UNIVERSITY OF COPENHAGEN

University of Copenhagen

Potential natural vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia)

van Breugel, Paulo; Kindt, R.; Lillesø, Jens-Peter Barnekow; Bingham, M.; Demissew, Sebsebe; Dudley, C.; Friis, Ib; Gachathi, F.; Kalema, J.; Mbago, F.; Minani, V.; Moshi, H.N.; Mulumba, J.; Namaganda, M.; Ndangalasi, H.J.; Ruffo, C.K.; Jamnadass, R.; Graudal, Lars

Publication date:
2011

Document Version
Early version, also known as pre-print

Citation for published version (APA):
van Breugel, P., Kindt, R., Lillesø, J-P. B., Bingham, M., Demissew, S., Dudley, C., ... Graudal, L. O. V. (2011). Potential natural vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia): Volume 6: An overview of the methods and material used to develop the map. Forest & Landscape, University of Copenhagen. (Forest & Landscape Working Papers; No. 68/2011).

Download date: 12. Aug. 2016

FOREST & LANDSCAPE

FOREST & LANDSCAPE WORKING PAPERS 68 / 2011

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

VOLUME 6

An Overview of The Methods and Material Used to Develop The Map

P. van Breugel, R. Kindt, J-P.B. Lillesø, M. Bingham, Sebsebe Demissew, C. Dudley, I. Friis, F. Gachathi, J. Kalema, F. Mbago, V. Minani, H.N. Moshi, J. Mulumba, M. Namaganda, H.J. Ndangalasi, C.K. Ruffo, R. Jamnadass and L. Graudal

FACULTY OF LIFE SCIENCES
UNIVERSITY OF COPENHAGEN

Title
Potential Natural Vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia) Volume 6: An Overview of The Methods and Material Used to Develop The Map

Authors
van Breugel P, Kindt R, Lillesø J-PB, Bingham M, Sebsebe Demissew, Dudley C, Friis I, Gachathi F, Kalema J, Mbago F, Minani V, Moshi HN, Mulumba J, Namaganda M, Ndangalasi HJ, Ruffo CK, Jamnadass R and Graudal L.

Collaborating Partner
World Agroforestry Centre

Publisher
Forest & Landscape Denmark
University of Copenhagen
23 Rolighedsvej
DK-1958 Frederiksberg
sl@life.ku.dk
+45-33351500

Series - title and no.
Forest & Landscape Working Paper 68-2011

ISBN
ISBN 978-87-7903-562-1

Layout
Melita Jørgensen

Citation
Van Breugel P, Kindt R, Lillesø J-PB, Bingham M, Sebsebe Demissew, Dudley C, Friis I, Gachathi F, Kalema J, Mbago F, Minani V, Moshi HN, Mulumba J, Namaganda M, Ndangalasi HJ, Ruffo CK, Jamnadass R and Graudal L. 2011: Potential Natural Vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia) Volume 6: An Overview of The Methods and Material Used to Develop The Map. Forest & Landscape Working Paper 68-2011

Citation allowed with clear source indication
Written permission is required if you wish to use Forest & Landscape Denmark's name and/or any part of this report for sales and advertising purposes.

The report is available electronically from
www.sl.life.ku.dk

NORDISK MILJØMÆRKNING
541 370
TRYKSAG

Introduction

This book represents **Volume 6** 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.

Thanks to anybody in our institutions who contributed directly or indirectly to the completion of the VECEA vegetation map and its associated documentation. We especially appreciate the assistance by Nelly Mutio (as for organizing logistics for the regional workshop that we organized in 2009 and for assisting in administrative issues), Melita Jørgensen (for desktop publishing), and of Jeanette van der Steeg for helping with the final preparation of the maps for Volume 1.

Thanks to Ann Verdoodt and Eric Van Ranst (both from the University of Ghent) for compiling and sharing thematic soil maps that were derived from the soil of Rwanda (Birasa, E.C., Bizimana, I., Bouckaert, W., Gallez, A., Maesschalck, G., and Vercruysse, J. (1992). Carte Pédologique du Rwanda. Echelle: 1/250.000. Réalisée dans le cadre du projet "Carte Pédologique du Rwanda" (AGCD, CTB). AGCD (Belgique) et MINAGRI, Kigali).

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 (fc, edaphic forest type)
Fd	Afromontane single-dominant *Hagenia abyssinica* forest
Fe	Afromontane moist transitional forest
fe (no capital)	Lake Victoria *Euphorbia dawei* scrub forest (fe, 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

Abbreviation	Full
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)

Contents

Introduction i
Acknowledgements ii
Abbreviations iii
Contents v
List of Tables viii

1. Introduction 1
1.1 Background 1
1.2 The VECEA project and map 2
1.3 Data sets 5
1.4 Combining the national maps 6
1.5 Documentation of the original national vegetation maps 6
1.5.1 Ethiopia Vegetation maps 6
1.5.2 Kenya vegetation maps 7
1.5.3 Malawi vegetation maps 10
1.5.5 Tanzania vegetation maps 12
1.5.6 Uganda Vegetation maps 13
1.5.7 Zambia Vegetation maps 14
2. Ethiopia 17
2.1 Description of base maps used 17
2.2 From the base maps to regional map 17
2.2.1 Notes on mapping of mapping some of the other vegetation types 17
3. Kenya 19
3.1 Description of base maps used 19
3.2 From the base maps to the VECEA map 20
3.2.1. Vegetation map for SW Kenya 20
3.2.2 Vegetation maps of the Rangeland management handbook 20
3.2.3 Vegetation map by Moomaw 21
3.2.4 Vegetation map by Delsol 22
3.2.5 Trump vegetation map for Narok 23
3.2.6 Notes on mapping of some forest types 23
3.2.7 Notes on mapping of some woodlands and wooded grasslands vegetation types 24
3.2.8 Notes on mapping of some bushland and thicket vegetation types 26
3.2.9 Notes on mapping of mapping some of the other vegetation types 26
3.2.10 Notes on creating the composite map for Kenya 27
4. Malawi 29
4.1 Description of base maps used 29
4.2 From the base maps to the VECEA map 29

4.2.1 Notes on mapping of some forests and scrub forest vegetation types 29
4.2.2 Notes on mapping of some woodlands and wooded grasslands vegetation types 32
4.2.3 Notes on mapping of Mt. Mulanje 34
5. Rwanda 37
5.1 Description of base maps used 37
5.2 From the base maps to the VECEA map 37
5.2.1 Forests types 37
5.2.2 Bushland types 38
5.2.3 Other vegetation types 40
5.3 Reclassifying secondary types and croplands 41
6. Tanzania 42
6.1 Description of base maps used 42
6.2 From the base maps to the VECEA map 42
6.2.1 Notes on mapping of some forests and scrub forest vegetation types 43
6.2.2 Notes on mapping of some woodlands and wooded grasslands vegetation types 50
6.2.3 Notes on mapping of some bushland and thicket vegetation types 56
6.2.4 Notes on mapping of some of the other vegetation types 59
6.2.5 Areas of cultivation 63
7. Uganda 64
7.1 Description of the base maps used 64
7.2 From the base maps to the VECEA map 64
7.2.1 F1 Forest - Savanna Mosaic 65
7.2.2 F2 Forest/Savanna Mosaic 66
7.2.3 Some notes on mapping vegetation types on the Kenyan and Ugandan sides of Mount Elgon 66
7.2.4 Notes on filling in the gaps using modelling 67
8. Zambia 69
8.1 Data sources 69
8.2 From the base maps to the VECEA map 69
8.2.1 Notes on the mapping of some forests and scrub forest vegetation types 69
8.2.2 Notes on mapping of some woodlands and wooded grasslands vegetation types 72
8.2.3 Notes on mapping of some bushland and thicket vegetation types 75
9. Appendix 77
9.1 List of environmental data layers used in this study 77
9.2 Correspondence between the Ethiopian base map and the VECEA map 79
9.3 Correspondence between the kenyan base maps and the VECEA map 80

9.3.1 Some notes on the results of the modelling 90
9.4 Correspondence between the Malawi base map and the VECEA map 92
9.5 Correspondence between the Rwanda base map and the VECEA map 99
9.6 Correspondence between the ugandan base map and the VECEA map 100
9.7 Correspondence between the Zambia base map and the VECEA map 119
10. References 120

List of Tables

Table 1.1: Co-authors for the different VECEA .. 3
Table 1.2: Codes and names of the potential natural vegetation .. 4
Table 3.1: Table with vegetation maps for Kenya .. 19
Table 4.1: Table with existing vegetation maps for Malawi .. 29
Table 6.1: Table with existing vegetation maps for Tanzania .. 42
Table 6.2: Assignment (X) to forest types .. 45
Table 9.1: Secondary data sets used in the development .. 77
Table 9.2: Data sets created for this study 78
Table 9.3: Table linking the legend of the national PNV map for Ethiopia .. 79
Table 9.4: Reclassification of the vegetation map .. 80
Table 9.5: Reclassification of vegetation types .. 81
Table 9.6: Reclassification table for the conversion of the Moomaw .. 87
Table 9.7: Conversion of the vegetation types of the Delsol map .. 87
Table 9.8: Results of the modelling of PNVs in south-west Kenya .. 89
Table 9.9: Aggretation of the original vegetation units .. 92
Table 9.10: Criteria to map the distribution of forest and bamboo .. 99
Table 9.11: Criteria used to delimit the distribution area of bamboo .. 99
Table 9.12: Classification of the lowland bushland, grasslands and .. 99
Table 9.14: Results of the modelling of PNVs .. 117
Table 9.15: Results of the modelling of PNVs .. 117
Table 9.16: Reclassification table used to reclassify the vegetation .. 119

1. Introduction

1.1 Background

In the 50s to 70s of the twenties century vegetation scientists and botanists mapped the vegetation and land cover of most of eastern Africa. These maps offer an unique insight in the vegetation patterns in the region. Unique because they were based on extensive field surveys, often in combination with detailed areal photography studies by experienced field botanists and vegetation scientists. These explorers were usually able to create detailed maps of entire countries, something which has become increasingly more difficult since much larger changes and fragmentation of natural vegetation has taken place in the decades since these maps were developed.

The vegetation maps were for long periods hardly utilized outside of plant ecology circles and they became largely forgotten. A plausible explanation for the lack of interest in the vegetation maps is that during the period following the completion of the vegetation maps, there was little interest in indigenous vegetation outside of national parks and forest reserves. The main species used for e.g. industrial forest plantations and social forestry woodlots were the species that had been established by the forestry services during the colonial era – mainly Central American *Pinus* and Australian *Eucalyptus* species (Evans & Turnbull 2004).

There is however a growing interest in the use of indigenous tree species for reforestation and vegetation restoration and for use in agricultural landscapes. Bringing this into practise has been hampered by the lack of information on the growth requirements or distribution of the vast majority of native tree species. This has lead to the rediscovery of existing vegetation maps as sources of invaluable information about the regional vegetation and their species distribution.

Arguably the most important effort to date to consolidate (and enhance) the wide, but effectively unavailable body of knowledge, was by Frank White. White and a committee of experts spent 15 years compiling maps and knowledge (> 2000 sources) to create a composite vegetation map for Africa (White 1983). The map, later modified (mainly simplified) by Olson *et al.* (2001) for their global ecoregional map, is accompanied by an extensive and detailed description of the mapped vegetation types. It provides an excellent baseline for e.g., conservation planning at the continental or global level (Olson & Dinerstein 2002). However, the map comes at a very large scale (1:5 million), while the compiled information from different sources was strongly aggregated (most mapping units represent compound vegetation types). This makes the map less useful for use at a national or sub-national level.

1.2 The VECEA project and map

Existing national vegetation maps often offer much higher levels of detail. However, most are only available as paper maps, often in a few locations only, impeding widespread use. Besides difficult to access, more detailed documentation on the different vegetation types, including information about the criteria used to define the vegetation classes and to delimit them spatially, is not always easily accessible and are in several cases only available through interactions with national botanists or ecologists. The large and extremely valuable existing body of information is thus not available for effective use.

In response to the demand for more detailed information on vegetation and species information in eastern Africa, Forest and Landscape of the Copenhagen University (FLD), the World Agroforestry Centre (ICRAF) and various partners from Ethiopia, Kenya, Tanzania, Uganda, Rwanda, Malawi and Zambia (henceforward to be called the VECEA region) joined hands within the project *"Vegetation and climate change in Eastern Africa: A high resolution digital vegetation map for land use planning, natural resource management and conservation of biodiversity in Eastern Africa (VECEA)"*. This project, funded by the Rockefeller foundation, collated, digitized and harmonized existing vegetation maps for Ethiopia, Kenya, Tanzania, Rwanda, Uganda, Malawi and Zambia (henceforward to be called the VECEA region).

Based on these maps and accompanying documentation as well as input from field experts (Table 1.1) a regional map of the potential natural vegetation map for the VECEA region was developed. The map is online available as a Google Earth layer (van Breugel *et al.* 2011) and is published as volume 1 in this series. The map is linked to a species database of useful tree species, providing a user friendly extension tools for selecting indigenous species available to farmers in specific environments for specific uses. Other potential uses are for the prediction of potential distributions of indigenous species in the agricultural landscapes and predict possible genetic variation across distributional ranges.

Table 1.1: Co-authors for the different VECEA countries involved in the making of the potential natural vegetation map for east Africa

Country	Botanical experts	Institute / affiliation
Ethiopia	Sebsebe Demissew	The National Herbarium, Addis Ababa University, PO Box 3434, Addis Ababa, Ethiopia
	I. Friis	Natural History Museum of Denmark (Botany), Gothersgade 130, DK-1123 Copenhagen K, Denmark
Kenya	F. Gachathi	Kenya Forestry Research Institute (KEFRI), PO Box 20412-00200, Nairobi, Kenya
Tanzania	F. M. Mbago	Department of Botany, University of Dar es Salaam, PO Box 35060, Dar es Salaam, Tanzania
	H.N. Moshi,	Department of Botany, University of Dar es Salaam, PO Box 35060, Dar es Salaam, Tanzania
	H.J. Ndangalasi	Department of Botany, University of Dar es Salaam, PO Box 35060, Dar es Salaam, Tanzania
Uganda	J. Kalema	Department of Botany, Makerere University, PO Box 7062, Kampala, Uganda
	M. Namaganda	Department of Botany, Makerere University, PO Box 7062, Kampala, Uganda
	J.W. Mulumba	Entebbe Botanical Gardens, National Agricultural Research Organisation, Entebbe, Uganda
Rwanda	C.K. Ruffo	Institute of Scientific and Technological Research, PO Box 227, Butare, Rwanda
	V. Védaste	Institute of Scientific and Technological Research, PO Box 227, Butare, Rwanda
Malawi	C. Dudley	University of Malawi (retired), PO Box 32086, Blantyre 3, Malawi
Zambia	M. Bingham	Private consultant

The theoretical background, rationale and potential uses of the map are presented in volume 1, the first volume in a 7 series publication. Volumes 2-5 provide more detailed information about the vegetation characteristics and species composition of the mapped potential natural vegetation types on this map. Volume 7 shows the results of modelling the distribution of potential natural vegetation types for six potential future climates.

This document is the 6th in the series and provides a description of the material and methods used to develop the regional vegetation map. The aim is to provide the user 1) a better understanding of how this regional map is related to the national vegetation and land cover maps, 2) the means and background information to reproduce or adapt the map. For rationale or theories behind the mapping of potential natural vegetation maps, references will be made to the above-mentioned volumes.

Because of the different data and information available per country, potential natural vegetation maps were first created per country. The structure of this document follows this approach, providing one chapter per country, describing the data, assumptions and methods used to create the Potential Natural Vegetation (henceforth called PNV) map per country. These were subsequently simply joined.

In a number of cases we aggregated vegetation types mapped within the countries to better align and harmonize the classification across countries. In those cases, we do provide background information about the mapping of the 'national types' too, as such information might be of interest for vegetation mapping at a national or sub-national level. The PNV types in the final regional classification are given in Table 1.2.

Table 1.2: Codes and names of the potential natural vegetation types mapped in the VECEA PNV map, as unique types or part of compound mapping units. A reference is given to the volume where the PNVs are discussed.

Code	PNV
Volume 2: Forests and edaphic forest types	
Fa	Afromontane rain forest
Fb	Afromontane undifferentiated forest (Fbu) and Afromontane single-dominant *Juniperus procera* forest (Fbj)
Fc	Afromontane single-dominant *Widdringtonia whytei* forest
Fd	Afromontane single-dominant *Hagenia abyssinica* forest
Fe	Afromontane moist transitional forest
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
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
Fs	Somalia-Masai scrub forest
fc	Zanzibar-Inhambane scrub forest on coral rag (edahpic forest type)
fe	Lake Victoria *Euphorbia dawei* scrub forest (edahpic forest type)
r	Riverine forests (edaphic forest type)edaphic forest
fs	Swamp forest (edahpic forest type)
Volume 3: Woodland and wooded grasslands and edaphic wooded grasslands	
Wb	*Vitellaria (*synonym: *Butyrospermum*) wooded grassland
Wc	*Combretum* wooded grassland
Wcm	Moist *combretum* wooded grassland (subtype of Wc)
Wcd	Dry *Combretum* wooded grassland (subtype of Wc)
Wd	*Acacia-Commiphora* deciduous wooded grassland
WdK	*Acacia tortilis* wooded grassland and woodland
We	Biotic *Acacia* wooded grassland
Wk	Kalahari woodland
Wm	Miombo woodland
Wmd	Drier miombo woodland (subtype of Wm)
Wmw	Wetter miombo woodland (subtype of Wm)
Wmr	Miombo on hills and rocky outcrops (subtype of Wm)
Wn	North Zambezian undifferentiated woodland and wooded grassland
Wo	Mopane woodland and scrub woodland
Wt	*Terminalia sericea* woodland
Wv	*Vitex - Phyllanthus - Shikariopsis (Sapium) - Terminalia* woodland and *Terminalia* glaucescens woodland (Wvt)
Wvs	*Vitex - Phyllanthus - Shikariopsis (Sapium) - Terminalia* woodland (subtype of Wv)
Wvt	*Terminalia* glaucescens woodland (subtype of Wv)
Wy	Chipya woodland and wooded grassland
wd	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils
wr	Riverine woodland
P	Palm wooded grassland
Wi	Sudanian *Isoberlinia - Daniellia* woodland
Volume 4: Bushland and Thicket	
Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (synonym: deciduous bushland
Be	Evergreen and semi-evergreen bushland and thicket
bi	Itigi thicket (edaphic vegetation type)
br	Riverine thicket (edaphic vegetation type
E	Montane Ericaceous belt
T	*Termitaria* vegetation, including bush groups around *termitaria* within grassy drainage zones (mapped as T/g)

Code	PNV
-	Kalahari thicket
-	*Commiphora - Euphorbia - Lannea* Bushland
-	Zambezian rupicolous bushland and thicket
Volume 5: Other potential natural vegetation types	
A	Afroalpine vegetation
B	Afromontane bamboo
D	Desert
G	Grassland (excluding semi-desert grassland and edaphic grassland, also referred to as climatic grassland)
L	Lowland bamboo
M	Mangrove
S	Somalia-Masai semi-desert grassland and shrubland
X	Fresh-water swamp
Z	Halophytic vegetation
g	Edaphic grassland on drainage-impeded or seasonally flooded soils
gv	Edaphic grassland on volcanic soils
s	Vegetation of sands

1.3 Data sets

The VECEA map is based on a number of national and regional vegetation and land use maps as well as the continental vegetation map by White (1983). The different maps are described in more detail in section 1.5. The White and the Rangeland Management Handbook (Herlocker, Shaabani, Stephens, *et al.* 1994; Herlocker *et al.* 1993; Herlocker, Shaabani, & Wilkes 1994a–c; Schwartz *et al.* 1991; Shaabani, Welsh, Herlocker, & Walther 1992a–c) map were already available in digital format. The other maps were digitized in ArcGIS as shapefiles and subsequently imported in a GRASS GIS database (version 6.4) (GRASS Development Team 2010) with SQLite database back-end for further processing and analysis.

The national and local maps differ considerably in terms of underlying classification systems, scale or resolutions of the maps and level of detail of the legend. The national (or sub-national) maps could therefore not be simple patched together. Instead, we used a reiterative process involving field experts from the countries (Table 1.1) and an extensive literature review of existing information to 'translate' nationally defined vegetation types into regional potential vegetation types. Where this was not possible due to lack of documentation, spatial analysis and modelling was used to fill in the blanks. Where available, additional information was used to further refine the map and to align the national maps. See also volume 2-5 for more detailed information.

In most countries we used auxiliary environmental data to define distribution limits of one or more of the PNVs that could not be mapped based on the (sub-) national vegetation maps only. Table 9.1 in Appendix 9 provides a list of the secondary data sets used. Additional environmental data layers that were created for this study are shown in Table 9.2 in Appendix 9.1. All vector maps were rasterized to a 3 arc seconds (≈ 90 meter at the equator) raster. Likewise, rasters were rescaled to 3 arc seconds, aligning the data layers with the highest resolution data layer available; the SRTM 90m digital elevation data layer).

1.4 Combining the national maps

The national maps all are based on the same regional classification scheme, although some sub-types were only mapped in specific countries and lumped with the main type on the regional map, as indicated in the country sections above.

Where vegetation types on maps of neighbouring countries did not align well, we revisited the evidence for the classification of those areas and make adjustments were needed (also explained in the country sections). Creating the regional map was therefore a matter of combining the different 'national' maps. Along some boundaries, the maps did not align completely, leaving some small gaps. Here we classified the empty cells based on their nearest neighbouring cells (mode of the 9 nearest neighbouring cells, carried out repetitively until all no-value cells were classified).

The main areas where there is a mismatch in the classification of vegetation types is along the border of Ethiopia and Kenya. Most areas on the Ethiopian side of the border are classified as Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd), with fewer areas mapped as Somalia-Masai semi-desert grassland and shrubland (S) or desert (D). A smaller area along Lake Tana is classified as dry *combretum* woodland. On the Kenyan side, these types plus a sub-type of Bd, *Acacia-Commiphora* stunted bushland (Bds), are mapped separately.

We looked at using modelling to create probability distribution models of the above-mentioned types, and to extrapolate these models to map the distribution of these types in Ethiopia. However, the distributions of these types are strongly influenced by edaphic types. There are no good edaphic/soil maps, making the modelling of these types, and especially the extrapolation of model results less reliable. We therefore decided to use the national maps, accepting some misalignments of vegetation types along the boundary.

1.5 Documentation of the original national vegetation maps

The vegetation maps for the countries have different histories, but in most cases were made at a level of detailed field work that is rarely met today (see also discussion in volume 1 of this series of documents). In this section we document how the original maps were made, while in the following chapters we document the process of making the VECEA map.

1.5.1 Ethiopia Vegetation maps

Vegetation maps used: Friis, Demissew, and van Breugel (2010).
Area: Country of Ethiopia
Scale and number of classes: 1:2,000,000. 12 major types, 5 of which with 12 subtypes.

How vegetation map was elaborated: For Ethiopia the potential natural vegetation map developed by Friis *et al.* (2010) was used. This map is a combination of the new vegetation map needed for the Ethiopian Flora Project,

and at the same time an input for Ethiopia to the VECEA-project, a substitute for the previous regional vegetation maps that were never produced for Ethiopia. The map was developed based on a review by Friis *et al.* (2010) of existing information on the vegetation of Ethopia.

Maps reviewed by the authors included the map by Pichi Sermolli (1957), and the Vegetation map of Africa (White, 1983). It furthermore included a detailed discussion of the vegetation types of Ethiopia by Breitenbach (1963), the analyses of the forests of the Horn of Africa by Friis (1992) and a new synthesis of a generalised map of the vegetation of Ethiopia on a small scale by Friis & Demissew (2001). One of the conclusions was that existing maps were lacking in quality and level of detail. Friis *et al.* (2010) developed the new vegetation map based on a set of classification criteria defining the altitudinal and rainfall limits for each of the vegetation types. In addition maps based on field observations from Ib Friis and Sebsebe Demissew were used, supplemented by forest maps of the south-west Ethiopia Forest Inventory Project (Chaffey 1978a-d).

The vegetation of Ethiopia has been divided into twelve major types, some of these divided into subtypes. The vegetation types are based on information from previous literature, field experience of the authors, as well as on an analysis of the information for about 1300 species of woody plants in the *Flora of Ethiopia and Eritrea*. Of the vegetation types and subtypes described in the text, fifteen units that have large enough extension are mapped and defined in relation to topographic features (altitude, rivers and lakes) and rainfall.

1.5.2 Kenya vegetation maps

Vegetation maps used: Trapnell and Brunt map (Kindt *et al.* 2005; Trapnell *et al.* (1966), Trapnell *et al.* (1976), Trapnell *et al.* (1969), Trapnell *et al.* (1986); Rangeland Management Handbook of Kenya RMHK map (Herlocker, 1994). Momaw Map (Moomaw 1960). Trump map (Trump, 1972); Mangrove map (Taylor et al, 2003); Delsol map (1995).
Area: Order of preference: Southwest Kenya: Trapnell and Brunt map, Narok District: Trump map. Northern Kenya: RMHK map. Mangroves: the mangrove map. Coast of Kenya: Moomaw map (but see section 3.5.1), the whole of Kenya (used to fill-in areas not covered by other maps): Delsol map. Figure 7i shows how the different maps contributed to classification of the national map.
Scale and number of classes: Trapnell and Brunt map 1:250.000; 18 Main classes (50 types). Trump map: 1:250,000. 18 classes. RMHK map: 1:500,000 to 1:1,000,000, approximately 166 type names. The mangrove map: 1: 50,000 and 1: 100,000, 1 class. Moomaw map: 1:500,000, 9 main classes. Delsol map: 1: 1,000,000, 39 classes.

How vegetation maps were elaborated: Botanical surveys in Kenya have been carried out with varying degree of detail. The mapping of potential natural vegetation of the densely populated highlands of Kenya is probably (together with the map of Uganda) the most detailed of any large scale vegetation surveys in Eastern and Southern Africa. Northern Kenya was

covered in relatively good detail albeit the wide ecotones in the arid flat landscapes make boundaries between vegetation types gradual. The coastal vegetation has been influenced by humans for hundreds of years rendering classification into PNVs less certain.

Trapnell and Brunt map (Southwest Kenya): Initially reconnaissance traverses in Southwest Kenya in 1957 showed great variation plus an invasion of species proper to other zones, as a sequel to the effects of human occupation. Main field work 1959-1961 was combined with preliminary air photograph studies. The final document was published in 1987 (Trapnell & Brunt, 1987). The four sheets were published as Trapnell *et al.* (1966), Trapnell *et al.* (1976), Trapnell *et al.* (1969), Trapnell *et al.* (1986). In addition Trapnell published a document on the forests of Kenya Highlands (Trapnell, 1997) and together with Langdale-Brown a vegetation map of East Africa (Trapnell & Langdale-Brown, 1972). The Southwest Kenya map was based on reinterpretation of air photos (Royal Airforce, Hunting Surveys Ltd., Canadian Air Survey) and revision of 137 field maps (1:50.000) with a cartographic reduction to 1:250.000. A supplementary set of 1/250.000 scale climatic maps based on a topographic base from data prepared by the Meteorological Department was also used. Field work consisted of Land Rover traverses along all the tracks in the less accessible areas, and in a close network over the remainder of the area. Traverses were as close as a mile apart in the most densely populated areas and altered areas of the former Kikuyu, Embu and Meru Reserves. Changes in vegetation were recorded by plotting the detailed traverse observations on 1/50.000 maps in the field, including the results of observations with binoculars on either side of the traverse route. The field observations were subsequently transferred from the field maps to air photographs, and used as the basis for a stereoscopic study of the vegetation pattern on the air photographs. During the study the boundaries of the vegetation zones were plotted and extrapolated, before being transferred to 1: 50.000 maps. Thus although as many as three sets of air photography have been used in interpretation over large areas of the maps, it has been attempted as far as possible to plot vegetation boundaries as they were in the period around 1960. The maps therefore contain an important record of the surviving climax vegetation in about 1960. The secondary communities are shown in the map keys under the head of the climax type from which field evidence has shown them to be derived. Based on the information in the map, Kindt *et al.* (2005) digitized and converted the map into a map of potential natural vegetation (PNV).

Trump map (Narok district): E.C. Trump is co-author of Trapnell *et al.* (1969) map of Southwest Kenya, with which the northern part overlaps (the maps are in agreement). Description of methodology is not provided. Reference is to a series of documents of which the most important is "Glover, P.E., and Trump, E.C. 1970. An ecological survey of the Narok District of Kenya Masailand. Part II. Vegetation. Kenya National Parks Report". Document is not available.

RMHK map (northern Kenya): Surveys were carried out at a level between reconnaissance and extensive (as defined by Kuchler, 1967). During

the inventory and mapping of vegetation types emphasis was given to the identification of the dominant species of the principal strata (vertical layers) as per Pratt and Gwynne (1977). Location of sample areas was landscape-guided (Kuchler and Zonneveld, 1988). Local elders were interviewed on past and present types of land use and vegetational changes over two or three decades or more. Field Survey: Sample plots were located within strata made using LANDSAT satellite imagery. The strata were units of similar landform and geology. Several sample plots were placed within each type of sampling unit. Samples were placed in areas thought to be most representative of the type of mapping unit. Often, more vegetation sample sites were added (usually 5 to 10 sites) to obtain adequately representative data. The sample site locations for each vegetation type were then related to the map of landforms and soils to define vegetation type boundaries. In some cases the vegetation type boundaries were quite different from the final land form and soil mapping units. Areas which were not visited were classified by extrapolating compositional and physiognomic information from sample sites elsewhere within the same type of initial mapping unit, but only if the vegetation had previously been found to be adequately uniform. In rare cases, the vegetation type was determined from previously published surveys or by viewing the area from the air. Physiognomic types often covered large areas and could be used to generalise on the physical nature of the vegetation, vegetation-environmental relationships and the nature and extent of livestock and wildlife habitat. Smaller units were defined by the dominant and, occasionally, non-dominant differential species. These vegetation types have more narrowly defined environmental relationships and habitat characteristics.

Mangrove map by Taylor *et al*: Georeferencing of a total of 34 topographical paper maps from the Survey of Kenya at a scale of 1:50,000 and three maps in scale 1:100,000. The 1:50,000 topographical maps from Survey of Kenya were lacking for the area north of Pate Island. Therefore, features were digitized from the 1:100,000 maps covering the same area.

Moomaw map (coastal region of Kenya): A series of five transects of about 300 square miles each were mapped from unrectified aerial photographs at the 1:32,000 scale of the photos. The resultant maps were taken in the field and used as guides for locating areas for detailed studies and were themselves completed to some degree on the ground by drawing in soil boundaries and vegetation type lines. This phase of mapping was completed to varying degrees for each of the maps but only one of the more satisfactory one were reproduced in the report. From the detailed maps and information acquired from the reconnaissance surveys a map of the general ecological land use types was projected on a base map of 1:500,000 scale.. "Climax" vegetation is impossible to find in many of the areas where cultivation has been going on for a thousand years, but in many instances reasonable projections can be made. 9 broad ecological units or land use classes have been distinguished on the basis of vegetation, climate and soils. Each of these units contains subdivisions and variants bringing the total number of vegetation types recognised to nearly 30. Of the 9 basic land-use classes, only 5, or perhaps 6, are of sufficient size and agricultural importance to be of concern with respect to management. These were treated much more

fully than the others which comprise the dune sand, swamp and pond, and beach littoral communities. The vegetation types discussed are for the most part distinct and the boundaries (ecotones) between them apparent. The principal exceptions to this statement are the interfingering *Acacia* Thorn bushland types of the hinterland and the *Diospyros-Manilkara* forest and the coppice and savanna formation that takes place at the edge of the tropical rain forest types.

Delsol map (Kenya): This vegetation map of Kenya is based on interpretation of: Landsat (MSS and TM) and SPOT satellite imagery. The interpretation was based on existing vegetation maps, including White's vegetation classification for Africa (White, 1983), and field data.

1.5.3 Malawi vegetation maps

Vegetation maps used and Area: Northern part: Young, A. & Brown, P. 1962). Central part: Brown, P. & Young, A. 1965. Southern Part: Stobbs 1971. Malawi-Zambia: Rattray &Wild 1961. Whole of Malawi: Shaxon (1976). Miombo region: Timberlake and Chidumayo (2001).
Scale and number of classes: Northern part: 1:500,000. Central part: 1:500,000. Southern Part: 1:500,000. Stobbs: Malawi-Zambia: 1:2,500,000. Whole of Malawi: 1: 1,000,000. Miombo region: 1: 4,000,000?
How the vegetation map was elaborated:
Jackson's paper (Jackson, 1954) was the first to outline the vegetation types of Malawi. Jackson produced a map in 1959 which is no longer available. The first published professional vegetation for Malawi was part of a map drawn by Rattray and Wild (1961). Rattray and Wild's information regarding Malawi is referenced from Jackson. In 1965 Steel produced a 1:3,000,000 vegetation map and brief descriptions of Malawi's vegetation types within the Ministry of Natural Resources and Agriculture's annual report. Unfortunately, this map also appears to be lost. Both Jackson's and Steel's maps and descriptions were used by Wild and Barbosa (1967) in their descriptions and map of the vegetation of the Flora Zambesica Area, an area including Malawi. They increased the detail and accuracy of the boundaries of the types. In the 1960s two maps were produced which documented the geophysical, soil, vegetation, present use and preferred use for the Northern (Young 1965a) and Central (Young, 1965b) regions of Malawi (1:500,000). In 1971 Stobbs completed a similar map for the Southern Region (Stobbs, 1971). Within each of the three political Regions of Malawi they described and defined what they called "natural regions", further broken down into "natural areas". While there was some effort to rationalize a vegetation classification among these natural areas, the main objective of the work was to characterize the country's physical environment with special reference to soils and agricultural potential, not to delineate vegetation types. In 1976 Shaxson mapped the whole of the country (1:1,000,000) utilizing the vegetation types of Brown, Young and Stobbs. Based entirely on his interpretation of Young, Brown and Stobbs' vegetation analysis given in the above three maps, he attempted to harmonize their types and mapped much larger segments of the country which he defined as biotic communities. This map later formed part of the *Atlas of Malawi* (1983). While Shaxson's work is a start, his map is only as good as the

source of this data. The relationship of Shaxson's groupings and the previous three authors is not always clear and is not discussed in his accompanying text. Shaxon remarked that the majority of savannas and wooded savannas (as well as grassland, particularly those of high altitude) should probably be considered seral disturbance stages of either woodlands or forests of various types.

Two other publications need mentioning as these have contributed to vegetation classification without producing any maps. Chapman and White (1970), while focusing on Malawi's evergreen forests, also provided an analysis and framework for all other types of vegetation. The most recent analysis of Malawi's evergreen flora is that of White, Dowsett-Lemaire and Chapman (2001). The information Dowsett-Lemaire includes in her synopsis of the vegetation of Malawi (Chapter 4) provides a clear basis on which to map the forest of Malawi both floristically and geographically. She also provides further insight into the broader woodland classes. In the last 30 years there have been several vegetation community analyses and/or mappings for the country, principally focused on smaller, usually conservation areas. These efforts provided strong support for the mosaic or transitional/regressional nature of much of the country's vegetation but none attempted to put their work within the context of a broader national scale nor utilized the vegetation types published by the earlier authors.

1.5.4 Rwanda vegetation maps

Vegetation maps used: Map developed by G. Troupin published in Prioul & Sirven (1981), see also Troupin (1976). This map is almost identical to the map in Bloesch, Troupin & Derungs (2009)
Area: Country of Rwanda
Scale and number of classes: Scale not mentioned (low resolution). 17 vegetation types.
How vegetation map was elaborated: Troupin (1976) describes that the map is based on field work, as also evidenced by Troupin (1978) and Bloesch, Troupin & Derungs (2009)

Vegetation maps used: Vegetation of Volcanoes National Park (Kayijamahe, u.n.**)**
Area: Virunga Volcano National Park
Scale and number of classes: 9 vegetation classes. Raster layer with resolution of 30 meter
How vegetation map was elaborated: Remote sending and field reconnaissance survey

Vegetation maps used: a set of data layers (intern drainage of dominant soil series and soil types based on soil profiles of the dominant soils) extracted from the Rwanda Soil map scale 1:250,000 (van Birasa *et al.*, 1992) by Ann Verdoodt and Erid van Ranst of the University of Gent.
Area: Country of Rwanda
Scale and number of classes: 1:250,000.

1.5.5 Tanzania vegetation maps

Vegetation maps used: Gillman (1949)
Area: Tanzania
Scale and number of classes: 1:2,000,000, 7 natural classes, and several sub-classes
How the vegetation map was elaborated:
The map by Gillman was based on his travels in Tanzania from 1917 to 1946 covering some 27,000 kilometres of traverse surveys. The map is physiognomic and does not interpret successional relationships. Gillman elaborated a draft at 1:500,000 that was reduced to 1: 2,000,000l. Gillman gave the map three degrees of reliability high (55%), medium (25%) and low (20%). The original digitized Gillman map, was adapted slightly to align the lake boundaries better with the boundaries of the lake boundaries in the global wetland database (Lehner & Döll 2004). A substantial part of the low reliability areas were reclassified utilising the maps of the Central African rail link development survey (Colonial Office, 1952). The Gillman map is based on physiognomic criteria, whereas the PNVs are based on floristic and physiognomic criteria. For the construction of the PNV map, we therefore adapted the Gillman map to include floristic boundaries, using information from the White vegetation map (White 1983), the miombo ecoregional map (Timberlake & Chidumayo, 2011), information from (Lovett, 1990), and the Central African rail link development survey maps of southern Tanganyika (Colonial Office, 1952). Note, we didn't always use the exact floristic boundaries of above-mentioned maps, but rather adapted the boundaries to match the boundaries of the polygons on the Gillman map to avoid splitting them. Main reason was to retain the details of the Gillman map, while introducing floristic patterns based on the other maps.

Vegetation maps used: Central African rail link development survey (Colonial Office, 1952).
Area: Southeastern part of Tanzania
Scale and number of classes: Map 8: Generalised vegetation and soil map of part of Southern Province, Tanganyika - 1: 1,000,000, 9 natural types. Map 12: Provisional vegetation and soil map Southern Tanganyika - 1:500,000, 19 natural types. Map 13. Provisional vegetation and soil map Usangu Plain Tanganyika - 1:125,000, 14 types.
How vegetation map was elaborated: Field reconnaissance surveys of vegetation and soil and aerial photographs were used to draw the map. Reference is made to the Gillman map (1949).

Vegetation maps used: Timberlake, J. & Chidumayo, E. (2001, revised 2011).
Area: Revised Miombo Ecoregion in Southern Africa
Scale and number of classes: Scale unknown. Number of vegetation classes: 9
How vegetation map was elaborated: White's original vegetation map (White 1983) was used as a basis for the revision, modified using a number of national and regional studies. The final map closely follows the boundaries of the White's Zambezian Regional Centre of Endemism, except for the transition to the Guinea- Congolia and Zanzibar-Inhambane phyto-

choria. It also broadly corresponds to the broad-leaved dystrophic savanna woodlands of southern Africa (Huntley 1982).

1.5.6 Uganda Vegetation maps

Vegetation maps used: Langdale-Brown *et al.* (1964)
Area: Country of Uganda
Scale and number of classes: 1: 500,000. 22 main vegetation types, which are further subdivided into a total of 86 mapping units. Of the mapping units 40 % are derived or secondary forms, 56 % are primary whereas 4 % show affinities of both primary and secondary successional status (calculated based on the descriptions in the text).
How vegetation map was elaborated: A very detailed explanation is presented in Langdale-Brown *et al.* (1964). Ecological survey was designed to yield information which could lead to improved land-use and increased production. A field procedure was devised to combine certain aspects of the Zurich-Montpelier approach (description of uniform stands and subsequent grouping) with the mileometer traverse technique used by Trapnell in Zambia (a series of parallel traverse lines with the aid of a compass, at fixed mile interval, along which the recurrences of standardised vegetation-soil units were recorded). The field survey was limited to non-forest areas as the forests were already adequately covered by the Forest Department, and because the ecological survey was intended primarily as an aid to agricultural development. The accounts of the forests and forest resources are based on the maps, plans and reports of the Forest Department. Preliminary surveys in 1955 and 1957. Main ecological survey 3 years during 1957-1960. Positions of the vegetation boundaries were estalished by making observations on vegetation changes and other salient features of the communities and landscape on both sides of traverse lines which were routed along roads, motorable tracks and footpaths. The distances between apparent changes in the vegetation were noted together with the salient features of the communities. Details of road intersections, work drainage lines and other landmarks were also recorded to facilitate correlation of the field data with aerial photographic interpretation. The nature of the different communities recognised during the traversing and validity of the boundaries were determined by examining sample sites and recording species present and their cover-abundance, the physiognomy (with height and percentage aerial cover of the different strata), soil type and depth, and topography and drainage conditions. Notes were made on any features thought to bear on successional relationships and similar sites were visited at different times of the year to assess seasonal variations. Observations were also made of the present land-use and enquiries were made about the previous history of each area. In all four criteria were used in the classification of the samples: (a) drainage conditions; (b) physiognomy; (c) floristic composition; successional relationships. Drainage conditions and physiognomy were used in an initial sorting of the samples from each area in order to reduce the amount of work involved in the comparison of their species lists. However, these features were not allowed to override the evidence of the floristic composition or indications of successional relationships which were the main criteria used in the recognition of the different units. Consequently while the methods used

in the selection and descriptions of the sample sites were similar to those of Braun-Blanquet (op. cit) the present method of classification places a greater emphasis on successional relationships. Finally, the units were listed under type headings according to the Yangambi classification and described by compiling the information from the individual sample sites. The nature and potential distributions of the various climatic climaxes are indicated on a separate map of the main ecological zones.

Traverse density

Region	Miles of traverse	Mapped area (sq. miles)	Area per mile of traverse (sq. miles)
Eastern Region	2,550	11,000	4.3
Buganda	2,544	16,247	6.3
Northern region*	2,228	20,638	9.3
Western region	2,818	15,895	5.6
Totals and average*	10,140	63,780	6.3

Excluding Karamoja. In addition, reference was made to the traverse data of some unpublished surveys (Trapnell *et al.*, 1953; Langdale-Brown, 1955, 1957). Karamoja has been excluded from this table as owing to the wilderness and inaccessibility of much of the country many miles of traverse had to be made on foot, occasionally involving treks of as much as 50 or 60 miles. The Karamoja survey therefore involved a lower density of more detailed traverses. Source: Langdale-Brown *et al.* (1964, table 3, page 25)

1.5.7 Zambia Vegetation maps

Vegetation maps used: Edmonds (1976)
Area: Country of Zambia
Scale and number of classes: 1:500,000. 17 vegetation classes
How vegetation map was elaborated: The main reference for the map is Fanshawe (1971) in which it is stated (p.2) " A map showing the territorial distribution of the vegetation types proposed in this article, prepared largely from aerial photographs, will be published shortly". Fanshawe had also made detailed districtwise vegetation descriptions (reissued in 2010 as Fanshawe, 2010), these were presumably also available to Edmonds. Edmonds closely followed the classification of Fanshawe. Fanshawe's vegetation classification closely followed that of Trapnell (1937, 1953), see below for a description of that map. Edmonds cites sources used for interpretation of vegetation: aerial photographs, published vegetation maps; unpublished Forest Department maps and field reconnaissance.

Vegetation maps used: Smith (2001) – the Trapnell map
Area: Country of Zambia
Scale and number of classes: 1: 1,000,000. 27 vegetation classes
How vegetation map was elaborated: The main framework of the vegetation represented is the skeleton of reconnaissance traverses made by Trapnell in the course of the Ecological Survey - North Western Rhodesia (1931-1936) and North Eastern Rhodesia (1937-1942). Trapnell and coworkers developed the mileometer traverse technique - a series of parallel traverse lines with the aid of a compass, at fixed mile interval, along which the recurrences of standardised vegetation-soil units were recorded. The final map was elaborated with information from a considerable number of

surveys. This combined the results of the survey with more detailed work in Seheke and Livingstone Districts by J.D. Martin. A 1:1-000.000 sheet of North-Eastern Rhodesia north of the 13th parallel was prepared (but not published) in 1940 in connection with the Report of the Survey of North-Eastern Rhodesia while traverses south of this line were retained on larger scale maps. Upon these outlines Trapnell superimposed information derived from extensive surveys made by various members of the Agricultural Department and its Forestry Branch in the Barotse, Eastern and Western Provinces, together with an interpretation of aerial photographs in conjunction with the Geological Map in the Kaonde-Lunda Province. In the first place extensive and detailed surveys of the vegetation of a great part of Barotseland carried out by J.D. Martin in the course of his investigations of forests and forestry in Barotseland. Mongu. Mankoys, Sesheke and eastern Senanga Districts were covered by him with a network of compass and mileometer traverses, and resulted in considerable revision of the topographic maps of these districts. Further mileometer traverses of vegetation types of Kalabo and north west Senanga Districts were made under his direction by the Head Forest Ranger, Machili. From this material J.D. Martin produced a series of District Vegetation maps on the scale of 1:250.000 together with a general 1:500.000 vegetation map of Barotseland. It contained numerous revisions of the previous reconnaissance work of the Ecological Survey and was accompanied by a very comprehensive Report on Forests and Forestry in Barotseland. Details of this map were discussed with Martin in 1941, and a pantographic reduction from it, checked from the larger-scale maps and added to or modified in minor points, constitute the Barotse sector of the Trapnell map. The Trapnell map also used information derived from a systematic detailed survey of the vegetation-soil types of the North Charterland Concession area of Fort Jameson and Petauke Districts in the Eastern Province, which was carried out under the direction of W. Allan between 1941 and 1944. This survey employed a series of parallel traverse lines from north to south, generally at two mile intervals, along which the recurrences of eighteen standardised vegetation-soil units were recorded. The traverse work was carried out by a team comprising W. Allen. W.B, van Wyk. J.R.E. Hindson and W.V. Morony. Maps based on these surveys, in combination with earlier reconnaissance traverses of the ecological survey were used by Trapnell to cover the Concession area on his vegetation-soil map. Trapnell furthermore used detailed maps of parts of the Western province based on surveys by messrs. B.C. Wills, D.U. Peters and W.B. van Wyk for the Crown Land portion of the Province south of the Kafulafuta. These surveys were carried out along traverses arranged in the form of a grid with lines at two-mile intervals from east to west and one mile intervals from north to south. This survey was complemented with results from a forest enumeration survey in selected portions of the Copperbelt conducted by C.E. Duff. During that survey along lines at 30 to 60 chain intervals. Trapnell carried out additional traverses in North-Western Rhodesia, principally the Kaonde-Lunda Province in 1943 and used for the interpretation of vertical and oblique photographs of Mwinilunga, Balovale and west Kasempa Districts together with the northern border of Mankoys. The vegetation data shown by the photographs were transposed to the 1:250.000 aerial maps made from them by the Aircraft Operating Company. A pantograph

reduction to 1:1.000.000 was then made of the limits of the Kalahari Sands in this quarter from the Geological Map of the Concession Companies and the vegetation data were superimposed on the same scale.

2. Ethiopia

2.1 Description of base maps used

We used the potential vegetation map of Ethiopia developed by Friis *et al.* (2010; 1 : 2,000,000). All authors that were involved in the development of the potential vegetation map of Ethiopia were also involved in the VECEA project.

Initially, the vegetation map by Pichi-Sermolli (1957) was considered as a base for the PNV map for Ethiopia. Friis & Sebsebe Demissew (2001) and Friis *et al.* (2010) however concluded that this map and other maps lack in quality and level of detail.

Based on this assessment Friis *et al* (2010) developed a new vegetation map based on a set of classification criteria defining the altitudinal and rainfall limits for each of the vegetation types. The altitude was obtained from the SRTM 90 meter digital elevation data (CGIAR-CSI 2008). The mean annual precipitation data was obtained from the WorldClim database (Hijmans et al. 2005). Additionally, the Global Wetlands Database (GLWD) (Lehner & Döll 2004), and the AEON river database (de Wit & Stankiewicz 2006) were used to define the boundaries of water bodies and related vegetation types.

In some areas the vegetation could not be correctly classified based on altitude and rainfall data only. In these cases the map was adapted based on field observations from Ib Friis and Sebsebe Demissew, supplemented by forest maps of the south-west Ethiopia Forest Inventory Project (Chaffey 1978a-d). A detailed explanation of the steps used to develop the map are provided in Friis *et al.* (2010).

2.2 From the base maps to regional map

The Ethiopian classification framework is very similar to the one used for the regional PNV map, and the PNVs distinguished can be directly linked to the regional PNV classes, according to the reclassification rules presented in Appendix 10.2, Table 10.3.

2.2.1 Notes on mapping of some forests and scrub forest vegetation types

2.2.1.1 Afromontane moist transitional forest (Fe)

In the regional PNV map, the Ethiopia's Moist Transitional Forest is grouped with Kenya's Eastern Moist intermediate (transitional) forest as "Afromontane moist transitional forest". However, Kindt *et al.* (submitted) found that these forest types "did not cluster together well and had a large floristic distance". Furthermore, the Moist Transitional Forest in Ethiopia "has larger ecological affinity with the Lake Victoria region". This floristic

similarity was also recognized by Friis (Friis 1992).

On the other hand, based on the results of distance-based redundancy analysis using different distances Kindt et al. (submitted) suggest that these two and other transitional forests could be classified together with other transitional forests in an alternative category of "transitional forests" rather than allocating them to one of the phytochoria. They furthermore suggest that this intermediate position of the transitional forests is at least partly because the Zanzibar-Inhambane and Lake Victoria transitional forests include several Afromontane species. This points at a relative important role of a number of more wide spread Afromontane species in comparison to more distinct phytochorion specific species. It should be noted that analyses are based on presence-absence data and abundance data could alter the results considerably.

The current map maintains the original VECEA regional classification, considering that it is straightforward to treat these types separately per country in e.g., habitat distribution analyses.

2.2.2 Notes on mapping of some of the other vegetation types

2.2.2.1 Desert (D)

In Ethiopia no distinguishing was made between desert and semi-desert. Using the maps of desert areas in Kenya to model the desert areas in Ethiopia was considered. However, the deserts in Kenya are largely of edaphic nature. At the same time, some of the drier areas in northern Kenya, in terms of yearly rainfall or aridity (Zomer *et al.* 2008) are classified as *Acacia-Commiphora stunted bushland* or *Somalia-Masai Acacia-Commiphora bushland and thicket* rather then *Somalia-Masai semi-desert grassland and shrubland*, possibly also related to specific edaphic conditions. Without more accurate and detailed data layers on soil and substrate, it is not possible to model their distribution accurately, and even less so to project their distribution onto Ethiopia.

2.2.2.2 Somalia-Masai semi-desert grassland and shrubland (S)

In Ethiopia, desert and semi-desert were mapped together in the base vegetation map. See also the section above that mapping of desert (D) separately from semi-desert vegetation types was not possible in Ethiopia.

3. Kenya

3.1 Description of base maps used

For Kenya several vegetation maps were available, one covering the whole of Kenya while more detailed maps were available for northern Kenya, the Kenyan highlands, the coastal area and Narok district (Table 3.1).

Table 3.1: Table with vegetation maps for Kenya consulted or used for the development of the regional VECEA potential natural vegetation (PNV) m

Region / area	Map	Scale / resolution	Reference
south-west	Trapnell and Brunt vegetation map (Trapnell map)	1:250,000	(Kindt *et al.* 2005; Trapnell *et al.* 1987)
	Delsol vegetation map	1:1,000,000	(Delsol 1995)
north	Rangeland Management Handbook (RMHK map)	1:500,000 – 1:1 million	(Herlocker, Shaabani, Stephens, *et al.* 1994; Herlocker *et al.* 1993; Herlocker, Shaabani, & Wilkes 1994a-c; Shaabani, Welsh, Herlocker, & Walther 1992a-c)
Coastal zone	Moomaw vegetation map (Moomaw map)	1:500,000	(Moomaw 1960)
Narok county	Vegetation map for the Narok county (Narok map)	1:250,000	(Trump 1972)
Coastal zone of east Africa	Mangrove of east Africa	1:1,000,000	(Taylor *et al.* 2003)

The Rangeland management handbook contains vegetation maps for each of the North Kenya districts: Turkana, Marsabit, Mandera, Wajir, Isiolo, Baringo, Elgeyo-Marakwet and West-Pokot .

All maps were first reclassified to the regional classification separately. This was done based on an assessment by co-author Francis Gachathi from the Kenya Forestry Research Institute (KEFRI), literature study and comparing the floristic characteristics. See volume 2-5 for more details. Next the maps were patched together, whereby preference was given to the sub-national maps, filling in the remaining areas with the Delsol map.

3.2 From the base maps to the VECEA map

3.2.1. Vegetation map for SW Kenya



Figure 3.1: After the initial reclassification of the RMHK vegetation maps (Table 9.5), some adaptations were made for the final regional PNV map: (1) the riverine woodland marked red was shifted to match river location in river database (black outline). It was furthermore extended towards the south, including part of the polygon which was originally classified as *Acacia tortilis-balanites* evergreen a. semi-dec. Woodland (4.2). (2) The black area was initially classification as Juniperus forest. It was reclassified as Evergreen and semi-evergreen bushland (Bet), to match the classification of the adjacent areas on the T&B map.

For the south-western highlands of Kenya, we largely followed the vegetation map by Kindt *et al.* (Kindt *et al.* 2005), which was based on the vegetation map by Trapnell *et al.* (Trapnell *et al.* 1966, 1976, 1986, 1969, 1987). The reclassification scheme is provided in Appendix 9.3, Table 9.4. However, a number of modifications were made, as explained below for Afromontane single-dominant *Hagenia abyssinica* forest (Fd), Lake Victoria transitional rain forest (Ff), Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi), *Acacia-Commiphora* deciduous wooded grassland (synonym: deciduous wooded grassland, Wd), Biotic *Acacia* wooded grassland (We), riverine woodland (wr) and Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be). Modifications on the Kenyan side of Mt. Elgon are described in the section for Uganda where the modifications of the VECEA map for Mt. Elgon are described (section 7.2.3).

3.2.2 Vegetation maps of the Rangeland management handbook

For the Range Management Handbook of Kenya (RMHK), vegetation types naming was harmonized across the districts and types were grouped in main potential vegetation types based on the floristic and physiognomic descriptions of each of the mapping units. The reclassification scheme is given in Appendix 9.3, Table 9.5. Two subsequent modifications were made as explained in Figure 3.1.

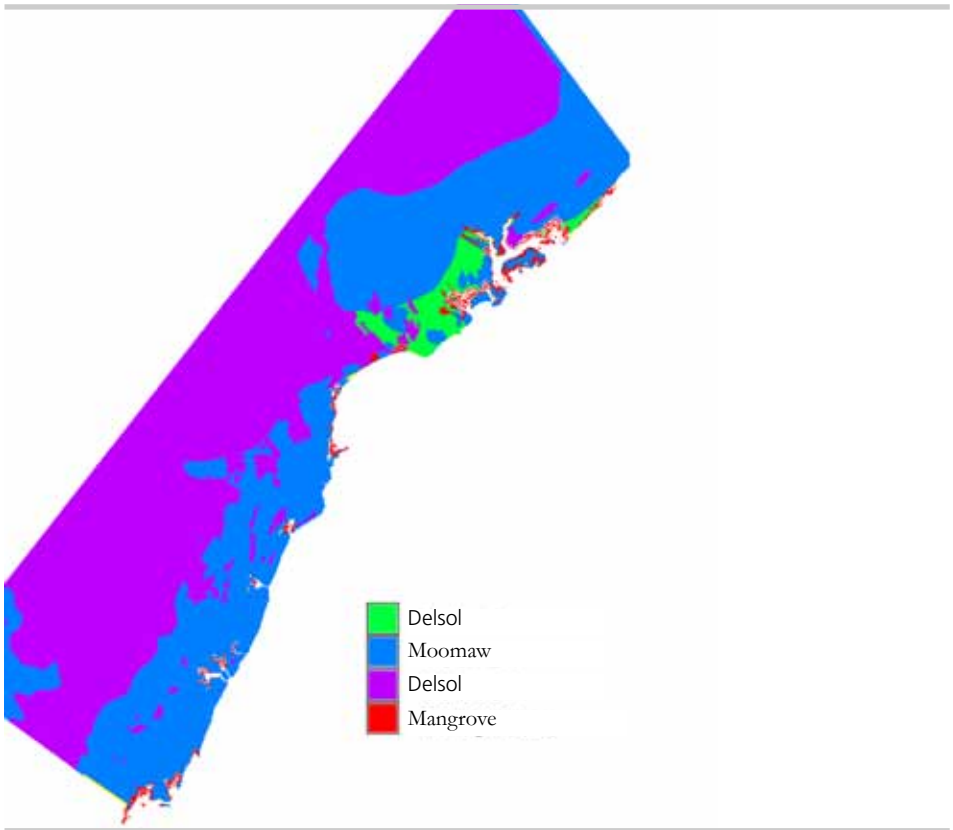


Figure 3.2: Map showing which map was used where to classify the coastal region of Kenya. The blue areas were based on the Moomaw vegetation map, the green and purple areas on the Delsol vegetation map and the red areas on the UNDP mangrove map.

3.2.3 Vegetation map by Moomaw

The vegetation map by Moomaw (1960), covering the coastal region of Kenya, was reclassified according to the reclassification scheme in Appendix 9.3, Table 9.6. The map and accompanying documentation provides a more detailed description than Delsol. On the other hand, boundaries are much less detailed. We therefore used the Moomaw map to (i) fill in the areas mapped by Delsol as secondary or agricultural vegetation / land cover types and (ii) verify or determine the classification of the remaining mapping units on Delsol map. Figure 3.2 shows how the Moomaw and Delsol maps were combined.

The mapping of the large sand dune and beach littoral area on the northern coast (green area in Figure 3.2) was considered an error, possibly because the number on the scanned map is unclear. The areas is not visible on satellite (Google maps) or mapped on any other map. We assumed Delsol to be correct in this area.

Some additional information and the combination of the Moomaw and Delsol maps is provided in the sections about Zanzibar-Inhambane scrub forest (Fq) and Mangrove (M).

3.2.4 Vegetation map by Delsol

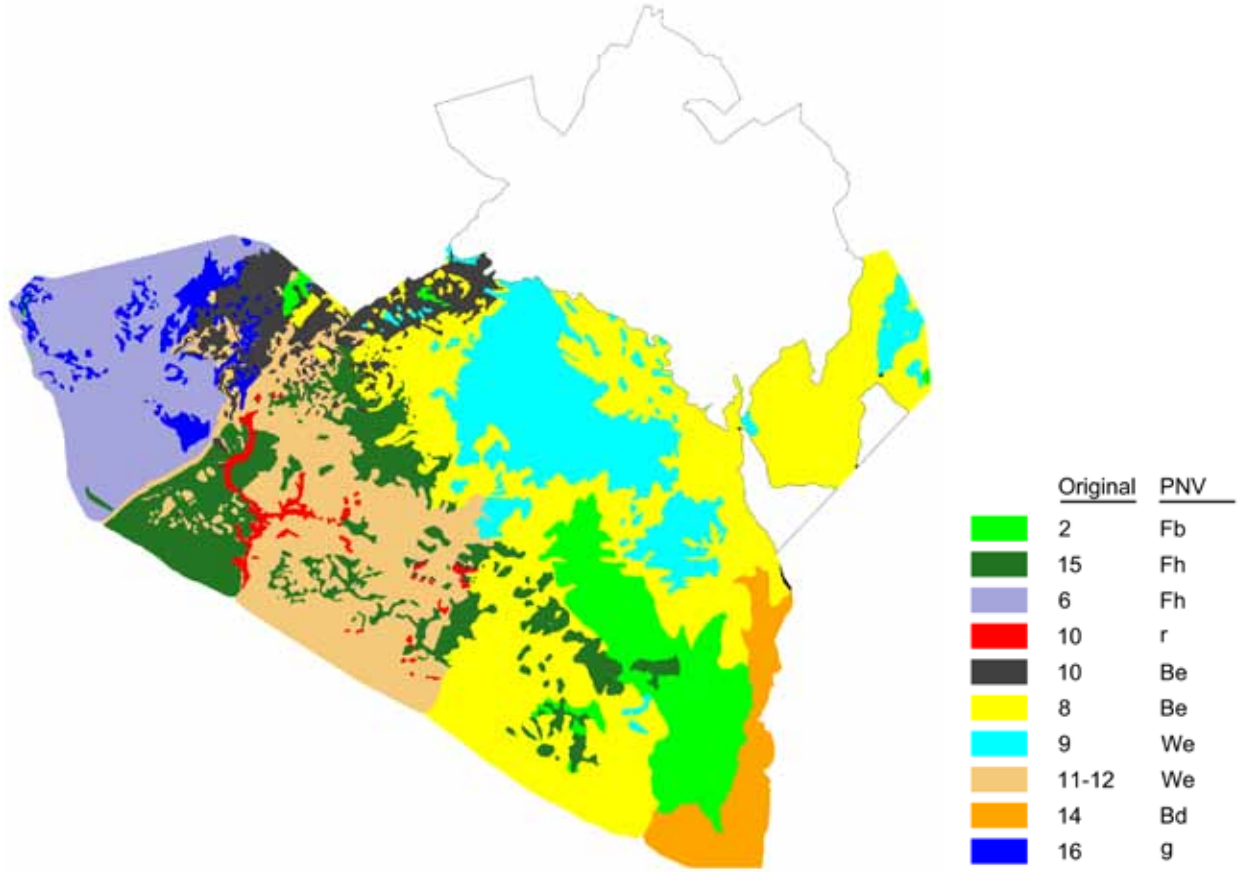


Figure 3.3: Adapted Trump vegetation map. The color legend and accompanying numerical code under the header 'Original' refer to the original mapping units of the Trump map (note, not all original classes were included in the adapted version, some others were lumped): 1 = Forest, 6 = evergreen clump grassland, 8 = evergreen and semi-deciduous bushland, 9 = grassland, 10 = semi-evergreen ticket and associate types, 11 = bushed and wooded grassland, 12 = grassland, 14 = Acacia-Commiphora bushed and wooded grassland, 15 = grassland on clay, 16 = evergreen clump grassland. The letter code under the header 'PNV' gives the code for the corresponding potential natural vegetation types: Be = Evergreen and semi-evergreen bushland, Fb = Undifferentiated Afromontane forest, We = biotic wooded grassland, g = edaphic wooded grassland on drainage-impeded or seasonally flooded soils, Fh = Afromontane dry transitional forest, Bd = Somalia-Masai Acacia-Commiphora bushland and thicket, and r = riverine wooded vegetation.

The vegetation map by Delsol (Delsol 1995) covers the whole of Kenya. Based on physiognomic and floristic descriptions in Delsol (1995) and expert knowledge (F. Gachathi), the vegetation types recognized on the map were reclassified according to Appendix 9.3, Table 9.7. Some additional information about reclassification is provided in the section about Zanzibar-Inhambane scrub forest (Fq).

3.2.5 Trump vegetation map for Narok

The Trump vegetation map north of latitude $1^{0}15'$ is based on the Trapnell and Brown vegetation map, albeit the 50 vegetation types recognized on the Trapnell and Brown vegetation map were aggregated into 18 types. The southern part

follows the same classification scheme (Trump 1972). The map was digitized and subsequently used to map the vegetation types as indicated in Figure 3.3. Notes on mapping of some forests and scrub forest vegetation types

3.2.6 Notes on mapping of some forest types

3.2.6.1 Afromontane single-dominant Hagenia abyssinica forest (Fd)

Hagenia-Hypericum woodland was a vegetation type of the original Trapnell and Brunt vegetation map that was not retained in the revised vegetation map by Kindt *et al.* (2007). For the VECEA map, this vegetation type was included as Afromontane single-dominant *Hagenia abyssinica* forest, however.

3.2.6.2 Lake Victoria transitional rain forest (Ff)

Kindt *et al.* (1997) classified the original "western moist intermediate forest" together with "eastern moist intermediate forest" as "moist intermediate forest". White (1983, page 181) mentioned that Kakamega forest is a transitional rain forest, albeit with more elements of the Guineo-Congolian drier peripheral semi-evergreen forest (Fi) than other manifestations of this forest type. White (1983) mentions 1520 m as the lower altitude limit of the Kakamega forest.

We used the 1520 m altitude limit to separate Lake Victoria Transitional rain forest" (Ff) from the Guineo-Congolian drier peripheral semi-evergreen forest (Fi) within areas that were mapped by Trapnell and Brunt as "western moist intermediate forest" (or vegetation types secondary to "western moist intermediate forest").

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

See comments for Lake Victoria transitional rain forest (Ff)

3.2.6.4 Zanzibar-Inhambane scrub forest (Fq)

The areas classified as 'Dry forest with *Manilkara-Diospyros*' on the Delsol map were reclassified as PNV Zanzibar-Inhambane scrub forest (Fq). We furthermore classified "tree savannah with *Afzelia-Albizia*" as Zanzibar-Inhambane scrub forest based on the observation by Moomaw (1960) that this is derived from *Manilkara-Diospyros* forest. And in fact, the area with "tree savannah with *Albizia-Afzelia*" on the Delsol map coincides with the area on the Moomaw map classified as *Manilkara-Diospyros* forest.

The Delsol vegetation type of 'Tree savannah with *Manilkara-Dalbergia*' was reclassified as 'Zanzibar-Inhambane scrub forest'. However, these areas extend much more land inwards than the areas classified as Zanzibar-Inhambane scrub forest (*Manilkara-Dalbergia/Hyparrhenia* and *Manilkara-Diospyros*) on the Moomaw map. We assumed that the boundary on the Moomaw map was more accurate. (In comparison, the boundaries of the 'East African coastal mosaic' on the White [1983] map keeps the middle between the Delsol and Moomaw maps.). The remaining part is reclassified as 'Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket', but could probably be considered a transitional zone.

There was not much information about the Delsol vegetation type of "Coastal pseudo-steppic vegetation (*Acacia-Euphorbia*)". However, it lies largely within the Zanzibar-Inhambane scrub forest as mapped by Moomaw. It furthermore borders the coast or mangrove forests (in north) and floodplains (Tana delta) in the south. We therefore assumed that this is a secondary type, originating from Zanzibar-Inhambane scrub forest.

3.2.6.5 Zanzibar-Inhambane lowland rain forest near Tavetta

Zanzibar-Inhambane lowland rain forests mostly occur along the lower parts of the eastern highlands arc. However, similar forests occur further inland as enclaves 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 (and could therefore possibly be classified as groundwater forests, which can also be found at Lake Manyara in Tanzania). On the Gillman map (see section 6.1), there is a small forest patch south-east of Mount Kilimanjaro near the town of Tavetta in Kenya. We assumed this forest therefore to be of or include the PNV type 'Zanzibar-Inhambane lowland rain forests'. See also volume 2.

3.2.7 Notes on mapping of some woodlands and wooded grasslands vegetation types

3.2.7.1 Acacia-Commiphora deciduous wooded grassland (synonym: deciduous wooded grassland, Wd)

Various *Acacia tortilis* wooded grassland and woodland types from the RMHK were mapped as a subtype of *Acacia-Commiphora* deciduous wooded grassland. This was done based on physiognomic characteristics only.

Acacia-Commiphora deciduous wooded grassland is also mapped in Tanzania (see section 6). However, on grounds of floristic and environmental differences between these subtypes we suspect that the Kenyan and Tanzanian subtypes are not manifestations of the same potential natural vegetation type. We expect that the Kenyan subtype is more similar to Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd). The type will therefore be mapped separately as WdK and Wd for Kenya and Tanzania respectively.

3.2.7.2 Biotic Acacia wooded grassland (We)

The Trump (1972) map distinguishes a number of vegetation types (grassland and bushed and wooded grasslands) which distribution is determined by fire, grazing and browsing. Without these factors, the vegetation might revert to evergreen bushland or evergreen thicket (Trump 1972). These dynamics are observed by various authors, whereby the balance between grasslands, wooded grasslands and woodlands are maintained by biotic (grazing, browsing) and abiotic factors (fire) (Belsky 1984; Dublin 1991, 1995; Sinclair *et al.* 2007). Rather then mapping these areas as evergreen bushland or evergreen thickets, we propose that these areas represent alternative stable states, as suggested by Dublin *et al.* (1990). We have therefore mapped these areas as biotic *Acacia* wooded grasslands. The density of trees is assumed to be deter-

mined by the grazing / browsing pressure and frequency of fire incidents, which can result in almost pure grasslands in e.g., the Loita plains).

Some of the grasslands on the Trapnell and Brunt vegetation map, like the Loita plains north of the Masai Mara, were marked as secondary to evergreen bushlands and thickets by the authors. Although classified as "evergreen bushland and thicket" by Kindt *et al.* (2007), we reclassified these as biotic *Acacia* wooded grassland, following the same reasons as explained above for the Trump map.

3.2.7.3 Riverine woodland (edaphic vegetation type, wr)

Acacia xanthophloea (mapping unit 30 on vegetation sheets 2 and 4 of the Trapnell and Brunt map), mixtures of *Acacia xanthophloea* and *Acacia kirkii* (original mapping unit 30 on vegetation sheet 3), *Acacia kirkii* (original mapping unit 30a), *Acacia polyacantha* (original mapping unit 30b) and *Acacia gerrardii* (original mapping unit 30c) were all classified by Trapnell *et al.* (1987) as upland *Acacia* vegetation subtypes that occur on recent alluvium. In the adapted vegetation map by Kindt *et al.* these were classified as "upland *Acacia*". However, *Acacia xanthophloea* and *Acacia polyacantha* are typical riparian species (White 1983 p. 129). Furthermore, the shape of various polygons such as the *Acacia xanthophloea* polygons north of Nyeri, the *Acacia xanthophloea* polygons within Nairobi National Park and the *Acacia xanthophloea* and *Acacia kirkii* polygons south and east of Narok also suggest that these are riparian vegetation types. In addition, the original upland *Acacia* areas surrounding the Rift Valley lakes of Elmenteita, Naivasha and Nakuru are also of the *Acacia xanthophloea* type. Based on these observations, mapping units 30a-c were changed to riverine wooded vegetation (red areas in Figure 3.4).

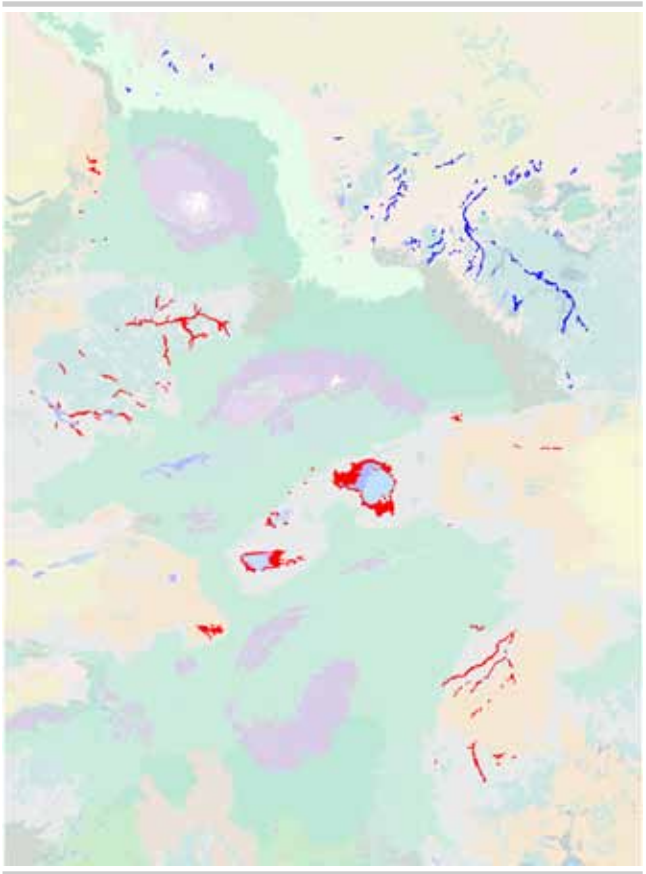


Figure 3.4: Areas reclassified as riverine wooded vegetation (red and blue areas)

3.2.8 Notes on mapping of some bushland and thicket vegetation types

3.2.8.1Somalia-Masai Acacia-Commiphora deciduous bushland and thicket (Bd)

See the section on Zanzibar-Inhambane scrub forest (Fq) how we mapped the boundary between this forest type and Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket and based on the Delsol and Moomaw maps.

3.2.8.2 Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

See comments on biotic *Acacia* wooded grasslands for the Trump (1972) map. Furthermore, note that it is possible to make a further subdivision of the semi-evergreen bushland and thicket (Be) in Lake Victoria semi-evergreen thicket in the west around Lake Victoria and Somalia-Masai evergreen and semi-evergreen bushland and thicket in the east (Figure 3.5). For the regional map this was not done, but it might be relevant for more local studies.

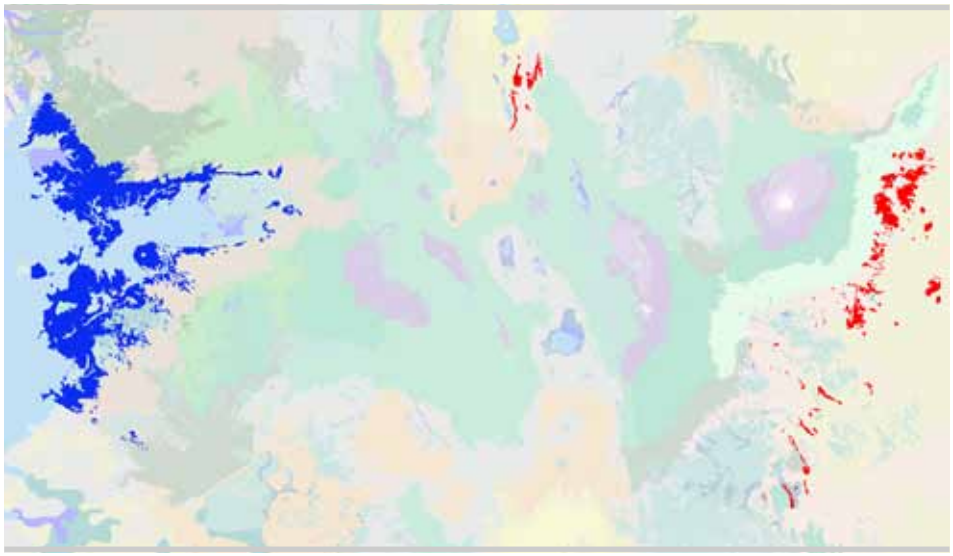


Figure 3.5: Split of evergreen thicket in Lake Victoria semi-evergreen thicket (blue areas) and evergreen and semi-evergreen bushland and thicket (red area)

3.2.9 Notes on mapping of mapping some of the other vegetation types

3.2.9.1 Mangrove (M)

Mangroves are mapped on the Delsol map and the Moomaw map, but a more detailed map of the mangrove distribution is available from the Mangroves of East Africa of the UNEP World Conservation Monitoring Centre (UNEP-WCMC). We use this map to map the distribution of Mangrove on the coast. This was done with the following step:

- All raster cells on the Delsol map classified as mangrove were reclassified to the same vegetation type as their nearest neighbouring raster cells.
- Next, all areas classified as mangrove on the 'UNEP-WCMC' mangrove map were classified as mangrove on the VECEA PNV map.

3.2.9.2 Halophytic vegetation (Z)

Scrub and saline shrubland was a vegetation type on the original Trapnell and Brunt vegetation map that was not retained in the revised vegetation map by Kindt *et al.* (2007). In the VECEA map, we classified the original vegetation type as halophytic vegetation, however.

3.2.10 Notes on creating the composite map for Kenya

The different maps described in 3.1 were patched together to create one national potential natural vegetation map. The order of preference was; the maps based on the Trapnell and Brunt map, the Trump vegetation map, the RMHK vegetation map, the UNEP mangrove map, Moomaw vegetation map (with the exceptions described above), and finally the Delsol vegetation map. Figure 3.6 shows how the different maps contributed to classification of the national map.

For some areas available information was not sufficient to classify the area as one of the PNVs. This included areas not covered by any of the sub-national maps and mapped as secondary or cultivated on the Delsol map. These areas are indicated in red in Figure 3.6.

We used habitat suitability modelling and environmental data layers presented in Table 9.1 and Table 9.2 to fill in these gaps. We created probability distribution models for each of the PNVs listed in Table 9.8 using maximum enthrophy method (Phillips *et al.* 2004; Phillips & Dudik 2008) as implemented in the MAXENT software (Phillips et al. 2010).

Next, we combined the modelled probability distribution layers, whereby the classification of each raster cell was determined by the PNV with the highest probability score.

The fairly high values for the area under the receiver operating characteristic curve (AUC, see Phillips *et al.* (2004) for both the training and test points (Table 9.8 in Appendix 9.3) suggest that the modelled suitability distributions of the individual PNVs correspond well with the mapped distribution. Overall, 79% of the total area was classified correctly (kappa of 0.75).

These results were considered sufficiently accurate to be used to estimate the distribution of PNVs in areas that were left unclassified red in Figure 3.6.

More details on the results from the modelling procedure are provided in Appendix 9.3.1.

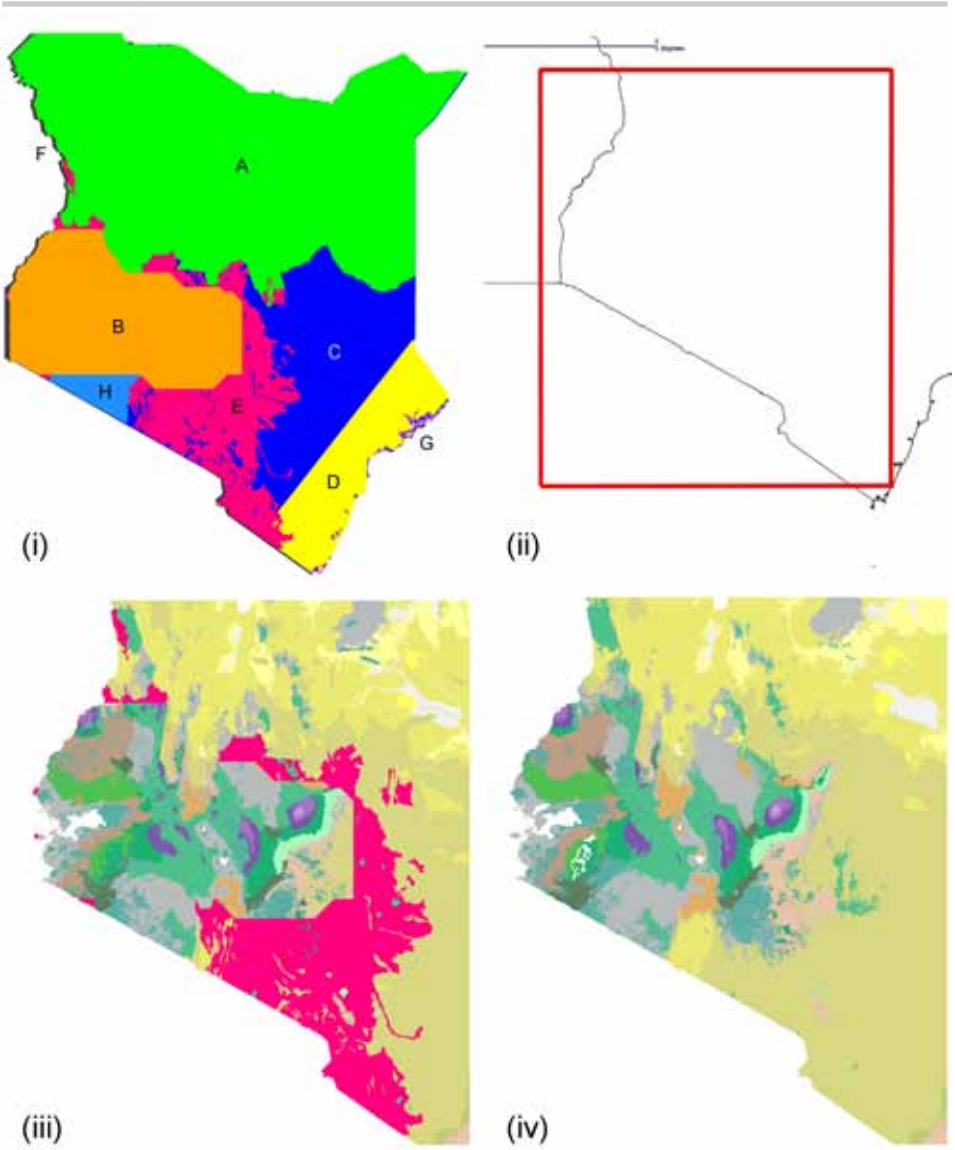


Figure 3.6. (i) Maps used to create the potential natural vegeation map for Kenya: A) RMHK vegetation maps; B) Trapnell and Brunt vegetation map; C) Del Sol vegetation map; D) Moomaw + Del Sol vegetation map, see Figure 3.2 for more details; E) modelling, see section 3.2.10; F) areas classified based on nearest neighbouring PNVs; H) Trump vegetation map; (ii) Areas sampled for modeling of non-classified areas in Kenya and areas in Tanzania bordering Kenya; (iii) Trapnell, Delsol, Trump and RMHK vegetation maps combined, with in pink the areas that could not be classified based on these maps; (iv) Combined probability distribution maps of the PNVs listed in Table 10.8.

4. Malawi

4.1 Description of base maps used

Various vegetation maps are available for Malawi, including the maps listed in Table 4.1. The three maps of the natural environment of Malawi by Young and Stobbs (Stobbs 1971; Young 1965a,b) provide most details and were used to develop the PNV map for Malawi, with some additional information derived from the map of biotic communities of Malawi by (Shaxson 1976) and the Miombo ecoregion map by Timberlake and Chidumayo (2011).

Table 4.1: Table with existing vegetation maps for Malawi consulted or used in the development of the regional VECEA potential natural vegetation (PNV) map

Region / area	Map	Scale / resolution	Reference
Northern part	Natural regions and areas. Sheet 1, Northern Malawi, environmental conditions and agriculture	1:500,000	(Young 1965a)
Central part	Natural regions and areas. Sheet 2, Central Malawi, environmental conditions and agriculture	1:500,000	(Young 1965b)
Southern part	Natural regions and areas. Sheet 3, Southern Malawi, environmental conditions and agriculture	1:500,000	(Stobbs 1971)
Miombo ecoregion	Vegetation types of the miombo ecoregion	1:10,000,000	(Timberlake & Chidumayo 2011; WWF-SARPO 2001)
Whole country	A map of the distribution of major biotic communities (map printed in 1979 by the Malawi government. Reprinted in 1983 as part of the 'Atlas of Malawi '	1:1,000,000	(Shaxson 1976)
Malawi, Zambia	Rattray, J.M. and H. Wild, 1961. Vegetation map of the federation of Rhodesia and Nyasaland	Unkn.	(Rattray & Wild 1961)

4.2 From the base maps to the VECEA map

The three maps by Stobbs and Young use slightly different naming conventions, so the first step was to harmonize the names across the three maps. These were subsequently aggregated into major natural vegetation types. How this was done is shown in Table 9.9.

Next, the 'national vegetation types' were reclassified according to the regional PNV classification scheme as indicated in Table 9.9. Some additional information is provided in the next sections on the mapping of specific vegetation types.

4.2.1 Notes on mapping of some forests and scrub forest vegetation types

4.2.1.1 Afromontane rain forest (Fa)

See section 4.2.3 for information how we mapped the vegetation on Mt. Mulanje.

Dowsett-Lemaire (1985) recognised six different types of evergreen forest occurring on the Nyika plateau, including Submontane forest of the eastern escarpment (1900-2250 meter), Submontane *Juniper* forest, Submontane for-

est of Nkhonjera hill, Submontane forest of the southwestern slopes and Montane forests of the high plateau (2250-2600 meter), confined to the heads of dambo's and streams, or where rocky outcrops have given some protection from fire. There is no precise information on how these forest types relate to the forest PNV types recognized on the regional PNV map. They were therefore classified as one or a mixture of the following forest PNV types: Afromontane rain forest / Undifferentiated Afromontane forest (including Single-dominant *Juniperus procera* forest) and Single-dominant *Hagenia abyssinica* forest).

Montane grasslands in northern Malawi were reclassified as forest PNVs. Today, forest cover on the Nyika plateau and other highlands in northern Malawi is limited, something which was already found during the earlier European vegetation explorations (Brass 1953). Forest patches are small, with sharply defined edges and are mainly confined to sheltered depressions.

Fire plays an important role in contemporary vegetation dynamics and patterns. It is estimated that forest areas two to three times that of forest cover today was destroyed in relative recent times (Dowsett-Lemaire 1985). In the current management of the Nyika national park and other parks in Malawi, fire is used as a management tool. Each hectare of plateau grassland is burned approximately every three years by park management, whereby care is taken not to affect the forest patches (Burrows & Willis 2005).

Whereas there seems to be little controversy about the importance of fire in maintaining the current distribution of montane grasslands and forest patches, there is considerably more debate about the age and origins of montane grasslands (and thus the potential extent of forests in these areas). According to Chapman and White (1970), the Nyika Plateau was mainly forested as recently as 1000 years ago. However, other lines of evidence, including palaeontological research and relative high levels of endemism in grassland related species (Willis *et al.* 2001) suggest that grasslands have been far more extensive than forests for 10,000 years and possibly much longer (Meadows 1984; Vincens 1991; White *et al.* 2001). For a detailed comparison of the main hypothesis about the distribution of montane grasslands in the afromontane region, see Meadows & Linder (1993).

There are many uncertainties about how vegetation will develop if left to itself under current conditions, i.e., what the potential natural vegetation is in these areas. This is further complicated as our knowledge on the relative role of climate (fluctuations) and fire in the distribution of forests and grasslands is limited.

We reclassified the montane grasslands in northern Malawi as potential natural forests, based on the assumptions that:

- The current climate conditions are suitable for the development of forests.
- Fire has been a major factor that caused and currently maintains the widespread distribution of grasslands (Meadows & Linder 1993).

We recognize that this might be controversial and that further evidence might necessitate revisions, marking montane grassland either as a separate potential natural vegetation type or as an alternative stable state of the afromontane forests in this region.

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

See notes on the reclassification of montane grassland as mosaics of different Afromontane forest types that were provided in the previous section on Afromontane rain forest (Fa).

Single-dominant *Juniperus procera* forest is thought to be a fire induced type derived from undifferentiated Afromontane forest (see also Volume 2).

4.2.1.3 Afromontane single-dominant Widdringtonia whytei forest (Fc)

On the original vegetation map for southern Malawi (Stobbs 1971), single-dominant *Widdringtonia whytei* forest occurs in a mosaic of Montane *Ericaceous* vegetation on the summit and high plateau of Mt. Mulanje. See the section on Mt. Mulanje (section 4.2.3).

4.2.1.4 Afromontane single-dominant Hagenia abyssinica forest (Fd)

See notes on the reclassification of montane grassland as mosaics of different Afromontane forest types that were provided in the section on Afromontane rain forest (Fa).

Within areas where this forest type was mapped in mosaics, it is expected to (potentially) occur in very small and scattered areas.

4.2.1.5 Zanzibar-Inhambane transitional rain forest (Fg)

See section 4.2.3 below that specifically deals with Mt. Mulanje.

4.2.1.6 Zambezian dry deciduous forest and scrub forest (Fn)

Zambezian dry deciduous forest and scrub forest (Fn) currently only occurs in a few small patches and the original extent is unknown. The know patches that still exist can be found in Liwonde National Park (upper Rift Valley, 450 m) and in Lengwe National Park (lower Rift Valley, 150 - 200m; C. Dudley, pers. comm.).

Coordinates of the known patches in Liwonde National Park are (C. Dudley, pers. obs.):
14˚37'08.55" – 35˚22'40.10"
14˚38'15.73 – 35˚22'50.09"
14˚46'18.96" – 35˚21'08.92"
14˚47'06.99" – 35˚21'39.86"

The one known patch in Lengwe National Park has following coordinates (C. Dudley, pers. obs.)
16˚13'38.99" – 34˚44'52.86".

4.2.1.7 Zanzibar-Inhambane lowland rain forest (Fo)

The base vegetation maps seem to underestimate the distribution of forests in Malawi, especially the Zanzibar-Inhambane lowland rainforest (Fo). Dowsett-Lemaire (1989) describes and maps more forests then mapped on the Stobbs and Young maps, and the potential distribution is probably larger still. We did not include this however as the information does not allow us to accurately map these forests. But see section 14.2 in volume 1 for the locations of the Zanzibar-Inhambane lowland rainforest forests mentioned by Dowsett-Lemaire (1989).

We did adapt forest distribution on Mount Mulanje as explained in section 4.2.3 below.

4.2.2 Notes on mapping of some woodlands and wooded grasslands vegetation types

4.2.2.1 Miombo woodland (Wm)

No distinguishing was made between drier and wetter miombo by Young and Stobbs. We therefore used the miombo ecoregion map (Timberlake & Chidumayo 2011) to further divide the miombo woodlands into wetter and drier miombo. The miombo ecoregion map is based on the White vegetation map of Africa, but with adapted boundaries between wetter and drier miombo. For Malawi this means that a much larger part of southern Malawi around Lake Malawi is classified as drier miombo then on the White vegetation map. This essentially follows the classification by Wild & Barbosa (1967) in their Flora Zambesiaca map.

Mapping units with vegetation codes NaNr 37a (*Brachystegia-Julbernardia* woodland and *Pterocarpus-Bauhinia-Brachystegia* woodland was split using a boundary dividing the mapping unit in a southern part (yellow in Figure 4.1, 37a1 in Table 9.9) and a northern part. The southern part was left unchanged and was linked to vegetation type 7 (*Brachystegia* Hill Woodland). The northern 1/3 (purple in Figure 4.1, 37a2 in Table 9.9) was assigned a new code 37a2 (*Colophospermum* mopane) and linked to vegetation type 11 (*Colophospermum* mopane Woodland, Wooded Grassland and Thicket).

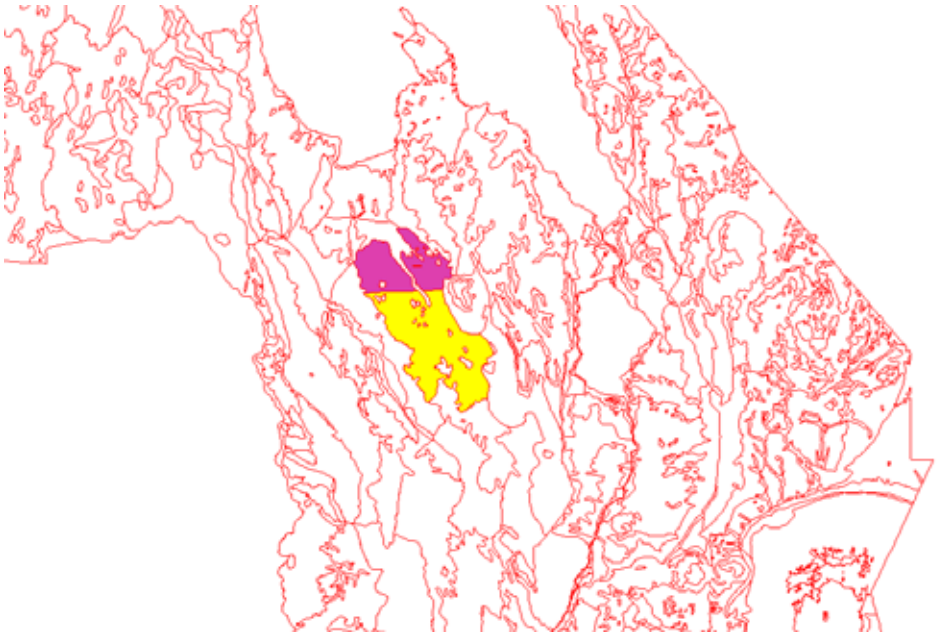


Figure 4.1: Split of vegetation type in NaNr 37a (yellow area) and NaNr 37a2 (purple area)

The *Brachystegia* escarpment, hill and foothill woodland, which was reclassified as Miombo on hills and rocky outcrops, is considered a problematic vegetation type as the canopy is composed of a variable mixture of *Brachystegia* species and a large proportion of species from Undifferentiated woodland (Wn) or riparian forests (r, see volume 2). It is moreover not mapped separately by White (1983) or on the miombo eco-regional map (Timberlake & Chidumayo 2011), where it is part of the wetter and drier miombo. It could possibly be considered a mosaic or transitional zone between the various mentioned PNVs. The same type is also mapped in Zambia, but for much smaller areas.

4.2.2.2 Mopane woodland and scrub woodland (Wo)

See notes on the split of original mapping unit NaNr37a in the section 4.2.2.1 on miombo woodland (Wm).

4.2.2.3 Terminalia sericea woodland (Wt)

See comments on the splitting of original mapping unit 45c provided in the section below on Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, wd).

4.2.2.4 Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, wd)

Marsh grasslands; *Chloris gayana-Setaria* associations on heavier soils of clay plain (mapping unit 45c) was split in two parts roughly following the boundary in the Biotic communities map (Shaxson 1976). Polygon 45c1 (blue in Figure 4.2) is linked to vegetation type 14 (Seasonally Wet Grasslands, (sometimes with scattered trees and bushes on *termitaria*). Polygon 45c2 (purple in Figure 4.2) is linked to vegetation type 12 *(Terminalia sericea* Woodland).

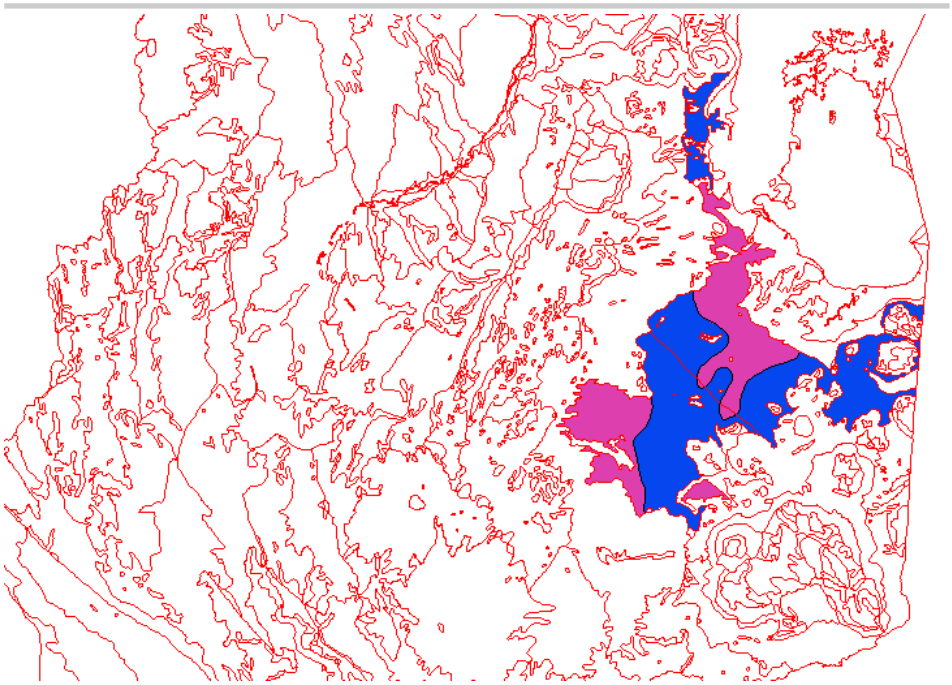


Figure 4.2: Split of vegetation type 45c into 45c1 (seasonally Wet Grasslands, sometimes with scattered trees and bushes on *termitaria*) and 45c2 (*Terminalia sericea* Woodland).

4.2.3 Notes on mapping of Mt. Mulanje

On the original vegetation map for southern Malawi (Stobbs 1971) Single-dominant *Widdringtonia cupressoides* forest occurs in a mosaic of Montane Ericaceous vegetation on the summit and high plateau. There is one areas on the southern foot slopes, which is presumably[1] the "Moist tall forest: *Newtonia buchananii-Khaya myassica-Albizzia spp.*" from the legend and described by Dowsett-Lemaire (1988, 1990) as tall forest patches dominated by *Newtonia buchananii* occurring between 600-900 meter. These forests are assumed to correspond with the PNV Zanzibar-Inhambane lowland rain forest (Fo). The rest of Mount Mulanje is covered by miombo on hills and rocky outcrops or 'Escarpment woodland with patches of montane evergreen forest in gully heads'.

In contrast, the Biotic communities map (Shaxson 1976) maps most of the southern and south-western slopes as semi-evergreen and montane evergreen forest. Moreover, Dowsett-Lemaire (1988, 1989) describe the occurrence of mid-altitude and montane evergreen forests on Mount Mulanje, indicating that the former occurs between 800-1500 m and the latter between 1500-2300 m. Based on their descriptions, these forests correspond to the PNVs Zanzibar-Inhambane transitional rain forest (Fg) and Afromontane rainforest (Fa) respectively.

Dowsett-Lemaire (1988) describes that vegetational altitude limits vary strongly between mountain sides. On the western slopes, "woodland ascends to 1200-1250 m, and small patches of low-canopy forest and dense secondary growth are found from 1200 m". On the south-eastern slopes conditions are more humid and forests descents to much lower altitudes (Dowsett-Lemaire 1988). Here, the lower altitudes between 650 and 900 meter, now largely cleared, were probably once covered by a mosaic of forest (in the stream depressions) and transition woodland, changing to closed forests at higher altitudes (Dowsett-Lemaire 1988).

1: On the original map the colour code suggest this is mapping unit 47d, which isn't defined in the legend. There is the mapping unit 46d (Moist tall forest: *Newtonia buchananii-Khaya myassica-Albizzia* spp.). Based on the location and description by Dowsett-Lemaire (1988) of the vegetation of Mt Mulanje, we assume that this should have been marked as 46d.

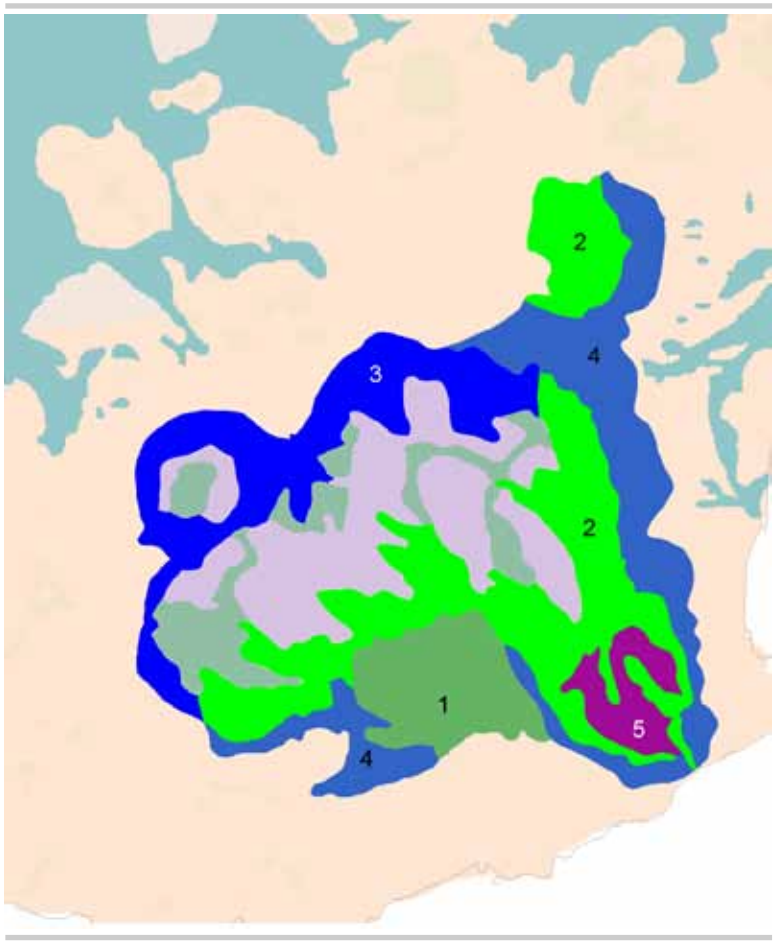


Figure 4.3: Areas that were reclassified to forest or woodland / forest types. See text for more details

From the above descriptions and after comparing this with the Shaxson map, we decided to split the mapping unit 'Escarpment woodland with patches of montane evergreen forest in gully heads' by Stobbs based on the slope aspect:

- On the drier north / north-western slopes this mapping unit, which occurs well below 1200 meter, was reclassified as miombo on hills and rocky outcrops
- On the south / southeastern slopes this mapping unit (area 4 in Figure 4.3) was reclassified as miombo on hills and rocky outcrops with patches of Zanzibar-Inhambane transitional rain forest if above 900 m and as Zanzibar-Inhambane lowland rain forest (Fo) if below 900m.
- As an exception to the rule above, the area described as the Chisongeli forest by Dowsett-Lemaire (1988) was reclassified as forest and reclassified according to the rules listed below (area 5 in Figure 4.3) .

Stobbs maps 'miombo on hills and rocky outcrops' on the slopes and plateau above the 'Escarpment woodland with patches of montane evergreen forest in gully heads'. Based on the description by Dowsett-Lemaire (1988, 1989) and the map of Shaxson, we assume that on the southern and eastern slopes these woodlands have replaced forests. For the north-western slopes

the before-mentioned authors are less conclusive whether fire and anthropogenic factors or also environmental factors limit the potential distribution of forests to more humid and protected pockets in the landscape (e.g, in valley-headsites and along streams).

- We split the mapping unit in a south-eastern and north-western part, using the boundaries on the Shaxson map, but adapted to better fit the boundaries of the polygons on the Stobbs map.
- On the south-eastern part (area 2 in Figure 4.3), we reclassified this mapping unit as Afromontane rainforest if above 1500 m and as Zanzibar-Inhambane transitional rain forest (Fg) between 900 and 1500 meter. Below 900 m, this mapping unit was reclassified as Zanzibar-Inhambane lowland rain forest (Fo).
- On the north-western and northern slopes (area 3 in Figure 4.3) we reclassified '*Brachystegia* Hill Woodland on scarps and gorges' as Miombo on hills and rocky outcrops with patches of Zanzibar-Inhambane transitional rain forest.

5. Rwanda

5.1 Description of base maps used

The original vegetation maps upon which this map is based is the Prioul/ Troupin vegetation map (Prioul & Sirven 1981). This map is published by Prioul, but it is based on a synthesis prepared by Georges Troupin (Troupin 1976).

Examining these maps showed that the vegetation boundaries on the map follow altitudinal limits mentioned in the documentation. However, the low scale resulted in coarse boundaries. We therefore reconstruct in part the boundaries using the indicated altitude limits, as explained in sections 5.2.3.1-5.2.3.2. As input we used the 90 meter digital elevation model (CGIAR-CSI 2008), henceforward to be called DEM.

Other data layers we used where the vegetation map of the Virunga Volcano National Park (Kayijamahe n.d.) and a set of data layers (intern drainage of dominant soil series and soil types based on soil profiles of the dominant soils) extracted from the Rwanda Soil map scale 1:250,000 (Birasa *et al.* 1992) by Ann Verdoodt and Erid van Ranst of the University of Gent.

5.2 From the base maps to the VECEA map

5.2.1 Forests types

5.2.1.1 Afromontane rain forests (Fa)

The main forest types on the Prioul/Troupin map are moist montane and moist intermediate forest. The criteria used to (re)map the distribution of these vegetation types as well as that of bamboo are given in Appendix 9.5, Table 9.10.

5.2.1.2 Single-dominant Hagenia abyssinica forest (Fd)

For the Virunga national park, we used the higher resolution vegetation map of Virunga National Park, which includes Single-dominant *Hagenia abyssinica* forest (see Appendix 9.5, Table 9.11)

5.2.1.3 Swamp forests (fs)

In all PNVs occurring below 1600 m (see Appendix 9.5, Table 9.12), there are localized occurrences of swamp forests (fs). However, there is not information on the extent of these areas.

5.2.1.4 Lake Victoria transitional rain forest and riverine forest

One can also find Lake Victoria transitional rain forest and riverine forests, which occur in a mosaic with semi-deciduous bushland as described in the next section.

5.2.2 Bushland types

5.2.2.1 Evergreen and semi-evergreen bushland and thicket (in mosaic)
Semi-deciduous bushland and forests cover all areas below 1600 meter altitude. This area coincides largely with the low altitude wooded grasslands (ID 5-7) on the Prioul/Troupin map in the east and the wooded grasslands of the Rusizi plain in the southwest and wooded grasslands on the shorelines of Lake Kivu (ID 5a on Prioul/Troupin map).

The area consists of a mosaic of evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation and *Euphorbia dawei* scrub forest. Within this mosaic, Prioul/Troupin mapped areas with more extensive distribution of *Euphorbia dawei* scrub forest separately (see volume 2 for more details). In all these PNVs there are localized occurrences of swamp forests (fs, PNV 47). However, there is no information on the extent of these areas. The criteria to further classify these areas are given in Appendix 9.5, Table 9.12.

Note that using the 1600 m criteria, the vegetation along Lake Kivu connects in the southeast to areas that are classified as 'grass savannas with *Exotheca abyssinica* on the Prioul/Troupin map'. An arbitrary line is drawn in the southern part to delimit the extension of the Lake Kivu vegetation (boundary between yellow and orange area in Figure 5.1.

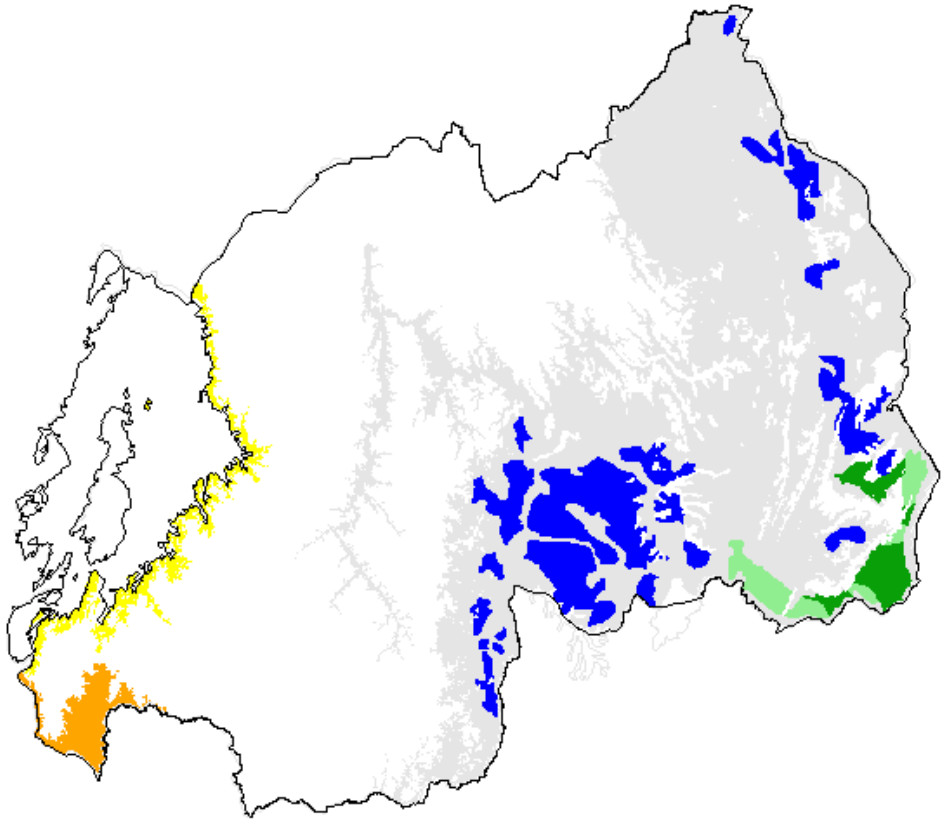


Figure 5.1: Semi-deciduous bushland and forests; grey, orange and blue and green areas mark the 'mosaic of semi-deciduous bushland and biotic grasslands, with gallery forests along streams and borders of swamp'. The blue and light green areas have larger extents of *Euphorbia dawei* scrub (thalweg) forest. In the light and dark green areas the gallery forests have a Zambezian component. The yellow area marks the distribution area of the Lake Kivu riparian vegetation with Congo affinity. The orange area marks the distribution area of the Rusizi-Bugarama plains.

5.2.2.2 Bamboo

Bamboo occurs in the Virunga area and was mapped using the map of the Virunga national park and according to the criteria given in Table 9.11 (Appendix 9.5).

However, Bamboo also occurs outside the area on the Virunga map at altitudes > 2500m. For the Virunga region (polygon 3 in Figure 5.2) we reclassified all areas above 2500m as Bamboo. For the other peaks / mountains there is no information about the distribution of bamboo (and other higher altitude vegetation types). However, it is unlikely that all areas above 2500 m altitude are covered by bamboo (see volume 5). Therefore, we have not classified areas outside the Virunga area as Afromontane bamboo, but made a note in the documentation about the likely occurrence of Bamboo above 2500 m altitude.

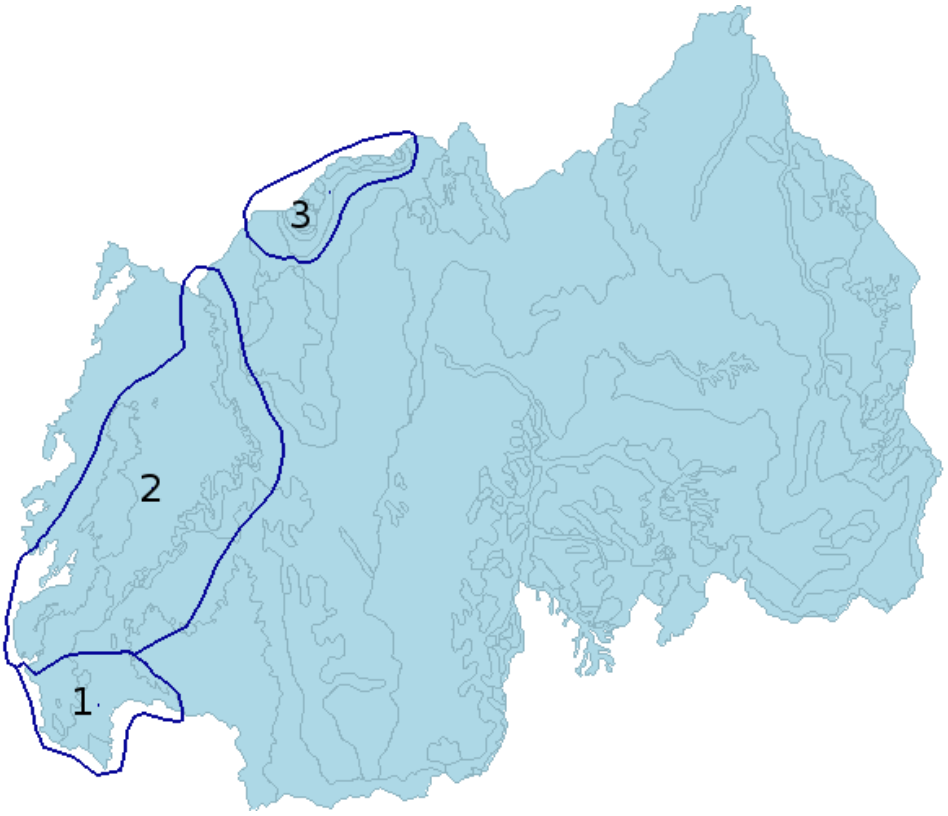


Figure 5.2: The polygons with dark blue outlines were used to restrict spatial queries used in create the forest and bamboo

5.2.3 Other vegetation types

5.2.3.1 Afro-alpine vegetation (A) and Ericaceous belt (B)

For the Virunga national park, we used the higher resolution vegetation map of Virunga National Park. Rules used to reclassify the mapping units to PNV types are given in Appendix 9.5, Table 9.11.

The only alpine vegetation types mapped on the Prioul/Troupin map are in the Virunga region. Thus, while acknowledging that some of the Alpine vegetation types are likely to occur on other high mountains too, we could not map their distribution.

5.2.3.2 Fresh-water swamps (X) and Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)

Prioul/Troupin distinguish medium altitude and highland marshes. We do not distinguish between these types on the regional map, aggregating them as freshwater swamps (X). For a national map it should perhaps be considered to keep the highland and medium altitude marshes separate, e.g., using the 1900 meter as the upper altitudinal limit for medium-altitude marshes.

Outlines on the Prioul/Troupin map are not very accurate. We therefore attempted to map the marshes more accurately using two thematic soil layers (scale 1:250,000) created by Ann Verdoodt and Erid van Ranst of the University of Gent based on the Rwanda soil map (Birasa *et al.* 1992). The

layers give the internal drainage and soil profile development of the dominant soils. The classes included in the first are excessive to moderate (0), imperfect (3) and very poor to poor (1). The classes mapped in the profile development map are entic (E), organic soils (O), vertic (V) and other (X).

Areas classified as V and O on the soil profile development layer and classes 1 and 3 on the internal drainage layer include all areas mapped as swamp on the global wetland database layer (GLWD) and on the Prioul/Troupin vegetation map. These soil types occur in valleys (high terrain wetness and low slope values), often around rivers (based on the AEON river database). And although no firm conclusions can be drawn from a simple overlay with satellite images from Google earth, the fact that virtually all these areas form a stark contrast (greener) with surrounding vegetation suggest that these are indeed wetter vegetation types.

Classifying all these areas as swamps might overestimate the extent of this vegetation type as it possibly include grasslands with impeded drainage too. We therefore classified all valleys mapped as marshes on the Prioul/Troupin map as freshwater swamp (X), while classifying all other areas as edaphic grassland on drainage-impeded or seasonally flooded soils / freshwater swamp (g/X).

5.3 Reclassifying secondary types and croplands

There is a large zone of 'Grass savannas with *Brachiaria platynota* and different types of cropland' on the Prioul/Troupin map. This consists of a mosaic of secondary vegetation types and croplands. This zone was split, and the resulting sub-zones classified according to the altitude criteria mentioned in Table 9.10, Appendix 9.5.

6. Tanzania

6.1 Description of base maps used

The base map for the PNV map for Tanzania is the Gillman "Tanganyika Territory Vegetation Types vegetation map" (Gillman 1949). After digitizing the original map, some adaptation were made to the lake boundaries to align them better with the boundaries of the lake boundaries in the global wetland database (Lehner & Döll 2004).

The Gillman map is based on physiognomic criteria, whereas the PNVs are based on floristic and physiognomic criteria. For the construction of the PNV map, we therefore adapted the Gillman map to include floristic boundaries, using information from the White vegetation map (White 1983), the miombo ecoregional map (Timberlake & Chidumayo 2011), information from (Lovett 1990), and the Central African rail link development survey provisional vegetation and soil map southern Tanganyika (Gibb and Partners & Overseas consultants Inc. 1952).

Table 6.1: Table with existing vegetation maps for Tanzania consulted or used in the development of the regional VECEA potential natural vegetation (PNV) map.

Region / area of	Map	Scale / resolution	Reference
Tanzania	A Vegetation-Types Map of Tanganyika Territory	1:2,000,000	Gillman 1949
Miombo ecoregion	Vegetation types of the miombo ecoregion	1:10,000,000	Timberlake & Chidumayo 2011; WWF-SARPO 2001
South Tanzania	Central African rail link development survey provisional vegetation and soil map southern Tanganyika	1:500,000	Gibb and Partners & Overseas consultants Inc. 1952
Global	Global database of lakes, reservoirs and wetlands	n.i.	Lehner & Döll 2004
Africa	HWSD map	30 arc-second	FAO *et al.* 2009
Africa	The vegetation of Africa	1:5,000,000	White 1983
East Africa	Vegetation map of east Africa	1:4,000,000	Trapnell & Langdale-Brown 1972
Coastal zone of east Africa	Mangrove of east Africa	1:1,000,000	Taylor *et al.* 2003
Southern Kenya and northern Tanzania	Vegetation formations and vegetation formation complexes.	1:1,000,000	Bader 1976

6.2 From the base maps to the VECEA map

To arrive at a physiognomic and floristic map for Tanzania while using a physiognomic base map (Gillman 1949), we compared the Gillman map (1949) with other vegetation map that were based on floristic criteria. We subsequently used the floristic boundaries from other maps to reclassify physiognomically-defined polygons on the Gillman map. For example, outline 1 of Figure 6.4 corresponds to the boundary of the Somalia-Masai floristic region on the White map. It does not, however, exactly match the boundaries of the White map as we wanted to avoid as much as possible to split polygons of the Gillman (1949) map.

Areas mapped as cultivated on the Gillman (1949) map were reclassified based on the classification of the neighbouring cells. This was done using

the r.neighbors function in GRASS GIS (version 6.4; GRAS development team 2010), using the mode of the circular 9x9 neighbourhood matrix (excluding cells classified as cultivated).

6.2.1 Notes on mapping of some forests and scrub forest vegetation types

We used the information available from Lovett (1990) and White (1983) to reclassify forest polygons into forest PNVs. Lovett underlines that the classification of many areas is based on a limited number of sample plots and the listed forest types may have missed one or more forest types in these areas. Nonetheless, it is the best information currently available. We used information from other sources (such as Google Earth and *http://www.easternarc.org/html/map.html*) to identify the forest areas mentioned by Lovett (1990). We subsequently used this to reclassify the forest areas on the Gillman map, including ridge and slope grasslands (see section 6.2.1.1 and Figure 6.1), the forest-woodland intermediate (see section 6.2.1.2 and Figure 6.3) and some other areas (sections 6.2.1.3 - 6.2.1.5) that were reclassified as forest during earlier steps.

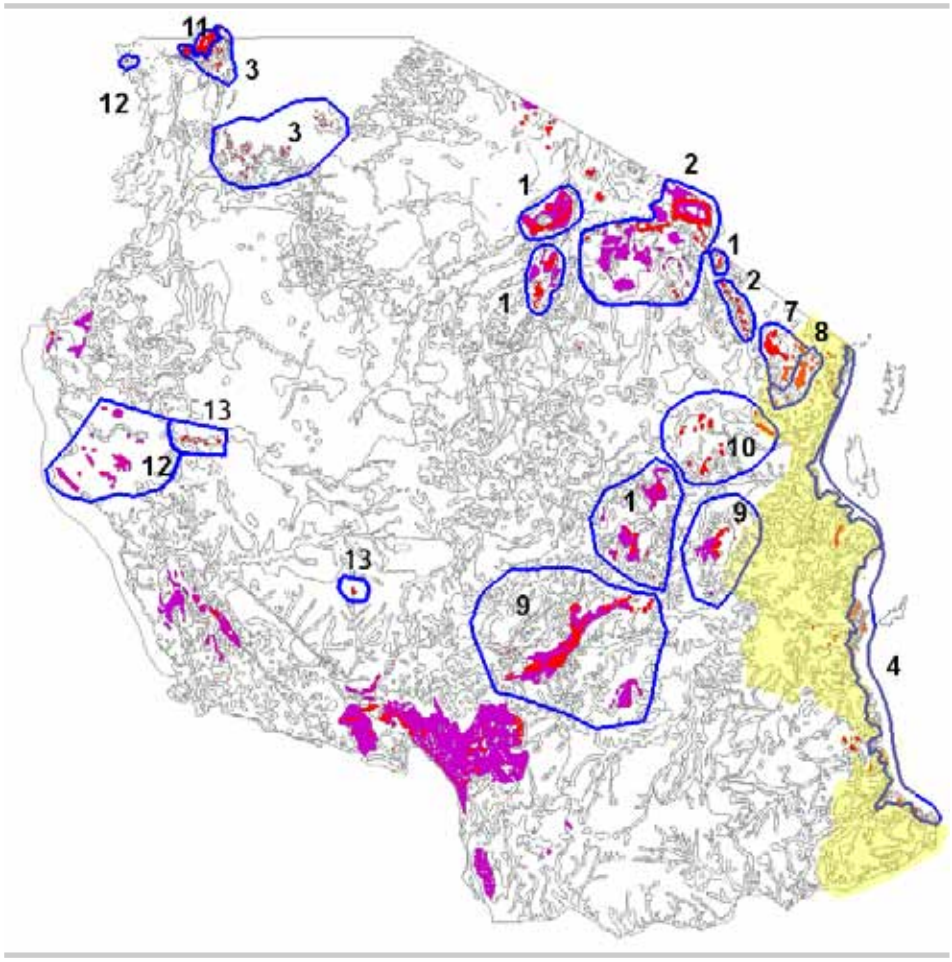


Figure 6.1: Red polygons correspond to forests on the Gillman physiognomic map. Purple areas polygons correspond to polygons that were originally classified as "forest woodland intermediate" (see Figure 6.3) or "ridge and slope grassland" areas (see Figure 6.2) by Gillman (1949). Both are considered to be secondary to forests. The outlines (blue) were used to assign regional forest types (see Table 6.2).Coloured polygons outside the outlines were classified as mosaics of Afromontane rain forest (Fa) and Afromontane undifferentiated forest (Fbu). The transparent yellow polygon marks the Zanzibar-Inhambane coastal mosaic. A number of areas are not mentioned altogether by Lovett (1990), including areas in northern Tanzania outside blue outlines in Figure 6.1 and forest areas near the border of Burundi. Most of these forest areas fall within mapping unit 19 (Afromontane forest) of the White (1983) map. These are therefore assumed to contain Afromontane rain forest or Afromontane undifferentiated forest. For the southern part of Lake Tanganyika and Lake Nyasa, Lovett lists areas either with Afromontane rain forest (Fa) and Afromontane undifferentiated forest, or only with Afromontane undifferentiated forest. Because we cannot identify the mentioned forests on the Gillman map with certainty, we classify all forests in both zones as Afromontane rain forest and/or Afromontane undifferentiated forests.

Some wooded grassland areas were reclassified as Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi), based their location, See Figure 6.4.

Table 6.2: Assignment (X) to forest types based on outlines in Figure 6.1. Assignments were based on Lovett (1990) and White (1983)

VECEA vegetation types	**1**	**2***	**3**	**7**	**8**	**9**	**10**	**11**	**12****	**13*****
Afromontane rain forest (Fa; see Table 6.2)	-	x	-	x	x	x	x	-	x	-
Afromontane undifferentiated forest (Fbu)	x	x	-	x	-	x	x	-	x	-
Afromontane single-dominant *Hagenia abyssinica* forest (Fd)	-	-	-	-	-	-	-	-	-	-
Afromontane dry transitional forest (Fh)	-	x	-	-	-	-	-	-	-	-
Zanzibar-Inhambane transitional rain forest (Fg)	-	-	-	x	x	x	x	-	-	-
Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	-	-	x	-	-	-	-	-	o	-
Zanzibar-Inhambane lowland rain forest (Fo)	-	-	-	-	x	x	x	-	-	-
Zanzibar-Inhambane undifferentiated forest (Fp)	-	-	-	-	-	-	-	-	-	-
Swamp forest (fs, edaphic forest type)	-	-	-	-	-	-	x	x	-	x

* see modifications for Mts. Kilimanjaro and Meru
** Lovett (1990) suggests the occurrence of Lake Victoria drier peripheral Guineo-Congolian rain forest in this area, but we relied on White (1983) instead
*** Floristic maps did not show these forest areas

In forest polygons within outlines 7, 8, 9 and 10 (Figure 6.1), polygons were split according to altitude limits of 1250 and 900 m (these approximate limits of 1200-1250 m and 800-900 m given by Lovett (1990, 1993) and White (1983), using the following procedure:

- Areas above 1250 m were classified as mosaics of Afromontane rainforest (Fa) and Afromontane undifferentiated forest (including the single-dominant sub-types)
- Areas between 900 and 1250 m were classified as Zanzibar-Inhambane transitional rain forest (Fg)
- Areas below 900 m were classified as Zanzibar-Inhambane lowland rain forests (Fo)

Such boundaries will in reality vary from mountain to mountain or even between slopes of the same mountain (see e.g., section on Mount Meru). However, at a regional scale, they are still useful to give a better approximation where to expect what forest type than by mapping all areas as mosaics.

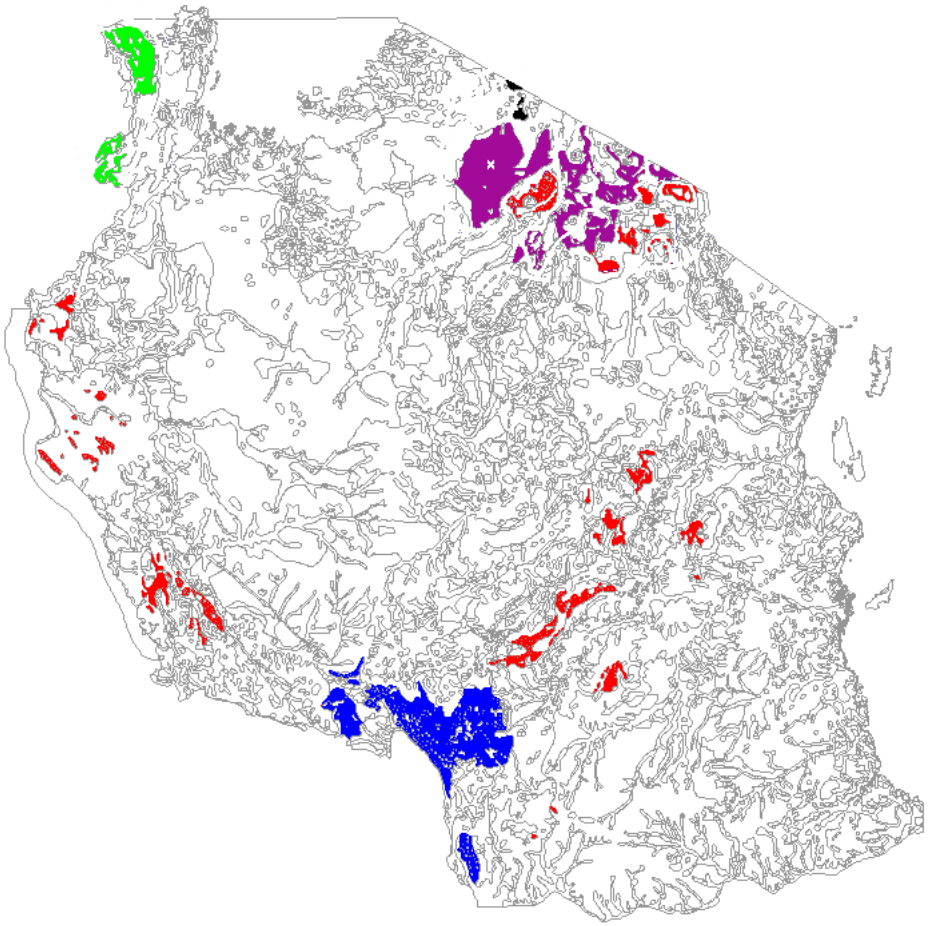


Figure 6.2: Distribution of Ridge and slope grassland on the Gillman map. The purple are reclassified as edaphic soils on volcanic soils. The green areas are considered to be secondary to Evergreen and Semi-evergreen bushland and ticket in the lake Victoria regional mosaic. The black areas were reclassified using modelling. The red and blue areas were classified as forests (for further reclassification into forest PNVs). See section 6.2.1 for some discussion points about the reclassification of the blue area.

6.2.1.1 Reclassification of montane grassland as forests

With some exceptions detailed below, ridge and slope grasslands on the Gillman map were considered secondary to forest based on Trapnell & Langdale-Brown (1972), White (1983), Lovett (1985, 1990; 2000) and their locations at generally higher altitudes (see also Figure 6.2). Some of the areas mapped as ridge and slope grassland on the Gillman map occur below 1250 altitude, which we considered as the lower limit for Afromontane forests (Lovett 1990; White 1983; see above). If we had no supplementary information that Zanzibar-Inhambane forest types occurred in those areas, all raster cells below 1250 meter were reclassified according to their nearest non-forest neighbours (this means essentially that we adapted the boundaries of Afromontane forests to follow the 1250 meter contour line). The rest was classified following the reclassification rules for forest given above (including Figure 6.1 and Table 6.2).

The hypothesis that ridge and slope grasslands are secondary vegetation types derived from forests should be be reviewed with care. Especially in the region around Lake Nyasa, which falls within the Southern Rift Montane Forest-Grassland mosaic (AT1015) on the WWF ecoregions map (Olson *et al.* 2001), the origin and potential distribution of montane grasslands and forests is debated. The largest area in Tanzania belonging to this region is the Kitulo plateau, which includes the proposed Kitulo national park (Tanzania National Parks 2008). Currently, these highlands are dominated by grasslands, with patches of forests, often at valley-headsites and more humid slopes (pers. comm. J. Timberlake). Although it is often assumed that grasslands have replaced forests because of fires, palaeontological research, the high level of endemism in grassland related species and the low percentage of montane forest pollen throughout the Holocene suggests that grassland in these areas were widespread for 10,000 years or longer. This would mean they are not (all) derived from forests through more recent human activities (DeBusk 1998; Meadows & Linder 1993). This doesn't discount the influence of current human land use activities, which are considerable (Lovett & Prins 2009), and may have shifted or maintained the balance further towards grasslands. For a detailed comparison of the main hypothesis about the distribution of montane grasslands in the afromontane region, see Meadows & Linder (1993).

6.2.1.2 Reclassification of forest-woodland intermediate as forest

We hypothesized that the forest - woodland intermediate on the Gillman map (Figure 6.3) are degraded forests. This means that all red areas in Figure 6.3 were first reclassified as forest. Subsequently they are reclassified following the reclassification rules for forest given above (including Figure 6.1 and Table 6.2). Alternative hypotheses to be considered are that these areas represent a transitional zone between forest and woodlands or transitional forests similar to the Afromontane moist transitional montane forest (Fe) or Afromontane dry transitional montane forest (Fh) in Kenya.

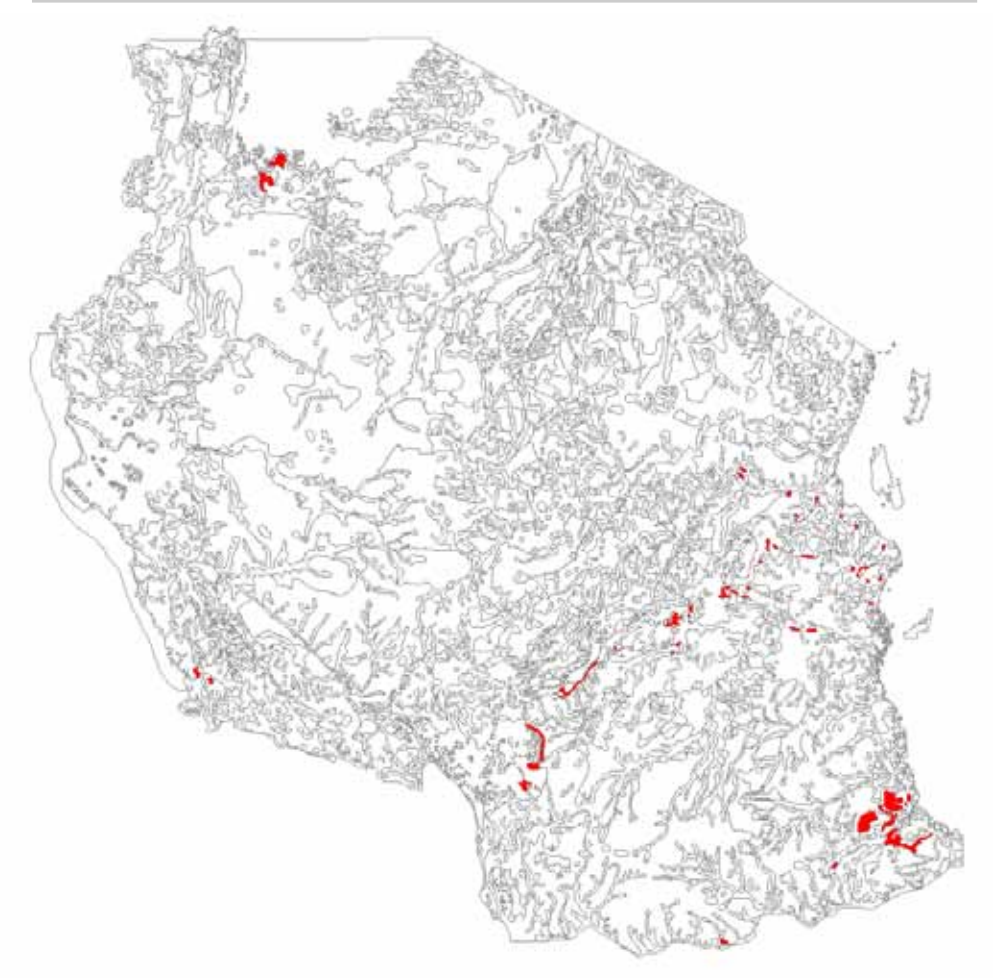


Figure 6.3: Red polygons correspond to the forest woodland intermediate vegetation type on the Gillman (1949) physiognomic map. These areas were reclassified as forest on the VECEA map, with exception of the areas falling within the Zanzibar-Inhambane coastal mosaic.

6.2.1.3 Mapping of Mount Kilimanjaro, Mount Meru and adjacent areas

Based on descriptions by Hemp (2005, 2006) and Grimshaw (1996), we hypothesized that the forest belt on Mnt Kilimanjaro includes Afromontane rain forest, Undifferentiated Afromontane forest and Afromontane dry transitional forest complex (Fa/Fb/Fh). We used the vegetation map by Hemp (Hemp 2006), which we georeferenced and overlaid on Google Earth, to estimate the boundaries of this forest belt.

Beesley (1972) gives altitudinal ranges of different Afromonane forest types that he identifies on Mount Meru.

- Dry evergreen forests - 1500 - 1700 meter altitude
- Sub-montane or mountain evergreen mist forest - 1700 - 1800 on Ngurdoto krater and up to 2100 m on Meru crater
- Montane forest - 2100 - 2600 meter.
- Beesley does not provide information about the vegetation in the 2600-3000 altitudinal zone. On the GlobCover (regional version 2.2 for Africa) the area is mapped as broadleaved deciduous forest, Closed to open (>15%) broadleaved evergreen or semi-deciduous forest, or Open (15-40%) needleleaved deciduous or

evergreen forest. On the MODIS Land Cover data for 2001, 2005 and 2009 (LP DAAC 2009) these areas are mapped as Evergreen Broadleaf forest, mixed forests, grasslands or woody savannah. Overall, the zone seems to consist of a mosaic of forest patches and Ericaceous vegetation.

We hypothesize that these three forest types correspond to respectively Afromontane dry transitional forest (Fh), Afromontane rain forest (Fa) and undifferentiated Afromontane forest (Fb). Beesley (1972) lists few indicator species only, so this need further verification. Although Beesley gives an altitude range for the different forests for Mount Meru, we don't know whether the same limits apply for the adjacent potential forest areas (areas in blue outline 2 in Figure 6.1). We therefore decided to classify all these areas the same as on Mount Kilimanjaro, as a mosaic of Fa/Fb and Fh.

Consequently, we mapped all areas up to 2700 meter as compound vegetation with Fa, Fb and Fh. In the 2700-3000m zone (excluding the bamboo zone), we classified all areas as compound vegetation with Fa, Fb and Fh that were classified as one of the closed forest types on GlobCover 2.2. The other areas were mapped as part of the Ericaceous belt. It should be noted however that this boundary may have been affected by non-climatic factors, especially fire.

We do not have information about the other potential forest areas within blue outline 2 in Figure 6.1, but we assume that the same forest types can be found as the neighbouring Mount Kilimanjaro and Mount Meru, i.e., compound vegetation with Fa, Fb and Fh. See volume 2 for more information about the distribution of these forest types.

6.2.1.4 Mapping Afromontane Undifferentiated forest (Fb) on Mount Hanang

Mount Hanang in Tanzania was classified as wooded grassland on the Gillman map. Given the height of this mountain and it being mentioned in Lovett (1990), we assumed that this was a wrong classification, and that the correct classification should be forest. In line with the classification of the nearest forests, we classified the area as Undifferentiated Afromontane forest (Fb), except for the peaks above 3000 meter, which were classified as Montane Ericaceous belt (E).

6.2.1.5 Mapping of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi) west of Lake Victoria

The dry wooded grasslands within outline 4 of Figure 6.4 were considered secondary to dry wooded Guineo-Congolian drier peripheral semi-evergreen rain forest (on the White map this is Mosaic of lowland rain forest and secondary grassland) and reclassified correspondingly. Note that this places the boundary between the two types much more to the east than on the White map. On the other hand, this does correspond better with how these types were classified on the Uganda PNV map.

6.2.2 Notes on mapping of some woodlands and wooded grasslands vegetation types

6.2.2.1 Acacia-Commiphora deciduous wooded grassland (Wd)

Wooded grasslands sensu Gillman (Figure 18) cover large parts of Tanzania, crossing various major floristic regions, including the Zambezian and Somalia-Masai floristic regions. The dry wooded grasslands within the Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket zone (sensu White 1983, outline 1 in Figure 6.4) were reclassified as *Acacia-Commiphora* deciduous wooded grassland. However, it should be noted that these areas may include *Combretum* wooded grasslands. Especially in the areas along valleys and along streams in central Tanzania, it might occur as a catena of *combretum* wooded grasslands and edaphic grasslands on drainage-impeded or seasonally flooded soil, similar to the catena of North Zambezian Undifferentiated woodland / edaphic grassland on drainage-impeded or seasonally flooded soils in the neighbouring Zambezian zone (see descriptions below and in Volume 3).

6.2.2.2 Biotic Acacia wooded grassland (We)

In the northern Serengeti, bordering the Masai Mara in Kenya, Gillman mapped dry wooded grasslands (mostly) and some smaller areas of Ridge and Slope Grassland. However, based on the White (1983) and Trump (1972) vegetation maps (on the Kenyan side), one could expect that various vegetation types that occur on the Kenyan side would extend into Tanzania, including evergreen and semi-evergreen bushland and ticket (Be), biotic *Acacia* wooded grassland (We; this is an alternative steady state of evergreen bushland), edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd), Afromontane dry transitional forest (Fh) and Undifferentiated Afromontane forest (Fb).

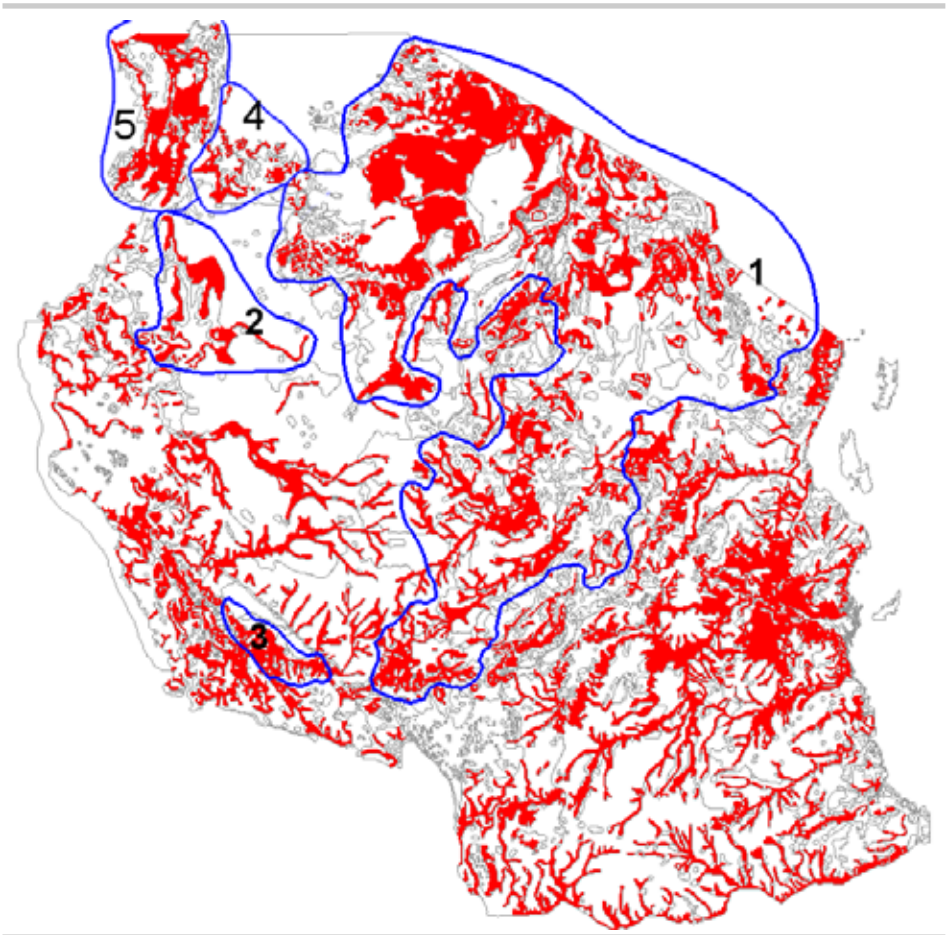


Figure 6.4: Red polygons correspond to wooded grasslands on the Gillman (1949) physiognomic map. Wooded grasslands were reclassified as catenas of north Zambezian undifferentiated woodland (Wn) and edaphic grassland on drainage-impeded or seasonally flooded soils (g), except wooded grasslands occurring within outlines (1-5). Wooded grasslands within outline 1 were reclassified as *Acacia-Commiphora* deciduous wooded grassland (Wd). Wooded grasslands within outline 2 were reclassified as north Zambezian undifferentiated woodland (Wn). Wooded grasslands within outlines 3 were reclassified as north Zambezian undifferentiated woodland (Wn). Wooded grasslands within outline 4 were reclassified as Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi). Wooded grasslands within outline 5 were reclassified as Evergreen and semi-evergreen bushland and thicket (Be).



Figure 6.5: The area in red was classified combining the Maxent probability distribution models of the individual PNVs created in section 3.2.10.

As we expect these various vegetation types to occur beyond the Kenya-Tanzania border, we used modelling to map where we expected these vegetation types. We first took the area that are mapped as evergreen and semi-evergreen bushland and thicket according to White, but with a wider margin (Figure 6.5). Next, we combined the modelled probability distribution layers created in section 3.2.10 to estimate the distribution of the different PNVs in the marked area. Given our definition of biotic wooded grassland as being derived from or secondary to evergreen and semi-evergreen bushland and thicket (see volume 3), we subsequently reclassified all areas classified as evergreen and semi-evergreen bushland and thicket by the combined model as biotic *Acacia* wooded grassland (We).

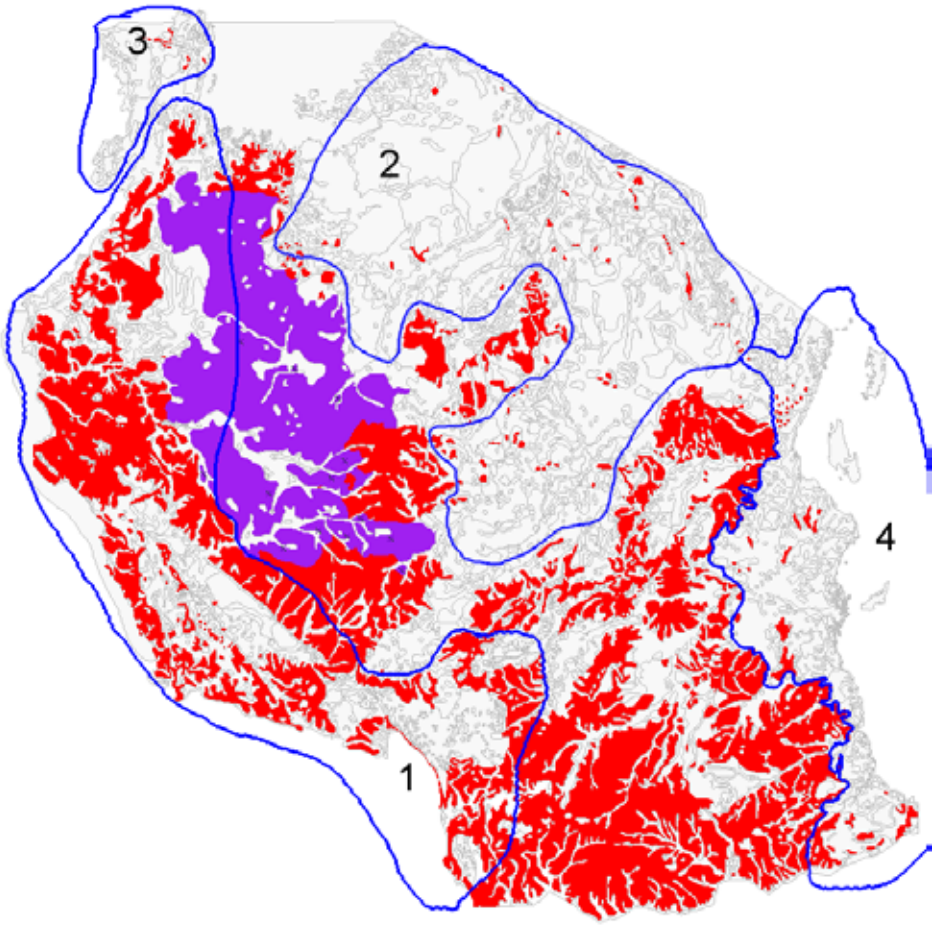


Figure 6.6: Red polygons correspond to woodlands and purple areas correspond to the "central plateau catena" as mapped by Gillman (1949). Red polygons within outline 1 delimits polygons that were reclassified as wetter miombo woodland. The red polygons outside the outlines(1-4) were reclassified as drier miombo. Likewise, the purple polygons were classified as catenas with wetter miombo (inside outlines 1-4) or catenas with drier miombo (outside outlines 1-4). We used the Soter soil map [REF] to further split these catena areas, separating the miombo areas from the 'catena of North Zambezian Undifferentiated woodland / edaphic grassland on drainage-impeded or seasonally flooded soils' (see section 6.2.2.4). Woodlands within outline 2 are reclassified as Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd). Woodlands within outline 3 were reclassified as Evergreen and semi-evergreen bushland and thicket (Be).Woodlands within outline 4 were reclassified as the Zanzibar-Imhambane coastal mosaic.

6.2.2.3 Miombo woodland (Wm)

Most of the woodlands (red areas in Figure 6.6) on Gillman's vegetation map (mapping unit 16 on the Gillman map) fall within the zone of miombo woodlands and where therefore classified as such. These areas were split into Wetter and Drier miombo following the miombo ecoregional map (Timberlake & Chidumayo 2011).

The woodlands within the blue outlines 2, 3 and 4 in Figure 6.6 fall outside the miombo region. Based on the White vegetation map, these are reclassified as respectively 'Somalia-Masai *Acacia-Commiphora* bushland and thicket', 'Zanzibar-Imhambane coastal mosaic' and 'Evergreen and semi-evergreen bushland and thicket'.

Based on the neighbouring vegetation types, part of the areas classified as "woodland – bushland" intermediates on the Gillman map (Figure 6.7) were reclassified as transitional vegetation types between drier miombo woodland and north Zambezian undifferentiated woodland (Wmd/Wn) or transitional vegetation types between miombo woodland areas and Somalia-Masai *Acacia-Commiphora* deciduous bushland and thickets (Wmd/Bd; see Figure 6.7).

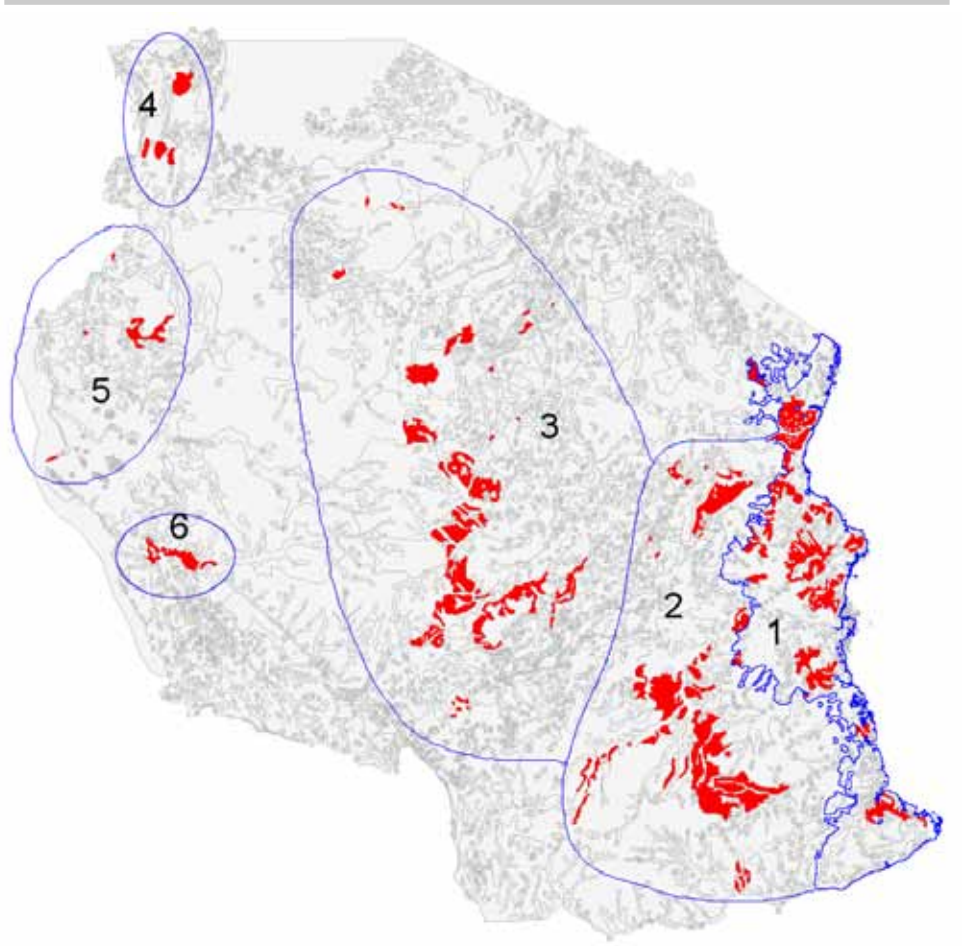


Figure 6.7: Red polygons correspond to the woodland bushland intermediate on the Gillman (1949) physiognomic map. Polygons within outline 1 were classified as part of the Zanzibar-Inhambane coastal mosaic. Polygons within outline 2 were classified as transitional vegetation types between drier miombo woodland and north Zambezian undifferentiated woodland (Wmd/Wn). Polygons within outline 3 were reclassified as transitional vegetation types between miombo woodland areas and Somalia-Masai *Acacia-Commiphora* deciduous bushland and thickets (Wmd/Bd). Polygons within outline 4 were classified as Evergreen and semi-evergreen bushland and thicket (Be). Polygons within outline 6 were classified as north Zambezian undifferentiated woodland (Wn). Polygons within outline 5 were merged with the surrounding vegetation (floristic maps did not provide sufficient information).

Some bushland areas were reclassified as miombo woodland based on their position (see Figure 6.7).

Gillman's Ugogo catena was reclassified as mosaic of miombo woodland and Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd).

6.2.2.4 North Zambezian undifferentiated woodland and wooded grassland (Wn)

Wooded grasslands sensu Gillman (Figure 6.4) cover large parts of Tanzania, crossing various major floristic regions, including the Zambezian and Somalia-Masai floristic regions. Within the Zambezian zone, the wooded grassland polygons were classified as catenas of north Zambezian undifferentiated woodland (Wn) and edaphic grassland on drainage-impeded or seasonally flooded soils (g; see Figure 6.4). More information is provided in Volume 3 on the nature of catenas of miombo woodland (Wm) – north Zambezian undifferentiated woodland (Wn) – edaphic grassland (g); see for example box 1 in that volume.

Gillman (1949) also describes the occurrence of *Combretum*-other species woodland as part of the central plateau catena (purple area in Figure 6.6) occurring on lower slopes in between miombo woodland (*Brachystegia*-other species) on relatively well drained ridges and their upper and middle slopes and the grassland of valley bottoms. We used the harmonized world soil data (HWSD) (FAO *et al.* 2009) map to identify and map the valley bottoms. On this map, one of the classes is 'Alluvium - Fluvial / A spatially distinct linear type hydrologic alluvial geologic feature; mixed texture'. Comparing this with the digital elevation model (CGIAR-CSI 2008) and river network database (de Wit & Stankiewicz 2006) shows that these represent well the valley bottoms and river beds in the central catena area. We subsequently classified all these areas on the HWSD map as 'catena of North Zambezian Undifferentiated woodland / edaphic grassland on drainage-impeded or seasonally flooded soils'. The rest was classified as wetter or drier miombo (see section 6.2.2.3). This might underestimate the extent of the north zambezian undifferentiated woodland as it may not include the slopes of the valley, but it gives an approximation of the distribution pattern of this PNV.

The wooded grasslands within the blue outline 3 in Figure 6.4 and the woodland-bushland intermediate within outline 6 in Figure 6.7 overlap with the zone classified as 'Transition from undifferentiated Zambezian woodland to *Acacia* deciduous bushland and wooded grassland' on the White map. Also Banda *et al.* (2008) highlight the special floristic composition of the vegetation in this area. However, the available information does not provide clear information where to draw the boundary between Undifferentiated woodland and 'Transition from undifferentiated Zambezian woodland to *Acacia* deciduous bushland and wooded grassland'. Furthermore, floristic information is limited. We decided to map this area as North Zambezian undifferentiated woodland and wooded grassland, but highlighting that this areas has some unique characteristics, as described in chapter 9 in volume 3.

6.2.3 Notes on mapping of some bushland and thicket vegetation types

6.2.3.1 Somalia-Masai Acacia-Commiphora deciduous bushland and thicket (Bd)

Areas mapped as Bushland and Thicket on the Gillman map (red areas in Figure 6.8) largely coincide with the "dry bushland and thicket" mapped by Trapnell and Langdale-Brown for the East Africa map (1972) and the "Somalia-Masai *Acacia-Commiphora* wooded grassland, bushland and thicket" by White (1983). In the coastal region at the border of Kenya and Tanzania, the boundaries of the Bushland and Thicket on the Gillman map also agrees well with that of *Acacia-Commiphora wooded grassland, bushland and thicket* on the Moomaw map (section 3.2.3). This mapping unit was therefore reclassified as Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bdd), except for some areas shown on Figure 6.8.

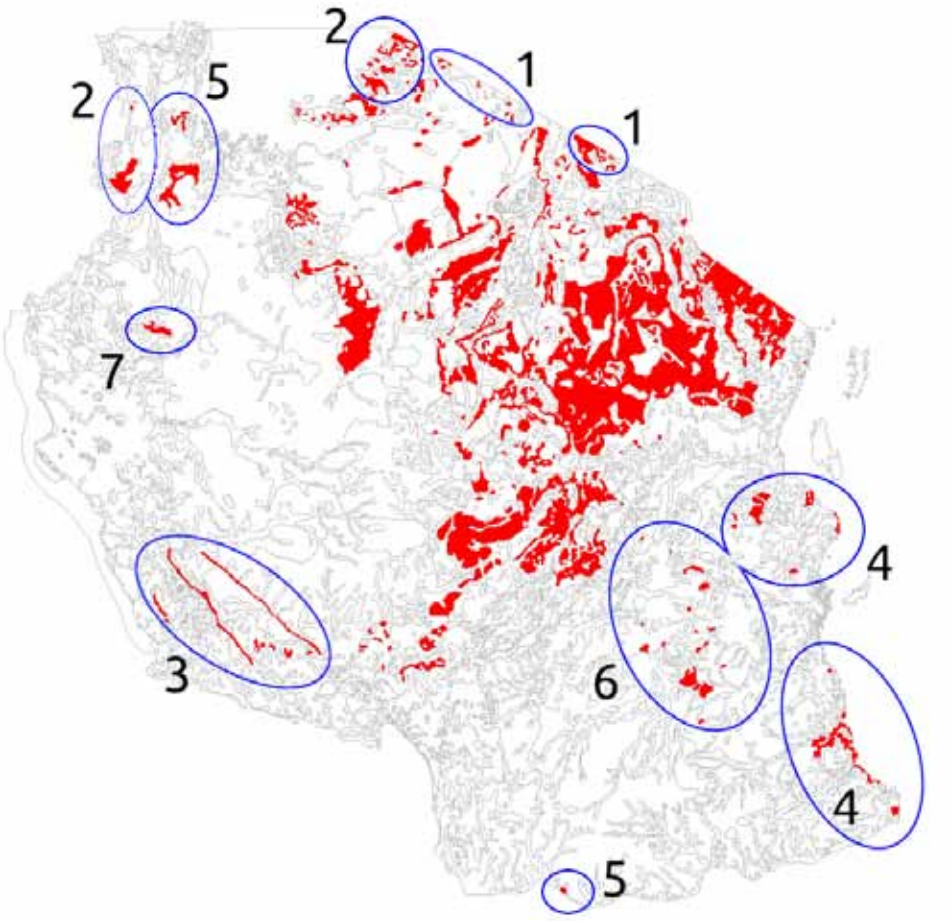


Figure 6.8: Red polygons correspond to bushlands and thickets on the Gillman (1949) physiognomic map. They were all reclassified as *Acacia-Commiphora* deciduous bushland and thicket (Bd), except for polygons within outlined areas. Based on the White vegetation map (1983) and the vegetation in adjacent areas in Rwanda and Uganda, the bushlands and thickets in areas 1 and 2 were reclassified as evergreen bushland (Be); in area 3 they were reclassified as "Transition from undifferentiated woodland to *Acacia* deciduous bushland and wooded grassland" (Wnt); in area 5 they were reclassified as wetter miombo woodland (Wmw) and in area 6 they were reclassified as drier miombo woodland (Wmd). Polygons in areas 4 were assigned to the Zanzibar-Inhambane coastal mosaic, whereas polygons in areas 7 were merged with surrounding polygons based on proximity (as there was no sufficient information from floristic maps)

The "Rain pond catena" is described by Gillman (1949) as a sea of dominating thornbush with irregular distributed islands of grassland, with a narrow fringe of wooded grassland. It is reclassified in VECEA as a catena of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket/edaphic grassland on drainage-impeded or seasonally flooded soils (Bdd/g). See also the description of mbugas in chapter 14, volume 3.

Based on floristic maps, some areas that were originally classified as woodlands were reclassified as Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd; see Figure 6.6). For these areas, we assumed that these were vegetation types that were slightly taller than typical bushlands and therefore classified them together with deciduous bushland (Bd). See also White 1983 p. 113 that "in higher rainfall areas, especially on rocky hills, the emergent trees occur closer together and are a little bit taller, though scarcely ever more than 10 m. Greenway (1969) refers to this variant (of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket) as woodland".

6.2.3.2 Evergreen and semi-evergreen bushland and thicket (Be)

We reclassified several physiognomic types such as woodland, wooded grassland or ridge and slope grassland to Evergreen bushland (Be) where we expected to find this vegetation type according to the White (1983) vegetation map. See Figure 6.2, 6.4-6.8.

The specialized thickets of regional extent in zone 2 in Figure 6.9 is probably the *Euphorbia* thicket described by Gillman (1949). According to this author, the succulent *Euphorbia* thicket is widely distributed on the slopes of the northern high blocks (Usambara and Pare). He considers it a well established secondary growth where forest has been destroyed on slopes too steep or too stony for the development of grassland. This vegetation type directly corresponds to the "Somalia-Masai scrub forest" that occurs between 700 and 960 m on the steep northern slopes of the Western Usambara mountains as described by White (1983, page 117). We especially expect this correspondence since White gives the synonym of "*Euphorbia* bushland and thicket" and mentions the same location of north west Usambara mountains. However, the extent of *Euphorbia* thicket seems to be wider, so we expect that this corresponds more to evergreen bushland and thicket. See also chapter 17 in volume 2. Given its limited distribution and possibly secondary nature, we decided not to consider this as a separate type for the regional map, but reclassify it as evergreen and semi-evergreen bushland and thicket (Be). For a national map, it would probably be a good idea to consider this type separately.

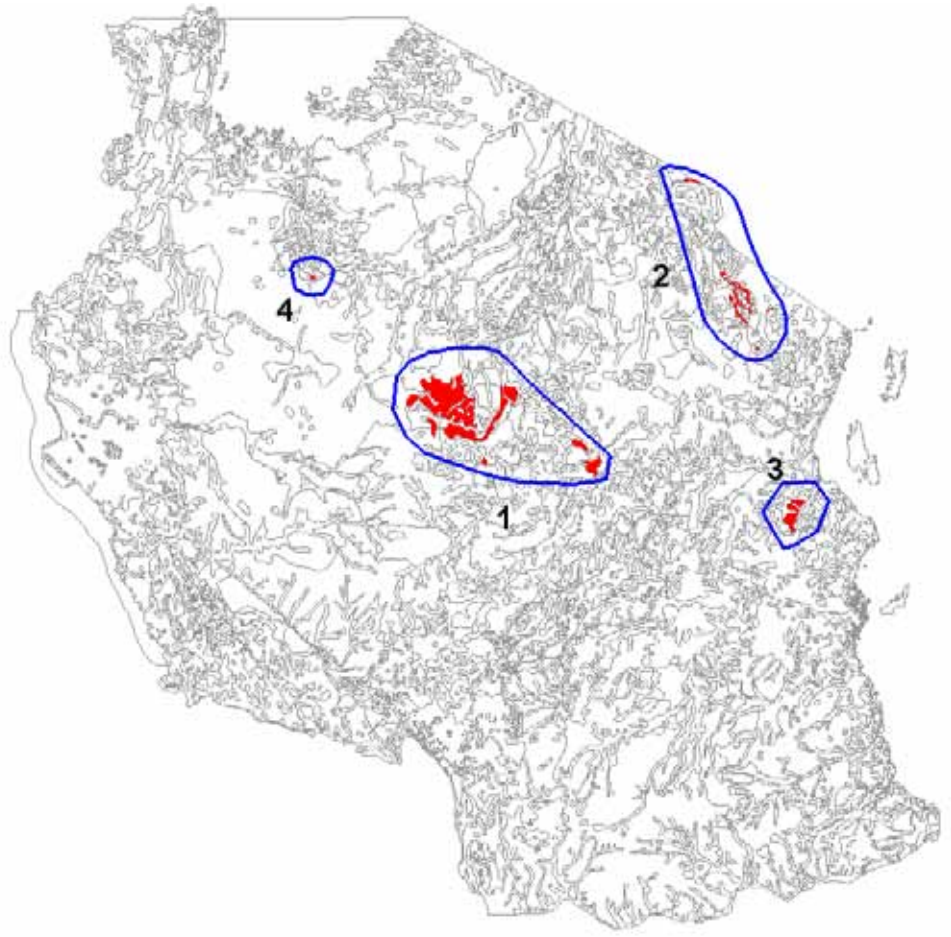


Figure 6.9: Red polygons correspond to specialized thickets of regional extent on the Gillman (1949) map. Outline 1 shows polygons that were reclassified as Itigi deciduous thicket (bi). Outline 2 shows polygons that were reclassified as Evergreen and semi-evergreen bushland and thicket (Be). Outline 3 shows the Msua thicket; we reclassified this vegetation type as part of the Zanzibar-Inhambane coastal mosaic. Polygons in outline 4 were merged with neighbouring vegetation types.

6.2.3.3 Itigi thicket (bi)

Itigi thicket corresponded to some of the areas mapped as 'specialized thickets of regional extent' by Gillman (1949) as shown in Figure 6.9.

The other 'specialized thickets of regional extent' were reclassified as evergreen and semi-evergreen bushland and thicket (see section 6.2.3.2 above). The Msua thicket (in zone 3 in Figure 6.9) is described by Gillman (1949) and occurs in the Zanzibar-Inhambane coastal region west of the Ruvu Valley. It covers some 800 square kilometers. It is a strange type of "semi-thicket low forest" composed of numerous tree species and abundant succulent or spiny shrubs and creepers, in places lichen-covered. It is probably maintained by mists that penetrate from the sea through the wide depression of the Ruvu Valley. See also Mashalla (1978) for a description of the area. Species occurring in this area are *Euphorbia candelabrum*, *Acacia kirkii, Albizia harveyi, Terminalia spinosa*, *Pteleopsis myrtifolia*, *Afzelia quanzensis*, *Dalbergia melanoxylon*, *Newtonia erlangeri*, *Haplocoelium foliolosum*, *Garcinia livingstonei* and *Teclea nobilis*. Given its limited distribution in the Zanzibar-Inhambane zone , we do not consider this type for regional comparisons, but classify it as part of the Zanzibar-Inhambane mosaic.

6.2.3.4 Montane Ericaceous belt (E)

The montane Ericaceous belt was not mapped on the Gillman map. However, various sources mention the occurrence of a Montane Ericaceous belt on Mount Meru, Mount Kilimanjaro and Mount Hanang.

For Mount Kilimanjaro, we used the vegetation map by Hemp (2006), which we georeferenced and overlaid on Google Earth to estimate the boundaries of Montane Ericaceous belt (E).

Lovett (1993) reports the existence of an Ericaceous belts on mount Meru between 3000 and 3700m, which is similar to Hedberg's (1951) observation that the zone can be found between 3000-3600 meter on the south slope, 3050-3450 on the west slope and up to 3700 meter on the northern slopes. Also Beesley (1972) describes an Ericaceous belt (which he calls heath zone), occurring above, and just below Meru crater. In addition, the landcover maps GlobCover 2.2 (regional version for Africa) (ESA & UClouvain 2010) and MODIS landcover layers for 2001 (LP DAAC 2009) all map a bush / shrub vegetation zone which distribution falls within the above-mentioned altitude limits.

Based on these observations, we mapped the montane Ericaceous belt on Mount Meru between the lower boundaries of the Afro-alpine vegetation (see section 6.2.4.1) and a lower boundary which was manually digitized based on a visual comparison of GlobCover 2.2. Hedberg does not provide conclusive information about the vegetation between 2700 and 3000 meter on the southern slope. We therefore extended the Ericaceous belt to the upper boundary of the bamboo (see section 6).

Mount Hanang in Tanzania, which has volcanic soils, is mentioned by Lovett (1993) as one of the mountains were an *Ericacea* belt can be found with *Philippia excelsa* occurring in closed and open moorland above 3000m. Google Earth shows that slopes are covered by bushland to forest. It is however classified as wooded grassland on the Gillman map. Given the height of this mountain and it being mentioned in Lovett, we assumed that the Gillman map provided a wrong classification and therefore areas above 3000 meter were classified as the Montane Ericaceous belt (E).

6.2.4 Notes on mapping of some of the other vegetation types

6.2.4.1 Afroalpine vegetation (A)

The peak and crater of Mount Meru was classified as valley grasslands on the Gillman map. However, judged by descriptions by various authors (see volume 5, chapter 3) the altitude and the very sparse vegetation that can be seen on Google Earth, we hypothesized that this is Afro-alpine vegetation (A). We manually digitized the lower boundaries of Afro-alpine vegetation (A) based on visual comparison with Google Earth.

We used the vegetation map by Hemp (2006), which we georeferenced and overlaid on Google Earth to estimate the boundaries of afroalpine vegetation (A) on Mount Kilimanjaro (Grimshaw 1999).

6.2.4.2 Afromontane bamboo (B)

Hedberg (1951), based on fieldwork on mount Meru, observed a distinct bamboo zone between 2300-2700 m. However, he adds that this is confined to the southern slope of the mountain. Following Hedberg, we classified all areas between 2300 and 2700 meter on the southern slope as bamboo. The 2700 altitude was also used to mark the lower boundary of the Ericaceous belt on the southern slope of the mountain.

Bamboo was also recorded to occur on the highest peak of the Uluguru mountains (White 1983) at 2400-2650 meter. We used this information to map Bamboo on this mountain between the given lower and higher altitude limit.

6.2.4.3 Mangrove (M)

We used the UNEP-WCMC Mangrove data (Taylor *et al.* 2003) to map the mangrove along the coast of Tanzani.

6.2.4.4 Fresh-water swamp (X)

All areas that are mapped in the Gillman map as Permanent Swamp Vegetation are retained as such (freshwater swamp, X), with exception of Lake Burungi, which was reclassified as Lakes with Halophytic shoreline vegetation (halophytic vegetation, Z). Note that we have only conclusive information for a few swamps that they are freshwater swamp, so other swamps may need to be reclassified later as halophytic swamps if such information becomes available.

Of the lakes on the Gillman map, only two are classified as freshwater lakes, viz.: lake Victoria and lake Tanganyika. In both cases boundaries deviate slightly from the boundaries in the GLWD. No changes were made however, because differences are small while it would involve a prohibitive amount of editing work.

6.2.4.5 Halophytic vegetation (Z)

A number of areas mapped as "deserts and semi-deserts" on the Gillman map were reclassified as lakes with halophytic shoreline vegetation (see below). Where needed, lake boundaries were aligned with those of the lakes on the global wetland database (GLWD) vector layer. We also added some new lakes:

- Lake Manyara;
- Lake Natron;
- Lake Eyasi;
- Lake Kitangiri; not on Gillman map, added based on GLWD
- Lake Ambussel
- Lake Burungi; on Gillman map classified as permanent swamp, reclassified.
- Lake Balangida
- Lake Rukwa; this lake is represented on the Gillman map by two separate polygons, the northwestern one is classified as desert and semi-desert while the southeastern is classified as a lake. In contrast on the GLWD the northwestern part is classified as lake. For the vegetation map, the boundaries were modified to more closely follow the boundaries of the GLWD. It should be noted that according to White (1983) the extent of the lake is highly variable between seasons and years.

All remaining areas of the original "deserts and semi-deserts" were reclassified as halophytic vegetation.

Note that one of the areas mapped as "desert and semi-desert" on the Gillman (1949) map corresponds to the Afromontane desert of Mt. Kilimanjaro. In the VECEA map, however, we used the vegetation map by Hemp (2006), which we georeferenced and overlaid on Google Earth to estimate the boundaries of Afromontane desert on Mount Kilimanjaro.

6.2.4.6 Edaphic grassland on drainage-impeded or seasonally flooded soils (g)

Most areas mapped as valley grasslands by Gillman (1949) were reclassified as edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g; see Figure 6.10).

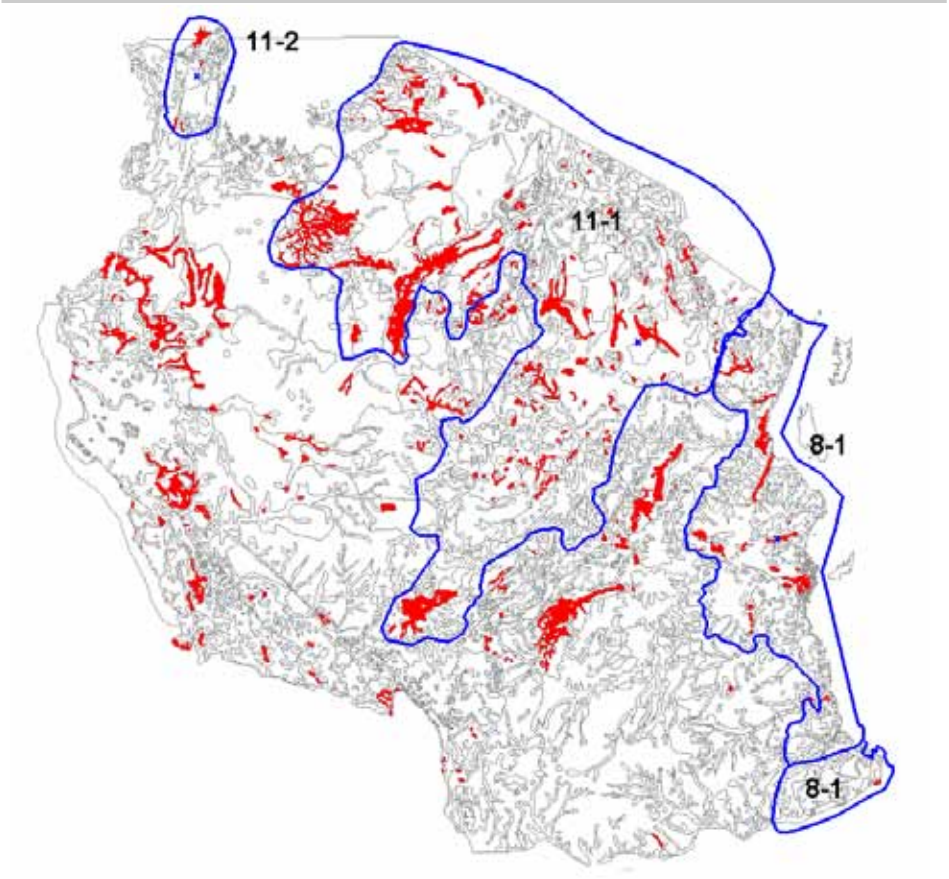


Figure 6.10: Red polygons correspond to valley grasslands in the Gillman (1949) physiognomic map. All these polygons were reclassified as edaphic grassland on drainage-impeded or seasonally flooded soils (g), except areas within outlines 8-1 that were reclassified as the Zanzibar-Inhambane coastal mosaic. Polygons within outline 11-1 fall within the Somalia-Masai floristic region (note that we have adapted the boundary of this floristic regionto respect polygon boundaries on the Gillman map). Polygons within outline 11-2 could be secondary to Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi).

In several places, edaphic grassland was mapped as part of 'catenas of North Zambezian Undifferentiated woodland / edaphic grassland on drainage-impeded or seasonally flooded soils' (see descriptions for north Zambezian undifferentiated woodland in section 6.2.2.4).

In some places, edaphic grassland is also mapped as "catena of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket / edaphic grassland on drainage-impeded or seasonally flooded soils (Bdd/g) (see description of deciduous bushland in section 6.2.3.1).

According to White, grasslands in zone 11-2 in Figure 6.10 are secondary to forests. At the same time it borders swamps, forests and swamp forest on the Gillman map. With no further information we retain this as an edaphic grassland in the Lake Victoria mosaic, with the note that this could well be a secondary type.

In the eastern part of Rwanda, the evergreen bushland mosaics are crossed by swamps or edaphic grasslands, which agree well with the soil type 14 (Alluvium - Fluvial / A spatially distinct linear type hydrologic alluvial geologic feature; mixed texture) on the HWSD map (FAO *et al.* 2009). To ensure a better continuum between areas in Rwanda and neighbouring areas in Tanzania, the HWSD map was used to identify areas likely to be swamps or edaphic grasslands in the evergreen bushland area in Tanzania west of lake Victoria. These areas were reclassified as edaphic grassland on drainage-impeded or seasonally flooded soils / freshwater swamp (g/X).



Figure 6.11: Image in Gillman (1949), showing forest – woodland intermediate types.; coastal hinterland peneplain, eastern Uzigua.

6.2.5 Areas of cultivation

On the Gillman map areas converted in agricultural lands are classified as cultivated by aliens or natives (Figure 6.12). We first reclassified all raster cells in these areas as 'No-value'. Next, we filled classified the No Data cells based on the mode of 11-cell neighbourhood. This was repeated till all No-value cells were classified.

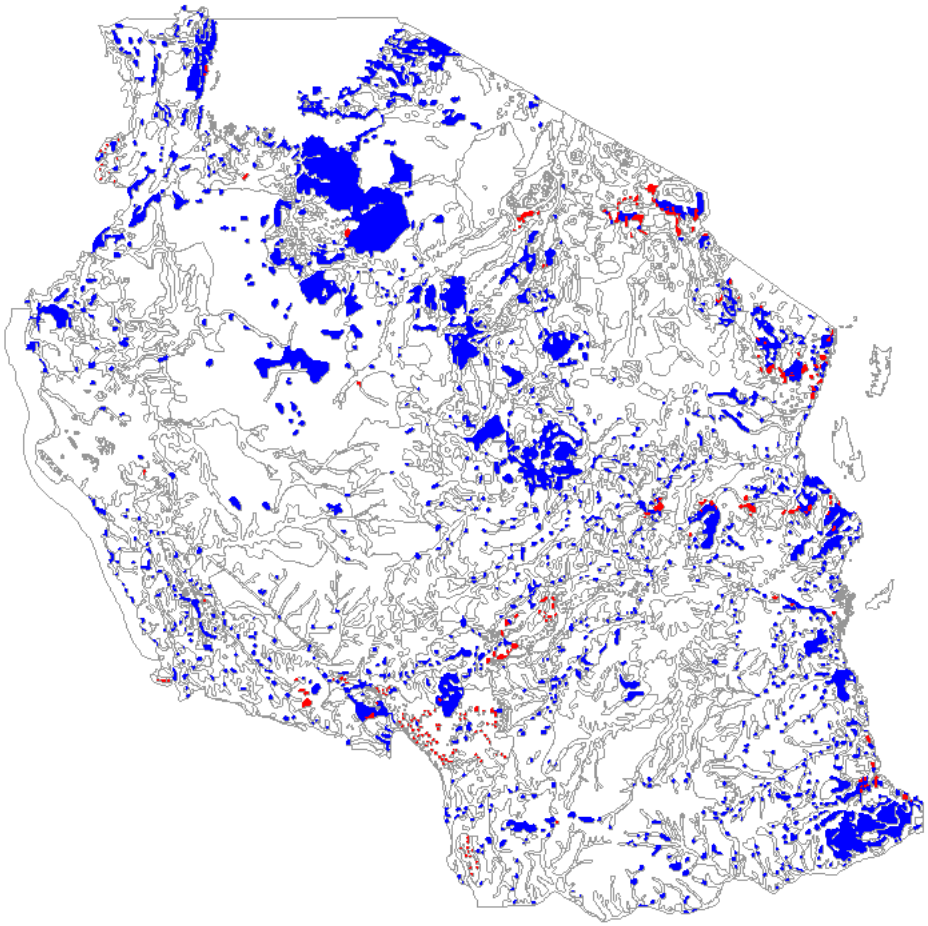


Figure 6.12: Cultivated areas, blue areas are cultivated areas induced by aliens, red are cultivated areas induced by natives

7. Uganda

7.1 Description of the base maps used

The Langdale-Brown *et al.* (1964) vegetation map is the most credible and detailed vegetation map for Uganda (Kalema *et al.* 2009). It distinguishes 22 main vegetation types, which are further subdivided into a total of 86 mapping units. Of these 40 % are derived or secondary forms, 56 % are primary whereas 4 % show affinities of both primary and secondary successional status.

For mapping of Mount Elgon, we also consulted a map by Hamilton and Perrott (1981).

7.2 From the base maps to the VECEA map

All original mapping units on the Langdale-Brown vegetation map were reclassified based on their floristic and physiognomic description (see Table 9.13). It is based on an earlier reclassification scheme by Kalema *et al.* (2009), with adaptations to better align the national classification with the regional classification for the VECEA PNV map. This included a further aggregation of some PNV sub-types that were mapped separately for Uganda, but not for the rest of the VECEA region. For mapping units with compound vegetation types that included post cultivation communities, we assumed the PNV to be the same as the other PNVs in that mapping unit.

For mapping units classified as post cultivation communities only (mapping units Z1-4), we used the Ecological zones map by Langdale-Brown, which accompanies the other vegetation maps in Langdale-Brown *et al.* (1964). For Z3 (post cultivation communities: *hyparrhenia-pteridium)*, we also considered landscape position and shape of the polygons. Areas along rivers, marshes and lakes were assumed to be more likely to be derived from 'edaphic grassland on drainage-impeded or seasonally flooded soils' or 'edaphic wooded grassland on drainage-impeded or seasonally flooded soils' (g/wd).

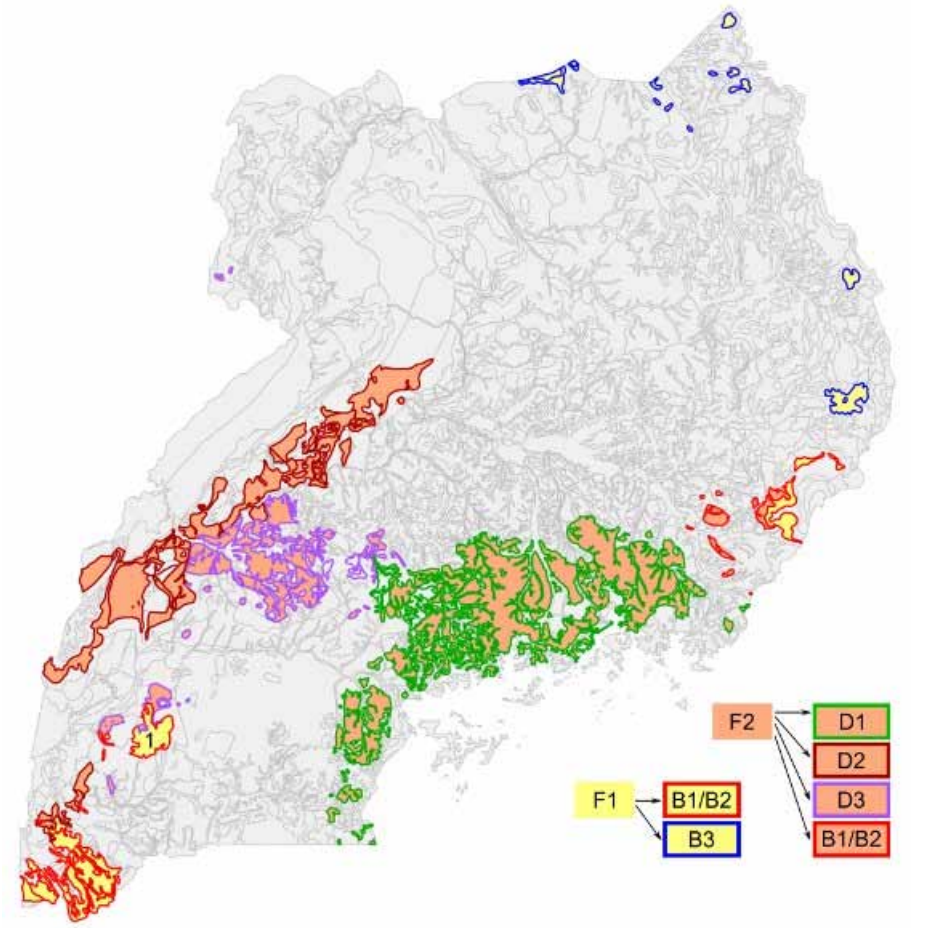


Figure 7.1: Distribution and reclassification of the Langdale Brown vegetation classes F1 and F2, which exception of polygon number 1. For this polygon we used modelling to infer the most likely PNV. See text for more details and meaning of the codes.

7.2.1 F1 Forest - Savanna Mosaic

The F1 forest – savanna mosaic was split in "Pygeum Moist Montane Forest" (B1), "*Hagenia-Rapanea* Moist Montane Forest" (B2) or "*Juniperus-Podocarpus* Dry Montane Forest" (B3; see Figure 7.1). These correspond to the regional PNV types Afromontane rain forest (Fa), Single-dominant *Hagenia abyssinica* forest (Fd) and Single-dominant *Juniperus procera* forest (Fbj) respectively.

Reclassification was done in two steps. In the first reclassification step, polygons were either reclassified to mosaics of B1/B2 or reclassified as B3. Polygons within area 1 of Figure 7.1 were not reclassified in step 1 because, according to White (1983) and the ecological zone map by Langdale-Brown *et al.*, this area falls within the Guineo-Congolian forest zone (we used modelling to classify polygons within this area, see below). The next classification rule was to classify areas from the B1/B2 mosaics that were above 8500 feet as B3 and those that were below 8500 feet as B1. As we found out that all original F1 areas are below 8500 feet, they were all reclassified as B1 in this step.

7.2.2 F2 Forest/Savanna Mosaic

The vegetation type F2 forest/savannah mosaic at medium altitudes was reclassified in "*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest" (D1), "*Cynometra-Celtis* medium altitude moist semi-deciduous Forest" (D2) and "*Albizia-Markhamia* medium altitude moist semi-deciduous Forest" (D3) or mixtures of B1-B2 as is shown in Figure 7.1. We used the same set of ancillary data sources as for the F1 reclassification exercise. Note for the regional map, D1-3 were all considered to be part of the Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi; see volume 2).

7.2.3 Some notes on mapping vegetation types on the Kenyan and Ugandan sides of Mount Elgon

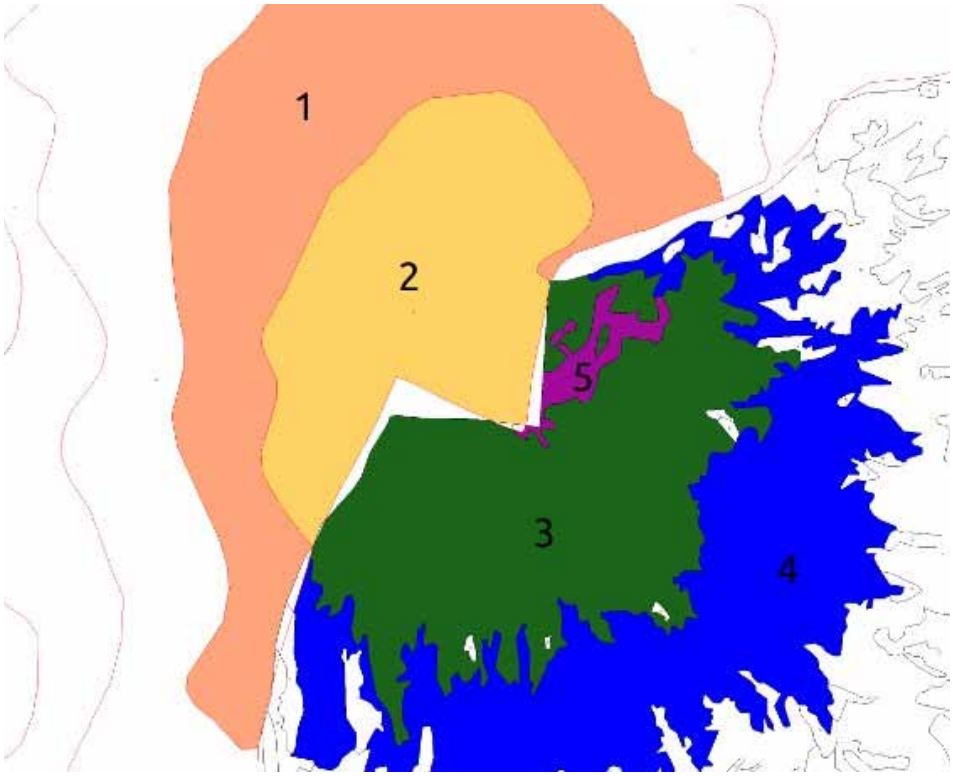


Figure 7.2: Classification of vegetation types on Mount Elgon according to Trapnell and Brunt and the Landale-Brown vegetation maps: 1) *Ericaceae* - Stoebe Heath; 2) *Alchemilla-Helichrysum* moorland; 3) undifferentiated moorland; 4) tree heather, thicket and scrub; 5) Giant groundsel and *Lobelia* (sub-type of undifferentiated moorland).

After completing the national PNV maps for Kenya and Uganda, we found out that the distribution of PNVs on Mount Elgon on the Uganda site did not align very well with those on the Kenyan side.

- Because the boundaries between Afromontane single-dominant *Hagenia abyssinica* forest and Afromontane bamboo were different on the Kenyan and Ugandan sides of Mt. Elgon, we first used a map prepared by Hamilton and Perrott (1981) to map Afromontane bamboo on the Ugandan side of Mt. Elgon. Next, we reclassified the remaining area within mapping unit B2+B4

on the Langdale-brown vegetation map as Afromontane single-dominant *Hagenia abyssinica* forest (Fd) when above the bamboo zone, and as Afromontane rainforest (Fa) when below the bamboo zone. We repeated the same process for the area mapped as bamboo-forest mixtures (mapping unit 51b) on the Kenyan side. This decision was partially inspired on the information from Hedberg (1951) that there is no distinct zone of *Hagenia* on Mount Elgon, except for some isolated groves of *Hagenia* trees occurring between 2600-3300 meter. In a final step, we made some small adaptations to the boundaries of the different mapping units slightly to align them better.

- Because the boundaries between Afroalpine vegetation (A) and the montane Ericacous belt (E) did not align well, we first reclassified Trapnell and Brunts mapping unit of 'Mountain scrubland and moorland' (original mapping unit 7) as Afroalpine vegetation (A; prior to this, we had only classified Trapnell and Brunt's mapping unit of "Alpine [giant groundsel and Lobelia] vegetation" [original mapping unit 7A] as Afroalpine vegetation). This decision was inspired by finding out that Langdale-Browns original mapping unit A1 corresponded better with the combined 7 and 7A of Trapnell than mapping unit 7A only (see Figure 7.2). In addition, since we found out that the boundary between '*Alchemilla - Helichrysum* high montane moorland' and '*Ericaceae - Stoebe* Heath' on the Langdale-Brown vegetation map essentially followed the 3600 m altitude line, we redrew this boundary using this altitude limit.

7.2.4 Notes on filling in the gaps using modelling

Some areas could not be reclassified based on the available maps and accompanying documentation. These areas are indicated in Figure 9.1 and are indicated as secondary types in Table 9.13. To fill in these 'gaps', we created PNV probability distribution models of the PNVs listed in Table 9.14 and 9.15 following the same approach explained in section 3.2.10. Likewise, for a number of the areas mapped as compound vegetation types on the Langdale-Brown map, we used modelling to map where what vegetation type was more likely to occur.

We created models for the 'national' sub-types, not the regional, more aggregated PNVs (see Table 9.13 in Appendix 9.6). We generated models for northern and southern Uganda separately. They show a very different range of climate conditions and PNVs and by splitting we limited the spatial and environmental heterogeneity (Wiens 1989) to be explained in the models of the individual PNVs. Next, we combined the modelled probability distribution layers, whereby the classification of each raster cell was determined by the PNV with the highest probability score.

Results (Tables 9.14 and 9.15 in Appendix 9) show that there is a reasonable good fit between the modelled and mapped distribution of the individual

PNVs. Overall, 80% and 73% of the total area was classified correctly in north and south Uganda respectively (kappa of 0.77 and 0.67 respectively). These results were considered sufficiently accurate to be used to estimate the distribution of PNVs in areas that were left unclassified. The main exceptions are PNVs that occur in very small areas (within the studies areas), which explains the low predictive power of the combined PNV map for these types. Some details of these areas are provided in Appendix 9.6.

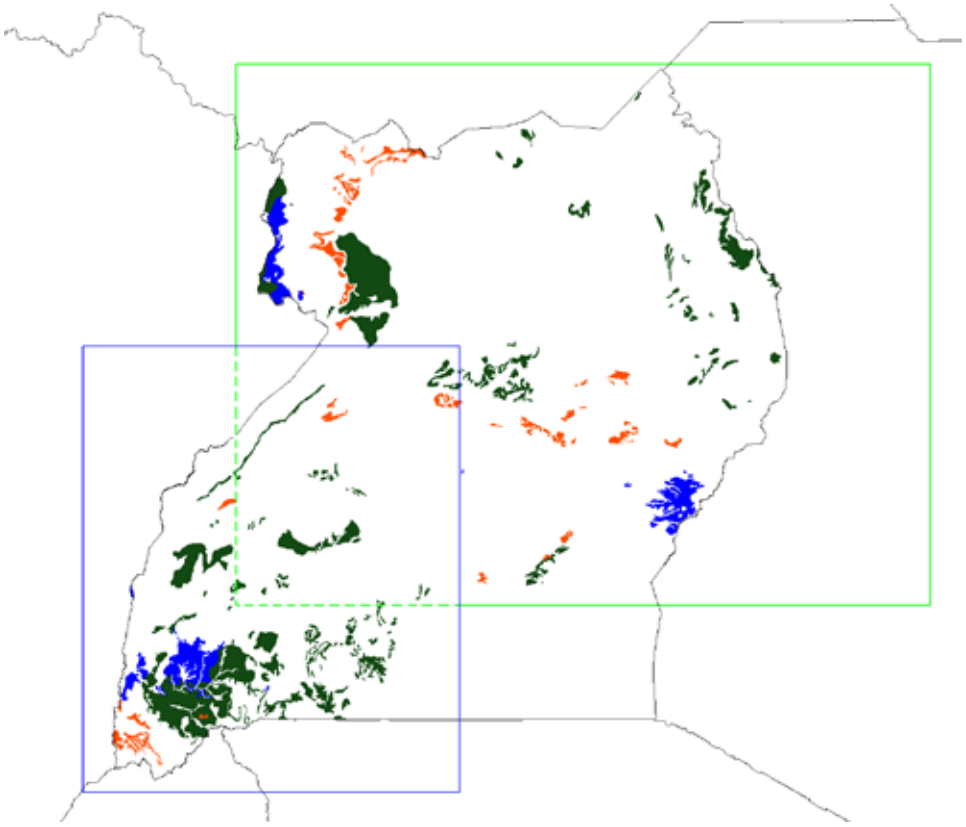


Figure 7.3: Areas which where mapped as post-cultivation communities (blue and orange) or secondary vegetation (green) on the Langdale-Brown vegetation map. For all marked areas except the orange ones, we used modelling to infer the PNV type. The orange areas were classified as 'post cultivation communities: *hyparrhenia-pteridium*' on the Langdale-Brown vegetation map. Considering their location along rivers, marshes and lakes, these were assumed to be derived from the PNV 'edaphic grassland on drainage-impeded or seasonally flooded soils' or 'edaphic wooded grassland on drainage-impeded or seasonally flooded soils' (g/wd).

8. Zambia

8.1 Data sources

The vegetation map by Edmonds (1976) is used as the based of the presented potential natural vegetation (PNV) map. Although we refer to the Edmonds map in the text, it should be noted that the classification used by Edmonds is based on the work by Fanshawe (1971), which is also one of the primary sources for the descriptions of the Zambian PNVs in volume 2-5. Thus, it is actually a map that should be described as the Fanshawe – Edmonds map. It is a very detailed map with a scale of the original map is 1:500,000 and with features smaller then 500 m depicted as an overlay of points.

The legend furthermore indicates how Edmonds vegetation classes are correlated to the vegetation classes used by Trapnell for this vegetation-soil map of Northern Rhodesia (2001a–c). Other input used for the reclassification and proposed modifications to the Edmonds map are the Trapnell soil and vegetation map (Trapnell 2001c), the White vegetation maps (White 1983), the miombo ecoregion map (Timberlake & Chidumayo 2011), CGIAR-CSI SRTM 90m DEM v4 (CGIAR-CSI 2008), Global Wetlands Database (GLWD) (Lehner & Döll 2004), and the AEON river database (de Wit & Stankiewicz 2006).

8.2 From the base maps to the VECEA map

The reclassification of the vegetation types on the Edmonds map to national PNV's was initially based on a review by Mike Bingham (2009) and on White (1983) and Fanshawe (1971). The reclassification scheme in Appendix 9.7, Table 9.16 shows for each of the vegetation types / mapping units on the Edmonds map how these correspond to potential natural vegetation types (PNVs) used on the regional PNV map.

8.2.1 Notes on the mapping of some forests and scrub forest vegetation types

8.2.1.1 Afromontane rain forests (Fa)

The Edmonds vegetation map only recognizes Montane forest (mapping unit 8). Based on the description of montane forests in Fanshawe (1971), we inferred that Montane forest corresponds to Afromontane rain forest (Fa) and Afromontane undifferentiated forest (Fbu, see Volume 2).

The original mapping unit is marked by a point only on the Mafinga Hills on the border of Malawi. The vegetation on the rest of this mountain is classified as grasslands (mapping unit 17, see section on other vegetation types below). Given the altitude and location these grasslands are presumably montane grasslands, like the grasslands with patches of montane forest across the border in Malawi. Like for Malawi, we reclassified these areas as

potential Afromontane rain forest and Undifferentiated Afromontane forest (including Single-dominant *Juniperus procera* forest) and possibly smaller and dispersed patches of Single-dominant *Hagenia abyssinica* forest.

The Nyika plateau, which for the most part lies in Malawi but extends into Zambia, is also classified on the Edmonds map as grasslands and described as grasslands with patches of forests by others (Burrows & Willis 2005; Dowsett-Lemaire 1985). Also here, we reclassified these areas as potential Afromontane rain forest and Undifferentiated Afromontane forest.

8.2.1.2 Afromontane undifferentiated forest (Fb)

See the section of Afromontane rain forest how we mapped this vegetation type in Zambia. Note that *Juniperus procera* is not known to occur in Zambia.

8.2.1.3 Afromontane single-dominant Hagenia abyssinica forest (Fd)

Fanshawe (1971) 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.

8.2.1.4 Zambezian dry evergreen forest (Fm)

On the Fanshawe-Edmonds map, *Parinari* forest (one of the 3 Zambian forest types that were aggregated into Zambezian dry evergreen forest, see Appendix 9.7, Table 9.16) was mapped together with Copperbelt chipya (mapping unit 1). Possibly, the Copperbelt Chipya could be considered part of the Zambezian chipya woodland (mapped as Wy by VECEA). However, we have no further information that would allow us to separate the two. We therefore mapped the original mapping unit 1 as Zambezian dry evergreen forest (Fm) only.

8.2.1.5 Zambezian dry deciduous forest and scrub forest (Fn)

In the legend of the Fanshawe vegetation map an indication is given that *Baikiaea* forest corresponds to the Trapnell vegetation class K6 (*Baikiaea plurijuga* forest 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).

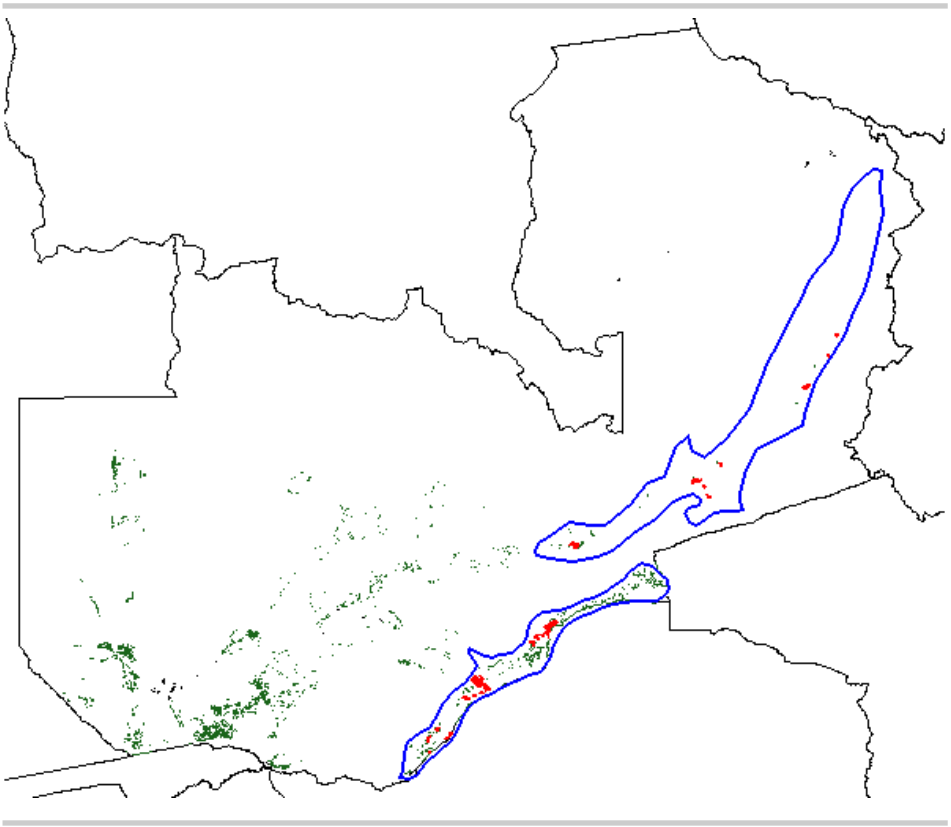


Figure 8.1: Distribution of *Baikiaea* forest and deciduous thicket (green) on the Edmonds map and *Commiphora-Combretum Pterocarpus* thicket or forest occurring on lower valley soils (L2) on the Trapnell map (red areas). The blue outline is used to separate *Baikiaea plurijuga* forests on transitional Kalahari sands (K6 – outside blue outline) and L2

K10 on the Trapnell map (2001c) occurs in small patches on the south-eastern border of what is mapped as *Baikiaea* forests by Edmonds. There is no clear boundary between the two, which makes separating these types not possible without additional information.

The distribution of L2 on the Trapnell map on the other hand suggest a distinct distribution along the south-eastern Zambian border (Figure 8.1), following the division between vegetation types on Kalahari sands and on valley soils on the Trapnell map. Further evidence that the blue outlines would allow to map the L2 type is that this forest type is mentioned to occur in the valleys of the lower Luano, Luangwa and Zambezi rivers.

8.2.2 Notes on mapping of some woodlands and wooded grasslands vegetation types

8.2.2.1 Kalahari woodland (Wk)

The Kalahari woodlands (mapping unit 13 on the Edmonds map) were reclassified as 'Zambezian Kalahari woodland' (Wk), except for the area defined below.

On the Trapnell map (Trapnell 2001c) miombo woodland is divided into various sub-types, including the plateau sub-type "Central *Isoberlinia paniculata Brachystegia* woodlands on Kalahari sands" (K3). K3 on the Trapnell vegetation map overlaps for a large part with the Kalahari woodlands on the Edmonds map (Figure 8.2). This would suggest that contrary to the classification on the Edmonds map, these areas are part of the miombo woodland. This would also agree with the boundaries on the White vegetation map or the miombo ecoregion map. We therefore reclassified this area of overlap as miombo. Subsequently, we used the boundaries of the miombo ecoregion map (Timberlake & Chidumayo 2011) to draw the boundary between wetter and drier miombo woodland as explained in the section about miombo woodland.

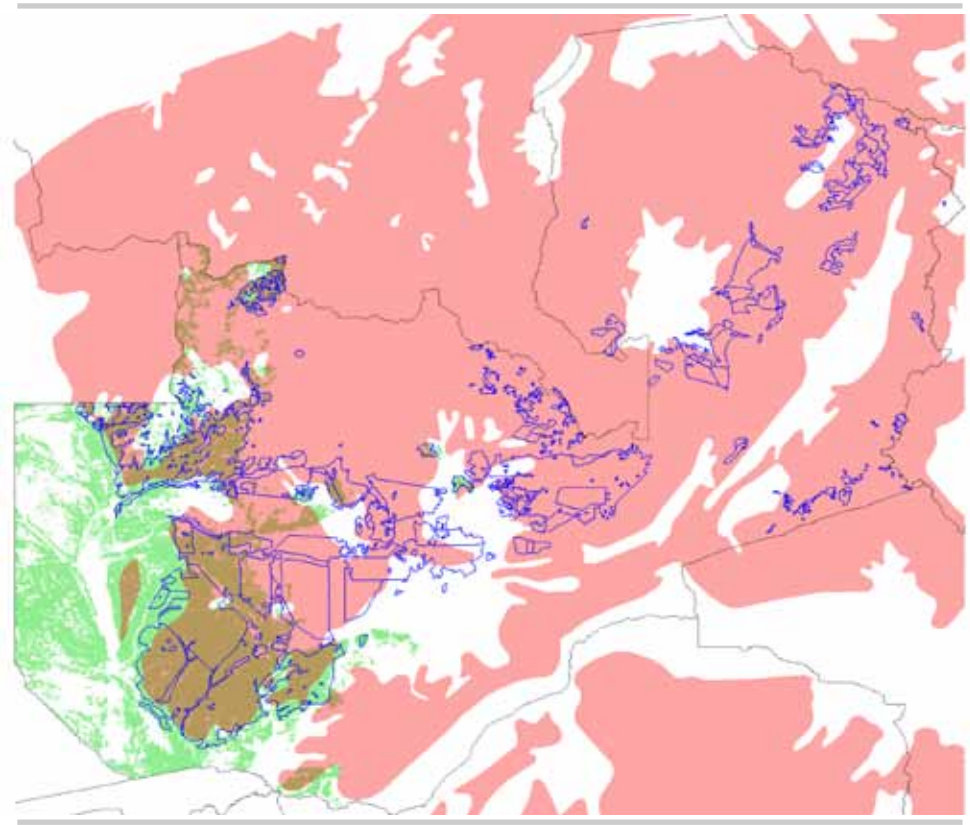


Figure 8.2: The distribution of miombo on the White vegetation map (pink area) and the Kalahari woodland on sands on the Gillman map (green). The yellow-green area is where the two overlap. Central Isoberlinia paniculata *Brachystegia* woodlands on the Trapnell map are indicated by the blue boundaries.

Furthermore, a section of the Fanshawe-Edmonds original mapping unit 16 of "termitary and bush groups" was classified as patches of Kalahari woodland in matrix of grasslands on edaphic soils (Wk/g). See the section on *Termitaria* vegetation (T).

8.2.2.2 Miombo woodland and miombo woodland on hills and rocky outcrops

Fanshawe (1971) distinguishes miombo on plateau, escarpments and valley bottoms, but these were mapped together on the Edmonds map (mapping unit 11). In contrast, White (1983) and Timberlake & Chidumayo (2011) distinguished between wet and dry miombo woodland. We used the miombo ecoregion map to separate the drier miombo (Wmd) and wetter miombo (Wmw) woodlands. However, the main dividing line between wet and dry miombo woodlands by White and Timberlake & Chidumayo follows roughly the plateau contour, which would thus be similar to the suggested subdivision of plateau and escarpment miombo by Fanshawe.

Because areas classified as miombo woodland on the Edmonds map do not extend as far west as the wetter and drier miombo on the miombo ecoregion map or White's vegetation map, we reclassified some areas of the Kalahari woodland on sands (original mapping unit 13) on the Edmonds map to become miombo woodland (see section on Kalahari woodland above).

8.2.2.3 North Zambezian undifferentiated woodland (Wn)

The original vegetation type of Munga woodland on heavy soils (mapping unit 15 on the Edmonds map) was reclassified as 'North Zambezian undifferentiated woodland' (Wn, see Appendix 9.7, Table 9.16). However, one area was reclassified as Palm wooded grassland (P, see details below).

A few sub-types of the North Zambezian undifferentiated woodland can be distinguished based on the Trapnell map, listed below. Note that we did not make this subdivision for the regional VECEA map. However, this might be of interest for future work at national scale.

- The distribution of *Acacia-Combretum* on lower valley (L3) on the Trapnell map corresponds largely with the distribution of the munga woodlands below 700 meter
- The distribution of *Combretum-Terminalia* in upper valley (U2) and *Acacia-Combretum* in upper valley (U3) on the Trapnell map agrees partly with the distribution of munga woodland above 700 m altitude).
- In the western part of its distribution, munga woodlands largely occur on transitional Kalahari sands, including the area mapped as *Acacia-Combretum* on transitional Kalahari sands (K12) on the Trapnell map.

8.2.2.4 Chipya woodland and wooded grassland (Wy)

On the Edmonds map, three types of Chipya woodlands are mapped; Lake basin chipya (mapping unit 3), Kalahari sand chipya (mapping unit 5) and Copperbelt Chipya (part of mapping unit 1). On the VECEA map, the first two were reclassified as Chipya woodland and wooded grassland (Wy). We have not mapped "Copperbelt chipya" separate from Zambezian dry evergreen forest (Fm). See description of Zambezian dry evergreen forest (Fm).

Fanshawe mentions that total or almost total destruction of *Cryptosepalum* forests leads eventually to Kalahari sand chipya. This would suggest that this Chipya type could also be classified as the potential natural vegeta-

tion types 'Zambezian dry evergreen forest' (Fm). The question is whether edaphic or biotic conditions have changes irrevocably due to earlier degradation of the original forests (because of fire or other factors). The answer would be less unequivocal if one considered fires as a permanent feature or environmental factor causing a different steady state.

8.2.2.5 Palm wooded grassland (P)

Fanshawe mentions that within the Munga woodlands, one can find areas of *Hyphaene* wooded grassland. The type was not mapped separately on the Edmonds map, although Trapnell's SK1 type (*Hyphaene* palm country) is listed in the legend to be correlated to the Munga woodlands. It is mapped on the Trapnell vegetation map, where it falls roughly within areas mapped as Munga by Edmonds (Figure 8.3). As shown in Figure 8.3, overlap between *Hyphaene* wooded grassland on the Trapnell map and munga woodland on the Edmonds map is only partial. This is presumably due to differences in scale and accuracy. Therefore, polygons classified as munga woodland on the Edmonds map which were closest to and partly overlapping with the *Hyphaene* wooded grasslands were completely classified as palm wooded grassland (P) as indicated in Figure 8.3. Because on the Trapnell map large areas are left unclassified, the mapped distribution of *Hyphaene* wooded grasslands may not represent the full distribution.

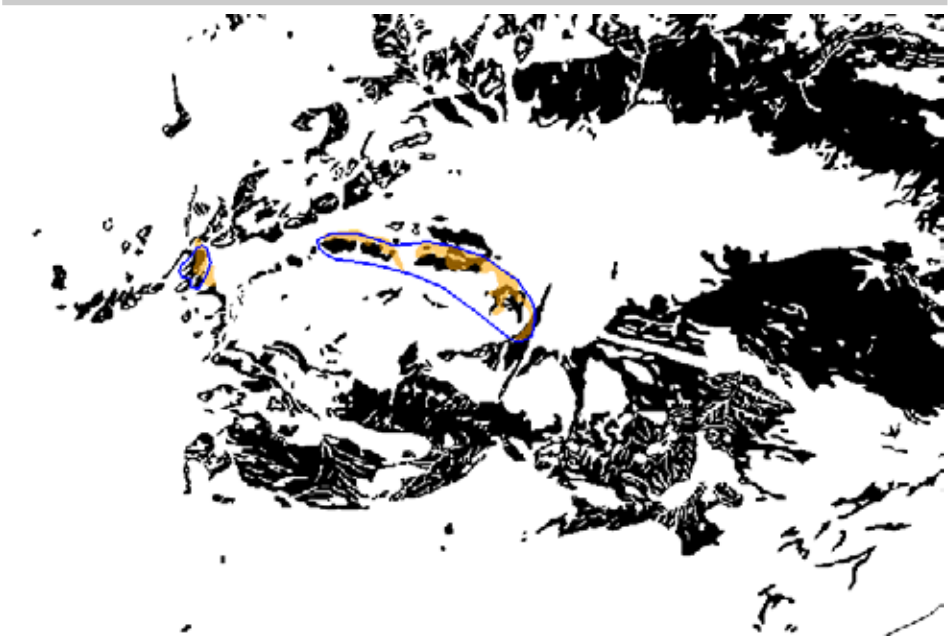


Figure 8.3: Distribution of munga woodlands on the Fanshawe vegetation map (black areas) with the distribution of *Hyphaene* Palm Country (mapping unit SK1) as mapped by Trapnell overlaid (orange and brown areas). The black areas within the blue outline were reclassified as *Hyphaene* wooded grasslands.

8.2.3 Notes on mapping of some bushland and thicket vegetation types

8.2.3.1 Termitaria vegetation, including bush groups around termitaria within grassy drainage zones (T)

On the Edmonds map, mapping unit 16 of "Termitary vegetation and bush group" is mapped as polygons (Figure 8.4) and as points across larger parts of Zambia within different vegetation types.

The point location occur across most woodland vegetation types, which is in line with the observation from Fanshawe that *Termitaria* occur across a wide range of vegetation types, including miombo, Kalahari, mopane, munga and riparian termitary. They occur as small islands, and are considered not-mappable at the scale of the regional map.

We only used the polygon layer for the vegetation map. Following the legend of the Edmonds map, we distinguished two different vegetation types: (i) mosaic of *termitaria* associated vegetation and dambo grasslands (T/g) and (ii) patches of Kalahari woodland in matrix of grasslands on edaphic soils (Wk/g). The latter were assumed to occur on Kalahari sands and related soil types (mapping units 'kalahari bracken sand', 'kalahari sands' or 'kalahari sand plains and watershed') as mapped on the Trapnell map (see Figure 8.4).

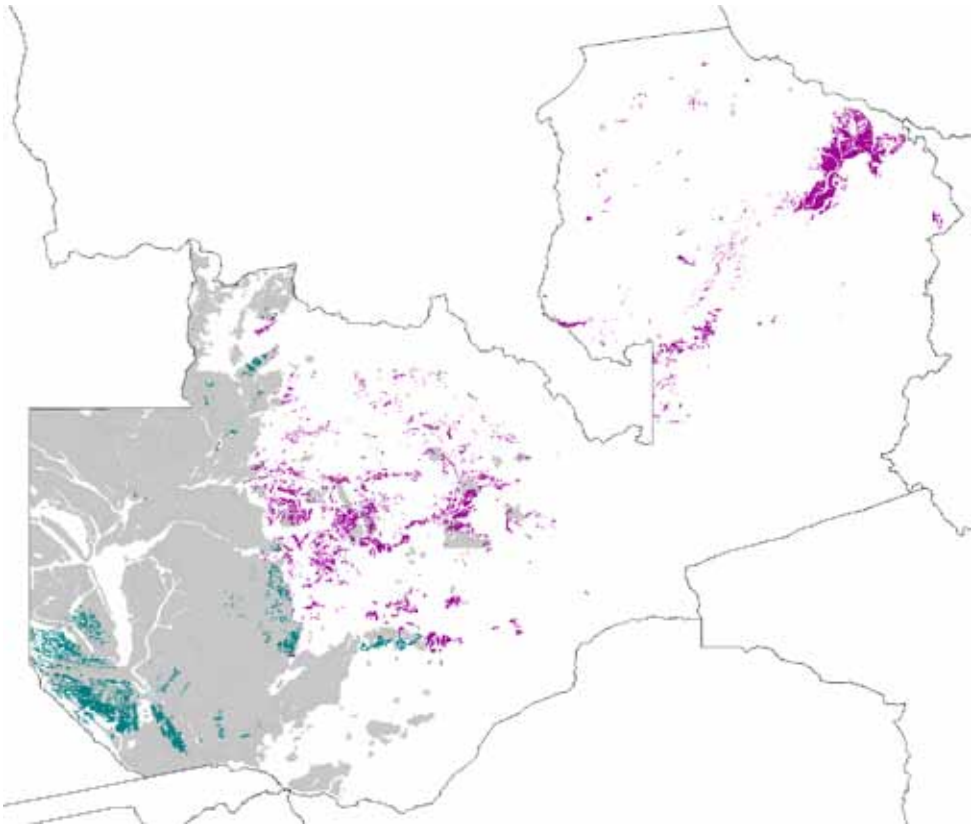


Figure 8.4: Termitary vegetation and bush group on the Edmonds map (blue and purple areas) and the Trapnell mapping units with 'kalahari bracken sand', 'kalahari sands' or 'kalahari sand plains and watershed' in grey. We used the Trapnell map to separate the mosaic of *termitaria* associated vegetation and dambo grasslands (purple) and patches of kalahari woodland in matrix of grasslands on edaphic soils (blue).

8.2.4 Notes on mapping of some of the other vegetation types

8.2.4.1 Fresh-water swamp (X)

The larger marshes and floodplains could be identified on the global lakes and wetlands database (GLWD). On Edmonds map, swamp and *papyrus* sudd are mapped together with different grassland types. Part of these areas were therefore classified as a mosaic containing Fresh-water swamp (X), see notes on edaphic grasslands.

8.2.4.2 Edaphic grassland on drainage-impeded or seasonally flooded soils (g)

The grasslands (mapping unit 17) on the Edmonds map include all natural treeless and grassy areas, comprising mountain (montane) and watershed grassland, kalahari-sand plain, dambo, floodplain, swamp and *papyrus* sudd. As explained in section 8.2.1, montane grasslands which could be positively identified were reclassified as a mosaic of different forest types.

The watershed grassland, kalahari-sand plain, dambo, and floodplain would all be reclassified as edaphic grassland on drainage-impeded or seasonally flooded soils (g). The swamp and *papyrus* sudd classify as Fresh-water swamp (X). Because we had no way to separate these two, the whole area is classified as g/X.

9. Appendix

9.1 List of environmental data layers used in this study

Table 9.1: Secondary data sets used in the development of the potential natural vegetation map for the VECEA region. Note that 3 arc seconds ≈ 90 meter at the equator, and 30 arc seconds ≈ 1 km at the equator. All data was rescaled to 3 arc-seconds. Projection of all data is geographic WGS 84 (EPGS 43)

Data	Description	Scale / resolution	Source
DEM	SRTM 90 meter digital elevation data	3 arc seconds	CGIAR-CSI (2008)
Precipitation	Monthly total rainfall	30 arc seconds	(Hijmans *et al.* 2005; Worldclim 2011)
Temperature	Monthly mean daily minimum and maximum temperature	idem	(Worldclim 2011)
Bioclim 1	Annual Mean Temperature	idem	idem
Bioclim 2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	idem	idem
Bioclim 3	Isothermality (bioclim2/bioclim7)	idem	idem
Bioclim 4	Temperature Seasonality (standard deviation *100)	idem	idem
Bioclim 5	Max Temperature of Warmest Month	idem	idem
Bioclim 6	Min Temperature of Coldest Month	idem	idem
Bioclim 7	Temperature Annual Range (bioclim5-bioclim6)	idem	idem
Bioclim 8	Mean Temperature of Wettest Quarter	idem	idem
Bioclim 9	Mean Temperature of Driest Quarter	idem	idem
Bioclim 10	Mean Temperature of Warmest Quarter	idem	idem
Bioclim 11	Mean Temperature of Coldest Quarter	idem	idem
Bioclim 12	Annual Precipitation	idem	idem
Bioclim 13	Precipitation of Wettest Month	idem	idem
Bioclim 14	Precipitation of Driest Month	idem	idem
Bioclim 15	Precipitation Seasonality (Coefficient of Variation)	idem	idem
Bioclim 16	Precipitation of Wettest Quarter	idem	idem
Bioclim 17	Precipitation of Driest Quarter	idem	idem
Bioclim 18	Precipitation of Warmest Quarter	idem	idem
Bioclim 19	Precipitation of Coldest Quarter	idem	idem
PET	Monthly potential evapotranspiration. Provided as part of the Global Aridity and PET Database	idem	idem
GLWD	The global lakes and wetlands database, includes a vector and raster layer	Scale vector: unkn. Resolution raster layer: 30 arc sec.	(Lehner & Döll 2004)
AEON river database	Vector layer with the perennial and non-perennial river and streams	Average stream separation of 15 km	(de Wit & Stankiewicz 2006)
HWSD	Harmonized World Soil Database, a raster database with soil mapping units linked to harmonized soil property data	30 arc-second	*http://www.fao.org/geonetwork/*

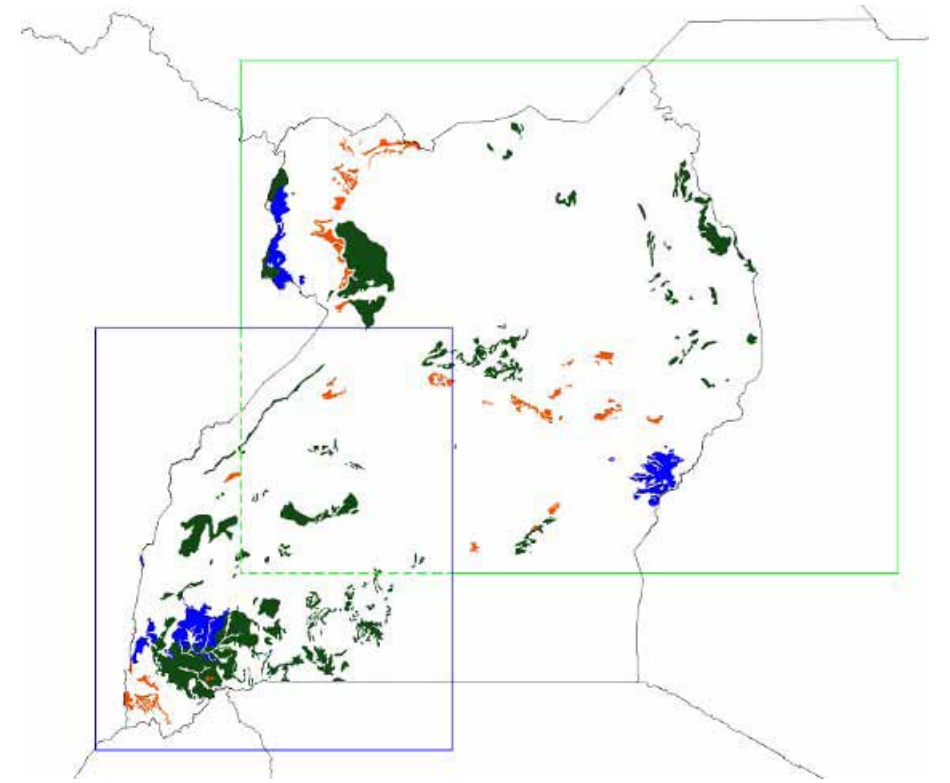


Figure 9.1: Areas which where mapped as post-cultivation communities (blue and orange) or secondary vegetation (green) on the Langdale-Brown vegetation map. For all marked areas except the orange ones, we used modelling to infer the PNV type. The orange areas were classified as 'post cultivation communities: *hyparrhenia-pteridium*' on the Langdale-Brown vegetation map. Considering their location along rivers, marshes and lakes, these were assumed to be derived from the PNV 'edaphic grassland on drainage-impeded or seasonally flooded soils' or 'edaphic wooded grassland on drainage-impeded or seasonally flooded soils' (g/wd).

Table 9.2: Data sets created for this study. The first two layers were created at a resolution of 3 arc-seconds. The others were created at a resolution of 30 arc-seconds, but re-scaled to 3 arc seconds for combination with the other layers. Projection of all data is geographic WGS 84 (EPGS 4326).

Data	Description
TWI	Terrain wetness index
pca_tmin	First two principle component of mean monthly maximum temperature, created using the i.pca function in GRASS GIS
pca_tmax	First two principle component of mean monthly maximum temperature, created using the i.pca function in GRASS GIS
pca_prec	First two principle component of monthly rainfall data, created using the i.pca function in GRASS GIS
pca_pet	First two principle component of monthly potential evapotranspiration, created using the i.pca function in GRASS GIS

9.2 Correspondence between the Ethiopian base map and the VECEA map

Table 9.3: Table linking the legend of the national PNV map for Ethiopia with the one used for the regional map. The first column gives the regional name, with between brackets the code used in the maps. The second column gives the national PNV names with between brackets the vegetation codes. The third column gives the code of the mapping unit, thus indicating the compound vegetation types.

Mapping unit ID	National classification	Regional classification
MAF	Primary or mature secondary moist evergreen Afromontane forest (MAF/P)	Afromontane rain forest (Fa)
DAF	Undifferentiated Dry evergreen afromontane forest (DAF/U)	Undifferentiated Afromontane forest (Fb)
DAF	Dry single-dominant Afromontane forest (DAF/SD)	Single-dominant Juniperus procera forest (Fb1)
DAF	Transition between Afromontane vegetation and *Acacia-Commiphora* bushland on the Eastern Escarpment (DAF/TR)	Evergreen and semi-evergreen bushland and thicket (Be)
TRF	Transitional rainforest (TRF)	Afromontane moist transitional montane forest (Fe)
ACB	*Acacia-Commiphora* woodland and bushland proper (ACB)	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)
DSS	Desert and semi-desert scrubland (DSS)	Somalia-Masai semi-desert grassland and shrubland (S)
CTW	*Combretum-Terminalia* woodland and wooded grassland (CTW)	*Combretum* wooded grassland (Wc)
ABC/RV	*Acacia* wooded grassland of the Rift valley (ABC/RV)	Biotic wooded grassland (We)
AA	Afroalpine belt (AA)	Afroalpine vegetation (A)
EB	Ericaceous belt (EB)	Montane Ericaceous belt (E)
FL/OW	Fresh-water marshes and swamps (FL/OW)	Freshwater swamp (X)
FL/MFS	Fresh-water marshes and swamps (FL/MFS)	Freshwater swamp (X)
SLV/OW	Salt lake open water vegetation (SLV/OW)	Halophytic vegetation (Z)
SLV/SSS	Salt pans saline/brackish and intermittent wetlands and salt-lake shore vegetation (SLV/SSS)	Halophytic vegetation (Z)
WGG	Wooded grassland of the Western Gambela region (WGG)	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)
RV	Riverine vegetation (RV)	riverine wooded vegetation (r)

9.3 Correspondence between the kenyan base maps and the VECEA map

Table 9.4: Reclassification of the vegetation map of southwest Kenya by Kindt *et al.* (2005) using the VECEA regional PNV classification.

Original name	**Regional name**
Bare land	Afromontane desert (D)
Bamboo woodland and thicket (bamboo)	Afromontane bamboo (B)
Montane scrubland and moorland	Montane Ericaceous belt (E)
Alpine	Afroalpine vegetation (A)
Moist montane forest	Afromontane rain forest (Fa)
Dry montane forest	Undifferentiated Afromontane forest (Fb)
Western moist intermediate forest	Guineo-Congolian drier peripheral semi-evergreen forest (Fi)
Eastern moist intermediate forest	Afromontane moist transitional montane forest (Fe)
Dry intermediate forest	Afromontane dry transitional montane forest (Fh)
Upland *Acacia w*oodland, savannah and shrubland	Biotic wooded grassland (We)
Mixtures of broadleaved savannah and evergreen bush	Evergreen and semi-evergreen bushland (Be)
Evergreen and semi-evergreen bushland	Evergreen and semi-evergreen bushland (Be)
Lowland *Acacia* woodland, bushland and thicket	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)
Dry *Combretum* savannah	Dry *Combretum* wooded grassland (Wcd)
Moist *Combretum-Terminalia* savannah	Wet *Combretum* wooded grassland (Wcm)
Swamp and *Papyrus*	freshwater swamp (X)
Open grassland areas on impeded soils	Edaphic grassland on drainage-impeded or seasonally flooded soils (g)
Acacia and allied vegetation on soils with impeded drainage (impeded *Acacia*)	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)
Saline scrubland	Halophytic vegetation (Z)

Table 9.5: Reclassification of vegetation types of the Rangeland management handbook vegetation maps to the regional potential natural vegetation types.
In the last column sub-types, if any, are given between brackets

Map-ping Code	Vegetation name	Physiognomic class	Code	Potential natural vegetation
1.1	*Juniperus-podocarpus* evergreen forest	Evergreen forest	Fb	Undifferentiated Afromontane forest (Single-dominant *Juniperus procera* forest)
1.2	*Cassipourea-diospyros*	Evergreen forest	Fb	Undifferentiated Afromontane forest (Single-dominant *Juniperus procera* forest)
1/12/14	Mixed vegetation types	Undifferentiated evergreen forest	Fb	Undifferentiated Afromontane forest (Single-dominant *Juniperus procera* forest)
10.1	*Juniperus-euclea* evergreen bushland	Evergreen bushland	Be	Evergreen and semi-evergreen bushland
10.2	*Croton-maytenus-euclea* evergreen bushland	Evergreen bushland	Be	Evergreen and semi-evergreen bushland
12.1	*Salvadora-a.tortilis-a.elatior* evergr. and semi-dec. Bushland	Evergreen and semi-deciduous woodland	Z	halophytic vegetation
12.2	*Dodonaea-croton* evergr. A. Semi-dec bushland	Evergreen and semi-deciduous bushland	Be	Evergreen and semi-evergreen bushland
12.3	*Croton-Acacia brevispica-euphorbia*	Evergreen and semi-deciduous bushland	Be	Evergreen and semi-evergreen bushland
12.4	*Croton-balanites-Acacia tortilis* evergr. A. Semi-dec. Bushland	Evergreen and semi-deciduous bushland	Be	Evergreen and semi-evergreen bushland
12.5	*Acacia tortilis-a.brevispica-combretum-dodonaea*	Evergreen and semi-deciduous bushland	Bds/S	*Acacia-Commiphora* stunted bushland / Somalia-Masai semi-desert grassland and shrubland
12.6	*Carissa-rhus-euclea-junisperus*	Evergreen and semi-deciduous bushland	Fb	Undifferentiated Afromontane forest (Single-dominant *Juniperus procera* forest)
12/13.1	*Tarchonanthus-Acacia gerrardii* mixture of vegetation types	Mixed vegetation types	Bds/S	*Acacia-Commiphora* stunted bushland / Somalia-Masai semi-desert grassland and shrubland
13.1	*Acacia brevispica-a. Tortilis* dec. A. Semi-dec. Bushland	Deciduous and semi-deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
13.2	*Acacia gerrardi-a.nilotica-croton* dec. A. Semi-dec. Bushland	Deciduous and semi-deciduous bushland	Be	Evergreen and semi-evergreen bushland
13.3	*Combretum-terminalia-albizia* dec. A. Semi-dec.bushland	Deciduous and semi-deciduous bushland	Be	Evergreen and semi-evergreen bushland
13.4	*Terminalia* dec. A. Semi-dec.bushland	Deciduous and semi-deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
13.5	*Combretum*	Deciduous and semi-deciduous bushland	Wcd	Dry *Combretum* wooded grassland
14.1	*Commiphora-boswellia-grewia*	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.11	*Commiphora-Acacia bussei-grewia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.12	*Commiphora-boswellia-ipomoea-grewia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.13	*Grewia-lippia-Acacia tortilis-Commiphora*	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.14	*Acacia tortilis-grewia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.15	*Acacia senegal-Commiphora-boswellia*	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.16	*Acacia reficiens-Commiphora*	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.17	*Acacia mellifera-a.nilotica-a.reficiens* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.18	*Acacia reficiens*-unknown species dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.19	*Commiphora-Acacia tortilis* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.2	*Commiphora-Acacia tortilis-cordia-ipomoea* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.20	*Acacia senegal-Acacia mellifera-Commiphora*	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.21	*Acacia mellifera-Acacia reficiens* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket

Mapping Code	Vegetation name	Physiognomic class	Code	Potential natural vegetation
14.22	*Acacia nilotica-albizia*	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.24	*Acacia nilotica-Acacia ?- Duosperma-?*	Deciduous bushland	Be	Evergreen and semi-evergreen bushland
14.25	*Acacia mellifera-Acacia ni?*	Deciduous bushland	Be	Evergreen and semi-evergreen bushland
14.3	*Commiphora-grewia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.4	*Cordia-grewia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.5	*Commiphora-grewia-blepharispermum* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.6	*Commiphora-boswellia-grewia-cordia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.7	Undifferentiated	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.8	*Commiphora-Acacia senegal-grewia* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
14.9	*Acacia zanzibarica* dec. Bushland	Deciduous bushland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.1	*Sporobolus-cordia-Acacia* spp dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.10	*Chrysopogon-pennisetum-Acacia tortilis-Acacia mellifera* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.11	*Panicum-Acacia tortilis* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.2	*Sporobolus-chrysopogon-Acacia reficiens* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.3	*Aristida-sporobolus-impomoea-a.tortilis* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.4	*Tetrapogon-aristida-a.tortilis-a.senengal* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.5	*Leptothrium-tetrapogon-Acacia mellifera* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.6	*Sporobolus-duosperma-Acacia tortilis* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.7	*Cynodon-microchloa-euclea-Acacia lahai* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.8	*Leptothrium-aristida-cordia-Acacia tortilis* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
15.9	*Pennisetum-Acacia seyal* dec. Bush grassland	Deciduous bush grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.1	*Tetropogon-sericocomopsis-cordia-Commiphora* deciduous bush annual grassland	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.2	*Aristida-acaia seyal* dec. Bush annual grassland	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.3	*Aristida-cordia* dec. Bush annual grassland	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.4	*Aristida-chloris-cordia-Commiphora* dec. Bush annual grassland	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.5	*Tetrapogon-aristida-Acacia tortilis-Acacia senegal* dec. Bush annual grassland	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.6	*Aristida-tetrapogon-Acacia tortilis-a.senegal-a.reficiens* dec. Bush annual grass	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
16.7	*Aristida-jatropha-Acacia tortilis* dec. Bush annual grassland	Deciduous bush annual grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
17.1	*Euclea-croton* evergreen shrubland	Evergreen shrubland	Be	Evergreen and semi-evergreen bushland
17.2	*Suaeda-salsola-lagenantha*	Evergreen shrubland	Z	halophytic vegetation

Mapping Code	Vegetation name	Physiognomic class	Code	Potential natural vegetation
19.1	*Croton* semi-dec. Shrubland	Semi deciduous shrubland	Be	Evergreen and semi-evergreen bushland
2.1	*Hyphaene* evergreen woodland	Evergreen woodland	wr	riverine wooded vegetation
20.1	*Acacia reficiens* (*sericocomopsis-sporobolus-aristida*) dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.10	*Cordia-Acacia tortilis-Commiphora* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.11	*Acacia mellifera* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.12	*Acacia* spp.-*Commiphora* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.13	*Acacia mellifera-a.reficiens-a.senegal* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.14	*Acacia mellifera-a.reficiens* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.15	*Acacia reficiens- Acacia mellifera-Commiphora* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.16	*Commiphora-Acacia reficiens-Acacia paolii*	Deciduous shrubland	Bds/S	*Acacia-Commiphora* stunted bushland / Somalia-Masai semi-desert grassland and shrubland
20.17	*Acacia reficiens-Acacia senegal*	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.18	*Acacia reficiens (enteropogon)*	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.19	*Acacia reficiens-Acacia mellifera-Acacia nilotica*	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.2	*Acacia reficiens (chrysopogon)* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.21	*Commiphora-euphorbia-plectranthus*	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.23	*Acacia mellifera-Acacia reficiens (duosperma)*	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.23+ 26.5	-	Mixed vegetation types	Bds/S	*Acacia-Commiphora* stunted bushland / Somalia-Masai semi-desert grassland and shrubland
20.3	*Dalbergia (aristida)* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.4	*Cordia (aristida)* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.5	*Acacia reficiens (paspalidium)* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.6	*Acacia reficiens- boscia* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.7	*Grewia-impomoea* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.8	*Acacia senegal* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
20.9	*Acacia reficiens* dec. Shrubland	Deciduous shrubland	Bds	*Acacia-Commiphora* stunted bushland
21.1	*Sporobolus*-unknown forb spp-*Acacia seyal* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.1	*Sporobolus*-unknown forb spp-*Acacia seyal* dec. Shrub grassland (in wajir)	Deciduous shrub grassland	wr	riverine wooded vegetation
21.10	*Sporobolus*-miscellaneous *Acacia species* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.11	Unknown perennial grass-*salvadora-capparid* sp.-*Acacia* spp. Dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland

Mapping Code	Vegetation name	Physiognomic class	Code	Potential natural vegetation
21.12	*Pennisetum-Acacia drepanolobium*	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.13	*Chrysopogon-lintonia-Acacia mellifera*	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.13+ 30.0	-	Mixed vegetation types	Bds	*Acacia-Commiphora* stunted bushland
21.16+ 26.2	-	Mixed vegetation types	Be	Evergreen and semi-evergreen bushland
21.2	*Chrysopogon-duosperma-a.mellifera-croton* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.3	*Cenchrus-pennisetum-a.tortilis a.etabaica* dec.shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.4	*Microchloa-duosperma-grewia-a.mellifer* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.5	*Cynodon-tetrapogon-Acacia nubica* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.6	*Leptothrium-barleria-duosperma-Acacia reficiens*	Deciduous shrub grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
21.7	*Dactyloctenium-leptothrium-duosperma-cordia-Acacia reficiens*	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.8	Unknown grass-*Acacia mellifera* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
21.9	*Leptothrium-duosperma-Acacia mellifera-Acacia reficiens* dec. Shrub grassland	Deciduous shrub grassland	Bds	*Acacia-Commiphora* stunted bushland
22.1	*Aristida-sporobolus-Acacia reficiens-Acacia mellifera*	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.10	*Aristida-tetrapogon-duosperma-Acacia reficiens* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.11	*Aristida-tetrapogon-jatropha-Acacia reficiens* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.12	*Aristida-tetrapogon-jatropha-Acacia tortilis* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.13	*Aristida-indigofera-Acacia senegal* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.14	*Aristida-jatropha* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.15	*Aristida indigofera-Acacia tortilis-Acacia senegal-Acacia reficiens*	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.16	*Aristida sericocomopsis-Acacia reficiens dec. Shrub* annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.17	*Aristida-indigofera-Acacia tortilis-a.senegal-a.reficiens* dec. Shrub annual gras	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.18	*Aristida-euphorbia-Acacia reficiens-hyphaene* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.19	*Tetrapogon-helichrysum-indigofera* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.2	*Aristida-tetrapogon-Acacia horrida-cordia* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.20	*Aristida-Acacia-Commiphora-euphorbia-jatropa*	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.21	*Aristida-duosperma-Acacia indigofera-a. Mellifera-a. Reficiens*	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.3	*Aristida-cordia* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland

Mapping Code	Vegetation name	Physiognomic class	Code	Potential natural vegetation
22.4	*Tetrapogon-Commiphora-cordia* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.6	*Aristida-enneapogon-a.senegal-a.reficiens-Commiphora*	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.7	*Aristida-duosperma-Commiphora* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.8	*Aristida-lintonia-Acacia mellifera* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
22.9	*Aristida-indigogera-Acacia reficiens-a. Tortilis* dec. Shrub annual grassland	Deciduous shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
25.1	*Sporobolus-cordia-duasperma-sericocomopsis* dec. Dwarf shrub grassland	Deciduous dwarf shrub grassland	S	Somalia-Masai semi-desert grassland and shrubland
25.2	*Leptothrium-duosperma* dec. Dwarf shrub grassland	Deciduous dwarf shrub grassland	S	Somalia-Masai semi-desert grassland and shrubland
25.4	*Indigofera* dec. Dwarf shrub grassland	Deciduous dwarf shrub grassland	S	Somalia-Masai semi-desert grassland and shrubland
26.1	*Aristida tetrapogon-indigofera-jatropha* dec.dwarf shrub annual grassland	Deciduous dwarf shrub annual grassland	S	Somalia-Masai semi-desert grassland and shrubland
26.2	*Aristida-tetrapogon-duosperma* dec.dwarf shrub annual grassland	Deciduous dwarf shrub annual grassland	S	Somalia-Masai semi-desert grassland and shrubland
26.3	*Aristida-tetrapogon-indigofera* dec.dwarf shrub annual grassland	Deciduous dwarf shrub annual grassland	S	Somalia-Masai semi-desert grassland and shrubland
26.3+ 21.13	-	Mixed vegetation types	S	Somalia-Masai semi-desert grassland and shrubland
26.3+ 30.0	-	Mixed vegetation types	S	Somalia-Masai semi-desert grassland and shrubland
26.4	*Aristida-sporobolus-heliotropium-indigofera*	Deciduous dwarf shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
26.5	*Aristida-duosperma-seriococomopsis-indigofera*	Annual grassland	S	Somalia-Masai semi-desert grassland and shrubland
26.5+ 30.0	-	Mixed vegetation types	S	Somalia-Masai semi-desert grassland and shrubland
27.1	*Sporobolus helvolus* grassland	Grassland	G	climatic grasslands
27.10	*Panicum-sporobolus* grassland	Grassland	g	edaphic grassland on drainage-impeded or seasonally flooded soils (Somalia-Masai edaphic grassland)
27.11	*Sporobolus consimilis* grassland	Grassland	Z	Halophytic vegetation
27.2	*Oropetium-heliotropium* grassland	Grassland	S	Somalia-Masai semi-desert grassland and shrubland
27.3	*Pennisetum-themeda* grassland	Grassland	G	climatic grasslands
27.4	*Themeda-microchloa* grassland	Grassland	G	climatic grasslands
27.5	*Chrysopogon-loudetia* grassland	Grassland	gv	Edaphic grassland on volcanic soils
27.6	*Cymbopogon-eragrostis-heteropogon* grassland	Grassland	gv	Edaphic grassland on volcanic soils
27.7	*Sporobolus-leptothrium-lintonia* grassland	Grassland	Bds	*Acacia-Commiphora* stunted bushland
27.8	*Sporobolus* grassland	Grassland	Bds	*Acacia-Commiphora* stunted bushland
27.9	*Dactyloctenium-leptothrium* grassland	Grassland		Somalia-Masai semi-desert grassland and shrubland
28.1	*Aristida-tetrapogon*	Annual grassland	D	Desert

Mapping Code	Vegetation name	Physiognomic class	Code	Potential natural vegetation
28.2	*Aristida* annual grassland	Annual grassland	g	edaphic grassland on drainage-impeded or seasonally flooded soils
28.3	*Sorghum* annual grassland	Annual grassland	wd	edaphic wooded grassland on drainage-impeded or seasonally flooded soils
29.1	*Cynodon-cyperus* seas. Flood. Grassland a. Perm. Swamp	Seasonally flooded grassland and permanent swamp	g/X	edaphic grassland on drainage-impeded or seasonally flooded soils / freshwater swamp
29.2	*Echinochloa-sorghum* seasonally flooded grassl. And perm. Swamp	Seasonally flooded grassland and permanent swamp	g/X	edaphic grassland on drainage-impeded or seasonally flooded soils / freshwater swamp
3.1	*Cynodon-balanites* evergreen wood. Grassland	Evergreen wooded grassland	Be	Evergreen and semi-evergreen bushland
30.1	Barrenland	Barrenland	D	Desert
31.1	*Aristida-indigofera-Commiphora-jatropa*	Shrub dwarf shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
31.2	*Aristida-duosperma-seriococomopsis-a. Reficiens-a. Mellifera*	Shrub dwarf shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
31.3	*Aristida-duosperma-seriococomopsis-a. Reficiens-a. Senegal*	Shrub dwarf shrub annual grassland	Bds	*Acacia-Commiphora* stunted bushland
31.3+ 30.0	-	Mixed vegetation types	S	Somalia-Masai semi-desert grassland and shrubland
4.1	*Acacia tortilis-balanites*	Evergreen and semi-deciduous woodland	WmK	*Acacia tortilis* wooded grassland and woodland (*Acacia-Commiphora* deciduous wooded grassland)
	Acacia tortilis-balanites evergreen a. Semi-dec. Woodland	Evergreen and semi-deciduous woodland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
4.2	*Acacia tortilis-Acacia elatior-hyphaene* evergreen and semi-dec. Woodland	Evergreen and semi-deciduous woodland	wr	riverine wooded vegetation
4.3	*Combretum-euphorbia*	Evergreen and semi-deciduous woodland	Wcd	Dry *Combretum* wooded grassland
4.4	*Hyphaene-Acacia tortilis* evergreen and semi-dec. Woodland	Evergreen and semi-deciduous woodland	wr	riverine wooded vegetation
4.5	*Combretum-Acacia nilotica*	Evergreen and semi-deciduous woodland	Be	Evergreen and semi-evergreen bushland
4.6	*Olea ?*	Evergreen and semi-deciduous woodland	Be	Evergreen and semi-evergreen bushland
5.1	*Acacia tortilis* semi-dec. Woodland (baringo)	Semi-deciduous woodland	WmK	*Acacia tortilis* wooded grassland and woodland
	Acacia tortilis semi-dec. Woodland (marsabit)	Semi-deciduous woodland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
5.2	*Acacia tortilis-Acacia elatior* (semi-dec. Woodland)	Semi-deciduous woodland	wr	riverine wooded vegetation
6.0/14.1	*Terminalia-Acacia hockii/croton-rhus*	Mixed vegetation types	Be	Evergreen and semi-evergreen bushland
6.1	Misc. *Forbs-Acacia tortilis-terminalia* semi-dec. Wood. Grassland	Semi-deciduous wooded grassland	WmK	*Acacia tortilis* wooded grassland and woodland
6.2	Misc. *Forbs-combretum-zizyphus* semi-dec. Wood. Grassland	Semi-deciduous wooded grassland	Wcd	Dry *Combretum* wooded grassland
7.1	*Acacia tortilis (duosperma)* dec. Woodland	Deciduous woodland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
7.2	*Acacia tortilis-salvadora-cadaba* dec. Woodland	Deciduous woodland	WmK	*Acacia tortilis* wooded grassland and woodland
8.1	*Sporobolus-duosperma-Acacia tortilis*	Deciduous wooded grassland	wr	riverine wooded vegetation
8.1	*Sporobolus-duosperma-Acacia tortilis* dec. Wooded grassland	Deciduous wooded grassland	Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
8.2	*Oropetium-indigofera-Acacia tortilis* dec. Wooded grassland	Deciduous wooded grassland	WmK	*Acacia tortilis* wooded grassland and woodland
8.3	*Lintonia-Acacia seyal*	Deciduous wooded grassland	wd	edaphic wooded grassland on drainage-impeded or seasonally flooded soils
9.1	*Chloris-aristida-Acacia tortilis* dec. Wooded ann. Grassland	Deciduous wooded annual grassland	WmK	*Acacia tortilis* wooded grassland and woodland
9.2	*Aristida-indigofera-Acacia tortilis* dec. Wooded annual grassland	Deciduous wooded annual grassland	WmK	*Acacia tortilis* wooded grassland and woodland

Table 9.6: Reclassification table for the conversion of the Moomaw vegetation types to the regional PNV types used on the VECEA PNV map

Original classification	**PNV classes**
Acacia-Euphorbia	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Cynometra-Manilkala (Sokola)	Dry Zanzibar-Inhambane undifferentiated forest
Sterculia-Chlorophora/Memecylon"	Moist Zanzibar-Inhambane undifferentiated forest
Afzelia-Albizia/Panicum	Moist Zanzibar-Inhambane undifferentiated forest
Sterculia-Chlorophora/Memecylon - Afzelia-Albizia	Moist Zanzibar-Inhambane undifferentiated forest
Manilkara-Dalbergia/Hyperrhenia	Zanzibar-Inhambane scrub forest
Manilkara-Diospyros	Zanzibar-Inhambane scrub forest
Combretum Schumanii-Cassipourea	Scrub forest on coral rag
Brachystegia-Afzelia	Coastal *Brachystegia* woodland
Mangrove Thicket and Adjacent Saline Areas	Mangrove
Sand Dune and Beach Littoral	Sand

Table 9.7: Conversion of the vegetation types of the Delsol map to the PNVs of the VECEA PNV map

Original classification	**Potential Natural Vegetation classification**
Afro-alpine grasslands with *Festuca;Agrostis;Koeleria*	Afroalpine vegetation
Forb communities with tall senecio and labelia	Afroalpine vegetation
Bamboos (*Arundinaria alpina*)	Afromontane bamboo
Dense semi-deciduous forest with *Brachylaena, croton*	Afromontane moist transitional montane forest
Dense evergreen forest with *Ocotea-Aningeria-Cassipourea*	Afromontane rain forest
Crops	-
Irrigated crops	-
Sisal crop	-
Nearly barren desertic soils	Desert
Sand dunes and sandy caps	Desert
Tree savannah *Combretum,Commiphora* and *Hyparrhenia*	Dry *combretum* wooded grassland
Dry forest with *Combretum schumanii-Cassipourea*	Dry Zanzibar-Inhambane undifferentiated forest
Dry forest with *Cynometra-Manilkara*	Dry Zanzibar-Inhambane undifferentiated forest
Flooded areas vegetation	Edaphic grassland on drainage-impeded or seasonally flooded soils
Palm savannah (*Hyphaene coriacea*)	Palm wooded grassland

Original classification	Potential Natural Vegetation classification
Shrub savannah with *Acacia (A.drepanolobium, A.seyal, A.gerrardii, A.hockii)* and *Themeda*	-
Srubby and/or herbaceous savannah	-
Mangroves	Mangrove
Dense semi-deciduous forest with *Sterculia-Chlorophora-Memecylon*	Moist Zanzibar-Inhambane undifferentiated forest
Moors with *Ericaceae* (*Erica; Philippia; vaccinium*)	Montane Ericaceous belt
Thickets with Ericaceae (Philippia)	Montane Ericaceous belt
Riparian forest	Riverine wooded vegetation
Dwarf-shrub pseudo-steppes with *Acacia (A.mellifera,A.reficiens,A. paoli)* and *Commiphora africana*	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Pseudo-steppic shrubby vegetation with *Acacia (A.nilotica,A.bussei,A. reficians,A.senegal)* and *Commiphora (C.africana,C.schimperi)*	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Thorn forest with *Acacia* predominant (*A.Xantophloea*)	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Mosaic of crops and grass savannas	-
Mosaic of crops and savannah woodlands	-
Mosaic of crops and shrubs savannas with *Acacia*	-
Herbaceous pseudo-steppes with *Chrysopogon* and *indigofera spinosa*	*Acacia-Commiphora* stunted bushland
Pseudo-steppic herbaceous vegetation in arid sandy areas	Somalia-Masai semi-desert grassland and shrubland
Pseudo-steppic thorny vegetation in arid areas	Somalia-Masai semi-desert grassland and shrubland
Dense evergreen forest with *Podocarpus-juniperus*	Undifferentiated Afromontane forest
Dry deciduous forest with *Ocotea Olea*	Undifferentiated Afromontane forest
Coastal pseudo-steppic vegetation (*Acacia-Euphorbia*)	Zanzibar-Inhambane scrub forest
Dry forest with *Manilkara-Diospyros*	Zanzibar-Inhambane scrub forest
Tree savannah with *Albizia-Afzelia*	Zanzibar-Inhambane scrub forest
Tree savannah with *Manilkara-Dalbergia*	Zanzibar-Inhambane scrub forest (but see section Error: Reference source not found)

Table 9.8: Results of the modelling of PNVs in south-west Kenya (see Figure 3.6ii). For model input, we used climate, topographic and edaphic variables were recorded, including the pca_tmin, pca_tmax, pca_prec, pca_pet, the 19 bioclimatic variables, altitude, lithology, morphology and terrain wetness index (Table 9.1). The AUC is based on training points (sampled at a density of 0.1/km^2) and test points (30% of all sample points) of the individual probability distribution models created with Maxent (Phillips et al. 2006). The surface gives the area covered by each of the PNVs within the area marked in Figure 3.6ii (excluding PNVs in compound mapping units). The commission and omission rate and estimated kappa are based on the final classification based on the combined PNV distribution models. For codes, see Table 1.2.

Code	AUCtraining	AUCtest	Surface (km^2)	Commission (%)	Ommission (%)	Estimated Kappa
Fa	0.991	0.988	7989	13.5	20.8	0.861
Fbu	0.971	0.969	18962	17.1	24.9	0.815
Fbj	0.990	0.970	3586	39.5	31.4	0.599
Fe	0.997	0.997	2598	8.3	24.3	0.916
Ff	0.994	0.993	5619	15.5	14.3	0.841
Fh	0.994	0.987	3712	36.5	27.8	0.629
Fq	0.999	0.999	822	21.6	26.1	0.784
D	0.996	0.994	2818	34.2	25.8	0.654
G	0.996	0.993	1612	41.6	31.2	0.581
S	0.986	0.981	8688	31.6	24.3	0.672
We	0.992	0.987	4135	33.8	30.9	0.656
B	0.995	0.992	3694	31.0	35.0	0.685
E	0.998	0.998	1290	12.1	19.9	0.878
wd	0.969	0.962	10265	49.1	42.6	0.488
Wcm	0.989	0.987	9412	17.8	21.9	0.815
Wcd	0.990	0.985	5072	47.5	32.9	0.515
Bes	0.997	0.994	741	54.3	52.2	0.456
Bev	0.994	0.992	3835	14.8	23.6	0.850
Bet	0.956	0.954	21731	30.7	29.0	0.663
Bds	0.923	0.929	51923	18.4	17.0	0.768
Bdd	0.858	0.848	74154	10.4	14.1	0.851

9.3.1 Some notes on the results of the modelling

The AUC's, percentage of false positives (commission) and false negatives (omission) and the estimated Kappa (Table 9.8) show that there is a reasonable good fit between the modelled and mapped distribution of the individual PNVs. The main exception is the edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd). However, where the wd borders non-classified mapping units (south-east of the Aberdares and the south-western corner of the Masai Mara), the modelled distribution represents the mapped distribution fairly well. Thus, including wd in the combined PNV distribution models allows for a better alignment of mapped and modelled PNV distribution in these areas.

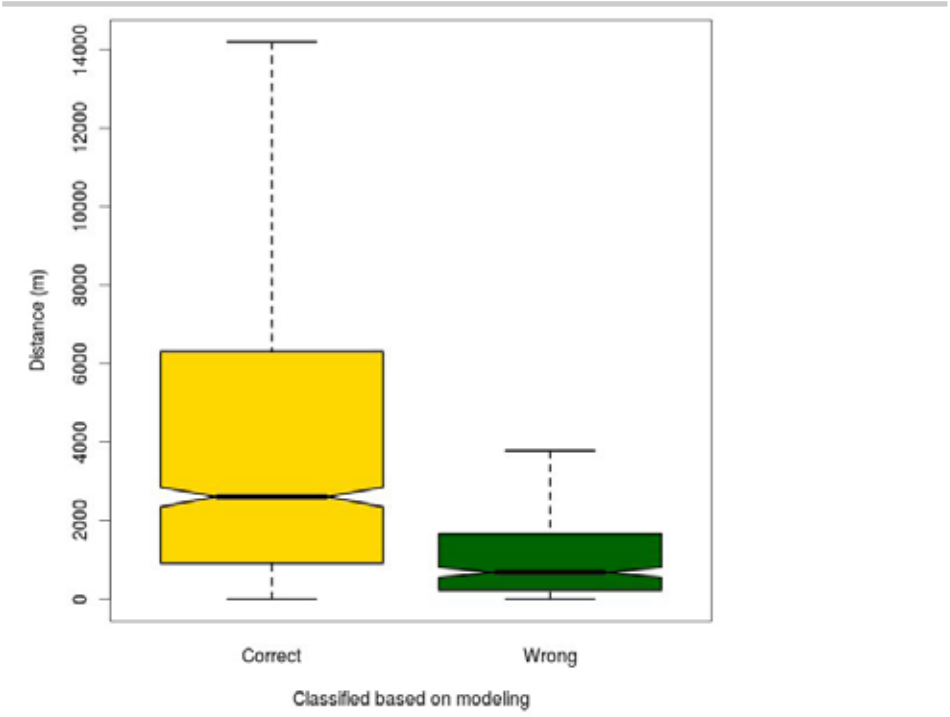


Figure 9.2: Distances distribution of raster cells correctly classified by the combined PNV probability distribution map and raster cells incorrectly classified.

The maximum PNV probability distribution map captures the overall vegetation patterns very well, but is less successful in capturing the smaller details. An important part of the wrongly classified areas are found close to vegetation boundaries (Figure 9.2) or where a PNV forms small 'islands' or 'peninsulas' within another PNV. A possible explanation is that as probability scores of bordering vegetation types are expected to be more similar close to their joined boundaries, errors close to vegetation boundaries are also more likely. And this is increasingly likely in areas with more gradual and fuzzy transitions between vegetation types.

Another possible explanation is that the resolution of the climatic data (30 arc-seconds) is high enough to capture the general vegetation distribution patterns, but is not sufficiently to capture the finer details of vegetation boundaries on the vegetation maps. Perhaps more importantly, smaller scale vegetation patterns are often determined by edaphic conditions. Unfortu-

nately, the edaphic data layers are of low (thematic) resolution, with large mapping units (compared to the mapping units on the vegetation maps).

Besides possible problems with the environmental data (explanatory variables), inconsistencies (or errors) in the vegetation maps (response variables) should also be considered as a potential source or errors.

9.4 Correspondence between the Malawi base map and the VECEA map

Table 9.9: Aggretation of the original vegetation units (columns 'Original vegetation units' and 'nanr' on the maps by Stobbs (1971) and Young (1965a,b) into major vegetation units (column VT name). These are subsequently linked to the regional potential natural vegetation types in the columns 'PNV name' and 'PNV code'.

Original vegetation names	nanr	VT name	PNV name	PNV code
Montane grassland and montane forest	3c	Montane Grassland (with relic evergreen forest patches)	Afromontane rain forest / Single-dominant *Juniperus procera* forest / Single-dominant Hagenia abyssinica forest	Fa/Fbj/Fbu/Fd
Montane grassland, and patches of montane forest	4a-d, 19b	"	"	"
Montane grassland	8a-d, 19a, 19e	"	"	"
Montane grassland, with small areas of moist *Brachystegia* woodland	10b-e, 13a-c, 19c	"	"	"
Moist *Brachystegia* woodland, with areas of montane grassland	19d	"	"	"
Montane grassland and *Brachystegia* hill woodland	40c	"	"	"
Brachystegia-Julbernardia plateau woodland and montane grassland	43b	"	"	"
Combretum-Acacia-Piliostigma cultivation savannah	28a-d	*Combretum/Acacia/*__Woodland of Plateau	*Combretum/Acacia/* Piliostigma Woodland and Thicket	Wnc
Combretum-Acacia-Piliostigma cultivation savannah and *Brachystegia-Julbernardia* plateau woodland	28e	"	"	"
Marsh grasslands with scattered trees	11c, 15d, 16f	Seasonally Wet Grasslands (sometimes with scattered trees and bushes on *termitaria*)	edaphic grassland on drainage-impeded or seasonally flooded soils / edaphic wooded grassland on drainage-impeded or seasonally flooded soils	g / wd
Marsh grassland with thicket patches	25d	"	"	"
Swamp grassland and *Acacia albida-Sterculia-Cordyla* woodland and thicket	36c1	"	"	"
Swamp grassland with *Acacia* spp; *A. seyal* (wet) and *A. spirocarpa* (dry)	45b	"	"	"
Marsh grasslands; *Chloris gayana-Setaria* associations on heavier soils of clay plain	45c1	"	"	"
Lake-shore thorn shrub, and lake-shore cultivation savannah	6d	Perennially Wet Grasslands/Swamps	edaphic grassland on drainage-impeded or seasonally flooded soils / freshwater swamp	g/X
Marsh grassland, Marsh grassland and reeds, including Marsh grassland and reeds with *Pennisetum purpureum, Phragmites mauritianus, Typha australis-Borassus* and *Hyphaene* palms on higher ground	11d, 21g, 50i, 50j, M	"	"	"
Swamp grassland, including pure stands of wild rice or *H. rufa* grassland; *Vossia* and *Phragmites* (Bango reed) swamp	44d, 45f	"	"	"
Marsh grassland and reeds.	50b	Perennially Wet Grasslands/Swamps	freshwater swamp + palm wooded grassland	X + P
Brachystegia hill woodland	1b, 3d-f, 4c, 4e,4f	*Brachystegia* Hill Woodland	miombo on hills and rocky outcrops	Wmr
Brachystegia low-altitude hill woodland	5a, 5c-g	"	"	"

Original vegetation names	nanr	VT name	PNV name	PNV code
Brachystegia lake-shore woodland	5b	"	"	"
Acacia-Piliostigma-*Combretum* cultivation savannah, and *Brachystegia* plateau woodland regrowth	35b	"	"	"
Bauhinia-Diplorrhyncus-Pseudolachnostylis-Diospyros hill woodland	37c-d, 38a	"	"	"
Brachystegia escarpment woodland	49a	"	"	"
Brachystegia foothill scrub and woodland and poor mixed woodland	54a	"	"	"
Brachystegia foothill woodland	48h, 52c	"	"	"
Brachystegia high-altitude hill woodland	9a	"	"	"
Brachystegia hill and escarpment woodland	48b-c, 52b [3]	"	"	"
Brachystegia hill woodland	7e-f, 12d, 17a, 18d, G, H, S	"	"	"
Brachystegia hill woodland [N], *Brachystegia-Julbernardia* hill woodland [C]	17e	"	"	"
Brachystegia hill woodland [S], Scarp foothill woodland [C]	33b	"	"	"
Brachystegia hill woodland, and grassland	7d	"	"	"
Brachystegia hill woodland, including high altitude type	6j, 9b-d	"	"	"
Brachystegia lake-shore woodland, and low-altitude marsh grassland	6f, 48g	"	"	"
Brachystegia-Isoberlinea woodland	51a	"	"	"
Brachystegia-Isoberlinea-Pterocarpus woodland; bamboo forest below escarpment	38d	"	"	"
Brachystegia-Julbernardia escarpment woodland	43d	"	"	"
Brachystegia-Julbernardia escarpment woodland. *B. Boehmii B. manga* and *B. bussei* dominant	43c	"	"	"
Brachystegia-Julbernardia foothill woodland	35a, 43k, 55c	"	"	"
Brachystegia-Julbernardia hill woodland	22a, , 24a, 24c, 24d, 26b, 29d, 31a, 32e, 33a, 34b, 43a, 54c	"	"	"
Brachystegia-Julbernardia hill woodland and scarp foothill woodland	24b, 25a	"	"	"
Brachystegia-Julbernardia hill woodland, with patch of montane evergreen forest	29e [4]	"	"	"
Brachystegia-Julbernardia woodland regrowth	35c	"	"	"
Brachystegia-Julbernardia woodland, with *Cryptosepalum pseudotaxus*, and *Brachystegia* hill woodland [N], *Brachystegia-Julbernardia* hill woodland [C]	17d	"	"	"
Brachystegia-Julbernardia-Bauhinia-Pterocarpus mixed woodlands	38e	"	"	"
Brachystegia-Pterocarpus-Bauhinia escarpment woodland and *Bauhinia-Diplorrhyncus* hill woodland	37e	"	"	"
Brachystegia-Uapaca-*Julbernardia* woodland and scrub	37f	"	"	"

Original vegetation names	nanr	VT name	PNV name	PNV code
Colophospermum mopane in the north, elsewhere *Brachystegia-Julbernardia* woodland and *Pterocarpus-Bauhinia-Brachystegia* woodland	37a1	"	"	"
Cultivation savannah	48a, 52a	"	"	"
Cultivation savannah, *Pterocarpus* angolensis	6i	"	"	"
Escarpment woodland, *Brachystegia* spp.	49c	"	"	"
Foothill woodland, *Brachystegia boehmii-Pterocarpus angolensis-Combretum* spp.	41e	"	"	"
Hill woodland, *Brachystegia* spp., *Pterocarpus* angolensis, B*auhinia peterseniana*	49b	"	"	"
Lake-shore cultivation savannah, and low-altitude marsh grassland	6e	"	"	"
Low altitude mixed woodland. *Bauhinia-Diospyros-Sterculia-Brachystegia* spp.	54d	"	"	"
Low-altitude *Brachystegia* hill woodland	6k-l	"	"	"
Mainly *Brachystegia* hill woodland	33c	"	"	"
Mainly cultivation savannah; *Pterocarpus* angolensis and *Terminalia sericea* dominant	53a	"	"	"
Mixed foothill woodland with *Brachystegia-Julbernardia* woodland re-growth	41d	"	"	"
Mixed savannah woodland and poor *Brachystegia* scrub woodland	41a	"	"	"
Moist *Brachystegia* woodland, and *Brachystegia* hill woodland	20c	"	"	"
Moist *Brachystegia* woodland, and *Brachystegia* hill woodland [N], *Brachystegia-Julbernardia* hill woodland [C]	20a-b	"	"	"
savannah regrowth. (i) *Brachystegia boehmii* mixed woodland (ii) *Acacia camphylacantha* mixed woodland on colluvial slopes	53b	"	"	"
Scarp foothill woodland, sometimes with cultivation savannah	29c, 30f-g	"	"	"
Scarp-foothill scrub-woodland; *Diplorrhyncus massambicensis-Pseudolachnostylis maprouneifolia* prominent	40d	"	"	"
Scarp-foothill woodland and *Brachystegia* woodland regrowth	40e	"	"	"
Sclerocarya-Capparidaceae savannah woodland and regrowth; *Adansonia digitata* sometimes dominant in cultivation	42a	"	"	"
Brachystegia hill woodland	1a	"	"	"
Escarpment woodland with patches of montane evergreen forest in gully heads	46a	"	"	"
Brachystegia-Isoberlinea woodland (sometimes with *Cryptosepalum pseudotaxus*)	2a-e	*Brachystegia/Isoberlinia* Plateau Woodland	miombo woodland	Wm
Acacia thicket and *Brachystegia-Julbernardia* woodland	15c	"	"	"
Brachystegia plateau woodland	39d, 42d, 48d-f	"	"	"
Brachystegia-Isoberlinea woodland, in parts with *Cryptosepalum pseudotaxus*	7a-c	"	"	"

Original vegetation names	nanr	VT name	PNV name	PNV code
Brachystegia-Julbernardia hill woodland with *J. globiflora* predominant, some *Combretum-Acacia-Piliostigma* cultivation savannah	39c	"	"	"
Brachystegia-Julbernardia hill woodland, with montane grassland and evergreen forest patches on crests	32d [1]	"	"	"
Brachystegia-Julbernardia plateau woodland	16g, 23a-e, 26a, 27a-b, 28f, 32b-c, 41b, 43g, 43i, 53c	"	"	"
Brachystegia-Julbernardia plateau woodland regrowth with *J. globiflora* prominent on hills	43e	"	"	"
Brachystegia-Julbernardia plateau woodland regrowth with montane evergreen forest on Cholo mountain, and locally elsewhere	43h [2]	"	"	"
Brachystegia-Julbernardia plateau woodland with patches of *Combretum, Acacia*	28g	"	"	"
Brachystegia-Julbernardia plateau woodland, and *Combretum-Acacia-Piliostigma* woodland	29a	"	"	"
Brachystegia-Julbernardia woodland (or regrowth)	16a, 16c, 16e, 17c, 18a-c, 37h, 43f, 43j, 47b	"	"	"
Brachystegia-Julbernardia woodland [N], *Brachystegia-Julbernardia* plateau woodland [C]	16d	"	"	"
Brachystegia-Julbernardia woodland with *J. globiflora* predominant	40b	"	"	"
Brachystegia-Julbernardia woodland with pure stands of *Uapaca* near escarpment. Montane grass and scrub on high peaks	40a	"	"	"
Brachystegia-Julbernardia woodland, and *Acacia-Combretum* thicket of plateaux	11a, 16b	"	"	"
Brachystegia-Julbernardia woodland, and *Combretum ghazalense-Acacia* savannah	12b-c	"	"	"
Brachystegia-Julbernardia woodland, with *B. boehmii-B. manga* woodlands prominent	37g	"	"	"
Brachystegia-Julbernardia woodland, with *Cryptosepalum pseudotaxus*, and *Brachystegia* hill woodland	17b	"	"	"
Combretum ghazalense-Acacia savannah, and marsh grassland	11b	"	"	"
Cultivation regrowth derived from *Brachystegia-Julbernardia* plateau woodland	45e, 45g	"	"	"
Cultivation regrowth from *Brachystegia* plateau woodland	47c	"	"	"
Cultivation regrowth, occacional local areas of moist *Brachystegia* woodland	47a	"	"	"
Cultivation savannah interspersed by *Brachystegia* plateau woodland	37b	"	"	"
Cultivation savannah; *Piliostigma thonningii* [N], Lake-shore cultivation savannah [C]	21e	"	"	"
Low montane grassland	22b, 29b, 32a	"	"	"
Lowland woodland and cultivation savannah. *Terminalia* common	45d	"	"	"

Original vegetation names	nanr	VT name	PNV name	PNV code
Mainly *Brachystegia-Julbernardia* plateau savannah woodland regrowth	39b	"	"	"
Mainly *Brachystegia-Julbernardia* plateau savannah woodland regrowth, and *Combretum-Acacia-Piliostigma* cultivation savannah	39a	"	"	"
Moist *Brachystegia* woodland	10a	"	"	"
Moist *Brachystegia* woodland	13d, 13f, 14a-c, 15a-b	"	"	"
Moist *Brachystegia* woodland, and *Brachystegia* hill woodland	10f-g	"	"	"
Moist *Brachystegia* woodland, and *Brachystegia* hill woodland [C], Montane grassland, parts woodland [C]	20d	"	"	"
Moist *Brachystegia* woodland, and semi-evergreen forest (sometimes cleared)	3a-b, 3g-h	"	"	"
Montane grassland and cultivation grass and scrub regrowth. Occacional relict woodland patches	34a	"	"	"
Semi-evergreen forest, and moist *Brachystegia* woodland	21a	"	"	"
Semi-evergreen forest, and moist *Brachystegia* woodland [N], Moist *Brachystegia* woodland [C]	21b	"	"	"
Montane grassland and heather heathland; Aloe in rocky places, scrub thicket in gullies	46b	Afromontane Evergreen Bushland/Thicket	montane Ericaceous belt	E
Small patchers of *Widdringtonia* woodland in montane grassland and heath	46c	Montane Grassland (with relic evergreen forest patches)	Montane Ericaceous belt / Single-dominant *Widdringtonia whytei* forest	E/Fc
Specialized vegetation of sands; *Terminalia sericea*	30e	*Terminalia sericea* Woodland	*Terminalia* woodland	Wt
Terminalia woodlands locally with *Brachystegia* woodlands	44a	"	"	"
Terminalia woodland; mainly as cultivation savannah	44b	"	"	"
Terminalia woodland on light soils; *Brachystegia-Julbernardia* plateau woodland elsewhere	44c	"	"	"
Sour grassland, *Teminalia sericea* woodland remnants	45a	"	"	"
Marsh grasslands; *Chloris gayana-Setaria* associations on heavier soils of clay plain	45c2	"	"	"
Acacia albida on fans; *Acacia-Combretum* woodland along the streams and rivers, with many areas of cultivation savannah	42b	*Acacia*/Adansonia/*Hyphaene*/*Sterculia* Woodland/Thicket of Lake Shore and Lower Rift Valley	North Zambezian undifferentiated woodland	Wn
Acacia albida parkland on cultivated alluvial fans. *Adansonia-Sterculia-Cordyla* woodland elsewhere	36e	"	"	"
Acacia albida parkland, *A. campylacantha* and *A. seyal* on seasonally waterlogged heavy soils, with swamp grassland	36b	"	"	"
Acacia cultivation savannah	25c, 30c, 30h	"	"	"
Acacia cultivation savannah of valley floors	2f, 3i, 4g, 12a	"	"	"
Brachystegia foothill scrub woodland, and mixed woodland of *Diplorrhyncus-Combretum* and *Pterocarpus* rotundifolius associations	54f	"	"	"

Original vegetation names	nanr	VT name	PNV name	PNV code
Brachystegia foothill woodland and poor mixed woodland	54e	"	"	"
Brachystegia low-altitude hill woodland	6a	"	"	"
Colophospermum mopane tree savannah. Westwards short tree and scrub savannah of *Combretum-Diospyros-Sterculia* spp.	51d	"	"	"
Cultivation savannah with *Adansonia-Sterculia-Cordyla* relicts; *Sclerocarya-Pterocarpus-Ostryoderris* associations in less cultivated areas	36a	"	"	"
Cultivation savannah, *Cordyla, Sterculia* relicts	50h	"	"	"
Cultivation savannah, lowland thicket and woodland remnants, derived from *Sclerocarya-Cordyla-Sterculia-Adansonia* association	50g	"	"	"
Cultivation savannah. *Cordyla, Boscia* and *Sterculia* spp. relicts. *Colophospermum* mopane on stony soils	50f	"	"	"
Foothill woodland; C. mopane thickets; local areas of close savannah woodland, *Brachystegia-Isoberlinea* and *Combretum-Diospyros-Pterocarpus* woodland	51c	"	"	"
Lake-shore cultivation savannah	6c, 14d, 30a, 30d	"	"	"
Lake-shore cultivation savannah, and (low-altitude) marsh grassland	6b, 30b	"	"	"
Low altitude woodland, (i) *Adansonia-Cordyla-Sterculia* (ii) *Adansonia-Acacia-Euphorbia*	54b	"	"	"
Lowland savannah and thicket associations as for vt065a	50e	"	"	"
Lowland savannah and thicket often reduced to cultivation savannah. *Sclerocarya-Cordyla-Sterculia-Adansonia-A. albida*, some *Combretum-Piliostigma-Acacia*	50d	"	"	"
Lowland woodland and thicket, largely reduced to cultivation savannah. *Sclerocarya-Cordyla-Sterculia-Adansonia* association. *Borassus* palms on swampy ground	50c	"	"	"
Lowland woodland species mainly as residuals in cultivation savannah *Sterculia-Adansonia* and *Acacia albida-Cordyla* associations	50a	"	"	"
Mainly regrowth; *Pterocarpus-Adansonia-Sclerocarya-Albizzia* typical species	41c	"	"	"
Marsh grassland with thicket patches	51f	"	"	"
Mixed savannah woodland and *Colophospermum* mopane woodland	51b	"	"	"
Short tree and scrub savannah. *Combretum-Diospyros-Pterocarpus-A. nigrescens-C.* mopane	51e	"	"	"
Swamp grassland and *Acacia albida-Sterculia-Cordyla* woodland and thicket	36c2	"	"	"
Sclerocarya-Adansonia-Cordyla-Sterculia savannah woodland regrowth. *Acacia albida* on alluvial fans; *Hyphaene* on lakeshore sandy areas	38b	*Acacia*/Adansonia/*Hyphaene*/*Sterculia* Woodland/Thicket of Lake Shore and Lower Rift Valley	Undifferentiated Mixed Woodlands/ Thicket of Lower Rift Valley + palm savannah	Wns + P

Original vegetation names	nanr	VT name	PNV name	PNV code
Lakeshore woodlands, thickets and parklands. *Adansonia-Sterculia-Cordyla* savannah woodland; *Acacia albida* on alluvial fans; *Borassus* palm on cultivation savannah; *Hyphaene* on lakeshore sands	38c	"	"	"
Lake-shore thorn shrub	6g	Vegetation of Sands (grass dunes and unvegetated)	vegetation on sands	n
Lake-shore cultivation savannah	6h	"	"	"
Dune grassland	55a	"	"	"
Specialised vegetation of sands, and unvegetated	L	"	"	"
Colophospermum mopane savannah	36d	*Colophospermum* mopane Woodland, Wooded Grassland and Thicket	Zambezian mopane woodland and scrub woodland	Wo
Colophospermum mopane in the north, elsewhere *Brachystegia-Julbernardia* woodland and Pterocarpus-Bauhinia-*Brachystegia* woodland	37a2	"	"	"
Colophospermum mopane with some mixed savannah woodland	41f	"	"	"
Colophospermum mopane woodland	42c	"	"	"
Mixed savannah woodland with local areas of *Colophospermum* mopane	55b	"	"	"
Semi-evergreen forest, and moist *Brachystegia* woodland	13e	Semi-evergreen Forest	Zanzibar-Inhambane lowland rain forest	Fo
Semi-evergreen forest	21c-d	"	"	"
Semi-evergreen forest, and moist *Brachystegia* woodland [N], Moist *Brachystegia* woodland [C]	21f	"	"	"
Moist tall forest: *Newtonia buchananii-Khaya myassica-Albizzia* spp.	46d	Mid-altitude rain forest	Zanzibar-Inhambane transitional rain forest	

[1] Mapping unit 32d includes the (unmapped) Chongoni and Dedza Mts. Evergreen forest
[2] Mapping unit 43h includes the (unmapped) Thyolo Mt evergreen forest and other 'riverine' evergreen forest patches south to Mulanje area.
[3] Mapping unit 52b includes the (unmapped) Malawi Hill lowland evergreen forest
[4] Mapping unit 29e includes the (unmapped) Ntchisi Mt evergreen forest

9.5 Correspondence between the Rwanda base map and the VECEA map

Table 9.10: Criteria to map the distribution of forest and bamboo vegetation types. Note, these rules where not used for the Virunga national park, for which we used the Virunga vegetation map (see section 5.2.3.1).

Name	Regional PNV	Criteria
bamboo	Afromontane bamboo	altitude > 2500 m
Moist montane forest	Afromontane rain forest	1900 m < altitude < 2500 m for the Virunga region altitude > 1900 m for other areas altitude > 1900 m for other areas
Moist intermediate forest	Lake Victoria transitional rain forest	1600 m < altitude < 1900 m

Table 9.11: Criteria used to delimit the distribution area of bamboo

Name	Regional PNV	Criteria
Alpine moss and lichen desert	Afroalpine vegetation	Class 6 on Virunga map
Moorland (Afro-alpine vegetation)	Afroalpine vegetation	Class 7, 8, 9 on Virunga map
Ericaceous heath	Montane Ericaceous belt	Class 3 on Virunga map
Hagenia-Hypericum zone	Single-dominant Hagenia abyssinica forest	Class 2, 4, 5 on Virunga map
Bamboo	Afromontane bamboo	Class 1 on Virunga vegetation map

Table 9.12: Classification of the lowland bushland, grasslands and forest mosaics, applied for all areas below 1600 m altitude.

Name	Regional PNV	Criteria
Mosaic of Semi-deciduous bushland, biotic savannah, riverine wooded vegetation (no zambezian influence). Occurrence of Euphorbia dawi scrub limited to smaller areas	Mosaic of Evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation	All areas which do not fulfill the criteria for 10-14 below and which are not classified as swamp (grey areas in Figure 5.1)
Same as above, but with larger areas of Euphorbia dawei scrub (thalweg) forest	Mosaic of Evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation and Euphorbia dawei scrub (thalweg) forest	All areas falling within Prioul/Troupin classes 6 and 7 (blue areas in Figure 5.1)
Mosaic of Semi-deciduous bushland, biotic savannah, riverine wooded vegetation and gallery forests (with Zambezian influence)	Mosaic of Evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation and gallery forests	All areas within the areas marked dark green in Figure 5.1.
Same as above, but gallery forests with Zambezian influence	Mosaic of Evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation and gallery forests	All areas within the areas marked light green in Figure 5.1.
Rusizi-Bugarama plain (note that these plains are distinct	Mosaic of Evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation and Euphorbia dawei scrub (thalweg) forest	All areas marked red in Figure 5.1 (based on Prioul/Troupin map, mapping unit 8)
Lake Kivu riparian vegetation with Congo affinity	Mosaic of Evergreen and semi-evergreen bushland and thicket, biotic wooded grassland, riverine wooded vegetation and gallery forests	All areas within the areas marked yellow in Figure 5.1.

9.6 Correspondence between the ugandan base map and the VECEA map

Table 9.13: Reclassification of the Langdale-Brown vegetation types for Uganda (original vegetation type) to potential natural vegetation types at a national level (national PNV) and a more aggregated version used for the VECEA PNV map (regional PNV). The notes column gives more information about the reclassification rules and process.

Code	Original vegetation type	National PNV	Regional PNV	Note
A1	high altitude heath and moorland: *alchemilla-helichrysum* moorland	afroalpine vegetation (A)	Afroalpine vegetation (A)	
A2	high altitude heath and moorland: *ericaceae-stoebe* heath	montane Ericaceous belt (E)	Montane Ericaceous belt (E)	
B1	high altitude forest: *pygeum* moist montane forest	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
B2	high altitude forest: *hagenia-rapanea* moist montane forest	Single-dominant *Hagenia abyssinica* forest (Fd)	Afromontane single-dominant *Hagenia abyssinica* forest (Fd)	
B2/B4	high altitude forest: *hagenia-rapanea* moist montane forest / *arundinaria* montane bamboo forest	Single-dominant *Hagenia abyssinica* forest / afromontane bamboo (Fd/B)	Afromontane single-dominant *Hagenia abyssinica* forest / afromontane bamboo (Fd/B)	But see section 7.2.3
B2+B4	high altitude forest: *hagenia-rapanea* moist montane forest + *arundinaria* montane bamboo forest	Single-dominant *Hagenia abyssinica* forest / afromontane bamboo (Fd/B)	Afromontane single-dominant *Hagenia abyssinica* forest / afromontane bamboo (Fd/B)	But see section 7.2.3
B3	high altitude forest: *juniperus-podocarpus* dry montane forest	Single-dominant *uniperus procera* forest (Fbj)	Undifferentiated Afromontane forest (Fb)	
B3/F1	high altitude forest / forest/savannah mosaic: juniperus-podocarpus dry montane forest / forest/savannah mosaic at high altitudes	Single-dominant *Juniperus procera* forest (Fbj)	Undifferentiated Afromontane forest (Fb)	F1 secondary to B3
B3/N11	high altitude forest / dry *combretum* savannah: *juniperus-podocarpus* dry montane forest / *Acacia-combretum*	Single-dominant *uniperus procera* forest / Dry *combretum* savannah (Fbj/Wcd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland (Fb/Wcd)	
B3/N8	high altitude forest / dry *combretum* savannah: *juniperus-podocarpus* dry montane forest / *combretum-Acacia-themeda*	Single-dominant *Juniperus procera* forest (Fbj)	Undifferentiated Afromontane forest (Fb)	N8 secondary to B3
B4	high altitude forest: *arundinaria* montane bamboo forest	Afromontane bamboo (B)	afromontane bamboo (B)	
C1	medium altitude moist evergreen forest: *piptadeniastrum-uapaca* forest	*Piptadeniastrum-Uapaca* medium altitude moist evergreen Forest (Fic1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
C1+C2	medium altitude moist evergreen forest: *piptadeniastrum-uapaca* forest + *piptadeniastrum-albizia-celtis* forest	*Piptadeniastrum-Uapaca* medium altitude moist evergreen Forest (Fic1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
C2	medium altitude moist evergreen forest: *piptadeniastrum-albizia-celtis* forest	*Piptadeniastrum-Albizia-Celtis* medium altitude moist evergreen Forest (Fic2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
C3	medium altitude moist evergreen forest: *parinari* forest	*Parinari* medium altitude moist evergreen Forest (Fic3)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
D1	medium altitude moist semi-deciduous forest: *celtis-chrysophyllum* forest	*celtis-chrysophyllum* medium altitude moist semi-deciduous Forest (Fid1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
D1+G1	medium altitude moist semi-deciduous forest + moist thicket: *celtis-chrysophyllum* + undifferentiated semi-deciduous thicket	*celtis-chrysophyllum* medium altitude moist semi-deciduous Forest / evergreen and semi-evergreen bushland and thicket (Fid1/Be)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket (Fi/Be)	

Code	Original vegetation type	National PNV	Regional PNV	Note
D1+G1+Q1	medium altitude moist semi-deciduous forest + moist thicket + grassland savannah: *celtis-chrysophyllum* forest + undifferentiated semi-deciduous thicket + moist *hyparrhenia* grass savannah	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / evergreen and semi-evergreen bushland and thicket (Fid1/Be)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket (Fi/Be)	Q communities are secondary to forest, wooded grassland and thicket.
D2	medium altitude moist semi-deciduous forest: *Cynometra-Celtis* forest	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
D2/K	medium altitude moist semi-deciduous forest / moist *combretum* savannah: *Cynometra-Celtis* forest / *combretum-terminalia-albizia-hyparrhenia rufa*	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	K secondary to forests
D2+W4	medium altitude moist semi-deciduous forest + communities on sites with impeded drainage: *Cynometra-Celtis* forest + *Acacia-imperata* grassland	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Fid2/wd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Fi/wd)	edaphic mosaic
D3	medium altitude moist semi-deciduous forest: *albizia-markhamia* forest	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest (Fid3)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
D4	medium altitude moist semi-deciduous forest: *albizia-chlorophora* forest	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest (Fid1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
D4+G1	medium altitude moist semi-deciduous forest + moist thicket: *albizia-chlorophora* forest + undifferentiated semi-deciduous thicket	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / evergreen and semi-evergreen bushland and thicket (Fid1/Be)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket (Fi/Be)	
D4+G1+K	medium altitude moist semi-deciduous forest + moist thicket + moist *combretum* savannah: *albizia-chlorophora* forest + undifferentiated semi-deciduous thicket + *combretum-terminalia-albizia-hyparrhenia rufa*	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / evergreen and semi-evergreen bushland and thicket (Fid1/Be)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket (Fi/Be)	K secondary to forests and semi-evergreen thickets
F1	forest/savannah mosaic: forest/savannah mosaic at high altitudes	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
F1/F2	forest/savannah mosaic: forest/savannah mosaic at high altitudes / forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
F1/N8	forest/savannah mosaic / dry *combretum* savannah: forest/savannah mosaic at high altitudes / *combretum-Acacia-themeda*	Single-dominant *Juniperus procera* forest (Fbj)	Undifferentiated Afromontane forest (Fb)	N8 secondary to B3
F1/Z3	forest/savannah mosaic / post cultivation communities: forest/savannah mosaic at high altitudes / *hyparrhenia*-pteridium	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
F1+G4	forest/savannah mosaic + moist thicket: forest/savannah mosaic at high altitudes + montane thicket	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	G4 assumed to be secondary
F1+Z3	forest/savannah mosaic + post cultivation communities: forest/savannah mosaic at high altitudes + *hyparrhenia-pteridium*	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
F2	forest/savannah mosaic: forest/savannah mosaic at medium altitudes	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest (Fid1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	

Code	Original vegetation type	National PNV	Regional PNV	Note
F2/N3	forest/savannah mosaic / dry *combretum* savannah: forest/savannah mosaic at medium altitudes / *combretum-Cymbopogon*	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / Dry *combretum* wooded grassland (Fid1/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / Dry *combretum* wooded grassland (Fi/Wcd)	
F2+Z2	forest/savannah mosaic + post cultivation communities: forest/savannah mosaic at medium altitude + *Cymbopogon-imperata*	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
F2+Z3	forest/savannah mosaic + post cultivation communities: forest/savannah mosaic at medium altitude + *hyparrhenia-pteridium*	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
G1	moist thicket: undifferentiated semi-deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	expected to be the semi-evergreen thickets of White and Trapnell
G1/D3	moist thicket / medium altitude moist semi-deciduous forest: undifferentiated semi-deciduous thicket / *albizia-markhamia*	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / evergreen and semi-evergreen bushland and thicket (Fid1/Be)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket (Fi/Be)	
G1+F2	moist thicket + forest/savannah mosaic: undifferentiated semi-deciduous thicket + forest/savannah mosaic at medium altitudes	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest (Fid3)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
G1+Q6	moist thicket + grassland savannah: undifferentiated semi-deciduous thicket + *themeda-heteropogon* grass savannah	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Q communities are secondary to forest, wooded grassland and thicket
G2	moist thicket: *riparian* thicket	riverine forest (r)	riverine forest (r)	But difficult to say whether this is riverine forest or woodland
G2/W8	moist thicket / communities on sites with impeded drainage: *riparian* thicket / *Acacia-setaria* savannah	edaphic wooded grassland on drainage-impeded or seasonally flooded soils / riverine forest (wd/r)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils / riverine forest (wd/r)	Idem
G2+P2	moist thicket + dry *Acacia* savannah: *riparian* thicket	riverine forest (r)	riverine forest (r)	landscape position of riparian thickets within dry *Acacia* savannah – might be riverine woodland too
G2+P2+W8	moist thicket + dry *Acacia* savannah + communities on sites with impeded drainage: *riparian* thicket + *Acacia-themeda-setaria* savannah + *Acacia-setaria* savana	edaphic wooded grassland on drainage-impeded or seasonally flooded soils / riverine forest (wd/r)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils / riverine forest (wd/r)	landscape position of riparian thickets and edaphic communities within dry *Acacia* savannah
G3	moist thicket: lowland bamboo thicket	lowland bamboo (L)	lowland bamboo (L)	
G4	moist thicket: montane thicket	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
G4+F1	moist thicket + forest/savannah mosaic: montane thicket + forest/savannah mosaic at high altitudes	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
G4+Z3	moist thicket + post cultivation communities: montane thicket + *hyparrhenia*-pteridium	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	
H1	woodland: *vitex-phyllanthus-terminalia* woodland	*Vitex-Phyllanthus-Sapium-Terminalia* woodland (Wv)	*Vitex-Phyllanthus-Sapium-Terminalia* and T*Terminalia glaucescens* woodland (Wv)	

Code	Original vegetation type	National PNV	Regional PNV	Note
H1/K	woodland / moist *combretum* savannah: *vitex-phyllanthus-terminalia* woodland / *combretum-terminalia-albizia-hyparrhenia rufa*	*Vitex-Phyllanthus-Sapium-Terminalia* woodland (Wv)	*Vitex-Phyllanthus-Sapium-Terminalia* and *Terminalia glaucescens* woodland (Wv)	K secondary to H1
H2	woodland: *terminalia* woodland	*Terminalia glaucescens* woodland (Wv)	*Vitex-Phyllanthus-Sapium-Terminalia* and *Terminalia glaucescens* woodland (Wv)	
H2/H1	woodland: *terminalia* woodland / *vitex-phyllanthus-terminalia* woodland	*Vitex-Phyllanthus-Sapium* and *Terminalia glaucescens* woodland (Wv/wt)	*Vitex-Phyllanthus-Sapium-Terminalia* and *Terminalia glaucescens* woodland (Wv)	
H4	woodland: *albizia-combretum* woodland	*Albizia-Combretum* woodland (Wca)	Moist *combretum* wooded grassland (Wcm)	
J1	moist *Acacia* savannah: *Acacia-albizia-Beckeropsiss-Cymbopogon*	secondary *Acacia-Albizia-Beckeropsiss-Cymbopogon* (sec01)	Reclassified using modelling, see section 7.2.4	Secondary moist *Acacia* wooded grassland
J1/F2	moist *Acacia* savannah / forest/savannah mosaic: *Acacia-albizia-panicum-chloris* / forest/savannah mosaic at medium altitudes	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest (Fid3)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	J1 secondary to forest
J1+C2	moist *Acacia* savannah + medium altitude moist evergreen forest: *Acacia-albizia-panicum*-chloris + piptadeniastrum-*albizia*-celtis forest	Piptadeniastrum-*Albizia*-Celtis medium altitude moist evergreen Forest (Fic2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	J1 secondary to forest
J1+F2	moist *Acacia* savannah + forest/savannah mosaic: *Acacia-albizia-panicum-chloris* + forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	J1 secondary to forest
J1+Z3	moist *Acacia* savannah + post cultivation communities: *Acacia-albizia-Beckeropsiss-Cymbopogon* + *hyparrhenia-pteridium*	secondary *Acacia-Albizia-Beckeropsiss-Cymbopogon* (sec01)	Reclassified using modelling	J1 secondary to forest
J2	moist *Acacia* savannah: *Acacia-albizia-panicum-chloris*	secondary *Acacia-Albizia-Panicum-Chloris* (sec02)	Reclassified using modelling	Secondary moist *Acacia* wooded grassland
J2/K	moist *Acacia* savannah / moist *combretum* savannah: *Acacia-albizia-panicum-chloris* / *combretum-terminalia-albizia-hyparrhenia rufa*	Moist *combretum* wooded grassland (Wcm)	Moist *combretum* wooded grassland (Wcm)	Secondary moist *Combretum* wooded grassland.
J2+Z4	moist *Acacia* savannah + post cultivation communities: *Acacia-albizia-panicum-chloris* + *eragrotis-chloris-hyparrhenia*	secondary *Acacia-Albizia-Panicum-Chloris* (sec02)	Reclassified using modelling	Secondary moist *Acacia* wooded grassland
K	moist *combretum* savannah: *combretum-terminalia-albizia-hyparrhenia*	Moist *combretum* wooded grassland (Wcm)	Moist *combretum* wooded grassland (Wcm)	Secondary moist *Combretum* wooded grassland.
K/F2	moist *combretum* savannah / forest/savannah mosaic: *combretum-terminalia-albizia-hyparrhenia rufa* / forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	K secondary to forests
K/J2	moist *combretum* savannah / moist *Acacia* savannah: *combretum-terminalia-albizia-hyparrhenia rufa* / *Acacia-albizia-panicum*-chloris	Moist *combretum* wooded grassland (Wcm)	Moist *combretum* wooded grassland (Wcm)	Secondary moist *Combretum* wooded grassland.
K/M1	moist *combretum* savannah / palm savannah: *combretum-terminalia-albizia-hyparrhenia* / *borassus-hyparrhenia rufa*	palm wooded grassland (P)	palm wooded grassland (P)	K secondary to forests or woodland. Assumption is that K is secondary to M1

Code	Original vegetation type	National PNV	Regional PNV	Note
K/M2	moist *combretum* savannah / palm savannah: *combretum-terminalia-albizia-hyparrhenia / borassus-hyparrhenia dissoluta*	palm wooded grassland (P)	palm wooded grassland (P)	K secondary to forests or woodland. Assumption is that K is secondary to M2
K+Z2	moist *combretum* savannah + post cultivation communities: *combretum-terminalia-albizia-hyparrhenia + Cymbopogon-imperata*	Moist *combretum* wooded grassland (Wcm)	Moist *combretum* wooded grassland (Wcm)	Secondary moist *Combretum* wooded grassland.
L1	*butryospermum*: *butryospermum-daniellia-hyparrhenia*	*Butyrospermum (Vitellaria)* wooded grassland (Wb)	*Butyrospermum* wooded grassland (Wb)	Secondary moist *Combretum* wooded grassland
L2	*butryospermum*: *butryospermum-hyparrhenia rufa*	*Butyrospermum (Vitellaria)* wooded grassland (Wb)	*Butyrospermum* wooded grassland (Wb)	
L2/K	*butryospermum* / moist *combretum* savannah: *butryospermum-hyparrhenia rufa / combretum-terminalia-albizia-hyparrhenia*	*Butyrospermum (Vitellaria)* wooded grassland (Wb)	*Butyrospermum* wooded grassland (Wb)	
L3	*butryospermum*: *butryospermum-hyparrhenia dissoluta*	*Butyrospermum (Vitellaria)* wooded grassland (Wb)	*Butyrospermum* wooded grassland (Wb)	
L3/G1	*butryospermum* / moist thicket: *butryospermum-hyparrhenia dissoluta* / undifferentiated semi-deciduous thicket	evergreen and semi-evergreen bushland and thicket / *Butyrospermum (Vitellaria)* wooded grassland (Be/Wb)	evergreen and semi-evergreen bushland and thicket / *Butyrospermum* wooded grassland (Be/Wb)	
L3/L2	*butryospermum*: *butryospermum-hyparrhenia dissoluta / butryospermum-hyparrhenia rufa*	*Butyrospermum (Vitellaria)* wooded grassland (Wb)	*Butyrospermum* wooded grassland (Wb)	
L3/N2	*butryospermum* / dry *combretum* savannah: *butryospermum-hyparrhenia dissoluta / combretum-hyparrhenia*	Dry *combretum* wooded grassland / *Butyrospermum (Vitellaria)* wooded grassland (Wcd/Wb)	Dry *combretum* wooded grassland / *Butyrospermum* wooded grassland (Wcd/Wb)	Used modelling to split between Wcd and Wb
L3/N5	*butryospermum* / dry *combretum* savannah: *butryospermum-hyparrhenia dissoluta / combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland / *Butyrospermum (Vitellaria)* wooded grassland (Wcd/Wb)	Dry *combretum* wooded grassland / *Butyrospermum* wooded grassland (Wcd/Wb)	Used modelling to split between Wcd and Wb
M1	palm savannah: *borassus-hyparrhenia rufa*	palm wooded grassland (P)	palm wooded grassland (P)	
M2	palm savannah: *borassus-hyparrhenia dissoluta*	palm wooded grassland (P)	palm wooded grassland (P)	
M2/M1	palm savannah: *borassus-hyparrhenia dissoluta / borassus-hyparrhenia rufa*	palm wooded grassland (P)	palm wooded grassland (P)	
M2/Q6/W4	palm savannah / grassland savannah / communities on sites with impeded drainage: *borassus-hyparrhenia dissoluta* / *themeda*-heteropogon grass savannah / *Acacia-imperata* grassland	edaphic wooded grassland / palm wooded grassland (wd/P)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils / palm wooded grassland (wd/P)	Q communities are secondary to forest, wooded grassladn and thicket, W4 is an edaphic type
M2/W2	palm savannah / communities on sites with impeded drainage: *borassus-hyparrhenia dissoluta* / *sorghastrum* grassland	edaphic grassland on drainage-impeded or seasonally flooded soils / palm wooded grassland (g/P)	edaphic grassland on drainage-impeded or seasonally flooded soils / palm wooded grassland (g/P)	
N1	dry *combretum* savannah: *combretum-terminalia-loudetia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	

Code	Original vegetation type	National PNV	Regional PNV	Note
N1/D3	dry *combretum* savannah / medium altitude moist semi-deciduous forest: *combretum-terminalia*-loudetia / *albizia*-markhamia forest	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest / Dry *combretum* wooded grassland (Fid3/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / Dry *combretum* wooded grassland (Fi/Wcd)	
N1/F2	dry *combretum* savannah / forest/savannah mosaic: *combretum-terminalia*-loudetia / forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest / Dry *combretum* wooded grassland (Fid2/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / Dry *combretum* wooded grassland (Fi/Wcd)	
N1/N2	dry *combretum* savannah: *combretum-terminalia*-loudetia / *combretum-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N1/N5	dry *combretum* savannah: *combretum-terminalia*-loudetia / *combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N1/Z4	dry *combretum* savannah / post cultivation communities: *combretum-terminalia*-loudetia / eragrotis-chloris-*hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N1+N3	dry *combretum* savannah: *combretum-terminalia*-loudetia + *combretum-Cymbopogon*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N10+N12	dry *combretum* savannah: boswellia-fagara-heeria + *Acacia*-heeria-*terminalia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N11	dry *combretum* savannah: *Acacia-combretum*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N11/W8	dry *combretum* savannah / communities on sites with impeded drainage: *Acacia-combretum* / *Acacia-setaria* savannah	Dry *combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	Dry *combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	
N11+T7	dry *combretum* savannah + bushland: *Acacia-combretum* + *Acacia-albizia-dichrostachy*s bushland	Dry *combretum* savannah (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
N12	dry *combretum* savannah: *Acacia-heeria-terminalia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N12/N6	dry *combretum* savannah: *Acacia-heeria-terminalia* / *combretum-Acacia*-lasiurus	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N12+T7	dry *combretum* savannah + bushland: *Acacia-heeria-terminalia* + *Acacia-albizia-dichrostachy*s bushland	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
N12+T7+V3	dry *combretum* savannah + bushland + dry thicket: *Acacia-heeria-terminalia* + *Acacia-albizia-dichrostachy*s bushland + *Acacia-Commiphora* thicket	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
N12+V1+T5	dry *combretum* savannah + dry thicket + bushland: *Acacia*-heeria-*terminalia* + undifferentiated deciduous thicket + *Commiphora-euphorbia-Lannea* bushland	Dry *combretum* wooded grassland / evergreen and semi-evergreen bushland and thicket (Be/Wcd)	Evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Be/Wcd)	
N13	dry *combretum* savannah: *Lannea-combretum-lonchocarpus*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N13/P2	dry *combretum* savannah / dry *Acacia* savannah: *Lannea-combretum-lonchocarpus* / *Acacia-themeda-setaria* savannah	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	

Code	Original vegetation type	National PNV	Regional PNV	Note
N13/W8	dry *combretum* savannah / communities on sites with impeded drainage: *Lannea-combretum-lonchocarpus* / *Acacia-setaria* savannah	Dry *combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	Dry *Combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	
N2	dry *combretum* savannah: *combretum-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N2/J1	dry *combretum* savannah / moist *Acacia* savannah: *combretum-hyparrhenia* / *Acacia-albizia-Beckeropsiss-Cymbopogon*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	sharing of *Acacia* polyacantha
N2/K	dry *combretum* savannah / moist *combretum* savannah: *combretum-hyparrhenia* / *combretum-terminalia-albizia-hyparrhenia*	Dry *Combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	but K maybe secondary to other types
N2/M2	dry *combretum* savannah / palm savannah: *combretum-hyparrhenia* / *borassus-hyparrhenia dissoluta*	Dry *combretum* wooded grassland / palm wooded grassland (Wcd/P)	Dry *combretum* wooded grassland / palm wooded grassland (Wcd/P)	
N2/N5	dry *combretum* savannah: *combretum-hyparrhenia* + *combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N2/V1	dry *combretum* savannah / dry thicket: *combretum-hyparrhenia* / undifferentiated deciduous thicket	Dry *combretum* wooded grassland / evergreen and semi-evergreen bushland and thicket (Be/Wcd)	Evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Be/Wcd)	
N2+V1	dry *combretum* savannah + dry thicket: *combretum-hyparrhenia* + undifferentiated deciduous thicket	Dry *combretum* wooded grassland / evergreen and semi-evergreen bushland and thicket (Be/Wcd)	Evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Be/Wcd)	
N3	dry *combretum* savannah: *combretum-Cymbopogon*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N3/D3	dry *combretum* savannah / medium altitude moist semi-deciduous forest: *combretum-Cymbopogon* / *albizia-markhamia* forest	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest / Dry *combretum* wooded grassland (Fid3/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / Dry *combretum* wooded grassland (Fi/Wcd)	
N3/F2	dry *combretum* savannah / forest/savannah mosaic: *combretum-Cymbopogon* / forest/savannah mosaic at medium altitudes	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / Dry *combretum* wooded grassland (Fid1/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / Dry *combretum* wooded grassland (Fi/Wcd)	
N3/G1/D3	dry *combretum* savannah / moist thicket / medium altitude moist semi-deciduous forest: *combretum-terminalia-loudetia* / undifferentiated semi-deciduous thicket / *albizia-markhamia* forest	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest / evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Fid3/Be/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Fi/Be/Wcd)	
N3/J1	dry *combretum* savannah / moist *Acacia* savannah: *combretum-Cymbopogon* / *Acacia-albizia-Beckeropsiss-Cymbopogon*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	sharing of *Acacia polyacantha, Acacia sieberiana*
N3/P2	dry *combretum* savannah / dry *Acacia* savannah: *combretum-Cymbopogon* / *Acacia-themeda-setaria* savannah	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N3+F2	dry *combretum* savannah + forest/savannah mosaic: forest/savannah mosaic at medium altitudes	*Albizia-Markhamia* medium altitude moist semi-deciduous Forest / Dry *combretum* wooded grassland (Fid3/Wcd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / Dry *combretum* wooded grassland (Fi/Wcd)	

Code	Original vegetation type	National PNV	Regional PNV	Note
N4	dry *combretum* savannah: *combretum*-oxytenanthera-*hyparrhenia*	lowland bamboo (L)	lowland bamboo (L)	N4 secondary to G3
N5	dry *combretum* savannah: *combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N5/J2	dry *combretum* savannah / moist *Acacia* savannah: *combretum-Acacia-hyparrhenia / Acacia-albizia-panicum*-chloris	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	J2 secondary to deciduous savannah
N5/K	dry *combretum* savannah / moist *combretum* savannah: *combretum-Acacia-hyparrhenia / combretum-terminalia-albizia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	K secondary but typically not N5
N5/L3	dry *combretum* savannah / *butryospermum*: *combretum-Acacia-hyparrhenia / butryospermum-hyparrhenia dissoluta*	Dry *combretum* wooded grassland / *Butyrospermum* (*Vitellaria)* wooded grassland (Wc/Wb)	Dry *combretum* wooded grassland / *Butyrospermum* wooded grassland (Wc/Wb)	
N5/N2	dry *combretum* savannah: *combretum-Acacia-hyparrhenia / combretum-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N5/P2	dry *combretum* savannah / dry *Acacia* savannah: *combretum-Acacia-hyparrhenia / Acacia-themeda-setaria* savannah	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N5+N11	dry *combretum* savannah: *combretum-Acacia-hyparrhenia + Acacia-combretum*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N5+N12	dry *combretum* savannah: *combretum-Acacia-hyparrhenia + Acacia-heeria-terminalia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N5+N12+T7	dry *combretum* savannah + bushland: *combretum-Acacia-hyparrhenia + Acacia-heeria-terminalia + Acacia-albizia-dichrostachys* bushland	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
N5+T7	dry *combretum* savannah + bushland: *combretum-Acacia-hyparrhenia + Acacia-albizia-dichrostachys* bushland	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
N6	dry *combretum* savannah: *combretum-Acacia-lasiurus*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N7	dry *combretum* savannah: *combretum-Acacia-heteropogon*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
N7/V1	dry *combretum* savannah / dry thicket: *combretum-Acacia-heteropogon* / undifferentiated deciduous thicket	Dry *combretum* wooded grassland / evergreen and semi-evergreen bushland and thicket (Be/Wcd)	Evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Be/Wcd)	
N8	dry *combretum* savannah: *combretum-Acacia-themeda*	Single-dominant *Juniperus procera* forest (Fbj)	Undifferentiated Afromontane forest (Fb)	N8 secondary to B3
N8/N13	dry *combretum* savannah: *combretum-Acacia-themeda / Lannea-combretum-lonchoccarpus*	Single-dominant *Juniperus procera* forest / Dry *combretum* wooded grassland (Fbj/Wcd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland (Fb/Wcd)	N8 secondary to B3
N8/P2	dry *combretum* savannah / dry *Acacia* savannah: *combretum-Acacia-themeda / Acacia-themeda-setaria* savannah	Single-dominant *Juniperus procera* forest (Fbj)	Undifferentiated Afromontane forest (Fb)	N8 secondary to B3

Code	Original vegetation type	National PNV	Regional PNV	Note
N8+N10+ N11	dry *combretum* savannah: *combretum-Acacia-themeda* + *boswellia-fagara-heeria* + *Acacia-combretum*	Single-dominant *Juniperus procera* forest / Dry *combretum* wooded grassland (Fbj/Wcd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland (Fb/Wcd)	N8 secondary to B3
N8+N11	dry *combretum* savannah: *combretum-Acacia-themeda* + *Acacia-combretum*	Single-dominant *Juniperus procera*forest / Dry *combretum* wooded grassland (Fbj/Wcd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland (Fb/Wcd)	N8 secondary to B3
N8+N12	dry *combretum* savannah: *combretum-Acacia-themeda* + *Acacia*-heeria-*terminalia*	Single-dominant *Juniperus procera* forest / Dry *combretum* wooded grassland (Fbj/Wcd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland (Fb/Wcd)	N8 secondary to B3
N8+N9	dry *combretum* savannah: *combretum-Acacia-themeda* + *combretum-Acacia-Commiphora*	Single-dominant *Juniperus procera* forest / Dry *combretum* wooded grassland (Fbj/Wcd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland (Fb/Wcd)	N8 secondary to B3
N8+N9+T3	dry *combretum* savannah + bushland: *combretum-Acacia-themeda* + *combretum-Acacia-Commiphora* + *Acacia-Commiphora* bushland	Single-dominant *Juniperus procera* forest / Dry *combretum* wooded grassland / Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Fbj/Wcd/Bdd)	Undifferentiated Afromontane forest / Dry *combretum* wooded grassland / Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Fb/Wcd/Bdd)	N8 secondary to B3
N9	dry *combretum* savannah: *combretum-Acacia-Commiphora*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	
P1	dry *Acacia* savannah: *Acacia-Cymbopogon/themeda* complex	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	
P1/F2	dry *Acacia* savannah / forest/savannah mosaic: *Acacia-Cymbopogon/themeda* complex / forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
P1/J1	dry *Acacia* savannah / moist *Acacia* savannah: *Acacia-Cymbopogon/themeda* complex / *Acacia-albizia-Beckeropsiss-Cymbopogon*	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	sharing of *Acacia* sieberiana
P1+Q3	dry *Acacia* savannah + grassland savannah: *Acacia-Cymbopogon/themeda* complex + dry *hyparrhenia* grass savannah	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Q communities are secondary to forest, wooded grassland and thicket
P1+Q4	dry *Acacia* savannah + grassland savannah: *Acacia-Cymbopogon/themeda* complex + *themeda*-chloris grass savannah	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Q communities are secondary to forest, wooded grassland and thicket
P2	dry *Acacia* savannah: *Acacia-themeda-setaria* savannah	biotic wooded grassland (We)	biotic wooded grassland (We)	Secondary?
P2/W8	dry *Acacia* savannah / communities on sites with impeded drainage: *Acacia-themeda-setaria* savannah / *Acacia-setaria* savannah	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
P2+G2	dry *Acacia* savannah + moist thicket: *Acacia-themeda-setaria* savannah + *riparian* thicket	riverine forest (r)	riverine forest (r)	landscape position of riparian thickets
P2+Z4	dry *Acacia* savannah + post cultivation communities: *Acacia-themeda-setaria* savannah + *eragrostis-chloris-hyparrhenia*	biotic wooded grassland (We)	biotic wooded grassland (We)	Secondary?
Q1	grassland savannah: moist *hyparrhenia* grass savannah	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q1/F2	grassland savannah / forest/savannah mosaic: moist *hyparrhenia* grass savannah / forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	Q communities are secondary to forest, wooded grassland and thicket.

Code	Original vegetation type	National PNV	Regional PNV	Note
Q1/N3	grassland savannah / dry *combretum* savannah: moist *hyparrhenia* grass savannah / *combretum-Cymbopogon*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	Q communities are secondary to forest, wooded grassland and thicket
Q1+F1	grassland savannah + forest/savannah mosaic: moist *hyparrhenia* grass savannah + forest/savannah mosaic at high altitudes	Afromontane rain forest (Fa)	Afromontane rain forest (Fa)	Q communities are secondary to forest, wooded grassland and thicket.
Q1+Z2	grassland savannah + post cultivation communities: moist *hyparrhenia* grass savannah + *Cymbopogon-imperata*	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q1+Z3	grassland savannah + post cultivation communities: moist *hyparrhenia* grass savannah + *hyparrhenia-*pteridium	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q2	grassland savannah: *hyparrhenia* grass savannah derived from *butryospermum* savannah	*Butyrospermum* (*Vitellaria*) wooded grassland (Wb)	*Butyrospermum* wooded grassland (Wb)	Q2 secondary to L
Q3	grassland savannah: dry *hyparrhenia* grass savannah	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q3/N13	grassland savannah / dry *combretum* savannah: dry *hyparrhenia* grass savannah / *Lannea-combretum-lonchocarpus*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	Q communities are secondary to forest, woodland and thicket
Q3/N5	grassland savannah / dry *combretum* savannah: dry *hyparrhenia* grass savannah / *combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	Q communities are secondary to forest, woodland and thicket
Q3/V1	grassland savannah / dry thicket: dry *hyparrhenia* grass savannah / undifferentiated deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Q communities are secondary to forest, woodland and thicket
Q3/W8	grassland savannah / communities on sites with impeded drainage: dry *hyparrhenia* grass savannah / *Acacia-setaria* savannah	*Acacia* wooded grassland on soils with impeded drainage (wd)	Reclassified using modelling	Secondary grass savannah
Q3+N5	grassland savannah + dry *combretum* savannah: dry *hyparrhenia* grass savannah + *combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	Q communities are secondary to forest, woodland and thicket
Q3+T3	grassland savannah + bushland: dry *hyparrhenia* grass savannah + *Acacia-Commiphora* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	T3 secondary to R1, Q3 also secondary
Q3+T6	grassland savannah + bushland: dry *hyparrhenia* grass savannah + *Lannea-Acacia-balanites* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	T types result from overgrazing
Q4	grassland savannah: *themeda*-chloris grass savannah	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q4/J1	grassland savannah / moist *Acacia* savannah: *themeda*-chloris grass savannah / *Acacia-albizia-Beckeropsiss-Cymbopogon*	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling,	Secondary moist *Acacia* wooded grassland and secondary grass savannah.
Q4+Z3	grassland savannah + post cultivation communities: *themeda*-chloris grass savannah + *hyparrhenia-pteridium*	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah

Code	Original vegetation type	National PNV	Regional PNV	Note
Q5	grassland savannah: *themeda*-loudetia grass savannah	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q5/C1	grassland savannah / medium altitude moist evergreen forest: *themeda*-loudetia grass savannah / *piptadeniastrum-uapaca* forest	Piptadeniastrum-Uapaca medium altitude moist evergreen Forest (Fic1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	Q communities are secondary to forest, woodland and thicket
Q5/D3	grassland savannah / medium altitude moist semi-deciduous forest: *themeda-loudetia* grass savannah / *albizia*-markhamia forest	*Albizia*-Markhamia medium altitude moist semi-deciduous Forest (Fid3)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	Q communities are secondary to forest, woodland and thicket
Q5/G1	grassland savannah / moist thicket: *themeda*-loudetia grass savannah / undifferentiated semi-deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Q communities are secondary to forest, woodland and thicket
Q5/J1	grassland savannah / moist *Acacia* savannah: *themeda-loudetia* grass savannah / *Acacia-albizia-Beckeropsiss-Cymbopogon*	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	These two are different secondary types (respectively secondary grass savannah and moist *Acacia* wooded grassland).
Q5/Q4	grassland savannah: *themeda*-loudetia grass savannah / *themeda*-chloris grass savannah	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q6	grassland savannah: *themeda-heteropogon* grass savannah	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q6/W4	grassland savannah / communities on sites with impeded drainage: *themeda-heteropogon* grass savannah / *Acacia-imperata* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
Q6+Z2	grassland savannah + post cultivation communities: *themeda-heteropogon* grass savannah + *Cymbopogon-imperata*	secondary grasslands and wooded grasslands (sec04)	Reclassified using modelling	Secondary grass savannah
Q7	grassland savannah: eragrostis-loudetia grass savannah	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
Q7/F2	grassland savannah / forest/savannah mosaic: *eragrostis-loudetia* grass savannah / forest/savannah mosaic at medium altitudes	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest / edaphic grassland on drainage-impeded or seasonally flooded soils (Fid1/g)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / edaphic grassland on drainage-impeded or seasonally flooded soils (Fi/g)	
Q7/W2	grassland savannah / communities on sites with impeded drainage: *eragrostis-loudetia* grass savannah / *sorghastrum* grassland	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
R1	tree and shrub steppe: *Acacia* tree and shrub steppe	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	R1 and R2 occur in much the same geographical area and environmental conditions. Floristic differences are small
R1/W8	tree and shrub steppe / communities on sites with impeded drainage: *Acacia* tree and shrub steppe / *Acacia-setaria* savannah	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	

Code	Original vegetation type	National PNV	Regional PNV	Note
R1+T1	tree and shrub steppe + bushland: *Acacia* tree and shrub steppe + *Acacia-Lannea* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T types result from overgrazing
R1+T7	tree and shrub steppe + bushland: *Acacia* tree and shrub steppe + *Acacia-albizia-dichrostachy*s bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T types result from overgrazing
R1+T8	tree and shrub steppe + bushland: *Acacia* tree and shrub steppe + *Acacia mellifera* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T types result from overgrazing
R1+T9	tree and shrub steppe + bushland: *Acacia* tree and shrub steppe + *Acacia* seyal-*Acacia nilotica-pennisetum mezianum* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T types result from overgrazing
R1+V5	tree and shrub steppe + dry thicket: *Acacia* tree and shrub steppe + *Acacia mellifera* thicket	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	V5 secondary to T1, T1 secondary
R2	tree and shrub steppe: *Lannea-Acacia* tree and shrub steppe	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	R1 and R2 occur in much the same geographical area and environmental conditions. Floristic differences are small
R2+T6	tree and shrub steppe + bushland: *Lannea-Acacia* tree and shrub steppe + *Lannea-Acacia-balanites* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T types result from overgrazing
R2+T6+T7	tree and shrub steppe + bushland: *Lannea-Acacia* tree and shrub steppe + *Lannea-Acacia-balanites* bushland + *Acacia-albizia-dichrostachy*s bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T types result from overgrazing, however other sequences
R2+T7	tree and shrub steppe + bushland: *Lannea-Acacia* tree and shrub steppe + *Acacia-albizia-dichrostachy*s bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	T types result from overgrazing
R2+V3	tree and shrub steppe + dry thicket: *Lannea-Acacia* tree and shrub steppe + *Acacia-Commiphora* thicket	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	V3 result from overgrazing
S	grass steppe: chrysopogon grass steppe	climatic grasslands (G)	climatic grasslands (G)	
S+T9	grass steppe + bushland: *chrysopogon* grass steppe + *Acacia* seyal-*Acacia nilotica-pennisetum mezianum* bushland	climatic grasslands (G)	climatic grasslands (G)	T types result from overgrazing
SuC	sugar estate: sugar estate	*Celtis-Chrysophyllum* medium altitude moist semi-deciduous Forest (Fid1)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
T1	bushland: *Acacia-Lannea* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	Secondary bushland resulting from overgrazing
T1+P1+ V5+W8	bushland + dry *Acacia* savannah + dry thicket + communities on sites with impeded drainage: *Acacia-Lannea* bushland + *Acacia-Cymbopogon/themeda* complex + *Acacia mellifera* thicket + *Acacia-setaria* savannah	evergreen and semi-evergreen bushland and thicket / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Be/wd)	evergreen and semi-evergreen bushland and thicket / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Be/wd)	overgrazing leads to T1, V5 is secondary to T1
T1+R1	bushland + tree and shrub steppe: *Acacia-Lannea* bushland + *Acacia* tree and shrub steppe	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	overgrazing leads to T1, V1 is secondary to T1

Code	Original vegetation type	National PNV	Regional PNV	Note
T1+R1+ V5	bushland + tree and shrub steppe + dry thicket: *Acacia-Lannea* bushland + *Acacia* tree and shrub steppe + *Acacia mellifera* thicket	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	overgrazing leads to T1, V1 is secondary to T1
T1+T5	bushland: *Acacia-Lannea* bushland + *Commiphora-euphorbia-Lannea* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	T1 is secondary bushland resulting from overgrazing. Using T5
T1+T6+T7	bushland: *Acacia-Lannea* bushland + *Lannea-Acacia-balanites* bushland + *Acacia-albizia-dichrostachys* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	Secondary bushland resulting from overgrazing
T1+V1	bushland / dry thicket: *Acacia-Lannea* bushland + undifferentiated deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	T types result from overgrazing, but maybe not from thicket
T1+V3	bushland + dry thicket: *Acacia-Lannea* bushland + *Acacia-Commiphora* thicket	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	Secondary bushland and thicket.
T1+V3+V4	bushland + dry thicket: *Acacia-Lannea* bushland + *Acacia-Commiphora* thicket + *Acacia nubica* thicket	*Acacia nubica* thicket (Bdn)	Reclassified using modelling	Secondary bushland and thicket.
T1+V4	bushland + dry thicket: *Acacia-Lannea* bushland + *Acacia nubica* thicket	*Acacia nubica* thicket (Bdn)	Reclassified using modelling	Secondary bushland and thicket.
T1+V5	bushland + dry thicket: *Acacia-Lannea* bushland + *Acacia mellifera* thicket	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	Secondary bushland resulting from overgrazing
T2/V1	bushland / dry thicket: *Acacia-Commiphora-Lannea* bushland / undifferentiated deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	T types result from overgrazing, but maybe not from thicket
T2+N9	bushland + dry *combretum* savannah: *Acacia-Commiphora-Lannea* bushland + *combretum-Acacia-Commiphora*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T types result from overgrazing
T3	bushland: *Acacia-Commiphora* bushland	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bdd)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	
T3+T4	bushland: *Acacia-Commiphora* bushland + *ac reficiens-Commiphora* bushland/thicket	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bdd)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	
T4	bushland: *ac reficiens-Commiphora* bushland/thicket	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bdd)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	
T4+V5	bushland + dry thicket: *ac reficiens-Commiphora* bushland/thicket + *Acacia mellifera* thicket	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bdd)	Somalia-Masai *Acacia-Commiphora* bushland and thicket (Bd)	V5 secondary
T6	bushland: *Lannea-Acacia-balanites* bushland	*Acacia* or *Lannea-Acacia* tree and shrub steppe (Bdl)	Reclassified using modelling	Secondary bushland resulting from overgrazing
T6/V1	bushland / dry thicket: *Lannea-Acacia-balanites* bushland / undifferentiated deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	T6 type however not overgrazing from thicket
T6/V1/G2	bushland / dry thicket / moist thicket: *Lannea-Acacia-balanites* bushland / undifferentiated deciduous thicket / riparian thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	

Code	Original vegetation type	National PNV	Regional PNV	Note
T6/W8	bushland / communities on sites with impeded drainage: *Lannea-Acacia-balanites* bushland / *Acacia-setaria* savannah	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
T6+N5	bushland + dry *combretum* savannah: *Lannea-Acacia-balanites* bushland + *combretum-Acacia-hyparrhenia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T6 result from overgrazing. Normally T6 would not be derived from N types. However, besides occuring in a mapping unit with N5, it also borders much larger areas with N5. We therefore assume here it is secondary to N
T6+T7	bushland: *Lannea-Acacia-balanites* bushland + *Acacia-albizia-dichrostachy*s bushland	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T6 is econdary bushland resulting from overgrazing and T7 probably secondary to dry *Combretum* savannah
T6+V1	bushland + dry thicket: *Lannea-Acacia-balanites* bushland + undifferentiated deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	T6 type however no overgrazing of thicket
T7	bushland: *Acacia-albizia-dichrostachy*s bushland	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah; however difficult type
T7/N12/W8	bushland / dry *combretum* savannah / communities on sites with impeded drainage: *Acacia-albizia-dichrostachy*s bushland / *Acacia-heeria-terminalia* / *Acacia-setaria* savannah	Dry *combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	Dry *Combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	T7 secondary to dry *Combretum* savannah
T7/W8	bushland / communities on sites with impeded drainage: *Acacia-albizia-dichrostachy*s bushland / *Acacia-setaria* savannah	Dry *combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	Dry *Combretum* wooded grassland / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Wcd/wd)	T7 secondary to dry *Combretum* savannah
T7+N12	bushland + dry *combretum* savannah: *Acacia-albizia-dichrostachy*s bushland + *Acacia*-heeria-*terminalia*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
T7+N13	bushland + dry *combretum* savannah: *Acacia-albizia-dichrostachy*s bushland + *Lannea-combretum-lonchocarpus*	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	T7 secondary to dry *Combretum* savannah
T7+V1+V3	bushland + dry thicket: *Acacia-albizia-dichrostachy*s bushland + undifferentiated deciduous thicket + *Acacia-Commiphora* thicket	Dry *combretum* wooded grassland / evergreen and semi-evergreen bushland and thicket (Be/Wcd)	Evergreen and semi-evergreen bushland and thicket / Dry *combretum* wooded grassland (Be/Wcd)	V3 secondary to T7, T7 secondary to N
T7+V3	bushland + dry thicket: *Acacia-albizia-dichrostachy*s bushland + *Acacia-Commiphora* thicket	Dry *combretum* wooded grassland (Wcd)	Dry *combretum* wooded grassland (Wcd)	V3 secondary to T7, T7 secondary to N
T7+V5	bushland + dry thicket: *Acacia-albizia-dichrostachy*s bushland + *Acacia mellifera* thicket	secondary bushland and thicket (sec05)	Reclassified using modelling	Secondary bushland and thicket
T8	bushland: *Acacia mellifera* bushland	climatic grasslands (G)	climatic grasslands (G)	T8 secondary to S1
T9	bushland: *Acacia* seyal-*Acacia nilotica-pennisetum mezianum* bushland	secondary bushland resulting from overgrazing (sec03)	Reclassified using modelling	T9 secondary bushland resulting from overgrazing

Code	Original vegetation type	National PNV	Regional PNV	Note
T9+V5	bushland + dry thicket: *Acacia* seyal-*Acacia nilotica-pennisetum mezianum* bushland + *Acacia mellifera* thicket	secondary bushland resulting from overgrazing (sec03)	Reclassified using modelling	V5 secondary to T9, which in turn is secondary bushland resulting from overgrazing
Udf	undifferentiated: undifferentiated	afroalpine vegetation (A)	afroalpine vegetation (A)	
V1	dry thicket: undifferentiated deciduous thicket	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	
V1/M1	dry thicket / palm savannah: undifferentiated deciduous thicket / *borassus-hyparrhenia rufa*	evergreen and semi-evergreen bushland and thicket / palm savannah (Be/P)	evergreen and semi-evergreen bushland and thicket / palm wooded grassland (Be/P)	
V1/W5	dry thicket / communities on sites with impeded drainage: undifferentiated deciduous thicket / *combretum-Acacia-hyparrhenia* savannah (1)	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
V1/Z4	dry thicket / post cultivation communities: undifferentiated deciduous thicket / *eragrostis-chloris-hyparrhenia*	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Cultivation – assumed to have same PNV as rest polygon
V1+T5	dry thicket + bushland: undifferentiated deciduous thicket + *Commiphora-euphorbia-Lannea* bushland	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	T5 secondary to R1
V1+Z4	dry thicket + post cultivation communities: undifferentiated deciduous thicket + *eragrostis-chloris-hyparrhenia*	evergreen and semi-evergreen bushland and thicket (Be)	Evergreen and semi-evergreen bushland and thicket (Be)	Cultivation – assumed to have same PNV as rest polygon
V2	dry thicket: *Acacia*-euphorbia thicket	secondary bushland and thicket (sec05)	Reclassified using modelling,	Secondary thicket
V3	dry thicket: *Acacia-Commiphora* thicket	secondary bushland and thicket (sec05)	Reclassified using modelling	Secondary thicket
V3+T9	dry thicket + bushland: *Acacia-Commiphora* thicket + *Acacia* seyal-*Acacia nilotica-pennisetum mezianum* bushland	secondary bushland and thicket (sec05)	Reclassified using modelling	Secondary bushland and thicket
V3+V5	dry thicket: *Acacia-Commiphora* thicket + *Acacia mellifera* thicket	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bdd)		Secondary thicket
V5	dry thicket: *Acacia mellifera* thicket	secondary bushland and thicket (sec05)		Secondary thicket
V5/W8	dry thicket / communities on sites with impeded drainage: *Acacia mellifera* thicket / *Acacia-setaria* savannah	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	Secondary thicket
W1	communities on sites with impeded drainage: *echinochloa* grassland	Grassland on soils with impeded drainage (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
W1/W2	communities on sites with impeded drainage: *echinochloa* grassland / *sorghastrum* grassland	Grassland on soils with impeded drainage (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
W1/X1	communities on sites with impeded drainage / swamp: *echinochloa* grassland / *cyperus papyrus* swamp	Grassland on soils with impeded drainage / Palm wooded grassland (g/P)	Grassland on soils with impeded drainage / Palm wooded grassland (g/P)	
W1+W2	communities on sites with impeded drainage: *echinochloa* grassland + *sorghastrum* grassland	Grassland on soils with impeded drainage (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	

Code	Original vegetation type	National PNV	Regional PNV	Note
W2	communities on sites with impeded drainage: *sorghastrum* grassland	Grassland on soils with impeded drainage (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
W2/W1	communities on sites with impeded drainage: *sorghastrum* grassland / *echinochloa* grassland	Grassland on soils with impeded drainage (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
W2/W4	communities on sites with impeded drainage: *sorghastrum* grassland / *Acacia-imperata* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W3	communities on sites with impeded drainage: *bracchiaria-hyparrhenia* grassland	Grassland on soils with impeded drainage (g)	edaphic grassland on drainage-impeded or seasonally flooded soils (g)	
W4	communities on sites with impeded drainage: *Acacia-imperata* grassland	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W4/W1	communities on sites with impeded drainage: *Acacia-imperata* grassland / *echinochloa* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W4+C2	communities on sites with impeded drainage / medium altitude moist evergreen forest: *Acacia-imperata* grassland + *piptadeniastrum-albizia*-celtis forest	*Piptadeniastrum-Albizia-Celtis* medium altitude moist evergreen Forest / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Fic2/wd)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest / evergreen and semi-evergreen bushland and thicket / edaphic wooded grassland on drainage-impeded or seasonally flooded soils (Fi/wd)	
W5	communities on sites with impeded drainage: *combretum-Acacia-hyparrhenia* savannah (1)	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W5/W1	communities on sites with impeded drainage: *combretum-Acacia-hyparrhenia* savannah (1) / *echinochloa* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W5/W2	communities on sites with impeded drainage: *combretum-Acacia-hyparrhenia* savannah (1) / *sorghastrum* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W6	communities on sites with impeded drainage: *combretum-Acacia-hyparrhenia* savannah (2)	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W6/W1	communities on sites with impeded drainage: *combretum-Acacia-hyparrhenia* savannah (2) / *echinochloa* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W7	communities on sites with impeded drainage: *Acacia-themeda* savannah	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W7/W1	communities on sites with impeded drainage: *Acacia-themeda* savannah / *echinochloa* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W8	communities on sites with impeded drainage: *Acacia-setaria* savannah	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
W8/W1	communities on sites with impeded drainage: *Acacia-setaria* savannah / *echinochloa* grassland	*Acacia* wooded grassland on soils with impeded drainage (wd)	edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)	
X1	swamp: *cyperus papyrus* swamp	freshwater swamp (X)	Fresh-water swamp (X)	
X1/W1	swamp / communities on sites with impeded drainage: *cyperus papyrus* swamp / *echinochloa* grassland	Grassland on soils with impeded drainage / Palm wooded grassland (g/P)	Grassland on soils with impeded drainage / Palm wooded grassland (g/P)	

Code	Original vegetation type	National PNV	Regional PNV	Note
X2	swamp: *miscanthidium* swamp	freshwater swamp (X)	Fresh-water swamp (X)	
X2/W1	swamp / communities on sites with impeded drainage: miscanthidium swamp / *echinochloa* grassland	Grassland on soils with impeded drainage / Palm wooded grassland (g/P)	Grassland on soils with impeded drainage / Palm wooded grassland (g/P)	
X2/X1	swamp: *miscanthidium* swamp / *cyperus papyrus* swamp	freshwater swamp (X)	Fresh-water swamp (X)	
X2/X2	communities on sites with impeded drainage: miscanthidium swamp / *miscanthidium* swamp	freshwater swamp (X)	Fresh-water swamp (X)	
Y1	swamp forest: *rauvolfia-croton* seasonal swamp forest	swamp forest (fs)	swamp forest (fs)	
Y2	swamp forest: *baikiaea-podocarpus* seasonal swamp forest	swamp forest (fs)	swamp forest (fs)	
Z1	post cultivation communities: *imperata-panicum-hyparrhenia*	Cultivated areas (anthrop)		Reclassified based on Langdale-Brown Ecological zones and nearest neighbouring vegetation types
Z1+Z2	post cultivation communities: *imperata-panicum-hyparrhenia* + *Cymbopogon-imperata*	Cultivated areas (anthrop)		Idem
Z2	post cultivation communities: *Cymbopogon-imperata*	Cultivated areas (anthrop)		Idem
Z3	post cultivation communities: *hyparrhenia*-pteridium	Cultivated areas (anthrop)		Idem
Z3+F2	post cultivation communities + forest/savannah mosaic: *hyparrhenia*-pteridium + forest/savannah mosaic at medium altitudes	*Cynometra-Celtis* medium altitude moist semi-deciduous Forest (Fid2)	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)	
Z4	post cultivation communities: *eragrostis-chloris-hyparrhenia*	Cultivated areas (anthrop)		Reclassified based on Langdale-Brown Ecological zones and nearest neighbouring vegetation types

Table 9.14: Results of the modelling of PNVs in north Uganda (see Figure 9.1). AUC based on training points and test points of the individual probability distribution models created with Maxent. The commission and omission rate and estimated kappa are based on the final classification based on the combined PNV distribution models. For codes, see Table 1.2.

Code	$AUC_{training}$	AUC_{test}	Commission (%)	Omission (%)	Estimated Kappa
Fa	0.992	0.986	26.7	26.6	0.73
Fbu	0.988	0.987	15.3	19.8	0.84
Fbj	0.983	0.979	12.9	29.0	0.87
Ff	0.995	0.995	7.6	11.3	0.92
Fh	0.998	0.997	24.2	44.3	0.76
Bd	0.989	0.988	16.0	17.7	0.84
G	0.998	0.998	2.8	28.9	0.97
S	0.992	0.991	22.2	13.3	0.77
Wb	0.952	0.949	13.1	16.6	0.85
We	0.994	0.991	42.1	33.0	0.58
Wv	0.991	0.990	55.5	43.9	0.44
B	0.997	0.996	38.6	42.9	0.61
Wcm	0.923	0.916	25.1	24.0	0.72
Wcd	0.860	0.859	24.4	23.6	0.69
Be	0.982	0.98	13.7	19.3	0.86
Bds	0.931	0.929	13.6	10.3	0.84
Bdd	0.946	0.944	22.7	29.4	0.75
Fid1	0.974	0.974	11.2	10.5	0.88
Fid2	0.986	0.983	27.4	19.3	0.72
Fid3	0.985	0.983	19.8	18.3	0.80

Table 9.15: Results of the modelling of PNVs in south Uganda (see Figure 9.1). AUC based on training points and test points of the individual probability distribution models created with Maxent. The commission and omission rate and estimated kappa are based on the final classification based on the combined PNV distribution models. For codes, see Table 1.2.

Code	$AUC_{training}$	AUC_{test}	Commission (%)	Omission (%)	Estimated Kappa
Fa	0.97	0.969	4.6	13.1	0.95
Ff	0.997	0.996	7.4	18.8	0.92
Be	0.838	0.834	7.0	11.5	0.89
Wcm	0.974	0.958	45.9	48.3	0.53
Wcd	0.896	0.901	19.3	29.0	0.77
Fid1	0.962	0.956	12.9	43.8	0.86
Fid2	0.93	0.918	20.4	48.5	0.77
Fid3	0.947	0.944	19.8	31.8	0.78
Fic1	0.996	0.996	0.0	99.8	1.00
Fic3	0.981	0.979	10.6	50.4	0.89

Results (AUC for training and test points in Tables 9.14 and 9.15 suggest that the models capture the distribution of the different individual PNVs well. The AUC for the distribution models of dry *Combretum* wooded grasslands (Wcd) in both north and south and evergreen and semi-evergreen bushland and thicket (Be) in south Uganda are somewhat lower, but values still indicate that the predictive power of the models is high.

The percentage of false positives (commission) and false negatives (omission) and the estimated Kappa are given in Table 9.14 and 9.15 *Terminalia glaucescens* woodland (Wvt) is mapped as a single PNV in a very small area, while occurring together with *Vitex-Phyllanthus-Sapium-Terminalia* woodland (Wvts) in a considerable larger area. For the modelling only single PNV mapping units where included.

Biotic *Acacia* wooded grassland occur in small but widely distributed areas. Moreover, they are, as the name implies, the result of biotic factors which are not included in the model.

Afromontane bamboo occurs in very small areas, with highly irregular boundaries, making it difficult to model.

Moist *Combretum* wooded grassland (Wcm) in south Uganda occurs in narrow zones bordering forest and evergreen bushland. See also the discussion in volume 3 about its possible secondary nature, derived from forests or evergreen bushland after fire. It furthermore can be considered an intermediate between forests and drier wooded grassland types. The reason why Wcm could be mapped more accurately in north Uganda might be because there it occurs in larger more continuous areas, which are easier to map.

9.7 Correspondence between the Zambia base map and the VECEA map

Table 9.16: Reclassification table used to reclassify the vegetation units on the Edmonds map to the regional potential natural vegetation classes used for the VECEA PNV map

ID	Original vegetation type	PNV(s)
1	*Parinari* forest	Zambezian dry evergreen forest' (Fm)
2	*Marquesia* forest	Zambezian dry evergreen forest' (Fm)
3	Lake basin chipya	Zambezian Chipya woodland (Wy)
4	*Cryptosepalum* forest	Zambezian dry evergreen forest' (Fm)
5	Kalahari sand chipya	Zambezian Chipya woodland (Wy)
6	*Baikiaea* forest and deciduous thicket	Zambezian dry deciduous forest and scrub forest (Fn)
7		
8	Closed forest - high altitude forest	Afromontane rain forest (Fa), Undifferentiated Afromontane forest (Fb), Single-dominant *Hagenia abyssinica* forest (Fd)
9	Swamp forest	Swamp forest (fs)
10	Riparian forest	Riverine forest (r)
11	miombo on plateau, escarpments and valley bottoms	Wetter miombo (Wmw), Drier miombo (Wmd)
12	Miombo woodland on hills and rocky out-crops	Miombo woodland on hills and rocky outcrops (Wmr)
13	Kalahari woodland on sands	Zambezian Kalahari woodland (Wk), wetter miombo (Wmw) and drier miombo (Wmd)
14	Mopane woodlands on clays	Mopane woodland and scrub woodland (Wo)
15	Munga woodland on heavy soils	North Zambezian undifferentiated woodland (Wn), palm wooded grassland (P)
16	Termitary vegetation and bush group	Mosaic of *termitaria* associated vegetation and dambo grasslands (T/g); Patches of kalahari woodland in matrix of grasslands on edaphic soils (Wk/g)
17	Grasslands (mountain, watershed grassland, kalahari-sand plain, dambo, floodplain, swamp and papyrus sudd	Edaphic grassland on drainage-impeded and/ or seasonally flooded soils or freshwater swamp' (g/X), Afromontane rain forest (Fa), Undifferentiated Afromontane forest (Fb), Single-dominant *Hagenia abyssinica* forest (Fd)

10. References

Bader, F. J. W. 1976.
Afrika-Kartenwerk 1:1000000 E - sheet E7. Borntraeger, Berlin.

Banda, T., Mwangulango, N., Meyer, B., Schwartz, M. W., Mbago, F., Sungula, M., & Caro, T. 2008.
The woodland vegetation of the Katavi-Rukwa ecosystem in western Tanzania. Forest Ecology and Management 255: 3382–3395.

Beesley, J. S. 1972.
Birds of the Arusha National Park, Tanzania. JE Afr. Nat. Hist. Soc 132.

Belsky, A. 1984.
Role of small browsing mammals in preventing woodland regeneration in the Serengeti National Park, Tanzania. African Journal of Ecology 22: 271-279.

Bingham, M. 2009.
Vegetation and Climate change in Eastern Africa (VECEA): The case of Zambia. A report submitted to VECEA Project. Forest and Landscape, University of Copenhagen and the World Agroforestry Centre, Copenhagen, Denmark; Nairobi, Kenya.

Birasa, E. C., Bizimana, I., Bouckaert, W., Gallez, A., Maesschalck, G., & Vercruysse, J. 1992.
Carte Pédologique du Rwanda. Echelle: 1/250.000. Réalisée dans le cadre du projet "Carte Pédologique du Rwanda (AGCD, CTB). AGCD, MINAGRI, Belgique, Kigali.

Birasa, E. C., Bizimana, I., Bouckaert, W., Gallez, A., Maesschalck, G., & Vercruysse, J. 1992.
Carte Pédologique du Rwanda. Echelle: 1/250.000. Réalisée dans le cadre du projet "Carte Pédologique du Rwanda (AGCD, CTB). AGCD, MINAGRI, Belgique, Kigali.

Bloesch, U., Troupin, G. & Derungs, N. 2009.
Les Plantes Ligneuses du Rwanda: Flore, Ecologie et Usages. Shaker Verlag;Aachen, The Netherlands

Brass, L. J. 1953.
Vegetation of Nyasaland. Report on the Vernay Nyasaland expedition of 1946. Memoires of the New York Botanical Garden 8: 161-190.

Breitenbach, F. von (1963).
The Indigenous Trees of Ethiopia. 2nd revised and enlarged edition. Ethiopian Forestry Association, Addis Abeba

Burrows, J. E. & Willis, C. K. 2005.
Plants of the Nyika Plateau: An account of the vegetation of the Nyika National Parks of Malawi and Zambia. South African National Biodiversity Network (SABONET).

CGIAR-CSI. 2008.
CGIAR-CSI SRTM 90m DEM Digital Elevation Database, version 4. CGIAR Consortium for Spatial Information (CGIAR-CSI). URL: http://srtm.csi.cgiar.org/Index.asp.

Chaffey, D. R. 1978a.
Southwest Ethiopia forest inventory project. An inventory of Magada forest. Project report 28. p. 52. Project report, Ministry of Overseas De-

velopment. Land Resources Development Centre.

Chaffey, D. R. 1978b.

Southwest Ethiopia forest inventory project. An inventory of forest at Munessa and Shashemane. Project report 29. p. 97. Project report, Ministry of Overseas Development. Land Resources Development Centre.

Chaffey, D. R. 1978c.

Southwest Ethiopia forest inventory project. An inventory of Tiro Forest. Project report 30. p. 60. Project report, Ministry of Overseas Development. Land Resources Development Centre.

Chaffey, D. R. 1978d.

Southwest Ethiopia forest inventory project. A reconnaissance inventory of forest in southwest Ethiopia. Project report 31. p. 316. Project report, Ministry of Overseas Development. Land Resources Development Centre.

Chapman, J. D. & White, F. 1970.

The evergreen forests of Malawi. Commonwealth Forestry Institute, Oxford.

Colonial Office, 1952.

Report on the Central African Rail Link Development Survey. Vol. 1. United Kingdom Colonial Office. London, UK. Maps 8, 12 and 13 are from southern Tanzania.

de Wit, M. & Stankiewicz, J. 2006.

Changes in Surface Water Supply Across Africa with Predicted Climate Change. *Science* 311: 1917-1921.

Delsol, J.P. 1995.

A vegetation map of Kenya. Including "Notice of the vegetation map of Kenya. Institut de la Carte Internationale de la Vegetation. Tolouse, France.

Dowsett-Lemaire, F. 1985.

The Forest Vegetation of the Nyika Plateau (Malawi-Zambia): Ecological and Phenological Studies. *Bulletin du Jardin botanique national de Belgique / Bulletin van de National Plantentuin van België* 55: 301-392.

Dowsett-Lemaire, F. 1988.

The Forest Vegetation of Mt Mulanje (Malawi): A Floristic and Chorological Study along an Altitudinal Gradient (650-1950 m). *Bulletin du Jardin botanique national de Belgique / Bulletin van de National Plantentuin van België* 58: 77-107.

Dowsett-Lemaire, F. 1989.

The Flora and Phytogeography of the Evergreen Forests of Malawi I: Afromontane and Mid-Altitude Forests. *Bulletin du Jardin botanique national de Belgique / Bulletin van de National Plantentuin van België* 59: 3-131.

Dowsett-Lemaire, F. 1990.

The Flora and Phytogeography of the Evergreen Forests of Malawi. II: Lowland Forests. *Bulletin du Jardin botanique national de Belgique / Bulletin van de National Plantentuin van België* 60: 9-71.

Dublin, H. T. 1991.

Dynamics of the Serengeti-Mara woodlands: an historical perspective. *Forest & Conservation History* 35: 169.

Dublin, H. T. 1995.

Vegetation dynamics in the Serengeti-Mara ecosystem: the role of elephants, fire and other factors. *Serengeti II: dynamics, management, and conser-*

vation of an ecosystem: 71–90.

Dublin, H. T., Sinclair, A. R. E., & McGlade, J. 1990.

Elephants and fire as causes of multiple stable states in the Serengeti-Mara woodlands. *The Journal of Animal Ecology* 59: 1147–1164.

Edmonds, A. C. R. 1976.

Vegetation map. The republic of Zambia. 9 Sheets. Government of the republic of Zambia, Lusaka, Zambia.

ESA & UClouvain. 2010.

GlobCover 2009 (version 2.3). ESA 2010 and UCLouvain. URL: http://ionia1.esrin.esa.int/.

Evans, J. & Turnbull, J. W. 2004.

Plantation forestry in the tropics: the role, silviculture, and use of planted forests for industrial, social, environmental, and agroforestry purposes. Oxford University Press, USA.

Fanshawe, D. B. 1971.

The vegetation of Zambia. Government Printer, Lusaka

Fanshawe, D.B. 2010.

Vegetation descriptions of the upper Zambezi districts of Zambia. Edited and reissued by J.R. Timberlake & M.G. Bingham. December 2010. Originally issuedas forest research pamphlets by the Zambia Forest Research Department, Zambia. Occasional Publications in Biodiversity No. 22. Biodiversity Foundation for Africa, P.O. Box FM 730 Famona, Bulawayo, Zimbabwe.

FAO, IIASA, ISRIC, ISSCAS, & JRC. 2009.

The harmonized world soil database (HWSD), version 1.10. raster/database, Food and Agriculture Organization of the United Nations (FAO) and the Land Use Change and Agriculture Program of IIASA (LUC), Rome, Italy and Laxenburg, Austria. URL: http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/.

Friis, I. & Sebsebe Demissew (2001).

Vegetation maps of Ethiopia and Eritrea. A review of existing maps and the need for a new map for the Flora of Ethiopia and the need for a new map for the Flora of Ethiopia and Eritrea. In: I. Friis & O. Ryding (eds). Biodiversity Research in the Horn of Africa Region, Proceedings of the 3rd International Symposium on the Flora of Ethiopia and Eritrea. Biol. Skrifter 54: 399-439. Edmonds, A.C.R. 1976. The vegetation of Zambia compiled by A.C.R. Edmonds, Forest Department, Government of Zambia, 1976

Friis, I. & Sebsebe Demissew. 2001.

Vegetation maps of Ethiopia and Eritrea. A review of existing maps and the need for a new map for the Flora of Ethiopia and Eritrea. Biodiversity research in the Horn of Africa region. 3rd International Symposium on the flora of Ethiopia and Eritrea. Biol. Skrifter 54: 399-439.

Friis, I. 1992.

Forests and forest trees of northeast tropical Africa – their natural habitats and distribution patterns in Ethiopia, Djibouti and Somalia. *Kew Bull. Additional Series* 15: 1-396.

Friis, I., Demissew, S., & Van Breugel, P. 2010.

Atlas of the potential Vegetation of Ethiopia. *Biologiske Skrifter (Biol.Skr. Dan.Vid.Selsk.)* 58: 307.

Gillman, C. 1949.
A Vegetation-Types Map of Tanganyika Territory. *Geographical Review* 39: 7-37.
GRASS Development Team. 2010.
Geographic Resources Analysis Support System (GRASS GIS) Software. Open Source Geospatial Foundation, USA. URL: http://grass.osgeo.org.
Grimshaw, J. M. 1996. Aspects of the ecology and biogeography of the forest of the northern slope of Mt. Kilimanjaro, Tanzania. Ph.D., University of Oxford, Oxford.
Grimshaw, J. M. 1999.
The afromontane bamboo, Yushania alpina, on Kilimanjaro. *Journal of East African Natural History* 88: 79-83.
Hamilton, A. C. & Perrott, R. A. 1981.
A Study of Altitudinal Zonation in the Montane Forest Belt of Mt. Elgon, Kenya/Uganda. *Vegetatio* 45: 107-125.
Hedberg, O. 1951.
Vegetation belts of the east African mountains. *Scensk Botanisk Tidskrift* 45: 1940-2003.
Hemp, A. 2005.
Continuum or zonation? Altitudinal gradients in the forest vegetation of Mt. Kilimanjaro. *Plant Ecology* 184: 27-42.
Hemp, A. 2006.
Vegetation of Kilimanjaro: hidden endemics and missing bamboo. *African Journal of Ecology* 44: 305–328.
Herlocker, D. 1994.
Chapter III. Vegetation. In Herlocker, D., Shaabani, S.B., Buigott, K.S.A. 1994. Range management handbook of Kenya, Vol. I, 1. Introduction to rangeland development in Kenya. GTZ/Division of Resource Surveys and Remote Sensing, Nairobi. Government of Kenya.
Herlocker, D. J., Shaabani, S., & Wilkes, S. 1993.
Range Management Handbook of Kenya. Vol. II, 5: Isiolo district. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Herlocker, D. J., Shaabani, S., &Wilkes, S. 1994a.
Range Management Handbook of Kenya. Vol. II, 8: West Pokot District. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Herlocker, D. J., Shaabani, S., & Wilkes, S. 1994b.
Range Management Handbook of Kenya. Vol. II, 9: Turkana District. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Herlocker, D. J., Shaabani, S., & Wilkes, S. 1994c.
Range Management Handbook of Kenya. Vol. II, 6: Baringo district. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Herlocker, D. J., Shaabani, S., Stephens, A., & Mutuli, M. 1994.
Range Management Handbook of Kenya. Vol. II, 7: Elgeyo Marakwet district. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Hijmans, R. J., Cameron, S. E., Parra, J. L., Jones, P. G., & Jarvis, A. 2005.

Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology* 25: 1965-1978.

Jackson, G. 1954.

Preliminary ecological survey of Nyasaland. Abstracts of the proceedings of the 2nd Inter-African Soils Conference. Leopoldville, 9-14 August 1954. Document 50, Section II A B. Commission for Technical Cooperation in Africa South of the Sahara.

Kalema, J., Namaganda, M., & Mulumba, J. W. 2009.

Vegetation and Climate change in Eastern Africa (VECEA): The case of Uganda. A report submitted to VECEA Project. p. 15. Forest and Landscape, University of Copenhagen and the World Agroforestry Centre, Copenhagen, Denmark; Nairobi, Kenya.

Kayijamahe, E. (n.d.)

Vegetation of Volcanoes National Park. CGIS-NUR (Center for Geographic Information System and Remote Sensing - National University of Rwanda

Kindt, R., Lillesø, J. P. B., van Breugel, P., & Nyabenge, M. 2005.

Potential natural vegetation of south-western Kenya for selection of indigenous tree species. Sheets 1-4. World Agroforestry Centre (ICRAF), Nairobi, Nairobi, Kenya.

Kindt, R., van Breugel, P., & Lillesø, J.-P. B. 2007.

Use of vegetation maps to infer on the ecological suitability of species using central and western Kenya as an example. Part I: Description of potential natural vegetation types for central and western Kenya. University of Copenhagen, Copenhagen.

Kindt, R., Lillesø, J.P.B., van Breugel, P., Bingham, M., Demissew, S., Dudley, C. Friis, I., Gachathi, F., Kalema, J., Mbago, F., Moshi, H.N., Mulumba, J.W., Namaganda, M., Ndangalasi, H.J., Ruffo, C.K., Védaste, M., Jamnadass, R.H., and Graudal, L. (submitted).

Correspondence in forest species composition between the Vegetation Map of Africa and higher resolution maps for seven African countries

Kuchler, A.W. & Zonneveld, I.S. 1988.

Vegetation mapping: Handbook of vegetation science. 10. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Kuchler, A.W. 1967.

Vegetation mapping. The Ronald Press Co. New York, United States of America.

Langdale-Brown, I., Omaston, H.A., and Wilson, J.G. 1964.

The vegetation of Uganda and its bearing on land-use. Entebbe, Government Printer, Uganda

Langdale-Brown, I., Osmaston, H. A., & Wilson, J. G. 1964.

The vegetation of Uganda and its bearing on land-use. pp. 157 + maps (scale 1:500,000): vegetation (4 sheets), current land use, range resources, ecological zones, rainfall. Government of Uganda, Kampala.

Lehner, B. & Döll, P. 2004.

Development and validation of a global database of lakes, reservoirs and wetlands. *Journal of Hydrology* 296: 1-22.

Lovett, J. 1985.

An overview of the moist forests of Tanzania. Final report of the Tanzania Forest habitat evaluation project. World Wildlife Fund.

Lovett, J. C. 1990.

Classification and status of the moist forests of Tanzania. *Proceedings of the Twelfth Plenary Meeting of AETFAT, Hamburg, September 4-10, 1988*. pp. 287–300. Institut fur Allgemeine Botanik, Hamburg.

Lovett, J. C. 1990.

Classification and status of the moist forests of Tanzania. Proceedings of the Twelfth Plenary Meeting of AETFAT, Hamburg, September 4-10, 1988. pp. 287–300. Institut fur Allgemeine Botanik, Hamburg

Lovett, J. C. 1993.

Temperate and tropical floras in the mountains of eastern Tanzania. *Opera Botanica* 121: 217–227.

Lovett, J. C., Hansen, J. R., & Horlyck, V. 2000.

Comparison with Eastern Arc Forests. *In*: N. Burgess & G. P. Clarke (eds.) *Coastal forests of Eastern Africa* pp. 115-125. World Conservation Union.

LP DAAC. 2009.

Land Cover Type Yearly L3 Global 500 m SIN Grid (MCD12Q1). Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center (lpdaac.usgs.gov), Sioux Falls. URL: https://lpdaac.usgs.gov/lpdaac/products/modis_products_table/land_cover/yearly_l3_global_500_m/mcd12q1.

Mashalla,, S. K. 1978.

Vegetation as a source of fuel in Tanzania: the case of Msua thicket, Coast Region. University of Dar es Salaam, Dar es Salaam, Tanzania. Meadows, M. E. & Linder, H. P. 1993. A Palaeoecological Perspective on the Origin of Afromontane Grasslands. *Journal of Biogeography* 20: 345-355.

Meadows, M. E. 1984.

Late Quaternary vegetation history of the Nyika Plateau, Malawi. *Journal of Biogeography*: 209-222.

Moomaw, J. C. 1960.

Plant ecology of the coast region of Kenya colony British East Africa. Kenya Department of Agricultur and East African Agriculture and Forestry Research and United States Educational Commission in the United Kingdom, Nairobi.

Olson, D. M. & Dinerstein, E. 2002.

The Global 200: Priority ecoregions for global conservation. *Annals of the Missouri Botanical Garden* 89: 199-224.

Olson, D. M., Dinerstein, E., D, W. E., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., & Kassem, K. R. 2001.

Terrestrial Ecoregions of the World: A New Map of Life on Earth. *BioScience* 51: 933-938.

Phillips, S. J. & Dudik, M. 2008.

Modeling of species distributions with Maxent: new extensions and a comprehensive evaluation. *Ecography* 31: 161–175.

Phillips, S. J., Anderson, R. P., & Schapire, R. E. 2006.

Maximum entropy modeling of species geographic distributions. *Ecological Modelling* 190: 231-259.

Phillips, S. J., Dudik, M., & Schapire, R. E. 2004.
A maximum entropy approach to species distribution modeling. *Proceedings of the twenty-first international conference on Machine learning* pp. 655-662. Banff, Canada.
Phillips, S., Dudik, M., & Schapire, R. 2010.
Maxent software for species habitat modeling. AT&T Labs-Research, Princeton University, and the Center for Biodiversity and Conservation, American Museum of Natural History. URL: http://www.cs.princeton.edu/~schapire/maxent/.
Pichi-Sermolli, R. E. G. 1957.
Una carta geobotanica dell'Africa Orientale (Eritrea, Ethiopia, Somalia). *Webbia* 13: 15-132 + map.
Pratt, D.J. & Gwynne, M.D. 1977.
Rangeland management and ecology in East Africa. Hodder and Staughton. London, United Kingdom.
Prioul, C. 1981.
Planche XI: Végétation. *In*: C. Prioul & P. Sirven (eds.) *Atlas du Rwanda* p. Ministère de la coopération de la République Francaise pour le compte de l'Université de Kigali-Rwanda, Kigali.
Rattray, J. M. & Wild, H. 1961.
Vegetation map of the Federation of Rhodesia and Nyasaland. *Kirkia* 2: 94-104.
Schwartz, H. J., Shaabani, S., & Walther, D. 1991.
Range Management Handbook of Kenya. Vol. II, 1: Marsabit District. (+ 20 maps). Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Shaxson, T. F. 1976.
A map of the distribution of major biotic communities in Malawi. *Society of Malawi Journal* 30: 36-48 + map.
Shaabani, S., Welsh, M., Herlocker, D. J., & Walther, D. 1992a.
Range Management Handbook of Kenya. Vol. II, 2: Samburu District. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Shaabani, S., Welsh, M., Herlocker, D. J., & Walther, D. 1992b.
Range Management Handbook of Kenya. Vol. II, 3: Wajir District. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Shaabani, S., Welsh, M., Herlocker, D. J., & Walther, D. 1992c.
Range Management Handbook of Kenya. Vol. II, 4: Mandera district. Republic of Kenya, Minstry of Livestock Development (MOLD), Range Management Division, Nairobi, Kenya.
Sinclair, A. R. E., Mduma, S. A. ., Hopcraft, J. G. ., Fryxell, J. M., Hilborn, R., & Thirgood, S. 2007.
Long-Term Ecosystem Dynamics in the Serengeti: Lessons for Conservation. *Conservation Biology* 21: 580–590.
Smith, P. (ed.). 2001.
Ecological Survey of Zambia. The traverse records of Zambia. Including Trapnell, C.G. Vegetation-soil map of Northern Rhodesia Sheets I & II, reprinted by Ordnance survey 1999. Compiled by C. G. Trapnell from field surveys carried out by C. G. Trapnell, J. D. Martin, W. Allen,

and other members of the Department of Agriculture and the Forestry Branch, Northern Rhodesia.

Stobbs, A. R. 1971.

Malawi, natural regions and areas. Sheet 3, southern Malawi. Environmental conditions and agriculture. Paper map, Malawi Government.
Tanzania National Parks. 2008. The official site of the Tanzania National Parks - Proposed Kitulo National Park. URL: http://www.tanzaniaparks.com/kitulo.html.

Taylor, M., Ravilious, C., & Green, E. P. 2003.

Mangroves of East Africa V4.0. UNEP World Conservation Monitoring Centre (UNEP-WCMC). URL: http://data.unep-wcmc.org/datasets/7.

Taylor, M., Ravilious, C., & Green, E. P. 2003.

Mangroves of East Africa V4.0. UNEP World Conservation Monitoring Centre (UNEP-WCMC). URL: http://data.unep-wcmc.org/datasets/7.

Timberlake, J. & Chidumayo, E. (2001, revised 2011).

Miombo Ecoregion vision report. Report for WWF-SARPO. Occasional Publications in Biodiversity No. 20. Biodiversity Foundation for Africa, Bulawayo, Zimbabwe. 79 pp.

Trapnell, C. G. & Clothier, J.N. 1937.

The soils, vegetation, and agricultural systems of North-Western Rhodesia. Report of the ecological survey. Government Printer, Lusaka. Northern Rhodesia (now Zambia).

Trapnell, C. G. & Langdale-Brown, I. 1972.

Natural vegetation. East Africa. *In*: W. T. W. Morgan (ed.) *East Africa: Its Peoples and Resources* pp. 128-139, 2nd ed. Oxford University Press, Nairobi, London, New York.

Trapnell, C. G. 1953.

The soils, vegetation, and agriculture of North-Eastern Rhodesia. Report of the ecological survey. Government Printer, Lusaka. Northern Rhodesia (now Zambia).

Trapnell, C. G. 2001a.

Ecological survey of Zambia. The traverse records of C.G. Trapnell 1932-43. Volume 1. Royal Botanic Gardens Kew, Kew.

Trapnell, C. G. 2001b.

Ecological survey of Zambia. The traverse records of C.G. Trapnell 1932-43. Volume 2. Royal Botanic Gardens Kew, Kew.

Trapnell, C. G. 2001c.

Ecological survey of Zambia. The traverse records of C.G. Trapnell 1932-43. Volume 3. Royal Botanic Gardens Kew, Kew.

Trapnell, C. G., Birch, W. R., & Brunt, M. A. 1966.

Kenya 1:250,000 Vegetation Sheet 1. Results of a vegetation – land use survey of south-western Kenya. British Government's Ministry of Overseas Development (Directorate of Overseas Surveys) under the Special Commonwealth African Assistance Plan.

Trapnell, C. G., Birch, W. R., Brunt, M. A., & Lawton, R. M. 1976.

Kenya 1:250,000 Vegetation Sheet 2. Results of a vegetation – land use survey of south-western Kenya. British Government's Ministry of Overseas Development (Directorate of Overseas Surveys) under the Special Commonwealth African Assistance Plan.

Trapnell, C. G., Brunt, M. A., & Birch, W. R. 1986.

Kenya 1:250,000 Vegetation Sheet 4. Results of a vegetation – land use survey of south-western Kenya. British Government's Overseas Surveys Directorate, Ordnance Survey under the UK Government's Technical Co-operation Programme.

Trapnell, C. G., Brunt, M. A., & Land Resources Development Centre. 1987.

Vegetation and climate maps of south western Kenya. Land Resources Development Centre, Overseas Development Administration, Surbiton, Surrey.

Trapnell, C. G., Brunt, M. A., Birch, W. R., & Trump, E. C. 1969.

Kenya 1:250,000 Vegetation Sheet 3. Results of a vegetation – land use survey of south-western Kenya. British Government's Ministry of Overseas Development (Directorate of Overseas Surveys) under the Special Commonwealth African Assistance Plan.

Trapnell, C.G. 1997.

Biodiversity and conservation of the indigenous forests of the Kenya Highlands. Sansom & Company, Bristol, United Kingdom.

Troupin, G. 1976.

Cartes de la végétation du Rwanda. *Boissiera* 24: 647.

Troupin, G. 1981.

La vegetation. Planche XI. In Prioul, C. & Sirven, P. Atlas du Rwanda. 1981. Association pour l'Atlas des Pays de Loire, Kigali, Rwanda.

Trump, E. C. 1972.

Vegetation and Land Use Survey of Narok District. Working Paper no. 10. p. 23 + map. Food and Agricultural Organization of the United Nations (FAO), Nairobi, Kenya. URL: http://library.wur.nl/isric/index2.html?url=http://library.wur.nl/WebQuery/isric/2738.

van Breugel, P., Kindt, R., Lillesø, J.-P. B., Bingham, M., Demissew, S., Dudley, C., Friis, I., Gachathi, F., Kalema, J., Mbago, F. M., Moshi, H. N., Namaganda, M., Ruffo, C. K., Védaste, M., Jamnadass, R., & Graudal, L. 2011.

Potential natural vegetation map of eastern africa: interactive vegetation map for ethiopia, kenya, malawi, rwanda, tanzania, uganda and zambia. Forest and Landscape; World Agroforestry Centre, Copenhagen, Denmark; Nairobi, Kenya. URL: http://www.sl.life.ku.dk/English/outreach_publications/computerbased_tools/vegetation_climate_change_eastern_africa.aspx.

Vegetation map of the Virunga Volcano National Park [REF]

Vincens, A. 1991.

Late quaternary vegetation history of the South-Tanganyika basin. Climatic implications in South Central Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology* 86: 207-226.

White, F. 1983.

The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa by F White. Natural Resources Research Report XX. U. N. Educational, Scientific and Cultural Organization, Paris. URL: http://www.grid.unep.ch/data/download/gnv031.zip.

White, F., Dowsett-Lemaire, F., & Chapman, J. D. 2001.

Evergreen forest flora of Malawi. Royal Botanic Gardens.

Wiens, J. A. 1989.

Spatial Scaling in Ecology. *Functional Ecology* 3: 385-397.

Wild, H. & Barbosa, L. A. G. 1967.
Vegetation map of the flora Zambesiaca area. Collins Ltd. Salisbury, Rhodesia.

Willis, C. K., Burrows, J. E., Fish, L., Phiri, P. S. M., Chikuni, A. C., & Golding, J. 2001.
Developing a Greater Understanding of the Flora of the Nyika. *Systematics and Geography of Plants* 71: 993-1008.

Worldclim. 2011.
WorldClim - Global climate data, Version 1.4 (release 3). http://worldclim.org/. URL: http://www.worldclim.org/futdown.htm.

WWF-SARPO. 2001.
Miombo ecoregion: Zambezian Miombo/Mopane woodlands vegetationmap. WWF SARPO, Harare.

Young, A. 1965a.
Malawi, natural regions and areas. Sheet 1, Northern Malawi. Environmental conditions and agriculture. Paper map, Malawi Government. Accompanies the memoir Young, A. & Brown, P. 1962. The physical environment of northern Nyasaland with special reference to soils and agriculture. Government Printer, Zomba, Nyasaland.

Young, A. 1965b.
Malawi, natural regions and areas. Sheet 2, central Malawi. Environmental conditions and agriculture. Paper map, Malawi Government. Accompanies the memoir Brown, P. & Young, A. 1965. The physical environment of central Malawi with special reference to soils and agriculture. Government Printer, Zomba, Nyasaland.

Zomer, R. J., Trabucco, A., Bossio, D. A., & Verchot, L. V. 2008.
Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. *Agriculture, Ecosystems & Environment* 126: 67–80.