Diplorhynchus condylocarpon* (Dic), *Erythrophleum africanum* (Ea) and *Maranthes polyandra* (Mp). Lawton 1978. Image obtained from URL: *http://www.jstor.org/stable/2259187*.

12.2. VECEA region

Within the VECEA region, Zambezian dry evergreen forest is only mapped for Zambia (Figure 12.3, see also Volume 6).

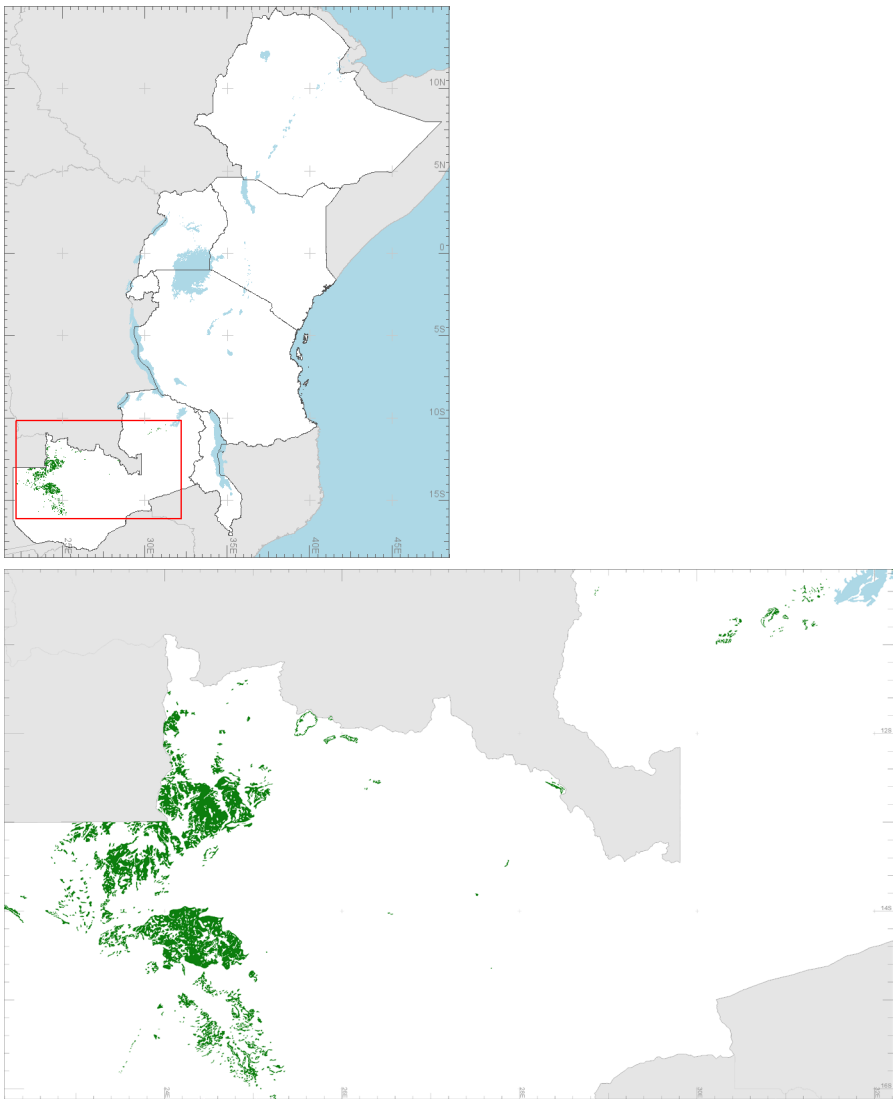


Figure 12.3. Mapped distribution of Zambezian dry evergreen forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Green polygons depict where we mapped this forest type.

In Zambia, Zambezian dry evergreen forest was originally mapped as subtypes of *Cryptosepalum* forest on Kalahari Sand, *Marquesia* forest in the lake basin and *Parinari* forest on the plateau; see below [11]).

The three Zambian subtypes of dry evergreen forest are described as three-storeyed forests with a closed evergreen or semi-deciduous canopy of 25 to 27 m high, with occasional emergents, a discontinuous evergreen understorey of 9 to 15 m high and a dense evergreen shrub - scrambler thicket of 1.5 to 6 m high and sometimes a well-marked lower storey of 0.3 - 1.3 m high (Fanshawe 1971 p. 11).

Cryptosepalum forest (original mapping unit 4) occurs in the northern Kalahari basin. In lower rainfall areas, canopy dominants are restricted to ***Cryptosepalum exfoliatum* ssp. *pseudotaxus* and** *Guibourtia coleosperma*. In higher rainfall areas, ***Cryptosepalum exfoliatum* ssp. *pseudotaxus*** is associated with ***Marquesia acuminata, Marquesia macroura, Parinari excelsa*** and ***Syzygium guineense* ssp. *afromontanum***. Partial destruction of *Cryptosepalum* forest followed by an invasion of dominant species from miombo woodland (Wm; especially *Brachystegia longifolia* and *Brachystegia spiciformis*) leads to miombo - Kalahari woodland (Wk). Total or almost total destruction of Cryptosepalum forest (or any of the regression stages to Kalahari woodland) eventually leads to Kalahari Sand Chipya woodland (Wy) where fire-hardy species occupy the canopy (Fanshawe 1971 pp. 16 - 17).

Marquesia forest (original mapping unit 2) occurs in the Bangweulu lake basin. Canopy dominants are restricted to *Anisophyllea pomifera*, ***Marquesia macroura***, *Podocarpus latifolius* (synonym *Podocarpus milanjianus*; this species occurs locally [in the Mukabe Protected Forest Area which lies in a slightly higher rainfall belt than most of the lake basin proper and drainage is impeded at depth by underlying rock] and is also characteristic for Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]) and ***Syzygium guineense* ssp. *afromontanum***. Partial destruction of *Marquesia* forest results in a gradual regression to miombo woodland (Wm). During this regression, the forest is invaded by *Brachystegia* species (mainly *Brachystegia spiciformis*, one of the dominant species of miombo woodland) and *Isoberlinia* species (*Isoberlinia angolensis* is a dominant species of miombo woodland). Total destruction of *Marquesia* forest (essentially the destruction of the canopy) results in lake basin Chipya woodland (Wy) where fire-hardy species occupy the canopy (Fanshawe 1971 pp. 14 - 16).

Parinari forest (original mapping unit 1) occurs on the plateau. Dominant species of the canopy are restricted to ***Parinari excelsa*** and ***Syzygium guineense* ssp. *afromontanum***, with odd emergent species of *Entandrophragma delevoyi*. *Marquesia macroura* and *Erythrophleum suaveolens* are canopy associates in the South Mutundu block which is close to Katanga (Democratic Republic of Congo) where *Erythrophleum suaveolens* is a dominant species. Partial destruction of *Parinari* forests results in Copperbelt Chipya woodland (Wy, included with *Parinari* forest in original mapping unit 1), which is a vegetation type that has resulted from gradual regression to miombo woodland (Wm)([12]). Total destruction of *Parinari* forest results in Chipya woodland (Cy) that is

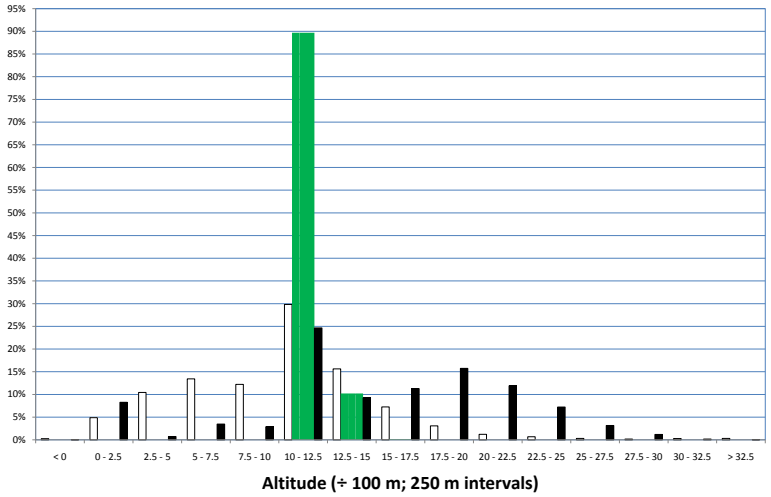
11: The coding of the Trapnell *et al.* (1950) soil - vegetation map is based on the soil type with a suffix for the vegetation type. In the legend of the Fanshawe vegetation map (Edmonds 1976), an indicating is given that *Cryptosepalum* forest corresponds to the Trapnell mapping unit K1 (*Cryptosepalum* low forest and woodland on Kalahari Sand), *Marquesia* forest corresponds to B1 (*Marquesia* and *Marquesia* woodlands on marginal Lake Basin soils) and *Parinari* forest together with Copperbelt chipya correspond to R (undifferentiated *Brachystegia - Isoberlinia* woodlands on red earths and allied red loams).

12: Remains of evergreen thickets are widespread in wetter miombo woodland; in several of these cases these could be relicts that suggest that evergreen forest was in former pluvial periods more widespread and have now been converted to wetter miombo woodland [Fanshawe 1971 p. 13]). In the Trapnell *et al.* (1950) vegetation - soil map, the *Parinari* forest and Copperbelt chipya (mapping unit 1) of Fanshawe corresponds to mapping unit R (Undifferentiated *Brachystegia - Isoberlinia* woodlands on red earths and allied red loams).

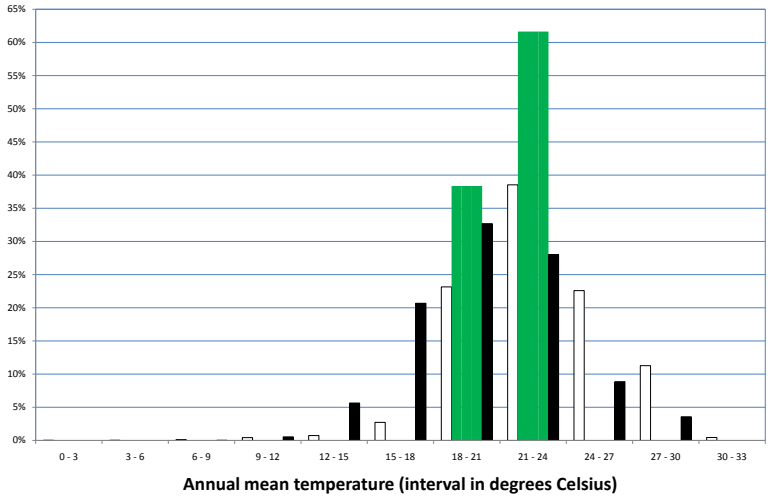
identical to Lake Basin Chipya (the result from total destruction from *Marquesia* forest) and where fire-hardy species have replaced the canopy species of *Parinari* forest (Fanshawe 1971 pp. 12 - 14).

Investigation of environmental distribution of Zambezian dry evergreen forest in the VECEA region (Figure 12.4) shows that most of this forest occurs between 1000 and 1500 m (with nearly all samples in this interval). The altitude interval where most of samples occur is the same for this vegetation type (1000 – 1250 m; 89.7% of samples) as for all forests combined (24.7%). Rainfall in Zambezian dry evergreen forest is below average with more than 95% of samples receiving 800 to 1400 mm annually. The only forest types that have a lower rainfall interval that contains the highest number of samples are Zambezian dry deciduous forest and scrub forest (Fn) and Zanzibar-Inhambane scrub forest (Fq).

(a)



(b)



(c)

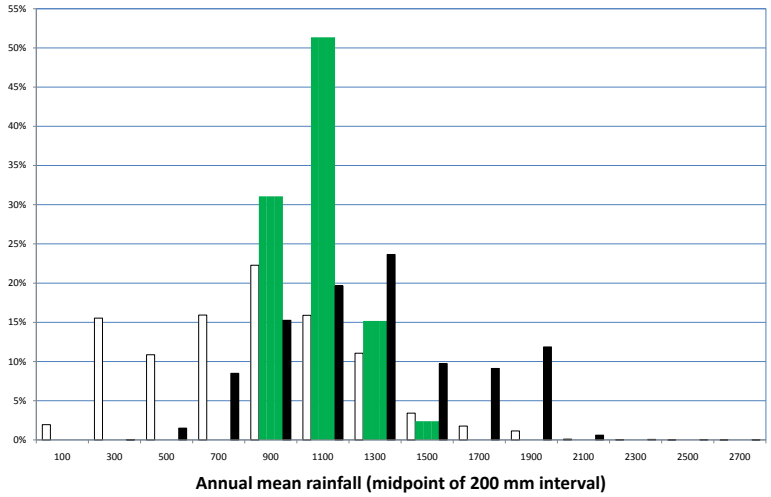


Figure 12.4. Histogrammes of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Zambezian dry evergreen forest (Fm, *n* = 4,512). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

12.3. Species composition

Species composition was obtained from the following references:

- Zambia: Fanshawe (1971). Species listed for the species composition table for "dry evergreen forest" provided on pages 17 to 18 were coded "x" (unless they were characteristic species).

Characteristic species were determined as:

- Zambia: Species that were listed in the main text as understorey species for *Cryptosepalum* forest were coded "Cc", whereas canopy dominant species were coded "Dc". Species that were listed in the main text as understorey species for *Marquesia* forest were coded "Cm", whereas canopy dominant species were coded "Dm". Species that were listed in the main text as understorey species for *Pariniri* forest were coded "Cp", whereas canopy dominant species were coded "Dp." Species that were only locally dominant were coded "C" instead of "D".

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in the regional information (White 1983).

Table 12. Species composition of Zambezian dry evergreen forest (Fm)

Species	**Regional status** (see section 2.3)	**FmZ (Zambia)**
Albizia adianthifolia		x
Apodytes dimidiata		x
Baphia massaiensis	not characteristic (indicator for *Baikiaea* forest)	Cc
Berlinia giorgii	indicator (dominant)	f
Bersama abyssinica		x
Cassipourea malosana		Cp
Chrysophyllum gorungosanum		x
Cryptosepalum exfoliatum	indicator (dominant, dominates dry evergreen forest on Kalahari Sand [*Cryptosepalum exfoliatum* ssp. *pseudotaxus*])	Dc
Daniellia alsteeniana	indicator (dominant)	f
Diospyros abyssinica		x
Entandrophragma delevoyi	indicator (dominant)	Cp
Erythrophleum suaveolens		Cp
Guibourtia coleosperma		Cc
Margaritaria discoidea		x
Marquesia acuminata	indicator (dominant)	Dm Cc
Marquesia macroura	indicator (dominant)	Dm Ccp
Maytenus acuminata		x
Olea capensis		Ccmp
Parinari excelsa	indicator (dominant)	Dp Cc
Peddiea fischeri		x
Podocarpus latifolius		Cm
Psydrax parviflora		x
Rinorea angustifolia		x
Smilax anceps		x
Strychnos lucens		x
Syzygium guineense	indicator (dominant [*Syzygium guineense* ssp. *afromontanum*])	Dmp Cc
Tabernaemontana pachysiphon		Cp
Vepris nobilis		Cp

13. Zambezian dry deciduous forest and scrub forest (Fn)

13.1. Description

Zambezian dry deciduous forests have a canopy that varies from 12 to 25 m that is not always continuous (White 1983 p. 90).

White (1983 p. 46) restricted dry forests to those forests that experience a dry season lasting several months and during which atmospheric humidity is low. Dry forests are shorter than rain forests and also simpler in structure and floristics. White (1983 pp. 46 - 47) further restricted deciduous forests to forests where the majority of individuals of the upper and lower canopy usually lose their leaves simultaneously and remain bare for several weeks. However, on favourable sites or in favourable years, the largest trees of Zambezian dry evergreen forest may remain evergreen over an almost completely deciduous lower canopy (White 1983 p. 47).

Zambezian dry deciduous forests occur in those parts of the Zambezian region where rainfall is between 600 and 900 mm per year. These forests are characteristically found on certain deep (usually sandy) soils which absorb all the rainfall and lateral seepage water and thereby remain moist at depth throughout the greater part of the dry season (White 1983 p. 90).

White (1983 p. 90) distinguishes between *Baikiaea* forests (where ***Baikiaea-plurijuga*** forms an almost pure canopy and ***Pterocarpus lucens*** [synonym *Pterocarpus antunesii*] is an abundant subdominant species) and related forests where ***Baikiaea plurijuga*** is absent, that occur in the valleys of the middle and lower Zambezi and that show continuous floristic change towards the east (*i.e.* towards Malawi). ***Baikiaea*** forests are almost confined to Kalahari Sand where ***Baikiaea plurijuga*** forms an almost pure canopy usually about 20 m high and the shrub layer (the 'mutemwa') forms a well-defined deciduous thicket of tall coppicing shrubs of 5 to 8 m high. *Pterocarpus-Newtonia* forests occur in the Lower Shire Valley of Malawi; here ***Baikiaea plurijuga*** is absent, ***Pterocarpus lucens*** and *Newtonia hildebrandtii* are co-dominant species and floristic composition is significantly different from ***Baikiaea-plurijuga*** forest (White 1983 p. 90).

Regional indicator species (characteristic species listed by White (1983) that were only provided for Zambezian dry deciduous forest and no other Zambezian forest type) that were listed as characteristic species for one or several national maps can be further classified as dominant, co-dominant or local emergent species, subdominant or associated species, 'mutemwa' species or other subclassifications (see section 13.2).

- Dominant, co-dominant or local emergent species include ***Baikiaea-plurijuga*** (dominant in ***Baikiaea*** forest), ***Entandrophragma caudatum*** (local emergent in ***Baikiaea*** forest), ***Newtonia hildebrandtii*** (co-dominant in *Pterocarpus-Newtonia* forest) and ***Pterocarpus lucens*** (dominant in ***Baikiaea*** forest, co-dominant in

Pterocarpus-Newtonia forest).

- Subdominant or associated species include ***Adansonia digitata*** (associate in *Pterocarpus-Newtonia* forest, absent in ***Baikiaea*** forest), ***Balanites maughamii*** (associate in *Pterocarpus-Newtonia* forest, absent in ***Baikiaea*** forest), ***Boscia albitrunca*** (subdominant in ***Baikiaea*** forest), ***Cordyla africana*** (associate in *Pterocarpus-Newtonia* forest, absent in ***Baikiaea*** forest), ***Croton gratissimus*** (subdominant in ***Baikiaea*** forest), ***Diospyros quiloensis*** (associate in *Pterocarpus-Newtonia* forest, absent in ***Baikiaea*** forest), ***Excoecaria bussei*** (subdominant in ***Baikiaea*** forest), ***Lonchocarpus nelsii*** (subdominant in ***Baikiaea*** forest) and ***Strychnos potatorum*** (subdominant in ***Baikiaea*** forest; this species also occurs in some types of Lake Victoria scrub forests [fe]).
- 'Mutemwa' species from ***Baikiaea*** forests include ***Acacia ataxacantha*** (most common), ***Acalypha chirindica, Alchornea occidentalis, Baphia massaiensis*** (most common), ***Bauhinia petersiana*** (most common), ***Canthium glaucum, Citropsis daweana, Combretum celastroides*** (most common), ***Combretum elaeagnoides*** (most common), ***Dalbergia martini*** (most common), ***Friesodielsia obovata*** (most common), ***Grewia flavescens, Markhamia zanzibarica, Rourea orientalis, Tarenna luteola*** and ***Tricalysia allenii***.

Kalahari thicket is similar to the 'mutemwa' deciduous understorey of ***Baikiaea plurijuga*** Zambezian dry deciduous forest (Fn). It is different from ***Baikiaea*** forest as it contains dwarf individuals (< 2 m tall) of ***Baikiaea plurijuga***. Since this vegetation type occurs near the edges or heads of certain dambos, dwarfing of ***Baikiaea plurijuga*** is probably a result from imperfect drainage (White 1983 p. 98). Whereas White (1983) described Kalahari thicket as a distinct vegetation type, we could not relate it to any national vegetation types. We assume that it was mapped together with Zambezian dry evergreen forest in the Zambian base map that we used (see section 13.2)

Figure 13.1 Zambezian dry deciduous forest (synonym: Namalembo thicket) in Liwonde National Park (Malawi). Photograph by C. Dudley.

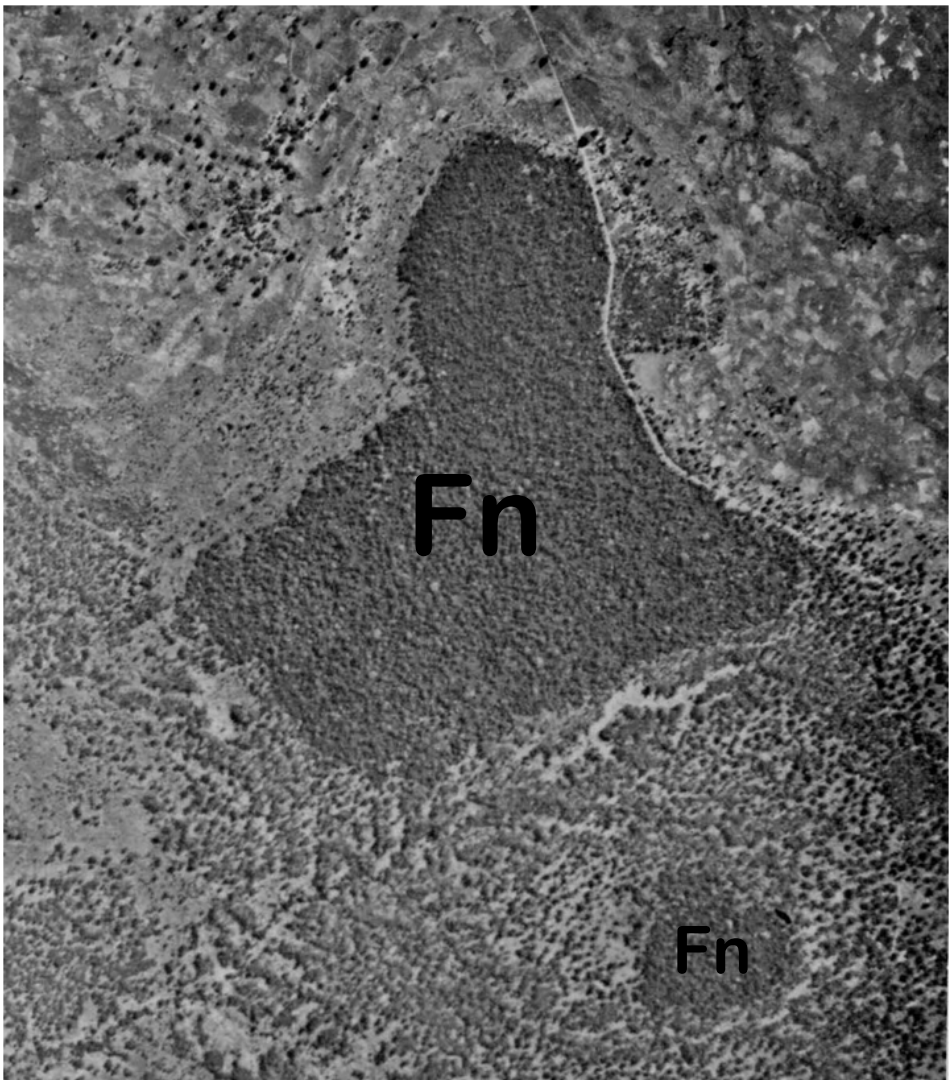


Figure 13.2 Aerial photographs of two patches of Zambezian dry deciduous forest and scrub forest (Fn, synonym: Namalembo thicket) in Liwonde National Park (Malawi). These two patches correspond to locations with coordinates of 14° 46.32′ S - 35° 21.15 E and 14° 47.12′ S - 35° 21.67′ S mentioned in the text. Photograph by C. Dudley.

13.2. VECEA region

Within the VECEA region, Zambezian dry deciduous forest and scrub forest is only mapped for Zambia (see Figure 13.3). This vegetation type also occurs in Malawi, but patches are too small to be mapped (C. Dudley, pers. comm.).

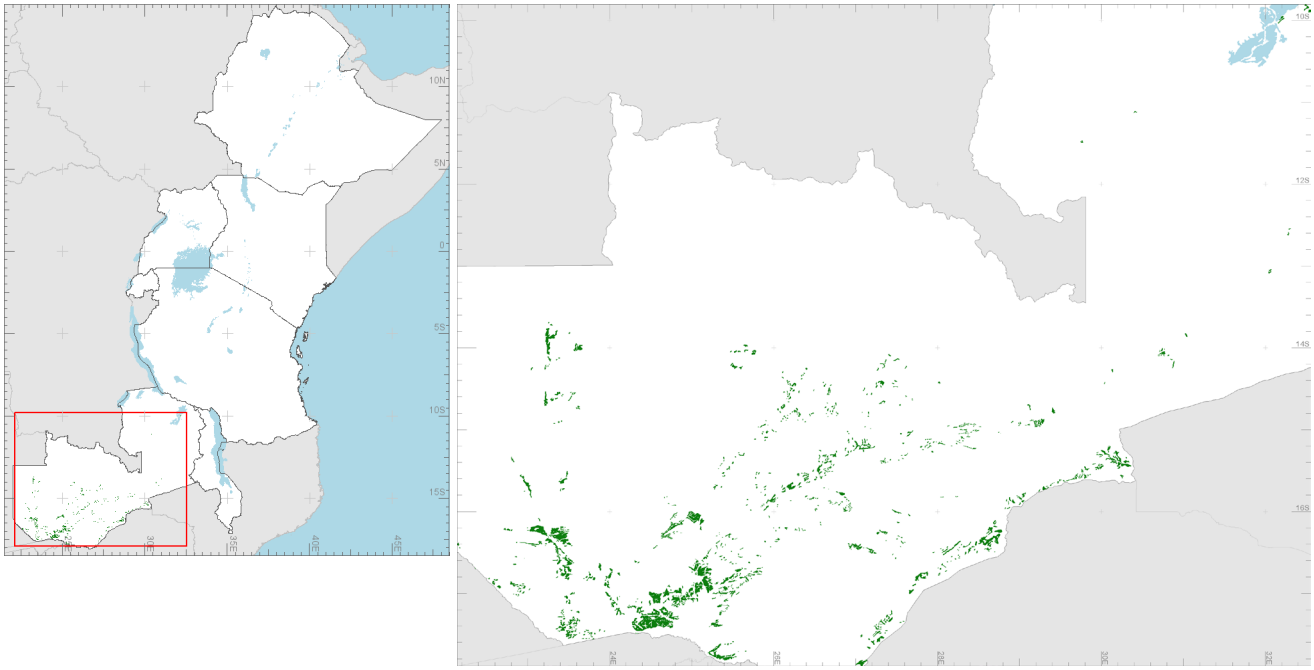


Figure 13.3. Mapped distribution of Zambezian dry deciduous forest and scrub forest (Fn) in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Green polygons depict where this forest type was mapped. This forest type occurs in Malawi, but patches were too small to be mapped.

In Malawi, Zambezian dry deciduous forest and scrub forest was orginally described as deciduous forest and thicket. In this country, Zambezian dry deciduous forests are found only in the southern end of the country in its Rift Valley. They are remnants of what historically was a much larger vegetation community. Through the impact of human activity and perhaps climate change, this type is now broken up into a mosaic of sizes, dispersion patterns and serial stages (thicket - forest). All presently lie within protected areas but continue to be altered through the activities of large mammals (elephants) and fire. These areas are too small to be mapped (C. Dudley, personal observations).[13]

Two subtypes can be distinguished in Malawi (C. Dudley, personal observations):

(i) the Upper Shire Valley forests are smaller (total area approximately 3 km^2) and lie within an extensive Mopane woodland (Wo, see volume 3) and relative uniform soil and topographic features; and
(ii) the Lower Shire Valley forests are more extensive (total area approximately 10 km^2) and occur in a wider range of woodland types and topographic characteristics.

In Zambia, Zambezian dry deciduous forest and scrub forest was originally mapped as *Baikiaea* forest together with Trapnell's K10 and L2 forests[14] (see also volume 6).

Fanshawe (1971 p. 21) describes *Baikiaea* forest as a two-storeyed forest with an open or closed and usually deciduous canopy of 9 to 18 (exceptionally 27) m high. The canopy is composed of ***Baikiaea plurijuga*** (dominant) and ***Pterocarpus lucens*** (subdominant in the best developed forests), with ***Entandrophragma caudatum*** as a local emergent. *Acacia erioloba* and *Combretum collinum* are widespread invasive species. The shrub layer (the 'mutemwa') is a well-defined deciduous thicket of 3 to 6 m high composed of shrubs and scramblers with a vague understorey of 0.6 - 1.3 m high.

Baikiaea plurijuga is the only species of the *Baikiaea* genus that is found south of the Congo-Kasai basin (for example, *Baikiaea insignis* is co-dominant in swamp forest [fs] on alluvial deposits of the Kagera river). Fanshawe (1971 p. 22) theorizes that *Cryptosepalum* forest (Fm) outcompeted *Baikiaea* forest in higher rainfall Kalahari Sands areas (where *Baikiaea* forest was first established), but that *Baikiaea* forests persisted in low rainfall Kalahari Sands areas since *Cryptosepalum exfoliatum* ssp. *pseudotaxus* was not able to adapt to low rainfall by becoming deciduous (as ***Baikiaea plurijuga*** did).

Baikiaea plurijuga must have a well-aerated and free draining soil. Where these conditions are not met, variants of Zambezian dry deciduous forest may occur that do not contain ***Baikiaea plurijuga*** but are otherwise almost identical in species composition:

(i) *Commiphora angolensis - Combretum - Pterocarpus lucens* forests (originally mapped by Trapnell as K10) that occur on transitional Kalahari sands where drainage is impeded;
(ii) *Commiphora angolensis - Kirkia acuminata* forests (originally mapped

13: locations of remnants known by our Malawian co-author (C. Dudley) include: 14° 37.14' S - 35° 22.67' E; 14° 38.26' S - 35° 22.83' E; 14° 46.32' S - 35° 21.15 E; 14° 47.12' S - 35° 21.67' E in Liwonde National Park (Upper Shire Valley); and 16° 13.65' S - 34° 44.88' E in Lengwe National Park (Lower Shire Valley) ; 15° 44.44' S - 35° 28.45' E in Sombani Forest Reserve; 16° 45 S - 35° 00' E in Mwabvi Wildlife Reserve

14: The coding of the Trapnell *et al.* (1950) soil – vegetation map is based on the soil type with a suffix for the vegetation type. In the legend of the Fanshawe vegetation map (Edmonds 1976), an indicating is given that "*Baikiaea* forest and deciduous thicket" corresponds to K6 (*Baikiaea plurijuga* forests on transitional Kalahari Sand), K10 (*Commiphora - Combretum - Pterocarpus* thicket or forest occurring on transitional Kalahari Sand) and L2 *(Commiphora - Combretum - Pterocarpus* thicket or forest occurring on Lower Valley soils).

by Trapnell as L2, these forests are very similar to K10 forests except for the presence of *Kirkia acuminata* in the valley) that occur on Karroo sands in the valleys of the lower Luano, Luangwa and Zambezi rivers (with very similar characteristics as transitional Kalahari sands);

(iii) a deciduous forest closely related to the K10 forests that occurs on the Nambala ironstone hills (characteristic emergent species include ***Adansonia digitata, Entandrophragma caudatum,*** *Kirkia acuminata* and *Millettia eetveldeana*); and

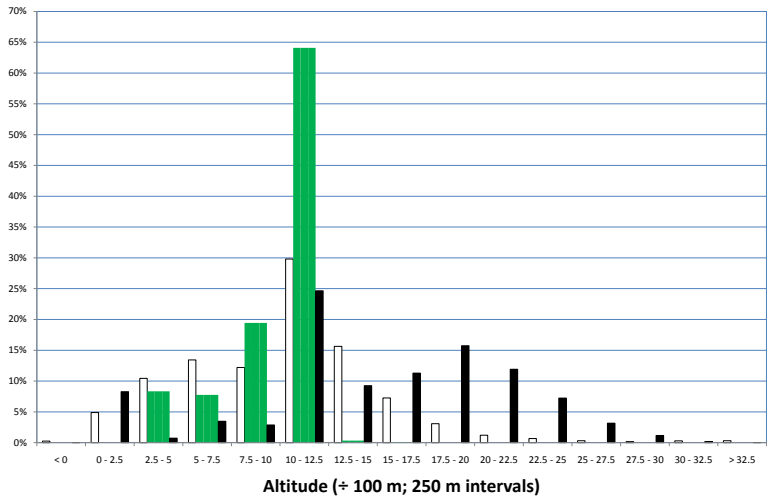
(iv) a deciduous forest with affinities to *Baikiaea* and *Commiphora* forests that occurs on dolomitic limestone around Lake Kashiba (where the common emergents are riparian species, mainly *Albizia glaberrima*, *Mimusops zeyheri* and *Xylopia katangensis*; Fanshawe 1971 pp. 22 - 23).

Xylia torreana (not a "useful tree species" and not listed in PROTA either) is a major constituent of the dry deciduous forests of the mid- and lower-Zambezi Valleys, and may well be regarded as the characteristic species of these forests (M. Bingham, pers. comm.).

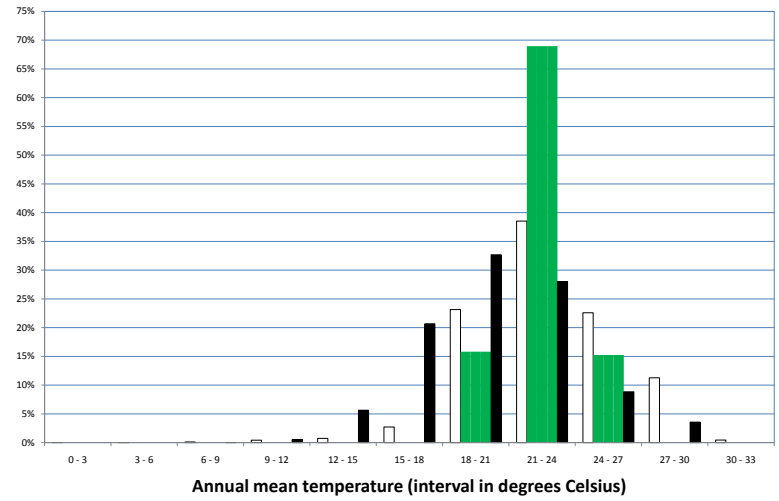
Partial destruction of *Baikiaea* forest (thinning of the overwood and gradual removal of the thicket by cultivation) leads to Kalahari woodland (Wk). Total or almost total destruction of *Baikiaea* forest results in a secondary type of *Baikiaea* forest where invasive species from Kalahari woodland (Wk) or Undifferentiated woodland (Wn) such as *Acacia erioloba*, *Combretum collinum* and *Terminalia sericea* superimpose on 'mutemwa' regrowth and where ***Baikiaea plurijuga*** or ***Pterocarpus lucens*** may not be present (depending whether crown fires occurred during the initial disturbance or not; Fanshawe 1971 p. 24).

Investigation of environmental distribution of Zambezian dry deciduous forest and scrub forest in the VECEA region (Figure 13.4) shows that most of this forest occurs between 250 and 1250 m (with almost all samples in this interval). The altitude interval where most of samples occur is the same for this vegetation type (1000 – 1250 m; 64.1% of samples) as for all forests combined (24.7%) and also for Zambezian dry evergreen forest (Fm, 89.7%). Much of this forest occurs at considerably lower altitudes than Zambezian dry evergreen forest (Fm). Rainfall in Zambezian dry deciduous forest and scrub forest is low with more than 95% of samples receiving 600 to 1000 mm annually. The only forest type that has the same low rainfall interval that contains the highest number of samples (600 – 800 mm; 64.9%) is Zanzibar-Inhambane scrub forest (Fq; 41.0%).

(a)



(b)



(c)

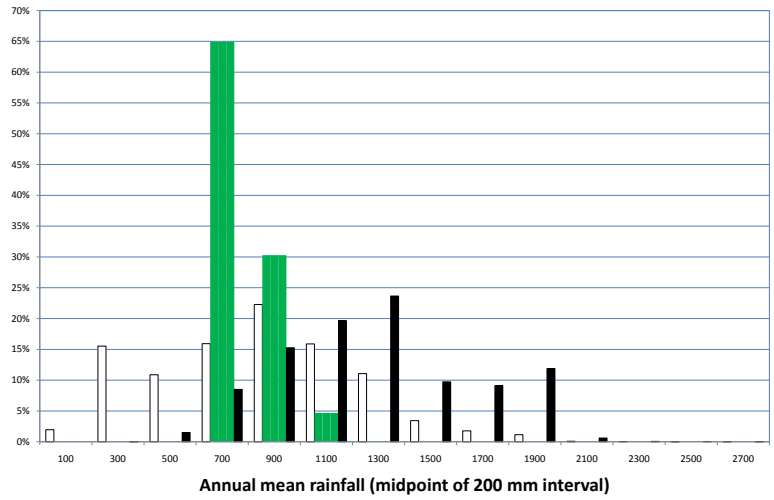


Figure 13.4 Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Zambezian dry deciduous forest and scrub forest (Fn, *n* = 2,074). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests *(n* =59,013).

13.3. Species composition

Species composition was obtained from the following references:

- Malawi: Dowset-Lemaire and Dowsett (2002), Dudley (1994), Hall-Martin (1972), Hall-Martin and Drummond (1980) and Palgrave (2002). Species were included in species assemblages partially based on the interpretation of our Malawian co-author (C. Dudley) since, given the range of environmental conditions that many of the species can tolerate, it becomes a value judgment whether to include the species as a common species of the forest type rather as just an accidental or very occasional species These species were coded "x" (unless they were characteristic species).A suffix of "l" indicates that the species is expected to only occur in the Lower Shire Valley. A suffix of "u" indicates that the species is expected to only occur in the Upper Shire Valley
- Zambia: Fanshawe (1971). Species listed for the species composition table for "dry deciduous forest - *Baikiaea* forest" provided on pages 26 to 27 were coded "x" (unless they were characteristic species). Species that were indicated to be restricted to Trapnell's K10 and L2 *Commiphora* thickets were coded "xc" (unless they were characteristic species). Species that were indicated to be secondary invasive species were coded "xs". Species listed in the main text for the "deciduous forest closely related to the K10 forests that occur on the Nambala ironstone hills" (Fanshawe [1971 p. 23]) were coded "y".

Characteristic species were determined as:

- Malawi: Species identified to be present as emergent trees (30 - 45 m) or large trees (20 - 30 m) were coded as "C". Liana species and species of marginal occurrence were not listed as characteristic species.
- Zambia: Species that were listed in the main text as canopy species for *Baikiaea* forest were coded "Db", whereas locally dominant or subdominant species were coded "Cb". Species that were listed in the main text as characteristic species for Trapnell's K10 and L2 Commiphora thickets were coded "Cc". [15]

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

15: retaining the "useful tree species" or those listed by Frank White resulted only in *Kirkia acuminata*, a species that does not occur in the K10 Commiphora thicket (Fanshawe 1971 p. 23).

Table 13. Species composition of Zambezian dry deciduous forest and scrub forest (Fn)

Species	Regional status	(Malawi)	(Zambia)
Acacia ataxacantha	indicator (shrub layer ['mutemwa'])	x	x
Acacia erioloba	invasive		Cb xs
Acacia fleckii	indicator (common in old fireholes)		x
Acacia nigrescens		f	xb
Acalypha chirindica	indicator (shrub layer ['mutemwa'])	f	x
Achyranthes aspera	indicator (shrubby herbs)	f	x
Adansonia digitata	indicator (associate in the Lower Shire Valley, not in *Baikiaea* forest)	C	xs
Afzelia quanzensis		x	f
Albizia glaberrima	(comment: in odd deciduous forest with affinities with *Baikiaea* or *Commiphora* forest)	f	y
Alchornea occidentalis	indicator (shrub layer ['mutemwa'])		x
Allophylus africanus		x	f
Baikiaea plurijuga	indicator (almost confined to Kalahari Sand)		Db
Baissea wulfhorstii	indicator (climber)		x
Balanites aegyptiaca			xc
Balanites maughamii	indicator (associate in the Lower Shire Valley, not in *Baikiaea* forest)	C	f
Baphia massaiensis	indicator (shrub layer ['mutemwa'])		x
Bauhinia petersiana	indicator (shrub layer ['mutemwa'])	f	x
Berchemia discolor		C	x
Blepharis maderaspatensis	indicator (shrubby herbs)		x
Boscia albitrunca	indicator (subdominant)		Cb
Brachystegia longifolia		f	xs
Canthium glaucum	indicator (shrub layer ['mutemwa'])	x	x
Capparis tomentosa		f	x
Cassia abbreviata		xu	f
Citropsis daweana	indicator (shrub layer ['mutemwa'])	x	f
Combretum celastroides	indicator (shrub layer ['mutemwa'])		x
Combretum collinum	invasive	f	Cb xs
Combretum elaeagnoides	indicator (shrub layer ['mutemwa'])		xs
Combretum imberbe		f	xb
Combretum mossambicense	indicator (climber)	x	x
Combretum schumannii		x	f
Combretum zeyheri		f	xb
Commiphora angolensis	indicator (locally subdominant)		Cb
Cordyla africana	indicator (associate in the Lower Shire Valley, not in *Baikiaea* forest)	C	f
Croton gratissimus	indicator (subdominant)	f	Cb xs
Croton pseudopulchellus	indicator (common in old fireholes)	xl	x
Croton scheffleri	indicator (smaller shrubs)	f	x
Dalbergia martinii	indicator (shrub layer ['mutemwa'])		x
Dichrostachys cinerea		x	x
Diospyros quiloensis	indicator (associate in the Lower Shire Valley, not in *Baikiaea* forest)	x	xc
Dombeya kirkii		x	f
Entandrophragma caudatum	indicator (local emergent)	C	Cb
Erythrococca menyhartii	indicator (smaller shrubs)		x

Species	Regional status	(Malawi)	(Zambia)
Euphorbia candelabrum	(comment: in odd deciduous forest with affinities with *Baikiaea* or *Commiphora* forest)	x	y
Excoecaria bussei	indicator (subdominant)	x	x
Friesodielsia obovata	indicator (shrub layer ['mutemwa'])	f	x
Garcinia livingstonei		x	f
Gardenia volkensii		xu	
Grewia avellana	indicator (smaller shrubs)		x
Grewia bicolor		f	x
Grewia flavescens	indicator (shrub layer ['mutemwa'])	x	x
Hypoestes forskaolii	indicator (shrubby herbs)		xs
Kirkia acuminata	(comment: not in *Commiphora* thicket K10)	xl	Cc xc
Lecaniodiscus fraxinifolius		x	f
Loeseneriella parvifolia	indicator (climber)	f	x
Lonchocarpus nelsii	indicator (subdominant)		Cb
Manilkara mochisia		x	f
Margaritaria discoidea		f	x
Markhamia obtusifolia	indicator (common in old fireholes)	x	x
Markhamia zanzibarica	indicator (shrub layer ['mutemwa'])	x	x
Newtonia hildebrandtii	indicator (codominant in the Lower Shire Valley)	C	f
Oncoba spinosa		x	f
Plumbago zeylanica	indicator (shrubby herbs)	f	x
Pterocarpus lucens	indicator (codominant in the Lower Shire Valley, subdominant in *Baikiaea* forest)	Cl	Cb
Pupalia lappacea	indicator (shrubby herbs)		x
Rhus tenuinervis		f	x
Rourea orientalis	indicator (shrub layer ['mutemwa'])	xu	x
Salvadora persica		x	f
Smilax anceps			xs
Sterculia quinqueloba	(comment: in odd deciduous forest with affinities with *Baikiaea* or *Commiphora* forest)	f	y
Strychnos innocua		f	Cb
Strychnos potatorum	indicator (subdominant)	x	Cb xs
Strychnos spinosa		x	f
Tarenna luteola	indicator (shrub layer ['mutemwa'])		x
Terminalia sericea		f	x
Tricalysia allenii	indicator (shrub layer ['mutemwa'])	x	x
Triumfetta annua	indicator (shrubby herbs)		x
Vitex ferruginea		xu	f
Vitex payos			x
Ximenia americana		xu	x
Xylia torreana		xu	f
Ziziphus pubescens		x	f

14. Zanzibar-Inhambane lowland rain forest (Fo)

14.1. Description

Zanzibar-Inhambane lowland rain forest has a main canopy that is almost evergreen and up to 20 m high. Emergents are 40 m or taller. This forest differs from Guineo-Congolian rain forests in greater degrees of bud protection, less developed drip-tips of leaves and low numbers of epiphytes (White 1983 p. 186).

Zanzibar-Inhambane lowland rain forests (Fo) differ from Zanzibar-Inhambane transitional rain forests (Fg) by occurring at lower altitudes (< 900 m) and having no admixture of Afromontane species (White 1983 p. 186) Zanzibar-Inhambane lowland rain forests were formerly extensively developed along the lower parts of the eastern highlands arc (especially the Nguru, Uluguru and Usambara Mts. of Tanzania), but only small fragments remain. Similar forests occur further inland as exclaves of the Zanzibar-Inhambane floristic region in other floristic regions such as on the Malawi Hills (within the Zambezian region) or near Tavetta (within the Somalia-Masai region; its presence is a result from the high water table in that location [16]; White 1983 p. 186).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane lowland rain forest and no other Zanzibar-Inhambane forest type) that were listed as characteristic species for one or several national maps (' indicators', see section 14.2) only include ***Burttdavya nyasica, Khaya anthotheca*** and ***Pouteria pseudoracemosa***. Most of the other characteristic species listed by White were also listed as characteristic species for other Zanzibar-Inhambane forest types (see section 14.2).

16: Dale (1939) mapped two patches of forests near Tavetta (and north of Lake Jipe) and classified these as "lowland evergreen edaphic forest". He describes them as forests that are unique in Kenya, but are similar in composition with the Lower Pare forests in Tanganyika and have also affinities with the S. Digo forests on the coast. These forests already were of small extent (not more than two square miles [~ 5 km²]) and occurred on volcanic ash in the vicinity of streams and rivers. Based on the description of the high water table, an alternative classification method could be as swamp forest (fs).

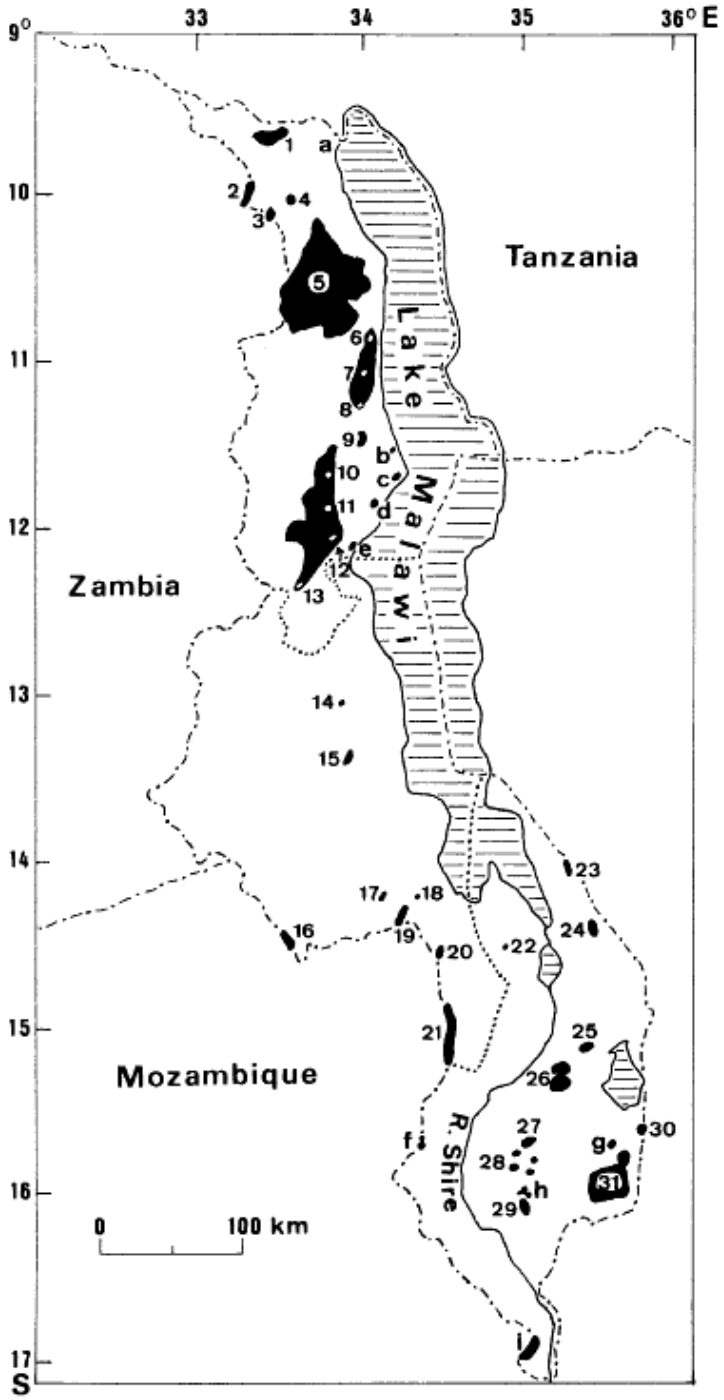


Figure 14.1 Distribution of Zanzibar-Inhambane lowland rain forest (Fo) in Malawi according to Dowsett-Lemaire 1990. a: Igembe Hill; b: Kalwe (Nkhata Bay), c: Nkuwadzi; d: Mzuma (Chintheche), e: Kuwilwe Hill; f: Thambani and Zobue Hills, g: Machemba Hill; h: Thyolo tea estates; i: Malawi Hills and 31: foot of Mt. Mulanje (locations with numbers 1 – 30 refer to areas of Afromontane forests and Zanzibar-Inhambane transitional rain forest in Malawi). Image obtained from URL: *http://www.jstor.org/stable/3668330*.

14.2. VECEA region

Within the VECEA region, Zanzibar-Inhambane lowland rainforest occurs in Kenya, Malawi and Tanzania (see Figure 14.4 and also Volume 6).

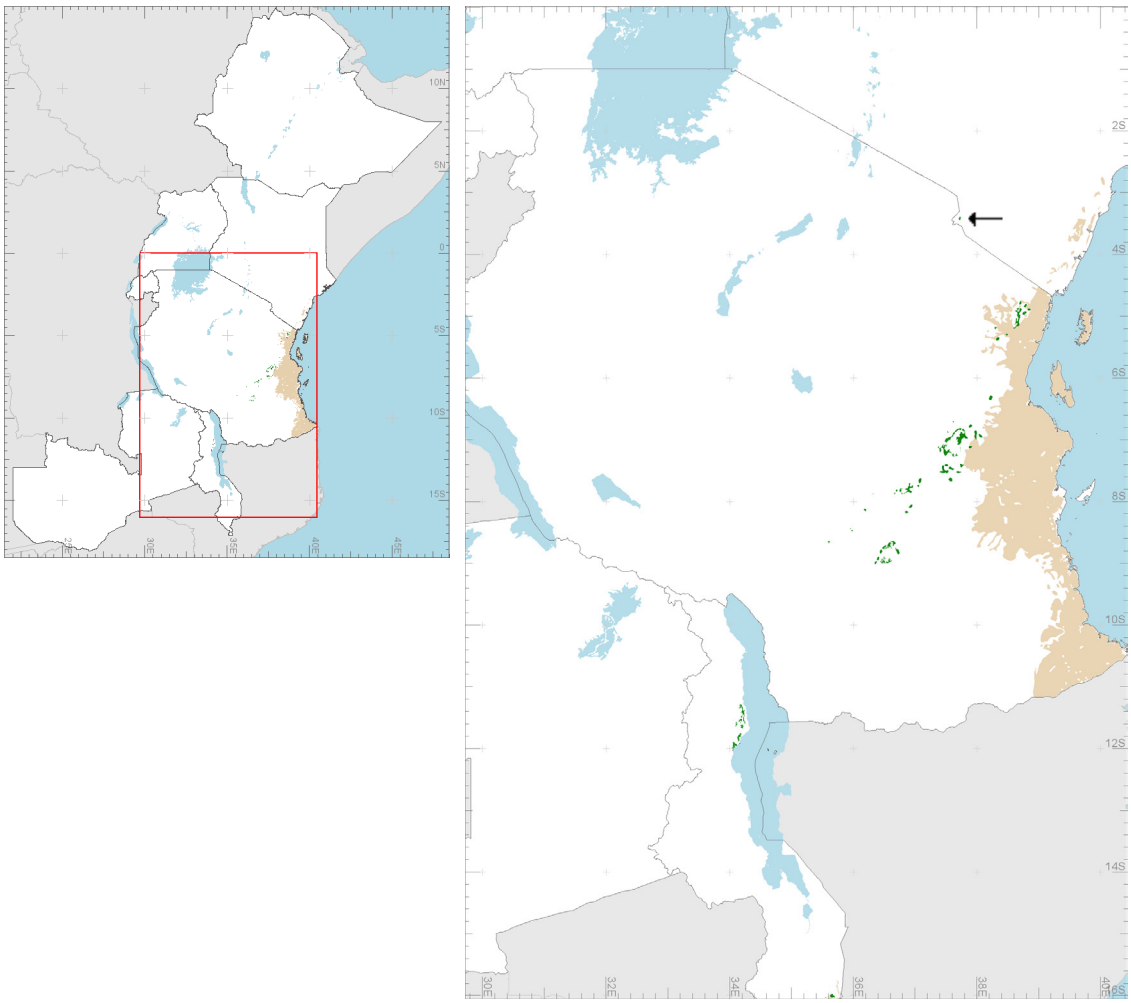


Figure 14.4 Mapped distribution of Zanzibar-Inhambane lowland rainforest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. This forest type is also mapped as part of different vegetation complexes (shown in greyish-brown). A variant of this forest type occurs near Tavetta in Kenya; an arrow indicates its location. Dowsett-Lemaire (1990; Fig FoA) provides a wider range of locations of this forest type in Malawi than depicted on the map (see Figure 14.1).

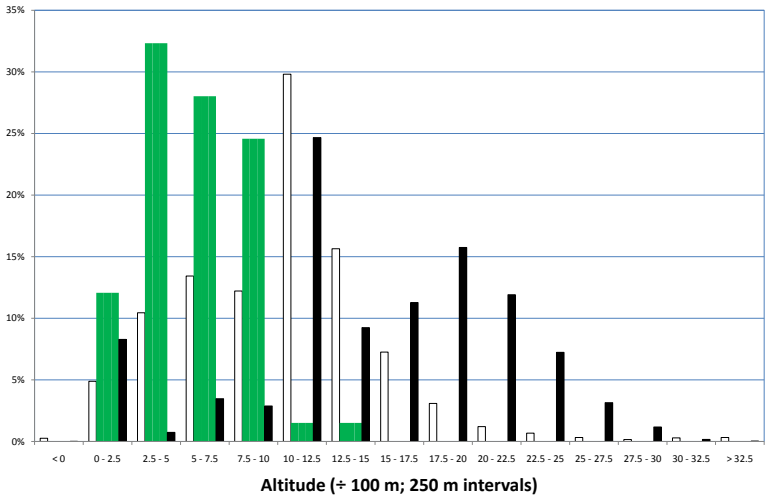
In Kenya, Zanzibar-Inhambane lowland rain forests occurred near Tavetta where its presence is a result from the high water table in that location (see previous section).

In Malawi, Zanzibar-Inhambane lowland rainforest was originally mapped as lowland rain forest. This forest type has long been under pressure from human activities and is the least preserved forest type in Malawi. Chapman and White's (1970) description of this forest type already showed serious declines in the extent of Lowland Rain Forest (they reported forest remnants to occupy about 20 km^2), whereas the extent of these forest is nowadays much smaller (C. Dudley, personal observations). Dowsett-Lemaire (1990) listed the following locations for lowland rain forest in Malawi: Nkuwadzi (600 m, 600 ha), Thyolo tea estates (1000 – 1100 m, 600 ha), Mzuma (Chintheche; 600 – 650 m, ~ 600 ha), Malawi Hills (600 – 940 m, ~ 400 ha), Kuwilwe Hill (500 – 1200 m, ~ 200 ha), the foothills of Mt. Mulanje (600 – 950 m, ~ 200 ha), Kalwe (Nkhata Bay; 500 m altitude, 80 ha), Thambani Hill (1100 – 1200 m, 78 ha), Machemba Hill (1150 – 1300 m, ~ 40 ha), Zobue Hill (900 – 1100 m, 20 ha), Mpita Estate (1100 m, 6 ha) and Igembe Hill. Only a subset of these locations were mapped in VECEA (see Figure 14.2 and Volume 6).

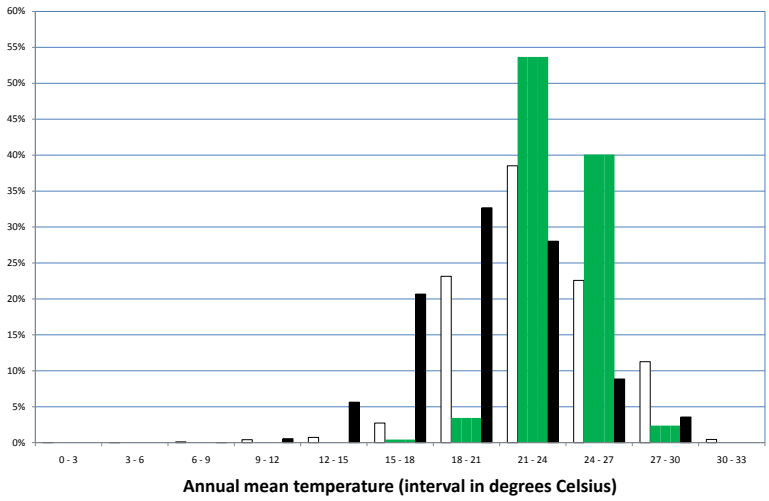
In Tanzania, Zanzibar-Inhambane lowland rain forests were originally described as "lowland forest". One of the synonyms listed by Lovett (1993a) for lowland forest is "Zanzibar-Inhambane lowland rain forest". Lovett (1998) clearly differentiated the Eastern Arc (including Zanzibar-Inhambane lowland rain forest) from coastal forests by having a separate column in the Appendix for lowland species that also occur in coastal forests (*i.e.* species that are no strict endemics of the Eastern Arc). In the VECEA map, we used the altitude limit of 900 m with the Gillman (1949) physiognomic map to infer the distribution of this forest type in Tanzania (see Volume 6).

Investigation of environmental distribution of Zanzibar-Inhambane lowland rain forest in the VECEA region (Figure 14.5; limits are for areas of the VECEA map where this forest is not mapped as mosaic) shows that the distribution in altitude (with > 95% of the samples in an interval from 0 – 1000 m) corresponded to the 900 m upper limit reported by White (1983; also see section 3.1). Note, however, that relatively few samples were obtained for this forest type. Moreover, finding this pattern is not surprising at all given that we used altitude limits to delineate this forest type in Tanzania. Annual rainfall of Zanzibar-Inhambane lowland rain forest is mainly between 800 and 1800 mm (94.4% of samples), representing average rainfall conditions for forests.

(a)



(b)



(c)

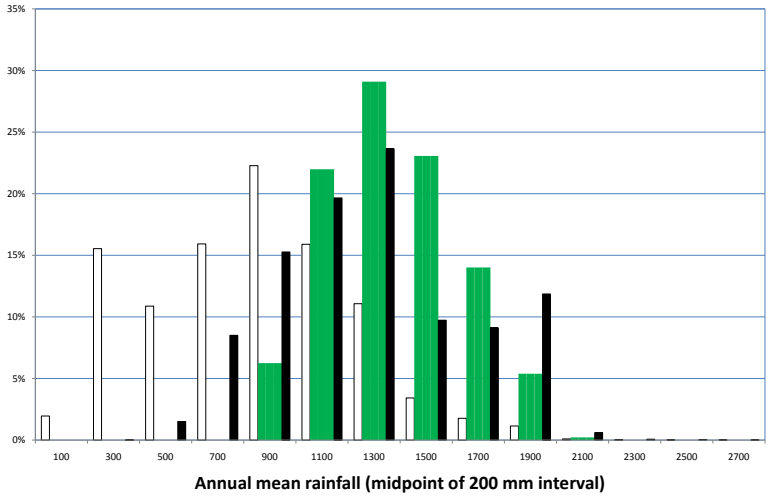


Figure 14.5. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Zanzibar-Inhambane lowland rain forest (Fo, *n* = 464). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,002).

14.3. Species composition

Species assemblages were obtained from the following references:

- Malawi: Chapman (1988) and Chapman and White (1970). These species were coded "x" (unless they were characteristic species).
- Tanzania: Lovett (1993a, 1998). Species that were mentioned for "lowland forest" in Lovett (1993a; altitude < 800 m; rainfall > 1500 mm) were coded "C" (since these species were interpreted as characteristic species).

Characteristic species were determined as:

- Malawi: Species identified to be present as emergent trees (30 - 45 m) or large trees (20 - 30 m, including stranglers) were coded as "C". Liana species were not listed as characteristic species.
- Tanzania: Species listed by Lovett (1993a) were coded "C".

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

All species listed by White (1983) for Zanzibar-Inhambane lowland rain forest were listed, even if their presence was not listed in the references that we consulted to obtain information on species assemblages (these species only had entries of "f").

Table 14. Species composition of Zanzibar-Inhambane lowland rain forest (Fo)

Species	Regional status (see section 2.3)	(Malawi)	(Tanzania)
Albizia adianthifolia	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	C	f
Anthocleista grandiflora		C	C
Antiaris toxicaria	characteristic		f
Blighia unijugata		x	f
Bombax rhodognaphalon		C	C
Brachystegia spiciformis		C	f
Burttdavya nyasica	indicator	C	f
Calodendrum capense		x	f
Celtis africana		x	f
Celtis gomphophylla		C	f
Cordyla africana	characteristic	x	f
Croton sylvaticus		C	f
Diospyros abyssinica	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest [rare])	C	f
Diospyros mespiliformis	characteristic	C	f
Dovyalis macrocalyx		x	f
Ekebergia capensis		x	f
Englerophytum natalense		x	C
Erythrophleum suaveolens	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	C	C
Ficus exasperata		x	f
Ficus sur		C	f
Ficus thonningii		C	
Ficus vallis-choudae	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	C	f
Filicium decipiens		x	C
Funtumia africana	not characteristic (indicator for Zanzibar-Inhambane transitional rain forest [Guineo-Congolian linking species])	C	C
Garcinia buchananii		x	C
Harrisonia abyssinica		x	f
Khaya anthotheca	indicator	C	C
Landolphia buchananii		x	
Landolphia kirkii		x	f
Lecaniodiscus fraxinifolius		x	f
Lovoa swynnertonii	characteristic		f
Macaranga capensis	not characteristic (characteristic for Zanzibar-Inhambane transitional rain forest and undifferentiated forest)	x	f
Maranthes goetzeniana	characteristic		f
Margaritaria discoidea		x	f
Milicia excelsa	characteristic	C	C
Newtonia buchananii	characteristic	C	f
Olyra latifolia			C
Oreobambos buchwaldii	(bamboo species indigenous to Africa)	x	
Parinari excelsa		f	C
Parkia filicoidea	characteristic	C	C

Species	Regional status (see section 2.3)	(Malawi)	(Tanzania)
Phoenix reclinata	(palm species)	x	f
Pouteria pseudoracemosa	indicator (very local)		Ce
Pterocarpus tinctorius		C	f
Rauvolfia caffra	not characteristic (indicator for Zanzibar-Inhambane transitional rain forest [Guineo-Congolian linking species])	C	f
Ricinodendron heudelotii	characteristic		C
Saba comorensis		x	
Shirakiopsis elliptica		x	C
Sorindeia madagascariensis		C	C
Sterculia appendiculata	characteristic	f	f
Synsepalum brevipes	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	x	f
Syzygium guineense		x	f
Tabernaemontana pachysiphon		x	C
Terminalia sambesiaca	characteristic	C	C
Treculia africana	not characteristic (indicator for Zanzibar-Inhambane transitional rain forest [Guineo-Congolian linking species])	f	C
Trichilia dregeana		C	f
Trilepisium madagascariense	not characteristic (indicator for Zanzibar-Inhambane transitional rain forest [Guineo-Congolian linking species])	C	C
Zanha golungensis		C	C

15. Zanzibar-Inhambane undifferentiated forest (Fp)

15.1. Description

White (1983) reserved the term of "undifferentiated forests" to forests that undergo rapid and kaleidoscopic changes in structure and species composition over short distances (White 1983 p. 47).

A distinction can be made between moister and drier variants of Zanzibar-Inhambane undifferentiated forest:

- The moister variants have a main canopy at 15 to 20 m with emergents of 30 to 35 m. Many of the canopy species are briefly deciduous, although not concurrently, but appreciably more deciduous than semi-evergreen lowland rain forests (*e.g.,* Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest [Fi]). The floristically richest types of moister variants of Zanzibar-Inhambane undifferentiated forests occur in Kenya and northern Tanzania (White 1983 p. 187).
- The drier forest variants are floristically more diverse than the moister variants. Most of the larger tree species are locally dominant or co-document and sometimes gregarious. The drier forests cover a larger area than the moister forests and also extend further to the north and south (White 1983 p. 187).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane undifferentiated forest and no other Zanzibar-Inhambane forest type) that were listed as characteristic species for one or several national maps can be further classified as characteristic species only listed for moister forest variants, only listed for drier forest variants or listed for both moister and drier variants:

- Characteristic species for moister forest variants: ***Albizia adianthifolia, Apodytes dimidiata*** (also characteristic of Afromontane undifferentiated forest [Fbu], Afromontane dry transitional forest [Fh] and Lake Victoria transitional rain forest [Ff]), ***Bombax rhodognaphalon, Celtis philippensis, Cola clavata, Diospyros abyssinica*** (also a characteristic species of Afromontane rain forest [Fa] and Afromontane dry transitional forest [Fh]), ***Erythrina sacleuxii, Erythrophleum suaveolens, Fernandoa magnifica, Ficus vallis-choudae, Inhambanella henriquesii, Lannea welwitschii, Malacantha alnifolia, Mimusops aedificatoria, Nesogordonia holtzii, Paramacrolobium coeruleum, Synsepalum brevipes*** and ***Xylopia parviflora***.
- Characteristic species for drier forest variants: ***Acacia robusta, Albizia petersiana, Brachylaena huillensis, Cassipourea euryoides, Cussonia zimmermannii, Cynometra webberi, Manilkara sulcata, Oldfieldia somalensis, Pleurostylia africana, Scorodophloeus fischeri, Tamarindus indica*** and ***Warneckea sansibarica.***

- Characteristic species both for moister and drier forest variants: ***Afzelia quanzensis, Balanites wilsoniana, Combretum schumannii, Hymenaea verrucosa, Julbernardia magnistipulata, Manilkara sansibarensis and Newtonia paucijuga***.

More information on coastal forests can be obtained from URL http://coastalforests.tfcg.org/ (last accessed June 2011).

15.2. VECEA region

Within the VECEA region, Zanzibar-Inhambane undifferentiated forest only occurs in the coastal areas of Kenya and Tanzania (Figure 15.1, see also Volume 6).

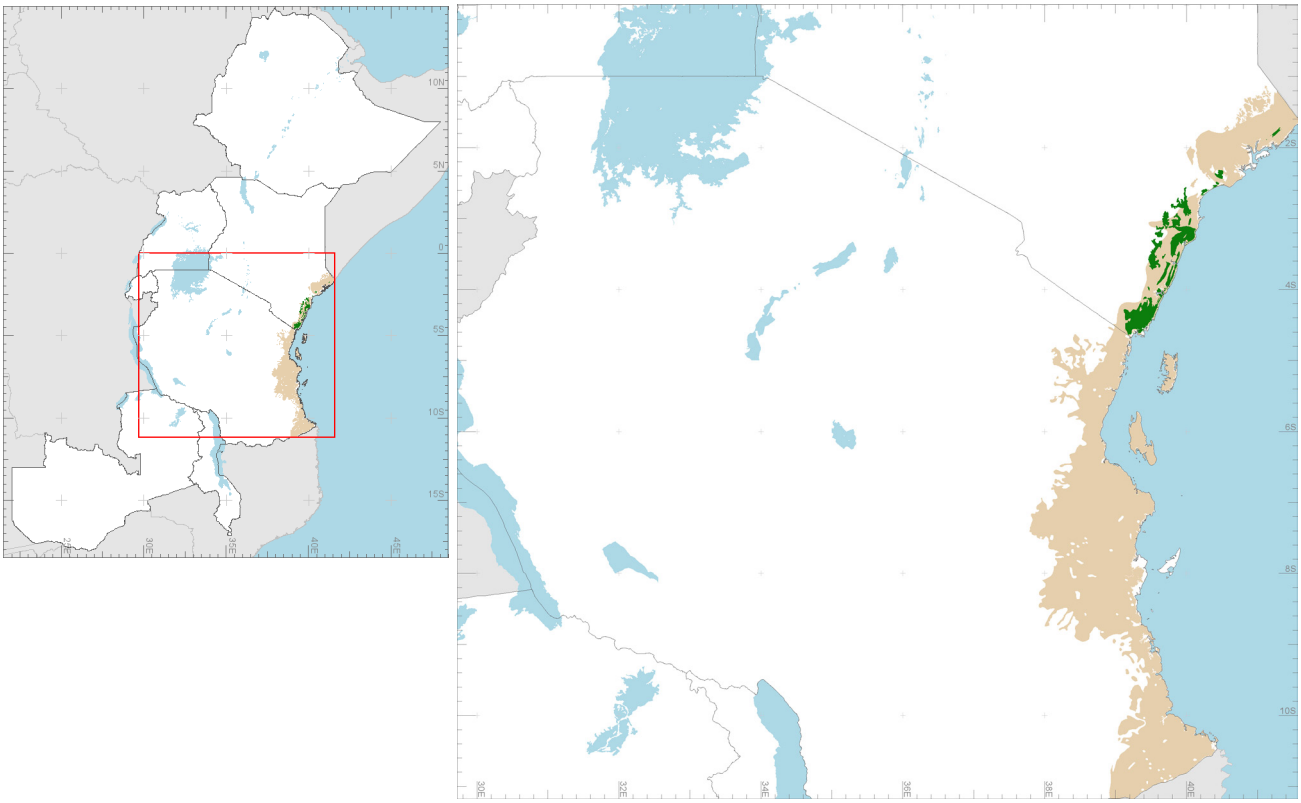


Figure 15.1. Mapped distribution of Zanzibar-Inhambane undifferentiated forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. This vegetation type is mainly mapped as part of vegetation mosaics

In the main reference that we consulted (Clarke and Robertson 2000), Zanzibar-Inhambane undifferentiated forest was originally classified as the subtypes of legume-dominated dry forest, mixed dry forest and Eastern African coastal - Afromontane transitional forest. [17]

Dry forest (sensu White 1983 p. 46; *i.e.* forests that experience low atmospheric humidity for several months) is the predominant vegetation type of the eastern African coastal forests and much of the area was probably covered by this forest type before human intervention. Two types of dry coastal forests can be distinguished: (i) legume-dominated dry forest; and (ii) mixed dry forest (Clarke and Robertson 2000):

- **Legume-dominated dry forest**. Many areas of coastal forest are dominated by trees of the *Fabaceae* (synonym: *Leguminosae*) family, with one or two *Fabaceae* species accounting for 50 to 95% percent of all individual trees (stems with diameter at breast height > 10 cm). From the species that were mentioned by White (1983, see above), ***Cynometra webberi, Erythrophleum suaveolens, Hymenaea verrucosa, Julbernardia magnistipulata, Paramacrolobium coeruleum, Scorodophloeus fischeri*** belong to *Caesalpinioideae* genera that are particularly well represented in legume-dominated dry forest. Legume-dominated dry forests appear not to be limited by edaphic conditions, apart from requiring free-draining sites, and have been found on infertile white coastal sands, clay soils and limestone karsts. The Arabuko-Sokoko forest (Kenya) contains areas that are dominated by ***Cynometra webberi***, sometimes together with ***Afzelia quanzensis*** and ***Hymenaea verrucosa*** (Clarke and Robertson 2000).
- **Mixed dry forest.** Classifying mixed dry forest communities that are not dominated by legumes is difficult. The experience of Clarke and Robertson (based on over a decade of field work within coastal forests) is that the more forests are visited, the harder it becomes to distinguish any recurring floristic patterns. 152 different tree species are documented to be dominant in at least one forest area. Among the most frequently encountered dominant tree species, those that were also listed by White (1983) (1983, see above) include ***Afzelia quanzensis, Albizia adianthifolia, Bombax rhodognaphalon, Brachylaena huillensis, Cassipourea euryoides, Combretum schumannii, Cussonia zimmermannii, Erythrophleum suaveolens, Hymenaea verrucosa, Julbernardia magnistipulata, Manilkara sansibarensis, Manilkara sulcata, Nesogordonia holtzii*** and ***Scorodophloeus fischeri***. Clarke and Robertson (2000) further mention that many of these species are geographically widespread, or distinctive or economically important timber species, which may have partially biased their status in available literature on being common species in mixed dry forests. Apart from ***Combretum schumannii***, species from the *Combretum* and *Grewia* genus are virtually absent - these are typical species for Zanzibar-Inhambane scrub forest (Fq). It is possible that mixed dry forests are a regeneration climax from legume-dominated dry forest since the wind or animal dispersed seeds of many species typical of mixed dry forest

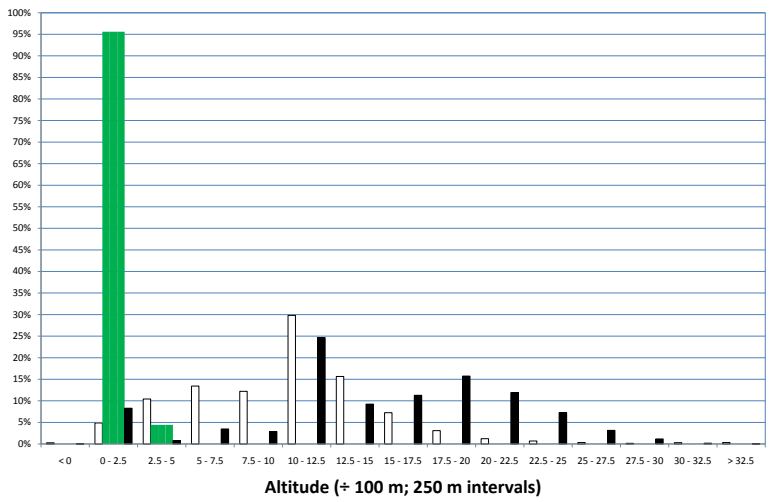
17: Lovett (1993a) describes "dry lowland forest" (altitude < 800 m; annual rainfall 1000 - 2000 mm) for which he gives the synonym of "Zanzibar-Inhambane undifferentiated forest". However, Lovett (1993a) described the forests from the Eastern Arc mountains, where this forest only occurs on fringes according to this author. Lovett (1993a) only lists two species: the woodland species *Pteleopsis myrtifolia* and the riverine species *Sterculia appendiculata*. Moreover, Lovett (1990) gives the altitudinal limits of Zanzibar-Inhambane undifferentiated forest as 300 - 800 m, thereby suggesting that information from forests (formally) occurring closer to the coast is not provided.

disperse much faster than seeds of legumes (especially from the *Caesalpinoideae* family) (Clarke and Robertson 2000).

Clarke and Robertson (2000) described "Eastern African coastal - Afromontane transitional forest". These authors did not distinguish between forest types that occur in areas on the coast that are on higher locations (and often where drainage is also impeded) such as the Shimba Hills of Kenya, and forests that occur in the foothills of the Eastern Arc Mountains such as the East Usambara, Udzungwa and Uluguru mountains. Since we followed White's (1983) differentiation between Zanzibar-Inhambane lowland rain forest (Fo), Zanzibar-Inhambane transitional rain forest (Fg) and Zanzibar-Inhambane undifferentiated forest (Fp, with moister and drier variants) and since we expected that Clarke and Robertson (2000) did not distinguish between these three types of forests, we suggest to crosscheck information on species assemblages with the information provided by White (1983) for the moist variant of Zanzibar-Inhambane undifferentiated forest.

Investigation of environmental distribution of Zanzibar-Inhambane undifferentiated forest in the VECEA region (Figure 15.2; limits are for areas of the VECEA map where this forest is not mapped as mosaic) shows that most of this forest type occurs below 250 m, causing this forest type together with Zanzibar-Inhambane scrub forest (Fq) to be among the two forest types that occur at the lowest altitudes in the VECEA region. Annual rainfall of Zanzibar-Inhambane undifferentiated forest below average as samples receive between 600 and 1400 mm.

(a)



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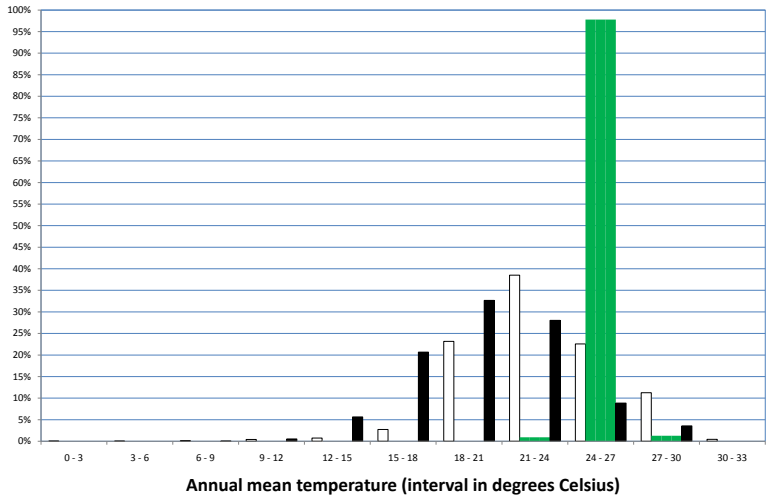


(c)

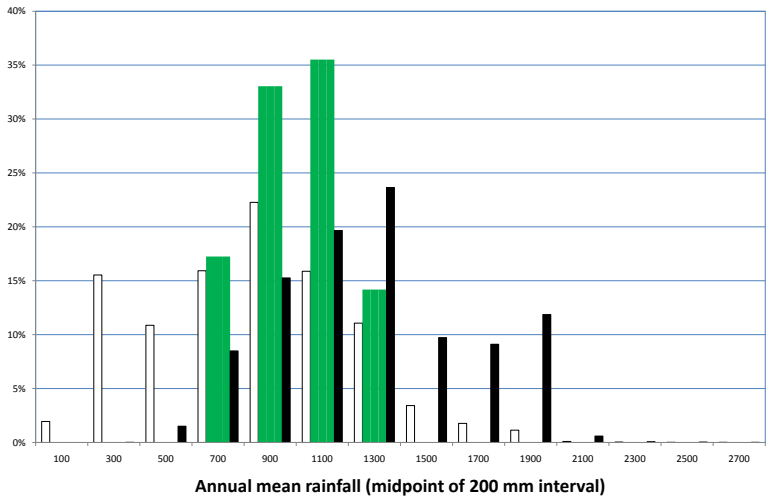


Figure 15.2 Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Zanzibar-Inhambane undifferentiated forest (Fp, *n* = 1,177). Bars on the left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within forests (*n* =59,013).

15.3. Species composition

Species assemblages were obtained from the following references:

- Burgess and Clarke (2000 Appendix 2 Table 1). In column "FplC", species listed for "legume-dominated eastern African coastal dry forest" were coded "x" (unless they were characteristic species). Species only listed from sources from Mozambique were excluded.
- Burgess and Clarke (2000 Appendix 2 Table 2). In column "FpdC", species listed for "mixed eastern African coastal dry forest" were coded "x" (unless they were characteristic species). Species only listed from sources from Mozambique, Pemba or Zanzibar were excluded. Suffixes indicate the heights of trees that were listed by White (1983 p. 188) for drier variants of Zanbibar-Inhambane undifferentiated forest.
- Burgess and Clarke (2000 Appendix 2 Table 5). In column "FpmC", species listed for "mixed eastern African coastal - Afromontane transitional forest" were coded "x" (unless they were characteristic species). Species only listed from sources from Malawi, Mozambique or the Selous Game Reserve were excluded. FpmC Excluded Mozambique and Malawi and T5. Suffixes indicate the heights of trees that were listed by White (1983 p. 187 - 188) for moister variants of Zanbibar-Inhambane undifferentiated forest.
- White (1983 p. 189). In column "WsC", species listed for Zanzibar-Inhambane secondary grassland and wooded grassland were coded "x". [18]

Characteristic species were determined as:

- Burgess and Clarke (2000). Species listed to be dominant were coded "C".

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

18: We made an exception in listing secondary vegetation in a separate column as many non-forest species were listed.

Table 15. Zanzibar-Inhambane undifferentiated forest (Fp)

Species	Regional status (see section 2.3)	FplC (coast subtype)	FpdC (coast subtype)	FpmC (coast subtype)	WsC (secondary)
Acacia polyacantha			C		
Acacia robusta	indicator (drier variants)	f	x20		
Acacia senegal	secondary grassland and wooded grassland				x
Adansonia digitata	probably introduced by humans and does not regenerate under a closed forest canopy		C		x
Afzelia quanzensis	indicator (moister and drier variants)	C	C15	f20	
Albizia adianthifolia	indicator (moister variants)	C	C	f25	
Albizia glaberrima		x	C	x	
Albizia gummifera		x	C	x	
Albizia petersiana	indicator (drier variants)	C	C15		
Albizia versicolor			C		
Annona senegalensis	secondary grassland and wooded grassland				x
Anthocleista grandiflora			C	C	
Antiaris toxicaria	characteristic (moister variants)		C	C35	
Antidesma venosum	secondary grassland and wooded grassland				
Aphania senegalensis			x		
Apodytes dimidiata	indicator (moister variants)			f	
Balanites wilsoniana	indicator (moister and drier variants)		C	f30	
Bersama abyssinica			C	x	
Blighia unijugata			x	C	
Bombax rhodognaphalon	indicator (moister variants)		C	C30	
Borassus aethiopum	secondary grassland and wooded grassland				x
Brachylaena huillensis	indicator (drier variants)	x	C15		
Brachystegia spiciformis			C		
Burttdavya nyasica	not characteristic (indicator for Zanzibar-Inhambane lowland rain forest)			x	
Caesalpinia volkensii				x	
Cassia abbreviata			x		
Cassipourea euryoides	indicator (drier variants)	x	C15		
Celtis africana			x		

Species	Regional status (see section 2.3)	FplC (coast subtype)	FpdC (coast subtype)	FpmC (coast subtype)	WsC (secondary)
Celtis gomphophylla			C	f	
Celtis mildbraedii			x	x	
Celtis philippensis	indicator (moister variants)		x	C20	
Cola clavata	indicator (moister variants)		C	f20	
Combretum schumannii	indicator (moister and drier variants)		C15	x25	
Commiphora eminii			x		
Cordyla africana	characteristic (moister variants)		C	C25	
Crossopteryx febrifuga	secondary grassland and wooded grassland				
Croton sylvaticus			C	x	
Cussonia zimmermannii	indicator (drier variants)	f	C15	C	
Cynometra webberi	indicator (drier variants)	C	x12		
Dalbergia melanoxylon	secondary grassland and wooded grassland				x
Dialium orientale			C		
Dichrostachys cinerea	secondary grassland and wooded grassland				x
Diospyros abyssinica	indicator (moister variants, but very rare)		x	C	
Diospyros mespiliformis	characteristic (moister variants)		C	x30	
Ekebergia capensis		x	C	C	
Elaeis guineensis	(palm species)		x	C	
Encephalartos hildebrandtii	cycad species that is locally plentiful in drier variants		f		
Englerophytum natalense				C	
Erythrina sacleuxii	indicator (moister variants)	C	x	x20	
Erythrophleum suaveolens	indicator (moister variants)	C	C	C25	
Euphorbia candelabrum	not characteristic (indicator for Zanzibar-Inhambane scrub forest)		x		
Fagaropsis angolensis			C		
Fernandoa magnifica	indicator (moister variants)		C	C20	
Ficus sur			C		
Ficus sycomorus			x		
Ficus vallis-choudae	indicator (moister variants)			f20	
Flacourtia indica	secondary grassland and wooded grassland		C		x

Species	Regional status (see section 2.3)	FplC (coast subtype)	FpdC (coast subtype)	FpmC (coast subtype)	WsC (secondary)
Flueggea virosa			x		
Funtumia africana	not characteristic (indicator for Zanzibar-Inhambane transitional rain forest [Guineo-Congolian linking species])		C	C	
Garcinia buchananii		x	C		
Garcinia livingstonei			C	x	
Harrisonia abyssinica	secondary grassland and wooded grassland				x
Harungana madagascariensis			x		
Hymenaea verrucosa	indicator (moister and drier variants)	C	C18	x30	
Hyphaene compressa	secondary grassland and wooded grassland (palm species)				x
Inhambanella henriquesii	indicator (moister variants)		C	f25	
Julbernardia magnistipulata	indicator (moister and drier variants)	C	C15	x30	
Khaya anthotheca	not characteristic (indicator for Zanzibar-Inhambane lowland rain forest)	x	C	C	
Kigelia africana			x		
Lannea schweinfurthii	secondary grassland and wooded grassland		C		x
Lannea welwitschii	indicator (moister variants)		x	f25	
Lecaniodiscus fraxinifolius			C	x	
Lovoa swynnertonii	characteristic (moister variants)		x	x35	
Macaranga capensis	characteristic (moister variants)		x	f25	
Malacantha alnifolia	indicator (moister variants)			f20	
Manilkara sansibarensis	indicator (moister and drier variants)	x	C18	f25	
Manilkara sulcata	indicator (drier variants)	x	C10		
Margaritaria discoidea			x		
Markhamia obtusifolia		x	x		
Markhamia zanzibarica			C		
Maytenus senegalensis			x		
Maytenus senegalensis	secondary grassland and wooded grassland				x
Maytenus undata			x		
Milicia excelsa	characteristic (moister variants and drier variants)		C	C35	x
Mimusops aedificatoria	indicator (moister variants)			x25	

Species	Regional status (see section 2.3)	FplC (coast subtype)	FpdC (coast subtype)	FpmC (coast subtype)	WsC (secondary)
Mimusops bagshawei			x		
Mimusops obtusifolia			C		
Mkilua fragrans				f	
Monodora grandidieri			C		
Nesogordonia holtzii	indicator (moister variants)	x	C	x20	
Newtonia buchananii	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane transitional rain forest)	C	C	C	
Newtonia paucijuga	indicator (moister and drier variants)	f	C15	C25	
Oldfieldia somalensis	indicator (drier variants)	x	x12		
Paramacrolobium coeruleum	indicator (moister variants)	C	x	x25	
Parinari curatellifolia			MZ1		
Parinari excelsa			C		
Parkia filicoidea	characteristic (moister variants)		x	C30	
Piliostigma thonningii	secondary grassland and wooded grassland				x
Pleurostylia africana	indicator (drier variants)		x15		
Psydrax schimperiana			x		
Pterocarpus angolensis					
Pterocarpus tinctorius			C		
Ricinodendron heudelotii	characteristic (moister variants)	x	C	C35	
Rinorea angustifolia		x			
Sclerocarya birrea	secondary grassland and wooded grassland				x
Scorodophloeus fischeri	indicator (drier variants)	C	C15	C	
Securidaca longipedunculata	secondary grassland and wooded grassland				x
Sideroxylon inerme	negative indicator (Zanzibar-Inhambane scrub forest)		C		
Sorindeia madagascariensis		x	C	C	
Sterculia africana			x		
Sterculia appendiculata	characteristic (moister and drier variants)		C	C35	x
Stereospermum kunthianum	secondary grassland and wooded grassland				x
Strychnos henningsii		x	C		

Species	Regional status (see section 2.3)	FplC (coast subtype)	FpdC (coast subtype)	FpmC (coast subtype)	WsC (secondary)
Strychnos mitis	not characteristic (indicator for Zanzibar-Inhambane transitional rain forest)		x	x	
Strychnos spinosa	secondary grassland and wooded grassland				x
Synsepalum brevipes	indicator (moister variants)	x	C	C25	
Syzygium cordatum			C		
Syzygium guineense			C		
Tabernaemontana pachysiphon			C	C	
Tamarindus indica	indicator (drier variants)		C12		
Terminalia sambesiaca	characteristic (moister variants)		C	x35	
Trema orientalis			C		
Trichilia emetica			C	C	
Trilepisium madagascariense	characteristic (moister and drier variants)		C15	x20	
Uapaca sansibarica					
Uvaria acuminata			f		
Vitex doniana			x	C	
Vitex ferruginea			x		
Vitex mombassae	secondary grassland and wooded grassland				x
Warneckea sansibarica	indicator (drier variants)	f	f9		
Xylopia parviflora	indicator (moister variants)		C	C25	
Zanha golungensis			x	C	
Zanthoxylum chalybeum			C		
Ziziphus pubescens			C		

16. Zanzibar-Inhambane scrub forest (Fq)

16.1. Description

Zanzibar-Inhambane scrub forest forms a quasi-continuous belt that separates the forests of the coastal region (*i.e.* Zanzibar-Inhambane undifferentiated forest [Fp]) from the bushlands of the interior (*i.e.* especially deciduous bushland [Bd]). This forest reaches the Kenyan coast between Malindi and Lamu, where the rainfall is lower than elsewhere, and extends to southern Tanzania. ***Diospyros cornii*** forms a discontinuous upper canopy of 9 to 15 m high. ***Manilkara mochisia*** is an almost constant associate, but is less plentiful. In many places, scrub forest has been degraded and converted into secondary deciduous bushland (White 1983 p. 188). ***Diospyros cornii*** and ***Manilkara mochisia*** are also emergent trees on termite mounds within Zanzibar-Inhambane edaphic grassland (White 1983 p. 189).

The annual rainfall is between 500 and 750 mm (White 1983 p. 188). Besides the dominant ***Diospyros cornii*** and ***Manilkara mochisia***, regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane scrub forest and no other Zanzibar-Inhambane forest types) that were listed as characteristic species for the national maps include ***Adenia globosa, Bivinia jalbertii, Catunaregam nilotica, Croton pseudopulchellus, Diospyros consolatae, Dobera glabra*** (abundant especially where the water-table is near the surface), ***Euclea natalensis, Euclea racemosa, Euphorbia candelabrum*** (rare), ***Euphorbia grandicornis, Grandidiera boivinii, Haplocoelum foliolosum, Haplocoelum inoploeum, Newtonia erlangeri*** (only in northern scrub forests), ***Ochna thomasiana, Sideroxylon inerme, Spirostachys venenifera, Suregada zanzibariensis, Thespesia danis*** and ***Thylachium africanum***.

16.2. VECEA region

Within the VECEA region, Zanzibar-Inhambane scrub forest is only mapped for the coastal areas of Kenya and Tanzania.

Clarke and Robertson (2000) mention that single tree dominance is rarely encountered in Zanzibar-Inhambane scrub forest (they used the synomym of "mixed Eastern African coastal scrub forest") and therefore classified these forests as "mixed scrub forests". The most frequently encountered dominant species that they list are often species that they also listed for mixed dry forest (Fp): ***Afzelia quanzensis, Bombax rhodognaphalon, Brachylaena huillensis, Combretum schumannii, Manilkara sulcata*** and *Pteleopsis myrtifolia*. They seem to suggest that the main floristic difference between "mixed dry forest" and "mixed scrub forest" is the absence of *Grewia* species (such as *Grewia conocarpa*) and *Combretum* species (except ***Combretum schumannii***) in mixed dry forest.

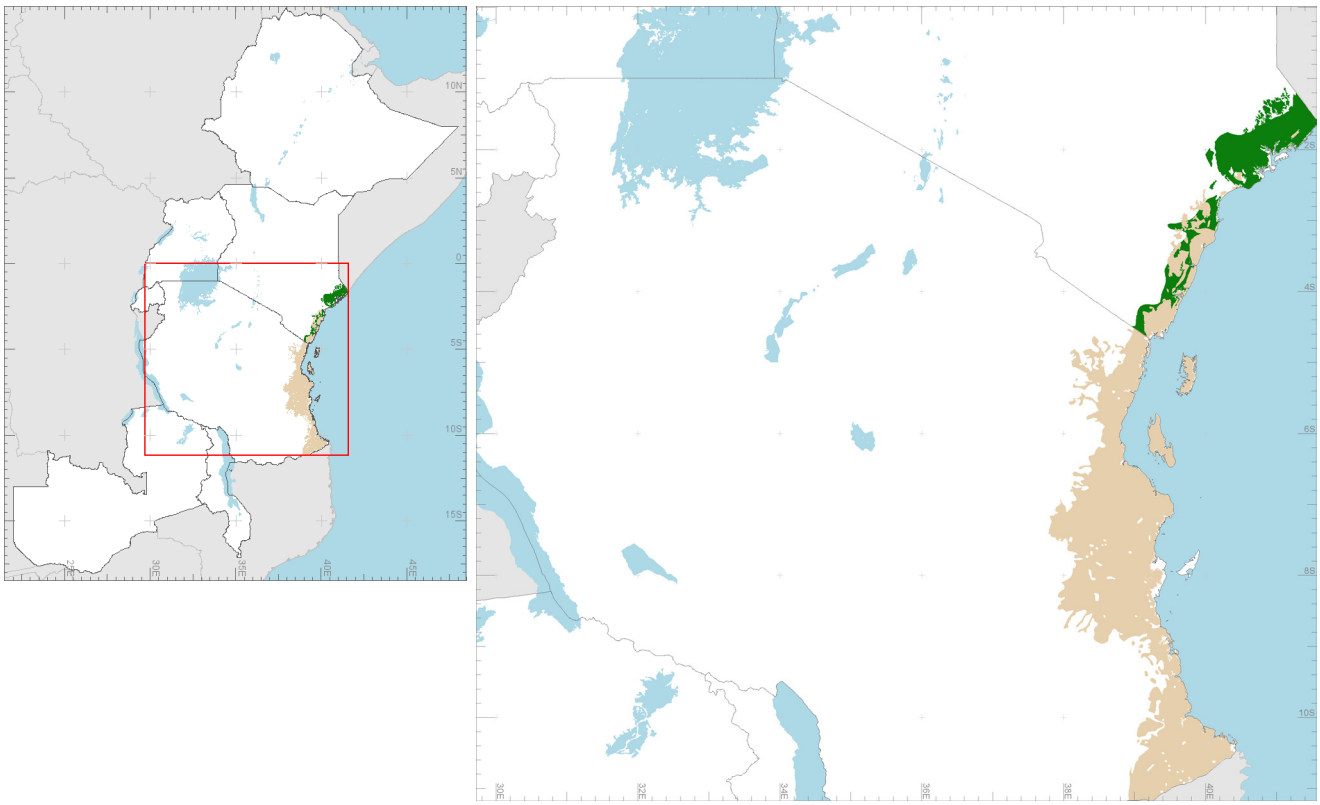
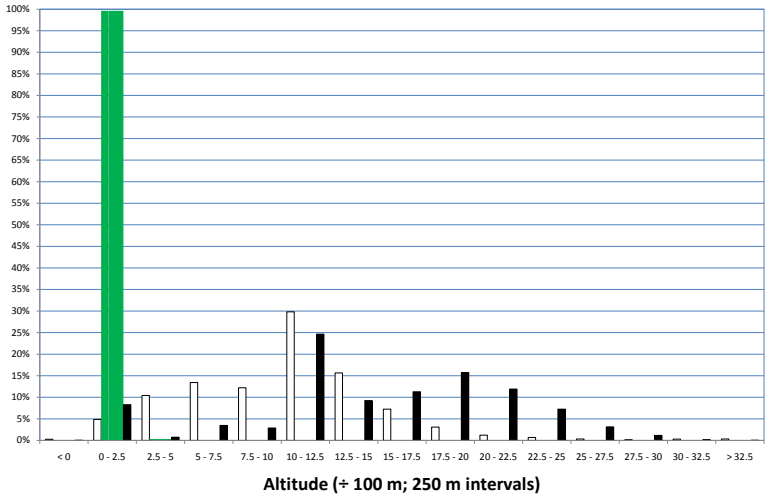


Figure 16.1. Mapped distribution of Zanzibar-Inhambane scrub forest in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. This vegetation type is mainly mapped as part of vegetation mosaics.

Investigation of environmental distribution of Zanzibar-Inhambane scrub forest in the VECEA region (limits are for areas of the VECEA map where this forest is not mapped as mosaic) shows that most of this forest type occurs below 250 m, making this forest type together with Zanzibar-Inhambane undifferentiated forest (Fp) one of the two forest types that occur at the lowest altitudes in the VECEA region. Annual rainfall of Zanzibar-Inhambane undifferentiated forest is definitely below average (compared to other forests) as most samples receive between 400 and 1200 mm (99.3%) and this is the only forest type where a substantial number of samples received rainfall between 400 and 600 mm (17.4%).

(a)



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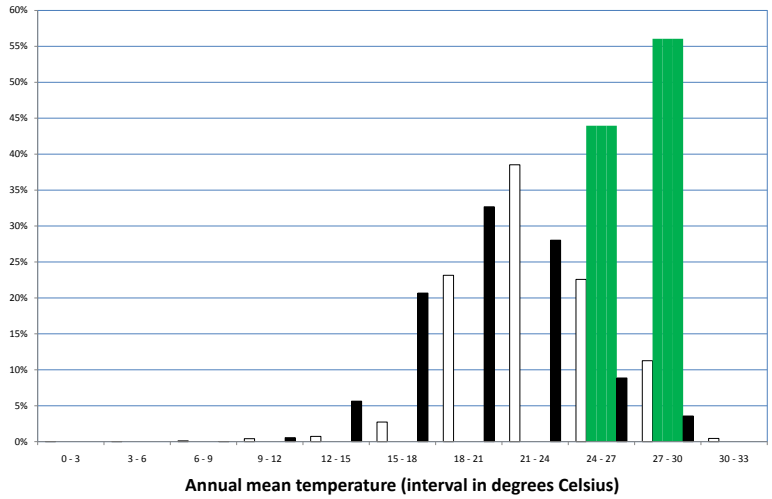

(c)

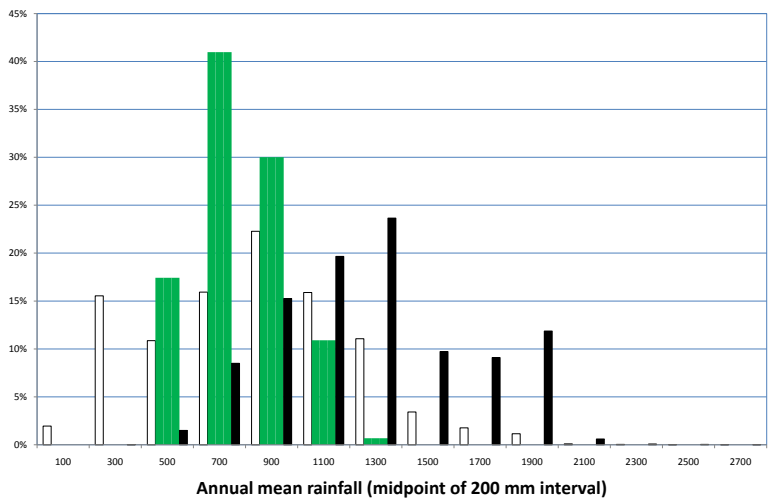

Figure 16.2. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Zanzibar-Inhambane scrub forest (Fq, n = 3,668). Bars on left (open) show the overall percentage of samples (n = 740,047). Bars on the right (black) show the percentages of samples within forests (n =59,013).

16.3. Species composition

Species assemblages were obtained from the following references:

- Burgess and Clarke (2000 Appendix 2 Table 3). Species listed for "mixed eastern African coastal scrub forest" were coded "x". Species only listed from sources from Mozambique, Pemba and the Selous Game Reserve were excluded.

Characteristic species were determined as:

- Dominant species listed by White (1983) (1983 p. 188) were coded "D".

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in the regional documentation (White 1983).

Table 16. Species composition of Zanzibar-Inhambane scrub forest (Fq)

Species	Regional status	(coast)
Acacia brevispica		x
Acacia bussei	secondary	f
Acacia mellifera	secondary	f
Acacia nilotica	secondary	f
Adenia globosa	indicator	x
Afzelia quanzensis	not characteristic (indicator for Zanzibar-Inhambane undifferentiated forest)	x
Albizia adianthifolia	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	x
Albizia anthelmintica	secondary	x
Albizia petersiana	not characteristic (indicator for drier variants of Zanzibar-Inhambane undifferentiated forest)	x
Albizia versicolor		x
Allophylus rubifolius		x
Bivinia jalbertii	indicator	f
Bombax rhodognaphalon	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	x
Boscia salicifolia		x
Brachylaena huillensis	not characteristic (indicator for drier variants of Zanzibar-Inhambane undifferentiated forest)	x
Carissa spinarum		x
Catunaregam nilotica	indicator	f
Combretum schumannii	not characteristic (indicator for Zanzibar-Inhambane undifferentiated forest)	x
Cordyla africana	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane undifferentiated forest)	x
		x
Dalbergia nitidula		x
Dialium orientale		x
Diospyros consolatae	indicator	x
Diospyros cornii	dominant	D
Diospyros mespiliformis	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane undifferentiated forest)	x
Dobera glabra	indicator (abundant especially where the water-table is near the surface)	f
Euclea natalensis	indicator	x
Euclea racemosa	indicator	f
Euphorbia candelabrum	indicator (rare and often absent)	f
Euphorbia grandicornis	indicator (dense communities in the understorey)	f
Euphorbia tirucalli		x
Garcinia livingstonei		x
Grandidiera boivinii	indicator	f
Grewia villosa		x
Haplocoelum foliolosum	indicator	f
Haplocoelum inoploeum	indicator	x
Harrisonia abyssinica		x
Hymenaea verrucosa	not characteristic (indicator for Zanzibar-Inhambane undifferentiated forest)	x

Species	Regional status	(coast)
Hyphaene compressa	secondary (palm species)	f
Lecaniodiscus fraxinifolius		x
Manilkara mochisia	dominant	Dx
Manilkara sansibarensis	not characteristic (indicator for Zanzibar-Inhambane undifferentiated forest)	x
Manilkara sulcata	not characteristic (indicator fordrier variants of Zanzibar-Inhambane undifferentiated forest)	x
Markhamia obtusifolia		x
Milicia excelsa	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane undifferentiated forest)	x
Newtonia erlangeri	indicator (only in northern forests)	x
Ochna thomasiana	indicator	f
Olea europaea	(*Olea europaea* ssp. *cuspidata*, synonym: *Olea africana*)	x
Sideroxylon inerme	indicator	f
Sorindeia madagascariensis		x
Spirostachys venenifera	indicator	x
Strychnos henningsii		x
Strychnos innocua		x
Suregada zanzibariensis	indicator	x
Syzygium cordatum		x
Syzygium guineense		x
Terminalia prunioides		x
Terminalia spinosa	indicator of disturbance	f
Thespesia danis	indicator	x
Thylachium africanum	indicator	x
Vitex doniana		x
Vitex payos		x
Zanthoxylum chalybeum		x

17. Somalia-Masai scrub forest (Fs)

17.1. Description

In a few places in East Africa, Somalia-Masai scrub forest (7 - 10 m tall) occurs at relatively low locations (700 - 950 m) where rainfall is too low to support true forest (*e.g.* Afromontane dry transitional forest [Fh]) but rainfall is also higher than that of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd; White 1983 p. 116).

White (1983) describes two Somalia-Masai scrub forests that occur in Tanzania: (i) a scrub forest that occurs on the escarpment above Lake Manyara; and (ii) a similar scrub forest that occurs on the steep northern slopes of the Western Usambara mountains. The dominant species include ***Commiphora baluensis, Commiphora campestris, Commiphora engleri, Commiphora merkeri*** and ***Euphorbia candelabrum*** (which we expect is the undefined "candelabra *Euphorbia*" that White (1983) refers to; White 1983 p. 116 - 117).

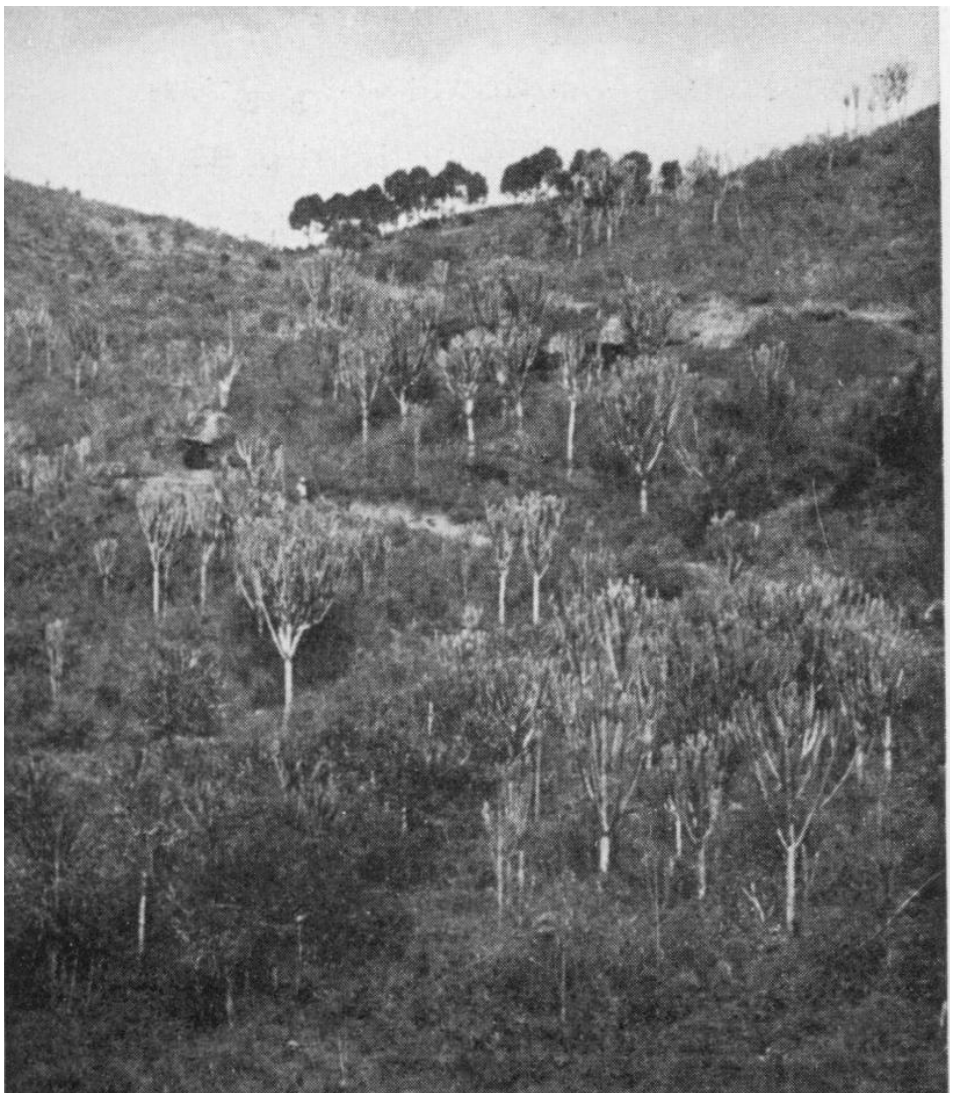

Figure 17.1 The succulent *Euphorbia* thicket is one of the three "specialized thickets of regional extent" on Gillman's (1949) vegetation map. White (1983 p. 116) listed this photograph (Gillman 1949 photograph 8) where Somalia-Masai scrub forest described. Within the VECEA map, we included the succulent *Euphorbia* thicket within the mapping unit of evergreen and semi-evergreen bushland and thicket (Be; see text). Image obtained from URL: *http://www.jstor.org/stable/211155*.

Figure 17.2 The photograph described as "woodland thicket" by Pratt *et al.* 1966 (Photograph 9) was one of the two photographs listed by White (1983 p. 116) for Somalia-Masai scrub forest. Image obtained from URL: *http://www.jstor.org/stable/2401259*.

17.2. VECEA region

Within the VECEA region, Somalia-Masai scrub forest was mapped as evergreen bushland in Tanzania (Be). Reasons for this mapping decision are made immediately below, whereas there was a clear cross-reference between the "Somalia-Masai scrub forest" sensu White (1983 pp. 116 - 117)" and the "succulent *Euphorbia* thicket" that was mapped and described by Gillman (1949) as one of the "thickets of regional extent": White (1983 p. 116) directly referred to Figure 8 (caption "Encroaching *Euphorbia* thicket, outer slopes of high block of Usambara above Mombo") of the Gillman (1949) documentation.

We mapped Somalia-Masai scrub forest as evergreen bushland (Be). Our main aims were to: (i) highlight the similarity of mosaics of scrub forests (fe) and evergreen bushland (Be) that occur in the Lake Victoria region; and (ii) suggest that evergreen bushland occurs outside the greater Serengeti system of Tanzania. By mapping the "*Euphorbia* thickets" as evergreen bushland (Be), we also followed the suggestion by White (1983) that this vegetation type occurs for climatic (rainfall) reasons rather than edaphic (stony soils) reasons.

More information on the scrub forest above Lake Manyara can be obtained from Greenway and Vesey-Fitzgerald (1969). More information on the scrub forest in the gap between the west Usambara and southern Pare mountains can be obtained from Greenway (1973 pp. 56 - 57).

17.3. Species composition

Species assemblages were obtained from the following references:

- White (1983 pp. 116 - 117): Species that were listed were coded "x".

Characteristic species were determined as:

- Species mentioned to be characteristic were coded "C". The unidentified "candelabra *Euphorbia* species" was assumed to be *Euphorbia candelabra.*

Table 17. Species composition of Somalia-Masai scrub forest (Fs)

Species	Regional status (see section 2.3)	Fs (Tanzania)
Acacia tortilis	indicator (norther slopes of the East Usambara Mts, also in deciduous bushland and deciduous wooded grassland)	x
Adansonia digitata	indicator (escarpment above Lake Manyara, also in deciduous bushland)	x
Afzelia quanzensis	indicator (norther slopes of the East Usambara Mts, also in Zanzibar-Inhambane undifferentiated forest)	x
Brachylaena huillensis	indicator (norther slopes of the East Usambara Mts, also in drier variants of Zanzibar-Inhambane undifferentiated forest)	x
Commiphora baluensis	indicator	C
Commiphora campestris	indicator (also in deciduous bushland)	C
Commiphora engleri	indicator	C
Commiphora merkeri	indicator	C
Euphorbia candelabrum	assumed to be the dominant candelabra *Euphorbia*	C
Manilkara sulcata	indicator (norther slopes of the East Usambara Mts, also in drier types of Zanzibar-Inhambane undifferentiated forest)	x
Newtonia hildebrandtii	characteristic (norther slopes of the East Usambara Mts, also in Somalia-Masai riparian forest)	x
Pappea capensis	indicator (norther slopes of the East Usambara Mts)	x

18. Zanzibar-Inhambane scrub forest on coral rag (fc, edaphic forest type)

18.1. Description

White describes evergreen thickets that are the climax vegetation types on shallow soils that overlie coral limestone and that have rainfall between 950 and 1200 mm per year. We decided to equate this vegetation type with the "maritime eastern African coastal scrub forest" described by Clarke and Robertson (2000) who described these forests as scrub forests and thickets (with canopies of 6 - 10 m and occasional emergents of 8 - 15 m) that develop on shallow and easily dessicated soils that overly coral rag (*i.e.* surface limestone derived from recent corals). Both White (1983) and Clarke and Robertson (2000) refer to the same reference of Birch (1963) when describing this vegetation type.

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Zanzibar-Inhambane scrub forest on coral rag and no other Zanzibar-Inhambane forest types, include ***Carpodiptera africana, Diospyros squarrosa, Grewia plagiophylla, Grewia truncata, Harrisonia abyssinica, Lannea schweinfurthii, Ludia mauritiana, Millettia usaramensis, Monanthotaxis fornicata, Pycnocoma littoralis, Sterculia rhynchocarpa, Tabernaemontana elegans, Uvaria leptocladon*** and ***Zanthoxylum chalybeum***.

18.2. VECEA region

Within the VECEA region, Zanzibar-Inhambane scrub forest on coral rag only occurs in the coastal areas of Kenya and Tanzania. We did not map it separately, but as part of the Zanzibar-Inhambane regional mosaic (see Volume 6).

Clarke and Robertson (2000) mention that 106 tree species are recorded in the literature as common or frequent in this vegetation type (the synonym that they used for this vegetation type was "maritime eastern African coastal scrub forest"), although often only in one source of information. The only species that were mentioned in a minimum of three sources of literature included *Adansonia digitata*, *Diospyros consolatae*, *Grewia glandulosa*, ***Lannea schweinfurthii***, *Manilkara sulcata* and *Sideroxylon inerme*.

18.3. Species composition

Species assemblages were obtained from the following references:

- Burgess and Clarke (2000 Appendix 2 Table 4). Species listed for "maritime eastern African coastal scrub forest" were coded "x". Species only listed from sources from Mozambique, Pemba and the Selous Game Reserve were excluded.

Characteristic species were not determined.

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in the regional documentation (White 1983).

Table 18. Species composition of Zanzibar-Inhambane scrub forest on coral rag (fc)

Species	regional status (see section 2.3)	f (coast)
Adansonia digitata		x
Afzelia quanzensis	not characteristic (indicator for Zanzibar-Inhambane undifferentiated forest)	x
Antiaris toxicaria	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest, Zanzibar-Inhambane transitional rain forest and Zanzibar-Inhambane undifferentiated forest)	x
Bombax rhodognaphalon	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	x
Bridelia micrantha		x
Carpodiptera africana	indicator (evergreen thicket on coral limestone)	x
Combretum schumannii	not characteristic (indicator for Zanzibar-Inhambane undifferentiated forest)	x
Dialium orientale		x
Dichrostachys cinerea		x
Diospyros mespiliformis	not characteristic (ndicator for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane undifferentiated forest)	x
Diospyros squarrosa	indicator (evergreen thicket on coral limestone)	f
Dodonaea viscosa		x
Encephalartos hildebrandtii		x
Euclea racemosa	not characteristic (indicator for Zanzibar-Inhambane scrub forest)	x
Euphorbia tirucalli		x
Ficus sur		x
Flacourtia indica		x
Flueggea virosa		x
Grewia plagiophylla	indicator (evergreen thicket on coral limestone)	x
Grewia truncata	indicator (evergreen thicket on coral limestone)	f
Harrisonia abyssinica	indicator (evergreen thicket on coral limestone)	x
Lannea schweinfurthii	indicator (evergreen thicket on coral limestone)	x
Ludia mauritiana	indicator (evergreen thicket on coral limestone)	x
Manilkara sansibarensis	characteristic (evergreen thicket on coral limestone)	x
Manilkara sulcata	not characteristic (indicator for drier variants of Zanzibar-Inhambane undifferentiated forest)	x
Markhamia zanzibarica		x
Millettia usaramensis	indicator (evergreen thicket on coral limestone)	x
Mimusops obtusifolia		x
Monanthotaxis fornicata	indicator (evergreen thicket on coral limestone)	f
Monodora grandidieri		x
Ozoroa insignis		x
Pandanus kirkii	genus occurs in Zanzibar-Inhambane swamp forest	x
Psydrax schimperiana		x
Pterocarpus angolensis		x
Pycnocoma littoralis	indicator (evergreen thicket on coral limestone)	f
Ricinodendron heudelotii	not characteristic (characteristic for Zanzibar-Inhambane lowland rain forest and Zanzibar-Inhambane transitional rain forest [Guineo-Congolian linking species])	x
Salvadora persica		x
Sclerocarya birrea		x

Species	regional status (see section 2.3)	f (coast)
Sideroxylon inerme	not characteristic (indicator for Zanzibar-Inhambane scrub forest)	x
Sorindeia madagascariensis		x
Sterculia africana		x
Sterculia rhynchocarpa	indicator (evergreen thicket on coral limestone)	f
Syzygium cordatum		x
Tabernaemontana elegans	indicator (evergreen thicket on coral limestone)	x
Tamarindus indica	not characteristic (indicator for drier variants of Zanzibar-Inhambane undifferentiated forest)	x
Uvaria leptocladon	indicator (evergreen thicket on coral limestone)	f
Xylopia parviflora	not characteristic (indicator for moister variants of Zanzibar-Inhambane undifferentiated forest)	x
Zanthoxylum chalybeum	indicator (evergreen thicket on coral limestone)	x

19. Lake Victoria *Euphorbia dawei* scrub forest (fe, edaphic forest type)

19.1. Description

Vegetation intermediate between rain forest and evergreen bushland (Be) probably occurred more extensively in the Lake Victoria basin than in other parts of Africa, but only few relicts remain (White 1983 p. 182).

White (1983 p. 182) describes the following types of Lake Victoria scrub forests: (i) *Cynometra-Euphorbia* scrub forest in Burundi and Uganda; (ii) ***Euphorbia dawei*** scrub forest in the basin of Lake Edward; (iii) ***Euphorbia dawei*** scrub forest in the Ruzizi valley and (iv) tall scrub forest in the Ruzizi valley (White 1983 p. 182):

- *Cynometra-Euphorbia* scrub forest in Burundi and Uganda is characterized by 10 m tall ***Cynometra alexandri*** (also a characteristic species of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest [Fi]) and is usually associated with ***Euphorbia dawei***.
- ***Euphorbia dawei*** scrub forest in the basin of Lake Edward (0º 21' S; 29º 37' E) forms forests have canopies of 12 to 15 m; they occur at 900 to 1000 m altitude in bands up to 3 km wide along the banks of rivers and on the lower slopes of escarpments.
- ***Euphorbia dawei*** forms scrub forests only in a single locality in the Ruzizi valley where ***Euphorbia dawei*** occurs as a 17 to 18 m high emergent above a 10 to 12 m canopy of ***Cynometra alexandri*** and *Tamarindus indica*. This formation is described as the Burundian 'La forêt sclérophylle à *Euphorbia dawei*' forest type by Lewalle (1972 p. 57, see below).
- Tall scrub forest of 15 m high is expected to be the climax community in the Ruzizi valley and consists of an upper canopy of ***Albizia grandibracteata***, *Euphorbia candelabrum*, *Grewia mollis*, ***Strychnos potatorum*** and *Tamarindus indica*. This formation is described as the 'La forêt sclérophylle à *Strychnos potatorum*' forest type by Lewalle (1972 p. 57) and as 'La forêt tropophile à ***Albizia grandibracteata*** et ***Strychnos potatorum*** ' forest type by Germain (1955 p. 41).

We classified *Euphorbia dawei* scrub forest as an edaphic vegetation type based on the suggestion that this vegetation type is especially restricted to rocky slopes, whereas evergreen bushland (Be) would be the climax vegetation type elsewhere (White 1983 p. 183).

Besides the **potentially** dominant ***Cynometra alexandri*** and ***Euphorbia dawei***, regional indicator species (characteristic species listed by White (1983) that were only provided for Lake Victoria ***Euphorbia dawei*** scrub forest and no other Lake Victoria forest types, include ***Cissus quadrangularis*** (liana species), [***Olea europaea* ssp. *cuspidata*,** (synonym: ***Olea africana***; also a indicator for Afromontane dry transitional forest [Fh]) and ***Psydrax parviflora***.

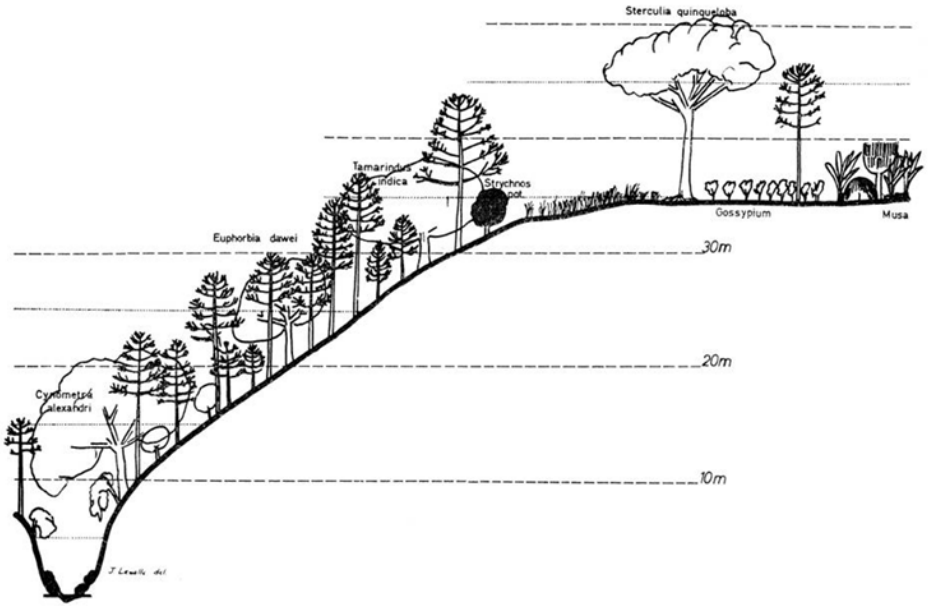

Fig. 15. — Profil-diagramme de la forêt sclérophylle à *Euphorbia dawei*.

Figure 19.1 Profile diagram of Lake Victoria *Euphorbia dawei* scrub forest in Burundi. Lewalle 1972. Image obtained from URL: *http://www.jstor.org/stale/3667406*.

19.2. VECEA region

Within the VECEA region, Lake Victoria *Euphorbia dawei* scrub forest is only described in the main national reference of Rwanda (see also Volume 6). We also expect that this vegetation type occurs in Uganda within areas that are mapped as evergreen bushland (Be, see previous section and below. Possibly this forest type also occurs in areas in Tanzania near the boundary with Rwanda that were mapped as evergreen bushland (Be).

In Rwanda, this vegetation type was originally described as "forêt de thalweg", which we translated as "ravine forest". "Thalweg" is an English loan word from German ("thal": valley, and "weg": way) that refers to ravines, therefore "thalweg forests" are named after the landscape position where they occur. The definition that Bloesch *et al.* (2009 p. 649) give for " forêt de thalweg " is that of a closed and semi-deciduous forest formation that is usually not very tall and that occurs in landscapes with wooded grasslands along ravines with steep slopes.

In Uganda, we expect from the information given in the previous section (19.1) (based on White 1983 p. 182) that especially the ***Euphorbia dawei*** variant or the ***Cynometra alexandri*** and ***Euphorbia dawei*** variants could occur in Uganda.

We expect that ***Cynometra alexandri*** was previously present in Lake Victoria scrub forests in Rwanda, although this species was not included in the woody plant species listed for Rwanda by Bloesch *et al.* (2009), our main reference for information on species composition of Rwandan vegetation types. Lebrun (1956) describes a sclerophyll forest formation with *Croton dichogamus* [19] and ***Euphorbia dawei*** that occurs on hill crests (as remnants) in the Akagera national park (surveyed in 1937 and 1938 by this author), but does not list ***Cynometra alexandri***. Lewalle (1972) describes the sclerophyll ***Euphorbia dawei*** forest formation of Burundi. Despite a thorough search throughout Burundi, Lewalle only found a small remnant of this forest type in a ravine of the Katunguru river (a tributary to the Rusizi river). However, he also mentions that this vegetation type was observed elsewhere in the Akagera national park (citing Lebrun 1955), in the Rwindi-Rutshuru plain south of Lake Edward (citing Lebrun 1947) and on islands on Lake Kivu. The profile diagram (Figure 19.1; Lewalle 1972 p. 68) shows that ***Cynometra alexandri*** occurs near the bottom of the ravine. We hypothesize, therefore, that the remnants that Lebrun observed on hill crests in Akagera part no longer had ***Cynometra alexandri***.

The tall scrub forest of 15 m high mentioned above (with synonym of 'la forêt sclérophylle à *Strychnos potatorum*' forest type by Lewalle [1972 p. 57]) was most likely the original vegetation type of floristic region 1A in Rwanda (the Ruzizi-Bugarama valley with influence from Congolian vegetation; most of this valley lays in Burundi) since this is suggested by White (1983) for the entire Ruzizi valley (1983 p. 182). *Strychnos potatorum* was listed by Bloesch *et al.* (2009) to be endemic to floristic region 1A.

19: *Croton dichogamus* is also a characteristic species of East African evergreen bushland [White 1983 p. 115

19.3. Species composition

Species assemblages were obtained from the following references:

- Rwanda: Bloesch *et al.* (2009). All species that were mentioned to occur in floristic regions 1B (littoral zone of Lake Kivu with influences from the vegetation of Congo) or 1C (south-eastern zone with influences from the vegetation of eastern Africa) and where a reference was made to 'forêt de thalweg' in the description of their ecology were coded "x" (unless they were characteristic species). To these species we added species listed by White (1983 p. 181) to occur at altitudes of 1600 - 1900 m (transitional rain forest) in western Rwanda.

Characteristic species were determined as:

- Rwanda: Characteristic species were coded "C". These only included ***Euphorbia dawei*** (the species that gives the name to the equivalent forest formation in Burundi, see above) and ***Cynometra alexandri*** (a species expected also to be characteristic; see discussion above).

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in the regional documentation (White 1983).

Table 19. Species composition of Lake Victoria *Euphorbia dawei* scrub forest (fe)

Species	Regional status (see section 2.3)	(Rwanda)
Acacia brevispica		x
Albizia adianthifolia		x
Albizia petersiana		x
Blighia unijugata		x
Bridelia micrantha		x
Canthium lactescens		x
Cissus quadrangularis	indicator (liana)	x
Clausena anisata		x
Craibia brownii		x
Croton dichogamus		C
Croton macrostachyus		x
Cynometra alexandri	dominant	f
Dovyalis macrocalyx		x
Elaeodendron buchananii		x
Euclea divinorum		x
Euphorbia dawei	dominant	C
Ficus sur		x
Garcinia buchananii		x
Lannea schimperi		x
Maytenus undata		x
Olea europaea	indicator (*Olea europaea* ssp. *cuspidata*, synonym: *Olea africana*)	x
Pavetta oliveriana		x
Psydrax parviflora	indicator	x
Psydrax schimperiana		x
Pterygota mildbraedii		x
Strychnos lucens		x
Tarenna graveolens		x
Vangueria apiculata		x

20. Riverine forests (fr, edaphic forest type)

20.1. Description

Although White (1983) treated riverine forests separately within the descriptions of regional centres of endemism, we decided not to map floristic variants of riverine forests. Actually, it was in most situations not practical to map riverine forests.

Zambezian riparian forest can be further classified in: (i) evergreen or semi-evergreen riparian forest; and (ii) deciduous riparian forest. Evergreen or semi-evergreen riparian forest of 20 m (or taller) occurs on fringes or perennial streams in areas where annual rainfall exceeds 1000 mm. Riparian forest where most of the tree species are deciduous for at least two months are confined to the banks of major watercourses in areas where annual rainfall is less than 800 mm. The latter riparian forest type has probably always been kept open by movements and browsing of large mammals, which explains the presence of heliophilous ('sun-loving') species of *Acacia* and other genera (White 1983 p. 91). Evergreen riparian forests are among the associated vegetation types that characterize wetter miombo woodland (Wn), whereas deciduous riparian forests are among the associated vegetation types that characterize drier miombo woodland (White 1983 p. 93).

Sudanian riparian forest was further classified in: (i) semi-evergreen riparian forest; and (ii) semi-deciduous riparian forest. The former occurs in the southern (wetter) half of the Sudanian region, whereas the latter occurs in the northern (drier) half of the Sudanian region where it is often degraded to riparian woodland (White 1983 p. 105).

Somalia-Masai riparian forest occurs only on the banks of larger rivers such as the Galana, Kiboko, Tana, Uaso Nyiro and Voi rivers of Kenya (riparian forests also occur in Tanzania; White 1983 p. 117).

Since we think that the riverine occurrence of riverine forests is more characteristic than the species composition of these forests, we refer to section 20.3 for information about characteristic species.

Figure 20.1 Riverine forest along the Rusumo River (Rwanda). Photograph by V. Minani (August 2008).

Figure 20.2 Riverine forest dominated by *Cynometra* and *Baphia* species along the Mpanga River Gorge (Kamwenge, Uganda. Photograph by J. Kalema (January 2009).

20.2. VECEA region

Within the VECEA region, riverine forest occurs in all countries. We refer to Volume 6 for information how we mapped these forests.

Riverine forests were named differently in the various VECEA countries. In Ethiopia, they were described as riverine vegetation (RV). In Kenya, they were described as riverine and ground-water forest. In Malawi, the name that was used was riparian forest and thicket. The Zambia national text referred to riparian forest. The reference from the coastal areas of Kenya and Tanzania originally used the name of "eastern African coastal riverine / groundwater forest".

The limits of riverine forest in Malawi are difficult to define due to the physiographic diversity which causes considerable local variation in climatic gradients. At low to medium altitudes, this forest has been largely destroyed in Malawi. Above 1200 m, Afromontane species become important and their contribution increases with altitude until 1500 to 2200 m where the floristic composition of the riparian forest is similar to that of the surrounding mid-altitude (Fg) or Afromontane (Fa) rain forests. Above these elevations, riverine forest is reduced to a very narrow and species-poor fringe. Most species included in the assemblages for riverine forest can also be found in other forest types, whereas relatively few species are confined to the riverine environment (Cornell Dudley, pers. comm.).

Fanshawe (1971 p. 35) mentions that the composition of riparian forests in Zambia varies from north to south, with a northern evergreen element and a southern semi-deciduous to deciduous element. The northern evergreen element is restricted to the high rainfall belt and the perennial streams of the Muchinga and southern escarpments. The southern element fringes all perennial and seasonal streams in the medium and low rainfall belts (except for the perennial escarpment streams) and mingles with the northern element on the middle reaches of larger rivers in the high rainfall belt.

In Tanzania, the presence of riverine forest can be inferred from the documentation of the original vegetation map that we consulted (but see also the reference of White (1983 p. 117) to the occurrence of Somalia-Masai riparian forest in Tanzania). Gillman (1949 pp. 24-25) indicates that riverine forest (he uses the synonym of "fringing forest") occur as "intrazonals" (defined as vegetation types that occur as a result of rapid alterations of geological, edaphic or anthropogenic conditions under a uniform climate, but that could not be represented on the Tanzanian map) in mapped woodland, wooded grassland, bushland and grassland physiognomic vegetation types.

The presence of riverine forest in Uganda could be inferred from the documentation of the original map as well. Langdale-Brown *et al.* (p. 55) indicate that *Vitex - Phyllanthus - Sapium - Terminalia* woodland is intersected by riparian forests containing *Khaya senegalensis* and *Mitragyna stipulosa*. Langdale-Brown *et al.* (p. 58) also refer to "true riparian forests" containing *Khaya grandifoliola*, *Syzygium guineense*, *Trichilia roka* and *Ficus* spp. that occur within *Vitellaria paradoxa* woodlands (Wb).

20.3. Species composition

Species assemblages were obtained from the following references:

- Ethiopia: Friis *et al.* 2010. Species mentioned in Appendix 3 for "Riverine vegetation" [RV] were coded "x" (unless they were characteristic species).
- Kenya: Species that were expected to occur in riverine forest based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x" in column "frK". In a separate column (wrK), species composition is provided for riverine woodland (see Volume 3).
- Malawi: Dowsett & Dowsett (2002), Palgrave (2002) and White *et al.* (2001) supplemented by unpublished data by our Malawian co-author (C. Dudley; he applied the criteria of White *et al.* [2001] of only including species that are strictly adapted to growing on the banks of water courses or that are otherwise influenced by water courses). These species were coded "x" (unless they were characteristic species).
- Rwanda: Bloesch *et al.* (2009). All species that were mentioned to occur in floristic region 1 and where a reference was made to 'galerie forestière' in the description of their ecology were coded "x" (unless they were characteristic species). Species that were only listed for floristic region 1A (Ruzizi-Bugarama plain with influence from the vegetation of Congo) were coded "xr" [(20)] , those that were only listed for floristic 1B (littoral zone of Lake Kivu with influence from the vegetation of Congo) were coded "xk" [(20)], those that were only listed for floristic region 1C (south-eastern zone with influence from the vegetation of East Africa) were coded "xe" and those that were only listed for floristic region 1D (depression of the Akagera river at Migongo with influence from the vegetation from the Zambezian region) were coded "xz". [(21)]
- Tanzania: White (1983 p. 117). The species that were listed to occur in Somalia-Masai riparian forests of Tanzania were coded "C" (these were all assumed to be characteristic species). ***Fernandoa magnifica*** (a characteristic species of the moister variants of Zanzibar-Inhambane undifferentiated forest [Fp]) that was mentioned to be endemic to the East African coast was coded "x".
- Zambia: Fanshawe (1971). Species listed for the species composition table for "riparian forest" provided on pages 36 to 38 were coded "x" (unless they were characteristic species).
- Uganda: see information for riverine thicket (br, Volume 4)
- Coastal areas of Kenya and Tanzania: Burgess and Clarke (2000 Appendix 2 Table 6). Species listed for "eastern African coastal riverine - groundwater forest" were coded "x" (unless they were characteristic species). Species only listed for the Uluguru Mountains or the Selous Game Reserve were excluded.

Characteristic species were determined as:

- Ethiopia: Those species that were mentioned in the description of the vegetation type in the main text were coded as "C".
- Kenya: Beentje (1994). Species for which a reference was made to

20: none of these species were later categorized as "useful tree species". Riverine species that were only recorded for the Lake Kivu floristic region included *Ficus ottoniifolia*, *Ficus pseudomangifera* and *Scolopia rhamniphylla*. Riverine species that were only recorded for the Ruzizi-Bugarama included *Grewia mollis* and *Piper umbellatum*.

21: Prioul (1981) mentions that these riverine forests contain species that occur nowhere else in Rwanda and therefore have an important biodiversity value. The best examples occur in the Rusumo region.

riverine (forest), gallery forest or stream banks in the ecology of the species were coded “C” in column "frK". For characteristic species of riverine woodland (wrK), see Volume 3.

- Malawi: Dominant trees were coded as “D”.
- Rwanda: Characteristic species were coded “C”. These species were selected by our Rwandan colleagues.
- Tanzania: All species were assumed to be characteristic, except ***Fernandoa magnifica*** (endemic to the East African coast, White [1983 p. 117])
- Uganda: see information for riverine thicket (br, Volume 4)
- Zambia: Species listed for the canopy layer were coded “C”. Species listed as characteristic species for the southern semi-deciduous to deciduous elements were coded “Cs”.
- Coastal areas of Kenya and Tanzania: Species listed to be dominant were coded “C”.

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

Table20 Species composition of riverine forests (fr)

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Abutilon angulatum		x			f	f		f	f	
Acacia abyssinica		f	f	f	x	f	f	f		
Acacia asak		x								
Acacia brevispica		f	x			f	f	f		f
Acacia drepanolobium		f	x				f	f		
Acacia elatior	Somalia-Masai riparian forest		C	C458				f		C
Acacia galpinii	Zambezian deciduous riparian forest				C				f	
Acacia gerrardii		f	C		f	f	f	x	f	f
Acacia hockii		f	x		f	f	f	f	f	f
Acacia kirkii	Lake Victoria swamp forest		C			x	f	f	f	
Acacia mellifera		f	x				f	f	f	f
Acacia nigrescens					f		f		Cs	
Acacia oerfota		f	x				f	C		f
Acacia polyacantha	Zambezian deciduous riparian forest	C	C		x	f	f	f	f	f
Acacia robusta	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f			f		f	C
Acacia seyal		f	x	C2a	f		f	f	f	
Acacia sieberiana	Sudanian riparian forest	f	C		x	f	f	f	f	f
Acacia tortilis	Zambezian deciduous riparian forest, along larger seasonal streams in Marsabit district	f	C	C458			f	C	f	f
Acacia xanthophloea	Zambezian deciduous riparian forest		C		x		f			f
Acokanthera oppositifolia			C		f				f	f
Acokanthera schimperi		f	x			f	f	f		f
Afzelia quanzensis			f		x		f	f	f	C
Agauria salicifolia		f	f		x	f	f	f	f	
Albizia glaberrima	Somalia-Masai riparian forest		C	f	x		C	f	x	f
Albizia grandibracteata		x	C			f	f	f		
Albizia malacophylla		x						f		
Albizia petersiana			C		x	f	f	f		f
Albizia saman	(exotic)		C							f
Albizia schimperiana		f	C		f		f	f	f	
Albizia versicolor	Zambezian deciduous riparian forest		f		x	f	f	f	f	x

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Albizia zimmermannii	Somalia-Masai riparian forest		C	f	x		f		f	
Albizia zygia			C				f	f		
Allophylus abyssinicus		x	C		x	f	f	f	f	
Allophylus africanus		x	x		x	x	f	f	x	
Allophylus rubifolius		f	C		f	f	f	f	f	f
Annona senegalensis		f	C		x	f	f	f	f	f
Anthocleista grandiflora			C		x		f	f		C
Antiaris toxicaria		f	f			f	f	f	f	C
Antidesma venosum		x	C		f		f	f	x	C
Aphania senegalensis	riparian forest in the greater Serengeti region	C	C				f	f		C
Apodytes dimidiata	afromontane species in forests on alluvial deposits at the mouth of the Kagera river	x	f		x	xe	f	f	C	f
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)					xe	f	f		
Balanites aegyptiaca		f	C			f	f	f	f	
Balanites wilsoniana			f				f	f		C
Baphia abyssinica		x								
Bauhinia petersiana					f		f		x	
Beilschmiedia ugandensis							f	f	x	
Berchemia discolor		x	C		x		f	f	f	f
Bersama abyssinica		x	C		f	x	f	f	f	f
Blighia unijugata		x	C		f	x	f	f	f	f
Bombax rhodognaphalon			f		x		f			C
Borassus aethiopum	(palm species)	f	C		D		f	f	f	f
Boscia coriacea		x	f				f	f		
Breonadia salicina	Sudanian and Zambezian evergreen or semi-evergreen riparian forest	C	x		C		f	f	C	C
Bridelia brideliifolia					x	x	x	x		
Bridelia micrantha		x	C		x	C	f	f	C	C
Bridelia scleroneura		x	f				f	f		
Burttdavya nyasica					C		f			C
Cadaba farinosa		f	C	C58		f	f	f		f
Caesalpinia volkensii			C				f	f		f

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Calodendrum capense			C		x		f	f		
Calotropis procera		x	C				f	f		f
Canthium lactescens		f	f			x	f	f	f	
Capparis tomentosa		x	C		x	f	f	x	x	f
Carissa spinarum		x	x		f	f	f	x	f	f
Cassipourea ruwensoriensis		f	f			x	f	f		
Celtis africana		C	C		f	f	f	f	f	x
Celtis toka		x						f		
Clausena anisata		f	C		x	x	f	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest				x		f		f	f
Commiphora eminii			f		x		f		f	
Cordia africana		f	C		x	x	f	f	f	
Cordia monoica		x	C				f	f		f
Cordia sinensis		x	C	C258			f	f	f	f
Cordyla africana	Zambezian deciduous riparian forest		f		C		f		f	f
Cornus volkensii			f		x	f	f	f		
Craibia brownii			C			f	f	f		f
Crateva adansonii		x	C				f	f		
Crotalaria agatiflora		f	C		f	f	f	f		
Croton macrostachyus		f	C		f	x	f	f	f	
Croton megalocarpus			C		f		f	f	f	
Cussonia holstii		f	f			x	f	f		
Cussonia spicata			C		f		f	f	f	
Delonix elata		f	f	C58			f	C	f	
Diospyros abyssinica		x	C		f	f	f	f	f	x
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	C		C	f	C	C
Diospyros scabra		x	x	C58				f		
Dobera glabra	Somalia-Masai riparian forest	f	x	f				f		f
Dodonaea viscosa		f	f		f	f	f	f	x	f
Dombeya buettneri		f				x				

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Dombeya kirkii		f	C		x	x	f	f	f	
Dovyalis abyssinica		x	C		f		f	f		
Dovyalis macrocalyx			C		x	x	f	f	f	f
Dracaena steudneri		f	f		x	xe	f	f	f	
Ehretia cymosa		x	f		f	xe		f		
Ekebergia capensis	riparian forest in the greater Serengeti region	f	C		x	x	f	f	x	f
Elaeodendron buchananii		f	C		x	f	f	f	f	
Embelia schimperi		x	f		x	x	f	f	x	
Ensete ventricosum		x	f		x	xe	f	f	f	
Entada abyssinica		f	C		f	f	f	f	f	
Erythrina excelsa			C				f	f	f	
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f		C		f	f	C	C
Erythroxylum fischeri		x	C				f	f		
Euclea divinorum		f	C		x	f	f	f	x	f
Euclea natalensis			C		x		f		f	f
Euclea racemosa		f	f		x	x	f	C	f	f
Eugenia capensis		x	f		f	x	f	f	f	
Fagaropsis angolensis		f	f		f	xz	f	f	f	f
Faidherbia albida	Zambezian deciduous riparian forest	f	C	C58	x		f	x	Cs	f
Faurea saligna			f		x	f	f	f	C	f
Fernandoa magnifica	Somalia-Masai riparian forest (near coast and endemic to coastal forests)		f				x			f
Ficalhoa laurifolia					x	f	f	f	f	
Ficus exasperata		x	f		x	f	f	f	f	f
Ficus ingens	Somalia-Masai riparian forest	f	C	f	f	x	f	f	f	f
Ficus natalensis			C		f	f	f	f	f	f
Ficus ovata		x	C		f	f	f	f	f	
Ficus sur	Zambezian deciduous riparian forest	x	C		x	f	f	f	Cs	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	x	C	C	f	f	C
Ficus thonningii		x	C		f	x	f	f	f	
Ficus vallis-choudae		x	C		x	x	f	f	f	x
Ficus vasta		x	C				f	x	f	

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Filicium decipiens		x	C		x		f			
Flacourtia indica		x	f		x	f	f	f	x	f
Flueggea virosa		f	C		f	f	f	f	f	f
Garcinia buchananii		x	f		f	f	f	f	f	f
Garcinia livingstonei	Somalia-Masai riparian forest (including greater Serengeti region)	x	C	f	x		f	f	Cs	C
Gardenia ternifolia		f	C			f	f	f		f
Gardenia volkensii		x	C				f	f	x	f
Grewia bicolor		f	x		f		f	f	f	
Grewia similis		f	f			x	f	f		
Grewia villosa		f	f	C2			f	f		f
Harrisonia abyssinica		f	C		x	f	f	f	f	C
Hibiscus diversifolius		x	f		f	f	f	f	f	
Hymenaea verrucosa			f				f			C
Hypericum quartinianum		f	C		f		f	f	f	
Hyphaene compressa	(palm species)	f	C	C4			f			C
Hyphaene coriacea	(palm species)		f	C24			f			f
Hyphaene petersiana	(palm species)				x		f		C	
Hyphaene thebaica	(palm species)	x								
Ilex mitis	afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	x	C		x	f	f	f	C	
Jatropha curcas			C		f		f	f	f	f
Jatropha multifida			x		f		f		f	
Justicia schimperiana		x	x				f			f
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		x	f	C		C	f	C	C
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f	x	C	C	x	f	C
Kigelia moosa			C				f	f		
Kirkia acuminata					x		f		f	
Landolphia buchananii		x	C		f		f	f	x	
Lannea barteri		x						f		

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Lannea schweinfurthii		f	x		x	f	f	f	f	f
Lawsonia inermis		f	C	x			f	f		C
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest	x	C	f	x		f	f	f	C
Lepidotrichilia volkensii		x	f		f	f	f	f	f	
Leptadenia hastata		f	C							
Lonchocarpus capassa					x		f		f	f
Maerua decumbens		f	C				f	f		f
Maesa lanceolata		x	f		x	xz	f	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	f	f	f	
Manilkara mochisia	Zambezian deciduous riparian forest		f		x		f		Cs	f
Markhamia lutea			C			x	f	f		
Markhamia zanzibarica			f		x		f	f	f	f
Maytenus arbutifolia		f	C			f	f	f		
Maytenus senegalensis		f	C		f	f	f	f	x	f
Maytenus undata		f	f		f	x	f	f	f	f
Meyna tetraphylla		x	f				f	f		f
Milicia excelsa		f	f		C	f	f	f		C
Mimusops bagshawei			C			xz	f	f		f
Mimusops kummel		C	C		f		f	f		
Mimusops obtusifolia			f		x		f			C
Mimusops zeyheri	Zambezian deciduous riparian forest				f		f		Cs	
Monodora myristica			C				f	f		
Monopetalanthus richard-siae	Zambezian evergreen or semi-evergreen riparian forest						f		x	
Moringa stenopetala		f	f					C		
Morus mesozygia		f	f		x		f	f	f	
Mussaenda arcuata		x	f				f	f		
Myrianthus holstii			C		f	f	f	f	f	f
Myrsine africana		f	f		f	f	f	f	x	
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C		C	x	f	f	f	C

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Newtonia hildebrandtii	Somalia-Masai and Zambezian deciduous riparian forest		C	f	x		f		f	
Nuxia congesta		f	f		f	xz	f	f	f	
Nuxia floribunda			f		f	xz	f	f	f	
Olea europaea	(*Olea europaea* ssp. *cuspidata*, synonym: Olea africana)	f	f		x	f	f	f	f	
Olyra latifolia		x	f				f	f		
Oncoba spinosa		x	C		x		f	f	x	
Oreobambos buchwaldii	(bamboo species indigenous to Africa)		C		x		f	f	f	
Oxystigma msoo			C				f			x
Parinari excelsa					x	f	f	f	C	C
Parkia filicoidea	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest (Lake Victoria swamp forest)		x	f	C		C	f	f	C
Parkinsonia aculeata			C							
Pavetta oliveriana		x	C			x	f	f		
Phoenix dactylifera	(palm species)		x				f			f
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; palm species	C	C		x	x	f	f	x	C
Phytolacca dodecandra		f	C		f	x	f	f	f	
Piliostigma thonningii		f	f		x	f	f	f	f	C
Pittosporum viridiflorum		f	C		x	xe	f	f	f	
Polyscias fulva			C		f	f	f	f	f	
Populus ilicifolia	Somalia-Masai riparian forest		C	f			f			C
Premna schimperi		x					f	f		
Prunus africana		f	C		x	f	f	f	f	
Pseudospondias microcarpa	Lake Victoria swamp forest; Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C			x	f	f	f	
Psychotria mahonii			C		x	f	f	f	f	
Psydrax parviflora		x	f		f	f	f	f	f	
Pterocarpus tinctorius					x		f		f	C
Pterolobium stellatum		f	f		f	f	f	f	x	

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Pterygota mildbraedii						x	f	f	f	
Raphia farinifera	Lake Victoria swamp forest (palm species)		C		x		f	f	C	f
Rauvolfia caffra			C		f		f	f	x	f
Rhamnus prinoides		x	f		f	f	f	f	f	
Rhoicissus revoilii		x	C		f	f	f	f	f	f
Rhoicissus tridentata		f	f		f	x	f	f	f	f
Rhus longipes		x	C		f	f	f	f	x	f
Rhus vulgaris		f	f		f	x	f	f	f	
Ricinodendron heudelotii			f				f	f		x
Ritchiea albersii		f	C			x	f	f	f	
Rothmannia urcelliformis		x	C		f		f	f	f	
Rubus apetalus		f	f		f	xe	f	f	f	
Saba comorensis		x	C		x					
Salvadora persica		x	C	C458	f		f	f	f	f
Sclerocarya birrea		f	C		f		f	f	f	f
Scutia myrtina		x	C		f	x	f	f	x	
Senna didymobotrya		f	C		f	f	f	f	f	
Senna septemtrionalis			C		f	f	f	f	f	
Sesbania macrantha			C		f	f	f	f	f	
Sesbania sesban		x	C		x	f	f	f	f	x
Shirakiopsis elliptica		x	C		C	x	f	f	x	
Sideroxylon inerme			C				f			f
Smilax anceps		f	C			f	f	f	x	
Solanecio mannii		x	C		f	f	f	f	x	
Solanum aculeastrum			C		f	f	f	f		
Sorindeia madagascariensis			C		C		f			C
Spathodea campanulata			C			x	f	f		
Spirostachys venenifera			C				f			C
Steganotaenia araliacea		f	C		f	f	f	f	f	
Sterculia appendiculata			C		C		f			C
Strychnos henningsii		f	C		x		f	f	f	x

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Strychnos lucens					f	f	f		x	
Strychnos mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	x	C		f		f	f		f
Strychnos potatorum	Zambezian deciduous riparian forest				x	f			Cs	
Strychnos spinosa		x	f		x	f	f	f	f	f
Suregada procera	greater Serengeti region	f	C		f		f	f	f	
Synsepalum brevipes			C		x		f	f	x	C
Syzygium cordatum	Lake Victoria swamp forest; Zambezian swamp forest		C		x	f	f	f	C	f
Syzygium guineense	Sudanian riparian forest (*Syzygium guineense* ssp. *guineense*)	C	C		C	xe	f	f	Cs	C
Syzygium owariense	Zambezian swamp forest				C		f	f	f	
Tamarindus indica	Somalia-Masai and Sudanian riparian forest	C	C	C58	x		C	f	x	f
Tamarix aphylla		x	x							
Tamarix nilotica		C	C				f			
Tarenna graveolens		f	C			f	f	f		
Terminalia brownii		f	C				f	x		f
Terminalia prunioides		f	C				f		f	f
Terminalia sambesiaca	Somalia-Masai riparian forest		x	f	C		f		f	C
Terminalia sericea					f		f		x	
Tetradenia riparia		x	f			f			x	
Thespesia garckeana			f		f		f		x	
Trema orientalis		x	C		f	C	f	f	x	f
Trichilia dregeana			C		f		f	f	f	f
Trichilia emetica	Somalia-Masai and Zambezian deciduous riparian forest	C	C	f	C		C	f	Cs	C
Uvaria scheffleri			C				f	f		f
Vangueria apiculata		x	C		f	f	f	f	f	
Vangueria infausta			C		f	f	f	f	f	f
Vangueria madagascariensis		f	C		f		f	f		f
Vepris nobilis		x	C		f	x	f	f	f	f
Vernonia amygdalina		x	C		x	x	f	f	f	

Species	regional status (see section 2.3)	rE (Ethiopia)	frK (Kenya subtype)	wrK (Kenya subtype)	rM (Malawi)	frR (Rwanda)	frT (Tanzania)	brU (Uganda)	frZ (Zambia)	frC (Coast)
Vernonia myriantha		x	f		x	f	f	f	f	
Vitex doniana	Sudanian riparian forest	f	f		x	f	f	f	x	f
Warburgia ugandensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	C		f		f	f		
Woodfordia uniflora		x	C					f		
Xanthocercis zambesiaca	Zambezian deciduous riparian forest				x				f	
Xeroderris stuhlmannii			f		f		f		f	f
Ximenia americana		x	f		f	f	f	f	f	f
Xylopia parviflora		f	f		x		f	f	f	C
Zanha golungensis		x	f		f	xz	f	f	f	f
Zanthoxylum chalybeum		f	x		f	f	f	f	f	f
Zanthoxylum gilletii		x	f			xe	f	f		
Zanthoxylum usambarense		f	x			f	f			f
Ziziphus abyssinica		f	f		x	f	f	x	f	f
Ziziphus mauritiana		x	C		f		f	f	x	f
Ziziphus mucronata		x	C		f	f	f	x	x	f
Ziziphus pubescens		x	C		x		f	f	f	f
Ziziphus spina-christi		f	C				f	f		f

21. Swamp forest (fs, edaphic forest type)

21.1. Description

In analogy with riverine forests (fr), we decided not to map floristic variants of riverine forests although White (1983) treated riverine forests separately within the descriptions of regional centres of endemism. Actually, it was in most situations not practical to map swamp forests.

In the wetter parts of the Zambezian region (with rainfall above 1000 mm), permanent swamp forest occurs around springs at the sources of tributary streams. Swamp forests also occurs along watercourses (*i.e.* also as subtype of riverine forest [fr]) where water movement is locally sluggish. In the latter situation, swamp forests merge into other types of riparian forest in which the water table is at some distance below the surface for at least part of the year (White 1983 p. 91).

Although White (1983) lists a heading within the description of the Sudanian region as "Sudanian swamp forest and riparian forest", he does not give a specific description of Sudanian swamp forest (White 1983 pp. 103 - 104).

Swamp forests dominated by species that are widespread in tropical Africa occur extensively on the shores of Lake Victoria and elsewhere in the Lake Victoria region. On alluvial deposits of the Kagera river (on the western shore of Lake Victoria), a unique swamp forest occurs that is composed almost in equal proportions of lowland (especially Guineo-Congolian) and Afromontane species and that is dominated by *Baikiaea insignis* (a Guineo-Congolian species) and by *Podocarpus usambarensis* var. *dawei* (an Afromontane species; White 1983 p. 181).

Fresh-water swamp forest is of restricted occurrence in the Zanzibar-Inhambane region. *Barringtonia racemosa*, a species associated with mangroves (M), often occurs in swamp forests immediately behind the mangrove zone and extends upstream for considerable distances (White 1983 p. 188).
Since we think that the occurrence of swamp forests in swampy areas is more characteristic than the species composition of these forests, we refer to section 20.3 for information about characteristic species.

21.2. VECEA region

Within the VECEA region, swamp forest occurs in all countries.
For Ethiopia, swamp forest was mapped together with freshwater marshes and swamps, floodplains and lake shore vegetation (Friis *et al.* 2010 p. 146]).

In Kenya, no distinction was made between riverine forest (fr) and swamp forest ('ground water forest').

In Malawi, this forest type is poorly represented and the patches where this forest type occur were also too small to be mapped (C. Dudley, pers.

comm.). White *et al.* (2001) only give a brief mention of a small montane swamp forest in northern Malawi.

In Rwanda, this forest was named "forêt marécageuse".

In Tanzania, Lovett (1990) listed two swamp forest types: Guineo-Congolian swamp forest and Zanzibar-Inhambane swamp forest. However, in the Gillman vegetation map we could also spot some swamp forests south of the Malagarasi depression that occurred in the Zambezian floristic region. Since the Zambezian floristic region extends into Tanzania, it is very likely that Zambezian swamp forests do exist in Tanzania.

In Uganda, forested swamps can be divided into permanent swamps (where the water level never falls far below the surface) and seasonal swamps (where soils dry up and crack deeply during the dry season (Langdale-Brown *et al.* 1964 pp. 74 - 75):

(i) Permanent swamp forests were not mapped in Uganda; they can be further subdivided in types dominated by *Hallea stipulosa*, *Macaranga schweinfurthii*, *Syzygium cordatum* (dominant in montane swamps) and *Xylopia aethiopica*.

(ii) Seasonal swamp forests occur throughout Lake Victoria drier peripheral Guineo-Congolian rain forest (Fi), but only two seasonal swamp forests were sufficiently extensive to be mapped: *Croton* [seasonal] swamp forest (original mapping unit Y1) and *Baikiaea - Podocarpus* seasonal swamp forest (original mapping unit Y2;).

In Zambia, Fanshawe (1971 p. 32) made the distinction between estuarine swamp (flooded all year), seepage swamp (where the water table is at or just above ground level all year) and seasonal swamp (flooded during the rainy season and with the water table near ground level for the rest of the year).

21.3. Species composition

Species composition was obtained from the following references:

- Ethiopia: Friis *et al.* 2010 only mentioned species in the main description; these were listed as characteristic species "C".
- Kenya: Beentje (1994). Species for which a reference was made to swamp (forest) or ground water forest in the ecology of the species were coded "C".
- Malawi: Chapman and White (1970) and White *et al.* (2001). Species mentioned in for "Montane swamp forest" were coded "x" (unless they were characteristic species).
- Rwanda: Bloesch *et al.* (2009). All species that were mentioned to occur in floristic region 1 and where a reference was made to 'forêt marécageuse' in the description of their ecology were coded "x" (unless they were characteristic species). 'Forêt marécageuse' occurs in areas that are periodically flooded.
- Tanzania. CARLDS (1952). Species listed to occur in groundwater forest were coded "C".
- Uganda: Langdale-Brown *et al.* (1964) and Howard & Davenport

[1996]. All species mentioned in the appendix to occur in "*Rauvolfia-Croton* swamp forest" (Y1) were coded "x" in column "fsrU" (unless they were characteristic species). In a separate column (fsbU), all species mentioned in the appendix to occur in "*Baikiae-Podocarpus* seasonal swamp forest" (Y2) were coded "x". Species listed to occur in Sango Bay forest (indicated on page 107 to only contain forest type "Y2") in the Uganda Forest Department Biodiversity Database (Howard & Davenport [1996]) were coded "xb".

- Zambia: Fanshawe (1971). Species listed for the species composition table for "swamp forest" provided on pages 33 to 34 were coded "x" (unless they were characteristic species).
- Coastal areas of Kenya and Tanzania: Burgess and Clarke (2000 Appendix 2 Table 7). Species listed for "eastern African coastal swamp forest" were coded "x". Species only listed for Zanzibar or the Selous Game Reserve were excluded.

Characteristic species were determined as:

- Ethiopia: species mentioned in the main description of the vegetation type were coded "C".
- Kenya: All species were assumed to be characteristic.
- Malawi: Species identified to be present as large trees (20 - 30 m) were coded as "C" Dominant trees were coded as "D". Dominant large trees were coded as "DL".
- Rwanda: Species that were listed to occur in more than one of the floristic regions of 1A, 1B, 1C or 1 D were considered to be characteristic.
- Tanzania: All species were assumed to be characteristic species.
- Uganda: Species listed as large trees in the appendix were coded "C", unless they were identified as dominant species (coded "D").
- Zambia: Species listed for the canopy layer were coded "C". Species listed as characteristic species for estuarine swamp were coded "Ce", those characteristic for seepage swamp were coded "Cp" and those for seasonal swamp were coded "Cs".
- Coastal areas of Kenya and Tanzania: Characteristic species were not determined.

Within the information on assemblages, coding "f " indicates that there is information that the species potentially occurs in the vegetation type since it occurs in the focal country and in the same forest type in other countries (see section 2.3).

Table 21. Species composition of swamp forest (fs)

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Acacia kirkii	Lake Victoria swamp forest		f		f	f	f	C	f	
Acrostichum aureum	Zanzibari-Inhambane swamp forest (fern species)					f				x
Albizia glaberrima	Somalia-Masai riparian forest		f	f		f	xb	f	f	f
Albizia grandibracteata		f	f		f	f	x	f		
Albizia gummifera			f	f	f	f	xb	f		f
Albizia zygia			f			f	xb	f		
Alchornea hirtella			f	f	f	f	x	f	x	
Alstonia boonei							xb	f		
Anthocleista grandiflora			C	x		f	f	f		x
Anthocleista schweinfurthii	Lake Victoria swamp forest	f			f	f	xb	f	C	
Antiaris toxicaria			f		f	f	xb	f	f	f
Antidesma venosum		C	f	f		f	f	f	f	f
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	xb	f	f	f
Aporrhiza nitida	Zambezian swamp forest			f					x	
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)				f	f	D	f		
Balanites wilsoniana			f			f	xb	f		f
Barringtonia racemosa	Zanzibar-Inhambane swamp forest, also mangrove associated species		f			f				x
Beilschmiedia ugandensis			f			f	x	f	C	
Bersama abyssinica			f	f	f	f	xb	f	f	f
Blighia unijugata		f	f	f	C	f	xb	C	f	f
Bridelia brideliifolia				f	f	f	xb	f		
Bridelia micrantha		f	f	f	f	f	xb	f	x	f
Canarium schweinfurthii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river	f				f	xb	f	f	
Carapa procera					f	f	xb	f		
Cassipourea malosana			f	f		f	xb	f	f	
Cassipourea ruwensoriensis			f		f	f	xb	f		

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Celtis africana		f		f	C	f	f	f	f	f
Celtis gomphophylla		f	f	f	f	C	f	C	f	f
Chrysophyllum albidum			f	f			xb	f		
Clausena anisata		f	f	f	f	f	xb	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest			f		f			f	f
Cordia africana		f	f	f	C	f	xb	f	f	
Cordia millenii			f			f	xb	f		
Cordyla africana	Zambezian deciduous riparian forest		C			C			f	f
Craterispermum laurinum	Zambezian swamp forest		f						x	
Croton macrostachyus		f	f	f	f	f	xb	D	f	
Croton megalocarpus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	xb	f	f	
Croton sylvaticus			f	f		f	xb	f	f	f
Diospyros abyssinica			f	f	f	f	xb	f	f	f
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	C	f		f	f	f	f	f
Dombeya rotundifolia		f	f	f	C		f	f	f	
Dombeya torrida		f	f	f	x	f	f	f		
Dovyalis abyssinica			f	f		f	xb	f		
Dovyalis macrocalyx			f	f	f	f	xb	f	f	f
Dracaena camerooniana	Zambezian swamp forest								x	
Dracaena fragrans		f	f	f	x	f	f	f		
Dracaena steudneri			f	f	f	f	xb	f	f	
Ehretia cymosa			f	f	f		xb	f		
Ekebergia capensis	riparian forest in the greater Serengeti region	f	f	f	C	f	xb	f	x	f
Elaeis guineensis	Zanzibar-Inhambane swamp forest (palm species)		f	f		f	f	f		x
Entandrophragma angolense			f			f	xb	f		
Entandrophragma excelsum				f	f	f	xb	f	f	
Erythrina abyssinica		f	f	f	x	f	xb	f	f	f
Erythrina excelsa	Lake Victoria swamp forest		f			f	xb	f	f	
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Erythroxylum fischeri			C			f	xb	f		
Euclea divinorum		f	f	f	C	f	f	f	f	f
Fagaropsis angolensis			f	f	f	f	xb	f	f	f
Faidherbia albida		f	C	f	f	f	f	f	f	f
Ficalhoa laurifolia				f	f	f	f	f	C	
Ficus mucuso			f			f	xb	f		
Ficus natalensis			C	f	f	f	xb	f	f	f
Ficus sur	Zambezian deciduous riparian forest	f	C	f	f	f	xb	f	Cs	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	x	f	x	f	xb	f	f	x
Ficus thonningii			f	f	f	f	xb	f	f	
Ficus trichopoda	Lake Victoria swamp forest; Zambezian swamp forest			x	C	f	f	f	Ce	
Ficus vallis-choudae		f	f	f	C	f	f	f	f	f
Flueggea virosa		f	f	f	f	f	xb	x	f	f
Funtumia africana			C	f		f	xb	f		f
Funtumia elastica							xb	f		
Garcinia smeathmannii	Zambezian swamp forest			f		f			x	
Gardenia imperialis	Zambezian swamp forest			f		f	f	f	x	
Guarea cedrata							xb	f		
Hallea stipulosa	Lake Victoria swamp forest; Zambezian swamp forest			x		x	f	f	Cep	
Harungana madagascariensis			f	f	f	f	xb	f	f	f
Hibiscus tiliaceus	Zanzibar-Inhambane swamp forest, also mangrove associated species		x			f				x
Hyphaene compressa	(palm species)	f	f			f				x
Ilex mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	f	f	f	f	f	C	f	Cps	
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest		f	f	f	f	xb	C	f	f

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Klainedoxa gabonensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Landolphia buchananii			f	f		f	f	f	x	
Lannea schweinfurthii			f	f	C	f	f	f	f	f
Lannea welwitschii			f			f	xb	f		f
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest		f	f		f	xb	f	f	f
Lepidotrichilia volkensii			f	f	f	f	xb	f	f	
Lonchocarpus capassa				f		f			f	f
Lovoa trichilioides					f	f	xb	f		
Macaranga capensis			f	f	f	f	xb	f	f	f
Macaranga monandra	Lake Victoria swamp forest					f	x	f		
Macaranga schweinfurthii	Lake Victoria swamp forest		C		x	f	xb	f	f	
Macaranga spinosa	Lake Victoria swamp forest					C				
Maesa lanceolata		f	f	f	f	f	xb	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f		f	f	x	f	f	
Margaritaria discoidea			f	f		f	xb	f	f	f
Markhamia lutea			f		f	f	xb	f		
Maytenus acuminata			f	f	f	f	xb	f	f	
Maytenus undata			f	f	f	f	xb	f	f	f
Mimusops bagshawei			f		f	f	xb	f		f
Monodora myristica			f			f	xb	f		
Musanga cecropioides	Lake Victoria swamp forest					x	f	f		
Neoboutonia macrocalyx			f	f	f	f	xb	f	f	
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C	f	f	f	f	f	f	f
Olea capensis		f	f	f	f	f	x	f	f	
Olea europaea	(*Olea europaea* ssp. *cuspidata,* synonym: *Olea africana)*		f	f	f	f	xb	f	f	f
Oncoba spinosa			f	f		f	xb	f	f	
Oreobambos buchwaldii	(bamboo species indigenous to Africa)		f	f		f	xb	f	f	
Parinari excelsa				f	f	f	x	f	C	f

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Parkia filicoidea	Lake Victoria swamp forest (also Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest)		C	f		f	x	f	f	f
Peddiea fischeri			f		f	f	x	f	x	
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; (palm species)	C	f	x	f	f	f	C	x	x
Pittosporum viridiflorum		f	f	f	f	f	f	f	x	
Pleiocarpa pycnantha			f		f	f	xb	f	f	f
Podocarpus falcatus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	f	f		
Podocarpus latifolius	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	x	f	D	f	f	
Podocarpus usambarensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river (dominant [*Podocarpus usambarensis* var. *dawei*])		f			f	D	f		
Polyscias fulva			f	f	f	f	xb	f	f	
Pouteria altissima			f		f	f	xb	f	f	
Prunus africana			f	f	f	f	xb	f	f	
Pseudospondias microcarpa	Lake Victoria swamp forest; Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	x	f	f	
Psychotria mahonii			C	f	f	f	xb	f	f	
Psychotria peduncularis	Zambezian swamp forest		f	f	x	f	f	f	x	
Psydrax parviflora			f	f	f	f	xb	f	f	
Pterocarpus tinctorius				f		C			f	f
Pterygota mildbraedii					f	f	xb	f	f	
Pycnanthus angolensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	xb	f	f	
Rapanea melanophloeos		f	f	f	f	f	f	f	x	f
Raphia farinifera	Lake Victoria swamp forest (palm species)		C	x		f	xb	f	Ce	x
Rauvolfia caffra			f	f		f	xb	D	Cs	f
Rauvolfia vomitoria						f	xb	f		
Rhus natalensis			f	f	f	f	xb	f	f	f
Rhus vulgaris			f	f	f	f	xb	f	f	

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Ritchiea albersii		f	f		C	f	xb	f	f	
Rothmannia urcelliformis		f	f	f		f	xb	x	f	
Schrebera arborea							x	C		
Scutia myrtina		f	f	f	C	f	x	f	x	
Senna didymobotrya			f	f	f	f	xb	f	f	
Shirakiopsis elliptica		f	f	f	C	f	xb	f	C	
Smilax anceps			f		f	f	f	f	x	
Sorindeia madagascariensis			C	f		f				x
Spathodea campanulata			f		f	f	xb	f		
Spondianthus preussii	Lake Victoria swamp forest					f	C	f		
Sterculia tragacantha					f	f			C	
Strombosia scheffleri	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	xb	f		f
Strychnos mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	xb	f		f
Symphonia globulifera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river				f	f	x	f	f	
Synsepalum brevipes			f	f		f	xb	f	f	f
Syzygium cordatum	Lake Victoria swamp forest; Zambezian swamp forest		f	D	C	f	f	x	Ceps	f
Syzygium guineense	Sudanian riparian forest (*Syzygium guineense* ssp. *guineense*)	C	f	f	x	f	xb	f	f	f
Syzygium owariense	Zambezian swamp forest			D		f	f	f	Cep	
Tabernaemontana pachysiphon			f	f		f	xb	f	f	f
Terminalia sambesiaca	Somalia-Masai riparian forest		f	f		C			f	f
Tetrapleura tetraptera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f				x	f		f
Treculia africana				f		f	xb	f	f	f
Trema orientalis		f	f	f	f	f	x	f	f	f
Trichilia dregeana			f	f		f	xb	f	f	f
Trichocladus ellipticus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	
Trilepisium madagascariense			f	f		f	xb	f	f	f
Typhonodorum lindleyanum	Zanzibar-Inhambane swamp forest					f				x

Species	Regional status (see section 2.3)	fsE (Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	fsbU (Uganda subtype)	fsrU (Uganda subtype)	(Zambia)	(coast)
Uapaca guineensis	Lake Victoria swamp forest; Zambezian swamp forest			f		f			Cep	f
Vangueria apiculata			f	f	f	f	xb	f	f	
Vangueria madagascariensis		f	C	f		f	f	f		f
Vepris nobilis		f	f	f	C	f	xb	f	f	f
Vernonia amygdalina			f	f	f	f	xb	f	f	
Vitex doniana	Sudanian riparian forest	f	f	f	f	f	f	f	f	x
Vitex ferruginea			f			f	xb	f	f	f
Voacanga thouarsii	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest		C	f		x	f	f	x	x
Warburgia ugandensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	xb	f		
Xylopia aethiopica	Zambezian swamp forest		f			f	xb	f	Cep	f
Xylopia rubescens	Zambezian swamp forest					f	f	f	Cp	
Xymalos monospora			f	f	f	f	xb	f		f
Zanha golungensis			f	f	f	f	xb	f	f	f
Zanthoxylum gilletii			f		f	f	xb	f		
Zanthoxylum rubescens			f			f	xb	f		
Zanthoxylum usambarense		f	f		x	f				f
Ziziphus pubescens		f	C	f		f	f	f	f	f

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Appendices

Appendix 1. Information on useful tree species

Information on useful tree species was obtained from the following references listing "useful trees and shrub species" for one of the seven VECEA countries: Bekele-Tesemma (2007), Fanshawe (1982), Katende *et al.* (1995), Maundu and Tengnas (2005), Mbuya *et al.* (1994), Nduwayezu *et al.* (2009), Simute et al. (1998) and Williamson (1975). From the Williamson (1975) reference, only species were included for which it was mentioned that their wood was used for timber or other purposes.

Table A1. Information on useful tree species that occur in at least one of the forest potential natural vegetation types. x = species was listed in the reference on useful tree species in the country; f = there is floristic information that the species occurs in the country; w = the only floristic information is from the UNEP-WCMC species database

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Abutilon angulatum	f		f	x		f	f
Acacia abyssinica	x	x	f	x	f	x	
Acacia asak	x						
Acacia brevispica	x	x		x	f	f	
Acacia bussei	x	f			f		
Acacia drepanolobium	f	x			f	f	
Acacia elatior		x				f	
Acacia erioloba							x
Acacia gerrardii	f	x	f	x	f	x	f
Acacia hockii	f	f	f	x	x	x	f
Acacia kirkii		x		x	f	f	f
Acacia lahai	x	x			f	x	
Acacia mearnsii	x	x		x	x	f	w
Acacia mellifera	f	x			x	x	f
Acacia nigrescens			x		f		f
Acacia nilotica	x	x	f		x	x	f
Acacia oerfota	x	f			f	f	
Acacia polyacantha	x	x	x	x	x	f	x
Acacia senegal	x	x		x	x	x	f
Acacia seyal	x	x	f		x	x	f
Acacia sieberiana	x	f	f	x	f	x	x
Acacia tortilis	x	x			x	x	f
Acacia xanthophloea		x	f		x		
Acokanthera oppositifolia		x	f				f
Acokanthera schimperi	x	x		x	x	f	
Adansonia digitata	x	x	f		x		x
Afzelia quanzensis		x	x		x	w	x
Agauria salicifolia	f	f	f	x	w	f	f
Albizia adianthifolia		f	f	x	f	x	x
Albizia anthelmintica	f	x	f		f	f	f
Albizia coriaria	f	x			f	x	f
Albizia glaberrima		x	x		f	x	f
Albizia grandibracteata	x	f		f	f	x	
Albizia gummifera	x	f	x	x	x	x	

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Albizia malacophylla	x					f	
Albizia petersiana		f	f	x	f	f	
Albizia saman		f				x	
Albizia schimperiana	x	f	w		x	f	w
Albizia versicolor		f	x	x	x	x	x
Albizia zygia		f			f	x	
Alchornea hirtella		f	f	x	f	f	f
Allophylus abyssinicus	x	f	f	f	f	x	w
Allophylus africanus	f	f	f	x	f	f	f
Allophylus rubifolius	f	f	f	x	f	f	f
Alstonia boonei	f					x	
Annona senegalensis	x	f	f	x	x	x	x
Anthocleista grandiflora		f	x	x	f	f	
Antiaris toxicaria	x	x		f	f	x	f
Antidesma venosum	f	x	f		f	f	f
Aphania senegalensis	f	x			w	f	
Apodytes dimidiata	x	x	x	x	f	f	f
Baikiaea insignis				x	f	x	
Baikiaea plurijuga							x
Balanites aegyptiaca	x	x		f	x	x	x
Balanites wilsoniana		x			f	f	
Balthasaria schliebenii				x	w		
Baphia abyssinica	x						
Baphia massaiensis					f		x
Bauhinia petersiana			f		x		x
Beilschmiedia ugandensis					f	x	f
Berberis holstii	x	f	f		f	f	
Berchemia discolor	x	x	x		x	f	x
Bersama abyssinica	x	x	f	x	x	x	f
Blighia unijugata	x	x	f	f	f	x	f
Bombax buonopozense						x	
Bombax rhodognaphalon		x		x	x		
Borassus aethiopum	x	x	x		x	x	x
Boscia coriacea	f	x			f	f	
Boscia salicifolia	f	f	f		x	f	f
Brachylaena huillensis		x			x	f	
Brachystegia longifolia			f		f		x
Brachystegia spiciformis		x	x		x		x
Breonadia salicina	x	f	x		x	w	w
Bridelia brideliifolia			f	x	f	f	
Bridelia micrantha	x	x	x	x	x	x	x
Bridelia scleroneura	f	f		x	f	f	
Buddleja polystachya	x	x			f	f	
Burttdavya nyasica			x		f		
Cadaba farinosa	w	x		f	x	f	
Caesalpinia decapetala	x	x	f	x	x	x	x
Caesalpinia volkensii		x			f	f	
Calodendrum capense		x	f		x	x	
Calotropis procera	x	f			f	f	
Canarium schweinfurthii	w				f	x	f

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Canthium lactescens	f	f		x	f	f	f
Capparis tomentosa	x	x	f	x	f	f	f
Carapa procera				x	f	x	
Carissa spinarum	x	x	f	x	x	x	f
Casearia battiscombei		x	f		f	f	
Cassia abbreviata		x	f		f		x
Cassipourea malosana	f	x	f		f	f	f
Cassipourea ruwensoriensis	w	f		x	f	f	
Catha edulis	x	f	f	w	x	x	f
Ceiba pentandra	x	x	x	x	x	x	f
Celtis africana	x	x	f	x	f	x	f
Celtis gomphophylla	f	f	f	x	f	x	f
Celtis mildbraedii		f			f	x	
Celtis toka	x					w	
Chrysophyllum albidum		f	w			x	
Chrysophyllum gorungosanum		f	x	f	f	x	f
Clausena anisata	f	x	f	x	w	f	f
Clerodendrum myricoides	f	x		f	f	f	
Combretum collinum	x	x	f	x	f	x	f
Combretum imberbe			x		f		x
Combretum schumannii		x	f		x		f
Combretum zeyheri		f	x		f		f
Commiphora eminii		x	w		x		w
Cordia africana	x	x	x	f	x	x	f
Cordia millenii		f			f	x	
Cordia monoica	f	x			x	x	
Cordia sinensis	f	x			x	x	f
Cordyla africana		x	x		x		x
Cornus volkensii		x	f	x	f	f	
Craibia brownii		x		f	f	f	
Crateva adansonii	f	x			f	f	
Crossopteryx febrifuga	f	f	x	f	f	f	
Crotalaria agatiflora	f	x	f	f	f	f	
Crotalaria grandibracteata					x		
Croton macrostachyus	x	x	f	f	x	x	f
Croton megalocarpus		x	f	x	x	x	f
Croton sylvaticus	f	f	f		f	x	f
Cryptosepalum exfoliatum			f		f		x
Cussonia holstii	f	x		f	f	f	
Cussonia spicata		f	x		f	f	f
Cyathea manniana	x	f	f	f	f	f	
Cynometra alexandri					f	x	
Cynometra webberi		x			f		
Dalbergia melanoxylon	x	x	x		x	x	f
Dalbergia nitidula			f	x	x	f	f
Delonix elata	f	x		x	f	f	f
Dialium orientale		x			f		
Dichrostachys cinerea	x	x	x	x	x	x	x
Diospyros abyssinica	x	x	f	w	f	x	f
Diospyros mespiliformis	x	x	x		x	x	x

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Diospyros scabra	f	x				f	
Discopodium penninervium	x	f	f	f	f	x	
Dobera glabra	x	x				f	
Dodonaea viscosa	x	x	f	x	x	x	f
Dombeya buettneri	f			f		x	
Dombeya kirkii	f	f	f	f	f	x	f
Dombeya rotundifolia	f	x	x	x	x	f	x
Dombeya torrida	x	x	w	x	f	x	
Dovyalis abyssinica	x	x	w		f	x	
Dovyalis macrocalyx		x	f	f	f	x	f
Dracaena fragrans	f	f	w	f	f	x	
Dracaena steudneri	x	x	w	x	f	x	w
Ehretia cymosa	x	x	f	f		x	
Ekebergia benguelensis		f	x		f		f
Ekebergia capensis	x	x	f	x	x	x	f
Elaeis guineensis		f	w	x	f	x	
Elaeodendron buchananii	f	x	f	x	f	f	f
Embelia schimperi	x	x	f	f	f	f	f
Encephalartos hildebrandtii		x			f	x	
Englerophytum natalense		f	f	x	f	f	
Ensete ventricosum	x	x	w	x	f	x	w
Entada abyssinica	x	x	f	x	x	x	f
Entandrophragma angolense		f			w	x	
Entandrophragma caudatum			x				f
Entandrophragma cylindricum						x	
Entandrophragma delevoyi					f		x
Entandrophragma excelsum			x	x	f	x	w
Entandrophragma utile						x	
Erica arborea	x	f		f	f	f	
Erythrina abyssinica	x	x	x	x	x	x	x
Erythrina brucei	x						
Erythrina excelsa		f			f	x	f
Erythrophleum suaveolens		f	x		f	x	f
Erythroxylum fischeri	x	f			f	f	
Euclea divinorum	f	x	f	f	x	f	f
Euclea natalensis		f	x		f		f
Euclea racemosa	x	f	f	x	f	f	f
Eugenia capensis	f	f	f	f	f	x	f
Euphorbia abyssinica	x	f	w		f	f	
Euphorbia candelabrum	x	x	w	x	f	x	w
Euphorbia tirucalli	x	x	f	x	x	x	x
Fagaropsis angolensis	x	x	f	f	x	f	w
Faidherbia albida	x	x	x		x	x	x
Faurea saligna		x	x	x	f	x	x
Ficalhoa laurifolia			f	x	f	x	f
Ficus exasperata	f	f	f	f	f	x	f
Ficus mucuso	f	w			f	x	
Ficus natalensis		f	f	x	f	f	f
Ficus ovata	f	f	f	x	f	x	f
Ficus platyphylla	f					x	

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Ficus sur	x	x	f	f	f	x	x
Ficus sycomorus	x	x	f	x	x	x	x
Ficus thonningii	f	x	f	x	x	f	f
Ficus vallis-choudae	f	f	f	x	f	x	f
Ficus vasta	f	f			w	x	w
Filicium decipiens	f	x	f		f		
Flacourtia indica	x	x	f	x	x	x	x
Flueggea virosa	x	x	f	x	f	f	f
Funtumia africana		f	f		w	x	
Funtumia elastica						x	
Galiniera saxifraga	x	f	w	x	f	f	
Garcinia buchananii	f	f	w	f	f	x	x
Garcinia livingstonei	f	x	f		x	f	f
Gardenia ternifolia	x	f		x	f	f	
Gardenia volkensii	x	x			f	f	
Grewia bicolor	x	x	f	x	x	x	f
Grewia ferruginea	x						
Grewia plagiophylla		x			f		
Grewia similis	f	f		x	x	f	
Grewia villosa	x	x			x	f	
Guarea cedrata						x	
Guibourtia coleosperma							x
Hagenia abyssinica	x	x	f	x	x	x	f
Hallea stipulosa						x	w
Harrisonia abyssinica	f	x	f	f	f	f	f
Harungana madagascariensis		x	f	x	f	x	f
Hexalobus monopetalus			f		f	f	x
Hibiscus diversifolius	f	f	f	x	f	f	f
Holoptelea grandis						x	
Hymenaea verrucosa		x			x		
Hypericum quartinianum	x	f	f		f	f	f
Hypericum revolutum	x	f	f	x	f	f	f
Hypericum roeperanum	x	f			f	f	f
Hyphaene compressa	f	x			f		
Hyphaene petersiana					f		x
Hyphaene thebaica	x						
Ilex mitis	x	x	f	x	f	x	f
Indigofera swaziensis		f			x	f	
Jatropha curcas	x	x	f	x	f	x	f
Jatropha multifida		f	f		f	x	f
Juniperus procera	x	x	x		x	x	
Justicia schimperiana	x	f			f		
Khaya anthotheca			x		x	x	x
Khaya grandifoliola						x	
Kigelia africana	x	x	x	x	x	x	x
Kigelia moosa		f		x	f	f	
Kirkia acuminata			x		f		x
Landolphia buchananii	f	x	f		f	f	f
Landolphia kirkii		x	f		f		f
Lannea barteri	f					x	

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Lannea fulva		x		x	f	x	
Lannea schimperi	f	x	f	x	f	f	f
Lannea schweinfurthii	f	x	x	x	x	x	x
Lannea welwitschii	x	f			w	x	
Lawsonia inermis	x	x			x	f	
Lecaniodiscus fraxinifolius	f	x	f		f	f	f
Lepidotrichilia volkensii	x	f	f	f	f	f	w
Leptadenia hastata	f	x					
Lonchocarpus capassa			x		x		x
Lovoa swynnertonii		f			f	x	
Lovoa trichilioides				f	f	x	
Macaranga capensis	f	x	f	x	f	x	f
Maerua decumbens	f	x			f	f	
Maesa lanceolata	x	f	x	x	f	x	f
Maesopsis eminii		x		x	f	x	w
Manilkara butugii	x	f				f	
Manilkara dawei					f	x	
Manilkara mochisia		x	f		f		f
Manilkara sansibarensis		x			f		
Manilkara sulcata		x			f		
Margaritaria discoidea	f	x	f		f	x	f
Markhamia lutea	x	x		x	f	x	
Markhamia obtusifolia		f	x	x	f		x
Markhamia zanzibarica		f	x		f	f	f
Maytenus acuminata		f	f	x	f	f	f
Maytenus arbutifolia	x	f		f	f	f	
Maytenus senegalensis	x	x	x	x	f	f	f
Maytenus undata	f	f	f	f	f	x	f
Meyna tetraphylla	f	x			f	f	
Mildbraediodendron excelsum						x	
Milicia excelsa	f	x	x	x	f	f	
Millettia dura		x	f	f	f	x	
Mimusops bagshawei		f		f	f	x	
Mimusops kummel	x	x	f		f	x	
Mimusops obtusifolia		x	f		f		
Mkilua fragrans		x			f		
Mondia whitei		x					
Monodora grandidieri		x	f		f		
Monodora myristica		f			f	x	
Morella salicifolia	x					x	
Morinda lucida					f	x	f
Moringa stenopetala	w	x					
Morus mesozygia	x	f	f		f	x	f
Mussaenda arcuata	f	f	x		f	f	
Myrianthus arboreus	w		x		f	f	
Myrianthus holstii		x	f	x	f	x	f
Myrsine africana	f	x	f	f	f	f	f
Nauclea diderrichii						x	
Neoboutonia macrocalyx		f	f	x	f	x	f
Newtonia buchananii		x	x	x	f	x	f

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Newtonia hildebrandtii		x			f		f
Nuxia congesta	x	x	x	x	f	x	f
Nuxia floribunda		f	f	x	f	f	f
Ocotea kenyensis	x	f	w	f	f	f	
Ocotea usambarensis		x	x	x	x	x	f
Olea capensis	x	x	f	f	x	x	f
Olea europaea	x	x	x	x	x	x	f
Olinia rochetiana	x	f	f	x	f	x	f
Olyra latifolia	x	f			f	f	
Oncoba spinosa	x	x	x		f	f	f
Oreobambos buchwaldii		f	x		f	f	f
Osyris lanceolata	f	x		x	x	f	
Oxystigma msoo		x			f		
Ozoroa insignis	f	x	x	x	x	x	f
Pandanus kirkii		x			f		
Pappea capensis	f	x	f	x	x	f	f
Parinari curatellifolia		x	x	x	x	x	x
Parinari excelsa			x	x	f	f	f
Parkia filicoidea		x	x		f	x	x
Parkinsonia aculeata	x	x			x	x	
Pavetta crassipes	f	x			f	f	
Pavetta oliveriana	x	f		f	f	f	
Peddiea fischeri		f		x	f	x	
Phoenix dactylifera	x	x			f		
Phoenix reclinata	x	x	w	x	x	x	x
Phytolacca dodecandra	x	f	f	f	f	x	f
Piliostigma thonningii	x	x	x	f	x	x	x
Piptadeniastrum africanum						x	
Pistacia aethiopica	f	x			f	f	
Pittosporum viridiflorum	x	f	f	f	f	x	f
Plectranthus barbatus	f	x			f	f	
Pleiocarpa pycnantha		f		x	f	f	f
Pleurostylia africana		f	f	x	f	f	f
Podocarpus falcatus	x	x	w	x	x	f	
Podocarpus latifolius		x	x	x	x	x	f
Podocarpus usambarensis		f			x	x	
Polyscias fulva	x	x	f	x	x	x	f
Populus ilicifolia		x			w		
Pouteria adolfi-friedericii	x	x	f	f	f	x	f
Pouteria altissima	x	f		f	f	x	f
Premna schimperi	x				f	f	
Prunus africana	x	x	x	x	x	x	f
Pseudospondias microcarpa		f		f	f	x	f
Psychotria mahonii		f	f	x	f	f	f
Psydrax parviflora	f	f	f	x	f	f	f
Psydrax schimperiana	x	f	f	x	f	f	f
Pterocarpus angolensis			x		x		x
Pterocarpus tinctorius			x		f		w
Pterolobium stellatum	f	f	f	x	f	f	f
Pterygota mildbraedii				x	w	x	f

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Pycnanthus angolensis					f	x	f
Rapanea melanophloeos	f	f	f	x	f	x	f
Raphia farinifera		x	x		f	x	
Rauvolfia caffra		x	x		x	x	f
Rauvolfia vomitoria					f	x	
Rhamnus prinoides	x	f	f	x	f	f	f
Rhamnus staddo	x	x		f	f	f	
Rhoicissus revoilii	x	f	f	f	f	f	f
Rhoicissus tridentata	x	x	f	f	f	f	f
Rhus longipes	f	f	f	x	f	f	f
Rhus natalensis	x	x	f	x	f	f	f
Rhus tenuinervis	f	x	f		f		f
Rhus vulgaris	x	x	f	f	f	f	f
Ricinodendron heudelotii		f			f	x	
Rinorea angustifolia		f		x	f	f	
Ritchiea albersii	f	f		x	f	f	f
Rosa abyssinica	x						
Rothmannia urcelliformis	f	f	w		f	x	w
Rubus apetalus	f	x	f	f	f	f	f
Rubus volkensii	f	x			f	f	
Saba comorensis	f	x					
Salvadora persica	x	x	f		x	f	f
Sambucus ebulus		f			f	x	
Schefflera abyssinica	x	f	f		f	f	f
Schefflera volkensii	f	f			f	x	
Schrebera alata	f	x	f	f	f	x	f
Schrebera arborea		w				x	
Sclerocarya birrea	x	x	x		x	x	x
Scutia myrtina	f	x	f	x	f	f	f
Securidaca longipedunculata	x	f	f	f	x	x	f
Senecio hadiensis	f	f		f	f	x	
Senna didymobotrya	x	f	f	x	f	x	f
Senna septemtrionalis		f	f	x	f	f	f
Sesbania macrantha		f	f	f	f	f	x
Sesbania sesban	x	x	f	x	x	x	x
Shirakiopsis elliptica	x	x	f	x	f	x	f
Sideroxylon inerme		x			f		
Sinarundinaria alpina	x	x	x	x	f	x	
Smilax anceps	f	f		f	f	x	
Solanecio cydoniifolius		f		f	f	x	
Solanecio mannii	f	x	w	f	f	x	w
Solanum aculeastrum		f	f	f	f	x	
Sorindeia madagascariensis		x	f		f		
Spathodea campanulata	x	x		x	x	x	x
Spirostachys venenifera		x			f		
Steganotaenia araliacea	x	f	f	f	f	x	f
Sterculia africana	x	x	f		x		x
Sterculia appendiculata		x	x		x		
Sterculia dawei		f				x	
Sterculia quinqueloba			x	f	x		x

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Sterculia tragacantha				x	f		f
Stereospermum kunthianum	x	x	f		x	x	f
Strombosia scheffleri		x	f	x	f	x	
Strychnos henningsii	x	x	f		f	f	f
Strychnos innocua	x	f	f	x	x	x	x
Strychnos lucens			f	x	f		f
Strychnos mitis	f	x	w		f	x	
Strychnos spinosa	x	x	f	x	x	x	x
Symphonia globulifera				x	f	x	f
Synsepalum brevipes		x	x		f	x	f
Syzygium cordatum		x	x	f	x	x	x
Syzygium guineense	x	x	x	x	x	x	x
Syzygium owariense			f		x	x	f
Tabernaemontana pachysiphon		f	f		f	x	f
Tabernaemontana stapfiana		f	f	x	f	f	
Tamarindus indica	x	x	x		x	x	x
Tamarix aphylla	x	f					
Tamarix nilotica	f	x			f		
Tarenna graveolens	f	f		x	f	f	
Terminalia brownii	x	x			x	x	
Terminalia prunioides	f	x			f		f
Terminalia sericea			x		x		x
Terminalia spinosa	f	x			x	f	
Tetradenia riparia	f	x		f			
Thespesia garckeana		f	f		x		x
Treculia africana		x	x		x	f	f
Trema orientalis	f	f	f	x	x	f	f
Trichilia dregeana	x	f	f		f	f	f
Trichilia emetica	x	x	x		x	f	x
Trilepisium madagascariense	x	f	f	x	f	f	f
Uapaca sansibarica			f		f	f	x
Uvaria acuminata		x					
Uvaria scheffleri		x			f	f	
Vangueria apiculata	f	x	f	x	f	f	f
Vangueria infausta		x	f	x	x	f	f
Vangueria madagascariensis	f	x	f		x	f	
Vepris dainellii	x						
Vepris nobilis	x	x	f	x	x	x	f
Vernonia amygdalina	x	x	f	x	f	f	f
Vernonia auriculifera	f	f		f	f	x	
Vernonia myriantha	f	f	f	f	x	f	f
Vitex doniana	x	x	x	f	f	x	x
Vitex ferruginea		f			f	x	w
Vitex keniensis		x					
Vitex mombassae		x			x		
Vitex payos		x			f		
Voacanga thouarsii		f	f			x	f
Warburgia ugandensis	x	x	f		x	x	
Woodfordia uniflora	x	f				f	
Xeroderris stuhlmannii		f	x		x		x

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Ximenia americana	x	x	x	x	x	x	x
Xylopia aethiopica		f			f	x	f
Xylopia parviflora	f	x	w		f	f	w
Xymalos monospora		f	x	x	f	f	
Zanha golungensis	f	f	x	f	f	f	f
Zanthoxylum chalybeum	f	x	f	x	x	x	f
Zanthoxylum gilletii	f	x		x	f	x	
Zanthoxylum rubescens		f			f	x	
Zanthoxylum usambarense	f	x		f	f		
Ziziphus abyssinica	f	x	f	f	f	x	x
Ziziphus mauritiana	x	x	f		x	f	x
Ziziphus mucronata	x	x	f	x	x	f	f
Ziziphus pubescens	x	f	f		f	f	f
Ziziphus spina-christi	x	f			f	f	

Appendix 2. Information on synonyms

We used a consistent naming system for all the species that were listed in this volume. The table immediately below shows how we reclassified some of the species that we encountered in national references. Note that we did not always use the most current name (mainly as a result of trying to use the same names of species listed in the Plant Resources of Tropical Africa (PROTA) database (URL *http://www.prota4u.org/*).

Table A2. Correspondence between species names as listed in the VECEA documentation and some synonyms of these species

Synonym	Species in VECEA
Acacia albida	*Faidherbia albida*
Acacia giraffae	*Acacia erioloba*
Acacia nubica	*Acacia oerfota*
Acacia oliveri	*Acacia senegal*
Adhatoda schimperiana	*Justicia schimperiana*
Adina microcephala	*Breonadia salicina*
Afrocarpus dawei	*Podocarpus usambarensis*
Afrocarpus gracilior	*Podocarpus falcatus*
Afrocrania volkensii	*Cornus volkensii*
Afrosersalisia cerasifera	*Synsepalum cerasiferum*
Agarista salicifolia	*Agauria salicifolia*
Albizia fastigiata	*Albizia adianthifolia*
Albizia maraguensis	*Albizia schimperiana*
Aningeria adolfi-friedericii	*Pouteria adolfi-friedericii*
Aningeria altissima	*Pouteria altissima*
Aningeria pseudoracemosa	*Pouteria pseudoracemosa*
Annona chrysophylla	*Annona senegalensis*
Anthocleista zambesiaca	*Anthocleista grandiflora*
Antiaris usambarensis	*Antiaris toxicaria*
Arundinaria alpina	*Sinarundinaria alpina*
Azanza garckeana	*Thespesia garckeana*
Bauhinia macrantha	*Bauhinia petersiana*
Bauhinia thonningii	*Piliostigma thonningii*
Bequaertiodendron natalense	*Englerophytum natalense*
Blepharis caloneura	*Blepharis maderaspatensis*
Breonadia microcephala	*Breonadia salicina*
Bridelia scleeroneuroides	*Bridelia scleroneura*
Byrsocarpus orientalis	*Rourea orientalis*
Canthium frangula	*Canthium glaucum*
Canthium rubrocostatum	*Psydrax parviflora*
Canthium schimperanum	*Psydrax schimperiana*
Canthium vulgare	*Psydrax parviflora*
Carapa grandiflora	*Carapa procera*
Carissa edulis	*Carissa spinarum*
Cassia didymobotrya	*Senna didymobotrya*
Cassia floribunda	*Senna septemtrionalis*
Cassine buchananii	*Elaeodendron buchananii*
Cassipourea celliottii	*Cassipourea malosana*
Cassipourea congensis	*Cassipourea malosana*

Synonym	Species in VECEA
Cassipourea ruwensorensis	*Cassipourea ruwensoriensis*
Celtis durandii	*Celtis gomphophylla*
Celtis wightii	*Celtis philippensis*
Cephaelis peduncularis	*Psychotria peduncularis*
Chlorophora excelsa	*Milicia excelsa*
Cleistanthus milleri	*Cleistanthus polystachyus*
Cola microcarpa	*Cola greenwayi*
Coleus barbatus	*Plectranthus barbatus*
Combretum binderianum	*Combretum collinum*
Combretum mechowianum	*Combretum collinum*
Commiphora zimmermannii	*Commiphora eminii*
Conopharyngia holstii	*Tabernaemontana pachysiphon*
Cordia ovalis	*Cordia monoica*
Cordia rothii	*Cordia sinensis*
Crassocephalum mannii	*Solanecio mannii*
Cryptosepalum pseudotaxus	*Cryptosepalum exfoliatum*
Cylicodiscus battiscombei	*Newtonia paucijuga*
Diospyros bussei	*Diospyros consolatae*
Dodonaea angustifolia	*Dodonaea viscosa*
Dombeya bagshawei	*Dombeya buettneri*
Dombeya goetzenii	*Dombeya torrida*
Dombeya leucoderma	*Dombeya torrida*
Dombeya mukole	*Dombeya kirkii*
Dovyalis engleri	*Dovyalis abyssinica*
Ekebergia rueppelliana	*Ekebergia capensis*
Ekebergia senegalensis	*Ekebergia capensis*
Erythrina tomentosa	*Erythrina abyssinica*
Erythrophleum guineense	*Erythrophleum suaveolens*
Euclea latidens	*Euclea racemosa*
Euclea schimperi	*Euclea racemosa*
Eugenia bukobensis	*Eugenia capensis*
Euphorbia obovalifolia	*Euphorbia abyssinica*
Excoecaria venenifera	*Spirostachys venenifera*
Fagara chalybea	*Zanthoxylum chalybeum*
Ficus burkei	*Ficus thonningii*
Ficus capensis	*Ficus sur*
Ficus congensis	*Ficus trichopoda*
Ficus dekdekana	*Ficus thonningii*
Funtumia latifolia	*Funtumia africana*
Gardenia jovis-tonantis	*Gardenia ternifolia*
Gardenia spatulifolia	*Gardenia volkensii*
Grewia platyclada	*Grewia flavescens*
Grumilea megistosticta	*Psychotria mahonii*
Hagenia anthelmintica	*Hagenia abyssinica*
Haplocoelum gallaense	*Haplocoelum foliolosum*
Harrisonia occidentalis	*Harrisonia abyssinica*
Heeria reticulata	*Ozoroa insignis*
Hexalobus monopetalanthus	*Hexalobus monopetalus*
Hippocratea parvifolia	*Loeseneriella parvifolia*
Hypericum keniense	*Hypericum revolutum*

Synonym	Species in VECEA
Hypericum lanceolatum	*Hypericum revolutum*
Hyphaene parvula	*Hyphaene coriacea*
Hyphaene ventricosa	*Hyphaene petersiana*
Hypoestes verticillaris	*Hypoestes forskaolii*
Iboza riparia	*Tetradenia riparia*
Khaya nyasica	*Khaya anthotheca*
Kigelia aethiopum	*Kigelia africana*
Lannea stuhlmannii	*Lannea schweinfurthii*
Lepisanthes senegalensis	*Aphania senegalensis*
Lovoa brownii	*Lovoa trichilioides*
Macaranga kilimandscharica	*Macaranga capensis*
Macaranga pynaertii	*Macaranga spinosa*
Maerua edulis	*Maerua decumbens*
Maerua subcordata	*Maerua decumbens*
Markhamia acuminata	*Markhamia zanzibarica*
Markhamia platycalyx	*Markhamia lutea*
Memecylon buchananii	*Warneckea sansibarica*
Memecylon sansibaricum	*Warneckea sansibarica*
Mimusops fruticosa	*Mimusops obtusifolia*
Mimusops ugandensis	*Mimusops bagshawei*
Mitragyna rubrostipulata	*Hallea rubrostipulata*
Mitragyna stipulosa	*Hallea stipulosa*
Mondia whytei	*Mondia whitei*
Morus excelsa	*Milicia excelsa*
Myrsine melanophloeos	*Rapanea melanophloeos*
Nesogordonia parvifolia	*Nesogordonia holtzii*
Nuxia usambarensis	*Nuxia floribunda*
Ochna longipes	*Ochna holstii*
Olea africana	*Olea europaea*
Olea chrysophylla	*Olea europaea*
Olea hochstetteri	*Olea capensis*
Olea welwitschii	*Olea capensis*
Olinia usambarensis	*Olinia rochetiana*
Ostryoderris stuhlmannii	*Xeroderris stuhlmannii*
Osyris abyssinica	*Osyris lanceolata*
Osyris compressa	*Osyris lanceolata*
Ozoroa reticulata	*Ozoroa insignis*
Pachystela brevipes	*Synsepalum brevipes*
Pachystela msolo	*Synsepalum msolo*
Phyllanthus discoideus	*Margaritaria discoidea*
Piptadeniastrum buchananii	*Newtonia buchananii*
Pittosporum malosanum	*Pittosporum viridiflorum*
Pittosporum mildbraedii	*Pittosporum viridiflorum*
Pittosporum rhodesicum	*Pittosporum viridiflorum*
Pittosporum spathicalyx	*Pittosporum viridiflorum*
Plectronia schimperiana	*Psydrax schimperiana*
Podocarpus gracilior	*Podocarpus falcatus*
Podocarpus milanjianus	*Podocarpus latifolius*
Popowia obovata	*Friesodielsia obovata*
Pterocarpus antunesii	*Pterocarpus lucens*

Synonym	Species in VECEA
Pterocarpus holstii	*Pterocarpus tinctorius*
Pterocarpus stolzii	*Pterocarpus tinctorius*
Pterolobium lacerans	*Pterolobium stellatum*
Pygeum africanum	*Prunus africana*
Rapanea pulchra	*Rapanea melanophloeos*
Rauvolfia inebriens	*Rauvolfia caffra*
Rauvolfia obliquinervis	*Rauvolfia caffra*
Rauvolfia oxyphylla	*Rauvolfia caffra*
Rhodognaphalon schumannianum	*Bombax rhodognaphalon*
Rhoicissus erythrodes	*Rhoicissus tridentata*
Rinorea ardisiiflora	*Rinorea angustifolia*
Rinorea gracilipes	*Rinorea angustifolia*
Rubus rigidus	*Rubus apetalus*
Sambucus africana	*Sambucus ebulus*
Sapium bussei	*Excoecaria bussei*
Sapium ellipticum	*Shirakiopsis elliptica*
Sclerocarya caffra	*Sclerocarya birrea*
Scutia commersonii	*Scutia myrtina*
Securinega virosa	*Flueggea virosa*
Senecio mannii	*Solanecio mannii*
Sideroxylon diospyroides	*Sideroxylon inerme*
Smilax kraussiana	*Smilax anceps*
Strychnos mellodora	*Strychnos mitis*
Syzygium parvifolium	*Syzygium guineense*
Tabernaemontana angolensis	*Tabernaemontana pachysiphon*
Tabernaemontana holstii	*Tabernaemontana pachysiphon*
Tabernaemontana johnstonii	*Tabernaemontana stapfiana*
Teclea fischeri	*Vepris trichocarpa*
Teclea nobilis	*Vepris nobilis*
Teclea simplicifolia	*Vepris simplicifolia*
Teclea trichocarpa	*Vepris trichocarpa*
Terminalia aemula	*Terminalia sambesiaca*
Trema guineensis	*Trema orientalis*
Trichilia volkensii	*Lepidotrichilia volkensii*
Trichocladus malosanus	*Trichocladus ellipticus*
Vangueria acutiloba	*Vangueria madagascariensis*
Vernonia ampla	*Vernonia myriantha*
Vitex amboniensis	*Vitex ferruginea*
Xeromphis nilotica	*Catunaregam nilotica*
Ximenia caffra	*Ximenia americana*

Appendix 3. Information on botanical families

Table A3. Species arranged by family or subfamily (species from the Fabaceae family were listed separately for the *Caesalpinioideae, Mimosoideae* and *Papilionoideae* subfamilies)

Family	Species
Acanthaceae	*Blepharis maderaspatensis*
	Hypoestes forskaolii
	Justicia schimperiana
Alangiaceae	*Alangium chinense*
Amaranthaceae	*Achyranthes aspera*
	Pupalia lappacea
Anacardiaceae	*Lannea barteri*
	Lannea fulva
	Lannea schimperi
	Lannea schweinfurthii
	Lannea welwitschii
	Ozoroa insignis
	Pistacia aethiopica
	Pseudospondias microcarpa
	Rhus longipes
	Rhus natalensis
	Rhus tenuinervis
	Rhus vulgaris
	Sclerocarya birrea
	Sorindeia madagascariensis
Annonaceae	*Annona senegalensis*
	Anonidium usambarense
	Enantia kummeriae
	Friesodielsia obovata
	Greenwayodendron suaveolens
	Hexalobus monopetalus
	Isolona heinsenii
	Mkilua fragrans
	Monanthotaxis fornicata
	Monodora grandidieri
	Monodora myristica
	Polyceratocarpus scheffleri
	Uvaria acuminata
	Uvaria leptocladon
	Uvaria scheffleri
	Uvariodendron anisatum
	Xylopia aethiopica
	Xylopia parviflora
	Xylopia rubescens
Apiaceae	*Steganotaenia araliacea*

Family	Species
Apocynaceae	*Acokanthera oppositifolia*
	Acokanthera schimperi
	Alstonia boonei
	Baissea wulfhorstii
	Carissa spinarum
	Funtumia africana
	Funtumia elastica
	Landolphia buchananii
	Landolphia kirkii
	Mondia whitei
	Pleiocarpa pycnantha
	Rauvolfia caffra
	Rauvolfia vomitoria
	Saba comorensis
	Tabernaemontana elegans
	Tabernaemontana pachysiphon
	Tabernaemontana stapfiana
	Voacanga thouarsii
Aquifoliaceae	*Ilex mitis*
Araceae	*Typhonodorum lindleyanum*
Araliaceae	*Cussonia holstii*
	Cussonia spicata
	Cussonia zimmermannii
	Polyscias fulva
	Schefflera abyssinica
	Schefflera volkensii
Arecaceae	*Borassus aethiopum*
	Elaeis guineensis
	Hyphaene compressa
	Hyphaene coriacea
	Hyphaene petersiana
	Hyphaene thebaica
	Phoenix dactylifera
	Phoenix reclinata
	Raphia farinifera
Asclepiadaceae	*Calotropis procera*
	Leptadenia hastata
Asteraceae	*Brachylaena huillensis*
	Senecio hadiensis
	Solanecio cydoniifolius
	Solanecio mannii
	Vernonia amygdalina
	Vernonia auriculifera
	Vernonia myriantha

Family	Species
Balanitaceae	*Balanites aegyptiaca*
	Balanites maughamii
	Balanites wilsoniana
Berberidaceae	*Berberis holstii*
Bignoniaceae	*Fernandoa magnifica*
	Kigelia africana
	Kigelia moosa
	Markhamia lutea
	Markhamia obtusifolia
	Markhamia zanzibarica
	Spathodea campanulata
	Stereospermum kunthianum
Bombacaceae	*Adansonia digitata*
	Bombax buonopozense
	Bombax rhodognaphalon
	Ceiba pentandra
Boraginaceae	*Cordia africana*
	Cordia millenii
	Cordia monoica
	Cordia sinensis
	Ehretia cymosa
Burseraceae	*Canarium schweinfurthii*
	Commiphora angolensis
	Commiphora baluensis
	Commiphora campestris
	Commiphora eminii
	Commiphora engleri
	Commiphora merkeri
Canellaceae	*Warburgia ugandensis*
Capparidaceae	*Boscia albitrunca*
	Boscia coriacea
	Boscia salicifolia
	Cadaba farinosa
	Capparis tomentosa
	Crateva adansonii
	Maerua decumbens
	Ritchiea albersii
	Thylachium africanum
Caprifoliaceae	*Sambucus ebulus*
Caricaceae	*Cylicomorpha parviflora*
Celastraceae	*Catha edulis*
	Elaeodendron buchananii
	Loeseneriella parvifolia
	Maytenus acuminata

Family	Species
Celastraceae	*Maytenus arbutifolia*
	Maytenus senegalensis
	Maytenus undata
	Pleurostylia africana
Chrysobalanaceae	*Magnistipula butayei*
	Maranthes goetzeniana
	Parinari curatellifolia
	Parinari excelsa
Clusiaceae	*Allanblackia stuhlmannii*
	Garcinia buchananii
	Garcinia livingstonei
	Garcinia smeathmannii
	Harungana madagascariensis
	Hypericum quartinianum
	Hypericum revolutum
	Hypericum roeperanum
	Symphonia globulifera
Combretaceae	*Combretum celastroides*
	Combretum collinum
	Combretum elaeagnoides
	Combretum imberbe
	Combretum mossambicense
	Combretum schumannii
	Combretum zeyheri
	Terminalia brownii
	Terminalia prunioides
	Terminalia sambesiaca
	Terminalia sericea
	Terminalia spinosa
Connaraceae	*Rourea orientalis*
Cornaceae	*Cornus volkensii*
Cupressaceae	*Juniperus procera*
	Widdringtonia whytei
Cyatheaceae	*Cyathea dregei*
	Cyathea humilis
	Cyathea manniana
Dipterocarpaceae	*Marquesia acuminata*
	Marquesia macroura
Dracaenaceae	*Dracaena camerooniana*
	Dracaena fragrans
	Dracaena steudneri
Ebenaceae	*Diospyros abyssinica*
	Diospyros consolatae
	Diospyros cornii

Family	Species
Ebenaceae	*Diospyros gabunensis*
	Diospyros mespiliformis
	Diospyros quiloensis
	Diospyros scabra
	Diospyros squarrosa
	Euclea divinorum
	Euclea natalensis
	Euclea racemosa
Ericaceae	*Agauria salicifolia*
	Erica arborea
Erythroxylaceae	*Erythroxylum fischeri*
Euphorbiaceae	*Acalypha chirindica*
	Alchornea hirtella
	Alchornea occidentalis
	Antidesma venosum
	Bridelia brideliifolia
	Bridelia micrantha
	Bridelia scleroneura
	Cleistanthus polystachyus
	Croton dichogamus
	Croton gratissimus
	Croton macrostachyus
	Croton megalocarpus
	Croton pseudopulchellus
	Croton scheffleri
	Croton sylvaticus
	Drypetes gerrardii
	Erythrococca menyhartii
	Euphorbia abyssinica
	Euphorbia candelabrum
	Euphorbia dawei
	Euphorbia grandicornis
	Euphorbia tirucalli
	Excoecaria bussei
	Flueggea virosa
	Jatropha curcas
	Jatropha multifida
	Macaranga capensis
	Macaranga monandra
	Macaranga schweinfurthii
	Macaranga spinosa
	Margaritaria discoidea
	Neoboutonia macrocalyx
	Oldfieldia somalensis

Family	Species
Euphorbiaceae	*Pycnocoma littoralis*
	Ricinodendron heudelotii
	Shirakiopsis elliptica
	Spirostachys venenifera
	Spondianthus preussii
	Suregada procera
	Suregada zanzibariensis
	Uapaca guineensis
	Uapaca sansibarica
Flacourtiaceae	*Bivinia jalbertii*
	Casearia battiscombei
	Dovyalis abyssinica
	Dovyalis macrocalyx
	Flacourtia indica
	Grandidiera boivinii
	Kiggelaria africana
	Ludia mauritiana
	Oncoba spinosa
Hamamelidaceae	*Trichocladus ellipticus*
Icacinaceae	*Apodytes dimidiata*
Irvingiaceae	*Klainedoxa gabonensis*
Lamiaceae	*Plectranthus barbatus*
	Tetradenia riparia
Lauraceae	*Beilschmiedia ugandensis*
	Ocotea kenyensis
	Ocotea usambarensis
Lecythidaceae	*Barringtonia racemosa*
Leguminosae: Caesalpinioideae	*Afzelia quanzensis*
	Anthonotha pynaertii
	Baikiaea insignis
	Baikiaea plurijuga
	Bauhinia petersiana
	Berlinia giorgii
	Brachystegia longifolia
	Brachystegia spiciformis
	Caesalpinia decapetala
	Caesalpinia volkensii
	Cassia abbreviata
	Cordyla africana
	Cryptosepalum exfoliatum
	Cynometra alexandri
	Cynometra webberi
	Daniellia alsteeniana
	Delonix elata

Family	Species
Leguminosae: Caesalpinioideae	*Dialium orientale*
	Englerodendron usambarense
	Erythrophleum suaveolens
	Guibourtia coleosperma
	Hymenaea verrucosa
	Isoberlinia scheffleri
	Julbernardia magnistipulata
	Mildbraediodendron excelsum
	Monopetalanthus richardsiae
	Oxystigma msoo
	Paramacrolobium coeruleum
	Parkinsonia aculeata
	Piliostigma thonningii
	Pterolobium stellatum
	Scorodophloeus fischeri
	Senna didymobotrya
	Senna septemtrionalis
	Tamarindus indica
	Zenkerella capparidacea
Leguminosae: Mimosoideae	*Acacia abyssinica*
	Acacia asak
	Acacia ataxacantha
	Acacia brevispica
	Acacia bussei
	Acacia drepanolobium
	Acacia elatior
	Acacia erioloba
	Acacia fleckii
	Acacia galpinii
	Acacia gerrardii
	Acacia hockii
	Acacia kirkii
	Acacia lahai
	Acacia mearnsii
	Acacia mellifera
	Acacia nigrescens
	Acacia nilotica
	Acacia oerfota
	Acacia polyacantha
	Acacia robusta
	Acacia senegal
	Acacia seyal
	Acacia sieberiana
	Acacia tortilis

Family	Species
Leguminosae: Caesalpinioideae	*Acacia xanthophloea*
	Albizia adianthifolia
	Albizia anthelmintica
	Albizia coriaria
	Albizia glaberrima
	Albizia grandibracteata
	Albizia gummifera
	Albizia malacophylla
	Albizia petersiana
	Albizia saman
	Albizia schimperiana
	Albizia versicolor
	Albizia zimmermannii
	Albizia zygia
	Dichrostachys cinerea
	Entada abyssinica
	Faidherbia albida
	Newtonia buchananii
	Newtonia erlangeri
	Newtonia hildebrandtii
	Newtonia paucijuga
	Parkia filicoidea
	Piptadeniastrum africanum
	Tetrapleura tetraptera
Leguminosae: Papilionoideae	*Baphia abyssinica*
	Baphia massaiensis
	Craibia brownii
	Crotalaria agatiflora
	Crotalaria grandibracteata
	Dalbergia martinii
	Dalbergia melanoxylon
	Dalbergia nitidula
	Erythrina abyssinica
	Erythrina brucei
	Erythrina excelsa
	Erythrina sacleuxii
	Indigofera swaziensis
	Lonchocarpus capassa
	Lonchocarpus nelsii
	Millettia dura
	Millettia usaramensis
	Pterocarpus angolensis
	Pterocarpus lucens
	Pterocarpus mildbraedii

Family	Species
Leguminosae: Papilionoideae	*Pterocarpus tinctorius*
	Schefflerodendron usambarense
	Sesbania macrantha
	Sesbania sesban
	Xanthocercis zambesiaca
	Xeroderris stuhlmannii
Loganiaceae	*Anthocleista grandiflora*
	Anthocleista schweinfurthii
	Buddleja polystachya
	Nuxia congesta
	Nuxia floribunda
	Strychnos henningsii
	Strychnos innocua
	Strychnos lucens
	Strychnos mitis
	Strychnos potatorum
	Strychnos spinosa
	Strychnos usambarensis
Lythraceae	*Lawsonia inermis*
Lythraceae	*Woodfordia uniflora*
Malvaceae	*Abutilon angulatum*
	Hibiscus diversifolius
	Hibiscus tiliaceus
	Thespesia danis
	Thespesia garckeana
Melastomataceae	*Warneckea sansibarica*
Meliaceae	*Carapa procera*
	Ekebergia benguelensis
	Ekebergia capensis
	Entandrophragma angolense
	Entandrophragma caudatum
	Entandrophragma cylindricum
	Entandrophragma delevoyi
	Entandrophragma excelsum
	Entandrophragma utile
	Guarea cedrata
	Khaya anthotheca
	Khaya grandifoliola
	Lepidotrichilia volkensii
	Lovoa swynnertonii
	Lovoa trichilioides
	Trichilia dregeana
	Trichilia emetica
	Turraea holstii

Family	Species
Melianthaceae	*Bersama abyssinica*
Monimiaceae	*Xymalos monospora*
Moraceae	*Antiaris toxicaria*
	Ficus exasperata
	Ficus ingens
	Ficus mucuso
	Ficus natalensis
	Ficus ovata
	Ficus platyphylla
	Ficus sur
	Ficus sycomorus
	Ficus thonningii
	Ficus trichopoda
	Ficus vallis-choudae
	Ficus vasta
	Milicia excelsa
	Morus mesozygia
	Musanga cecropioides
	Myrianthus arboreus
	Myrianthus holstii
	Treculia africana
	Trilepisium madagascariense
Moringaceae	*Moringa stenopetala*
Musaceae	*Ensete ventricosum*
Myricaceae	*Morella salicifolia*
Myristicaceae	*Cephalosphaera usambarensis*
	Pycnanthus angolensis
Myrsinaceae	*Embelia schimperi*
	Maesa lanceolata
	Myrsine africana
	Rapanea melanophloeos
Myrtaceae	*Eugenia capensis*
	Syzygium cordatum
	Syzygium guineense
	Syzygium owariense
	Syzygium sclerophyllum
Ochnaceae	*Ochna holstii*
	Ochna thomasiana
Olacaceae	*Strombosia scheffleri*
	Ximenia americana
	Olea capensis
	Olea europaea
	Schrebera alata
	Schrebera arborea

Family	Species
Oliniaceae	*Olinia rochetiana*
Pandanaceae	*Pandanus kirkii*
Passifloraceae	*Adenia globosa*
Phytolaccaceae	*Phytolacca dodecandra*
Pittosporaceae	*Pittosporum viridiflorum*
Plumbaginaceae	*Plumbago zeylanica*
Poaceae	*Olyra latifolia*
	Oreobambos buchwaldii
	Sinarundinaria alpina
Podocarpaceae	*Podocarpus falcatus*
	Podocarpus gracilior
	Podocarpus henkelii
	Podocarpus latifolius
	Podocarpus usambarensis
Polygalaceae	*Securidaca longipedunculata*
Proteaceae	*Faurea saligna*
Pteridaceae	*Acrostichum aureum*
Rhamnaceae	*Berchemia discolor*
	Rhamnus prinoides
	Rhamnus staddo
	Scutia myrtina
	Ziziphus abyssinica
	Ziziphus mauritiana
	Ziziphus mucronata
	Ziziphus pubescens
	Ziziphus spina-christi
	Maesopsis eminii
Rhizophoraceae	*Cassipourea euryoides*
	Cassipourea malosana
	Cassipourea ruwensoriensis
Rosaceae	*Hagenia abyssinica*
	Prunus africana
	Rosa abyssinica
	Rubus apetalus
	Rubus volkensii
Rubiaceae	*Breonadia salicina*
	Burttdavya nyasica
	Canthium glaucum
	Canthium lactescens
	Catunaregam nilotica
	Craterispermum laurinum
	Crossopteryx febrifuga
	Galiniera saxifraga
	Gardenia imperialis

Family	Species
Olacaceae	*Gardenia ternifolia*
	Gardenia volkensii
	Hallea rubrostipulata
	Hallea stipulosa
	Meyna tetraphylla
	Morinda asteroscepa
	Morinda lucida
	Mussaenda arcuata
	Nauclea diderrichii
	Pavetta crassipes
	Pavetta oliveriana
	Psychotria mahonii
	Psychotria peduncularis
	Psydrax parviflora
	Psydrax schimperiana
	Rothmannia urcelliformis
	Tarenna graveolens
	Tarenna luteola
	Tricalysia allenii
	Vangueria apiculata
	Vangueria infausta
	Vangueria madagascariensis
Rutaceae	*Calodendrum capense*
	Citropsis daweana
	Clausena anisata
	Fagaropsis angolensis
	Vepris dainellii
	Vepris nobilis
	Vepris simplicifolia
	Vepris trichocarpa
	Zanthoxylum chalybeum
	Zanthoxylum gilletii
	Zanthoxylum rubescens
	Zanthoxylum usambarense
Salicaceae	*Populus ilicifolia*
Salvadoraceae	*Dobera glabra*
	Salvadora persica
Santalaceae	*Osyris lanceolata*
Sapindaceae	*Allophylus abyssinicus*
	Allophylus africanus
	Allophylus rubifolius
	Aphania senegalensis
	Aporrhiza nitida
	Blighia unijugata

Family	Species
Sapindaceae	*Dodonaea viscosa*
	Filicium decipiens
	Haplocoelum foliolosum
	Haplocoelum inoploeum
	Lecaniodiscus fraxinifolius
	Pappea capensis
	Zanha golungensis
Sapotaceae	*Chrysophyllum albidum*
	Chrysophyllum gorungosanum
	Chrysophyllum perpulchrum
	Chrysophyllum viridifolium
	Englerophytum natalense
	Inhambanella henriquesii
	Malacantha alnifolia
	Manilkara butugii
	Manilkara dawei
	Manilkara mochisia
	Manilkara sansibarensis
	Manilkara sulcata
	Mimusops aedificatoria
	Mimusops bagshawei
	Mimusops kummel
	Mimusops obtusifolia
	Mimusops zeyheri
	Pouteria adolfi-friedericii
	Pouteria altissima
	Pouteria pseudoracemosa
	Sideroxylon inerme
	Synsepalum brevipes
	Synsepalum cerasiferum
	Synsepalum msolo
Scrophulariaceae	*Halleria lucida*
Simaroubaceae	*Harrisonia abyssinica*
	Kirkia acuminata
Solanaceae	*Discopodium penninervium*
	Solanum aculeastrum
Srnilacaceae	*Smilax anceps*
Sterculiaceae	*Cola clavata*
	Cola greenwayi
	Dombeya buettneri
	Dombeya kirkii
	Dombeya rotundifolia
	Dombeya torrida
	Pterygota mildbraedii

Family	Species
Sterculiaceae	*Sterculia africana*
	Sterculia appendiculata
	Sterculia dawei
	Sterculia quinqueloba
	Sterculia rhynchocarpa
	Sterculia tragacantha
Steruliaceae	*Nesogordonia holtzii*
Tamaricaceae	*Tamarix aphylla*
	Tamarix nilotica
Theaceae	*Balthasaria schliebenii*
	Ficalhoa laurifolia
Thymelaeaceae	*Peddiea fischeri*
Tiliaceae	*Carpodiptera africana*
	Grewia avellana
	Grewia bicolor
	Grewia ferruginea
	Grewia flavescens
	Grewia plagiophylla
	Grewia similis
	Grewia truncata
	Grewia villosa
	Triumfetta annua
Ulmaceae	*Celtis adolfi-fridericii*
	Celtis africana
	Celtis gomphophylla
	Celtis mildbraedii
	Celtis philippensis
	Celtis toka
	Celtis zenkeri
	Chaetacme aristata
	Holoptelea grandis
	Trema orientalis
Verbenaceae	*Clerodendrum myricoides*
	Premna maxima
	Premna schimperi
	Vitex doniana
	Vitex ferruginea
	Vitex keniensis
	Vitex mombassae
	Vitex payos
Violaceae	*Rinorea angustifolia*
Vitaceae	*Cissus quadrangularis*
	Rhoicissus revoilii
	Rhoicissus tridentata
Zamiaceae	*Encephalartos hildebrandtii*

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National centre for research, education and advisory services within the fields of forest and forest products, landscape architecture and landscape management, urban planning and urban design