

Okavango Basin - Vegetation

The vegetation of the Okavango basin is shaped by a strong environmental gradient. From the northwest to the southeast mean annual precipitation diminishes strongly and elevation drops from 1,850 m a.s.l. to just 940 m a.s.l. in the Delta. In the highlands of the Bié Plateau in central Angola the topographic positions and geologic substrate have a strong impact on vegetation patterns. However, the landscape in the middle reaches of the basin is rather flat and dominated by Kalahari sands; species composition here is mostly determined by nutrient availability or soil water regime. In the Delta area topographic microfeatures again become paramount as slight differences in altitude and relief position govern sedimentation and erosion processes, flooding frequencies, and flood duration. Furthermore, remnants of the former longitudinal dune system still shape the distribution of current vegetation in the sandy hinterland surrounding the Delta.

Large areas of the Okavango basin are remote and still hardly accessible. This holds true especially for the Angolan part of the basin. Therefore, remote sensing data are indispensable in generating a comprehensive overview of the vegetation cover. In the following we discuss the vegetation units resulting from the classification of multitemporal MODIS data (Stellmes et al. 2013). Groundtruthing is based on standardized vegetation plots (see Electronic Appendix) and quick vegetation assessments along the main access routes.

Miombo forests and woodlands

Miombo forests and woodlands are the dominant vegetation in the upper reaches of the basin. They form part of the tropical dry forest ecosystem stretching over large parts of south-central Africa where precipitation is seasonal and moderate ranging from 710 mm to 1,365 mm per year. The canopy of Miombo ecosystems is characterized by the dominance of Caesalpinoid tree species from the genera *Brachystegia*, *Cryptosepalum*, *Julbernardia* or *Isoberlinia*, and meso- and microphyllous, compound leaves (Campbell 1996).

Miombo forests with *Cryptosepalum exfoliatum* ssp. *pseudotaxus*: The

evergreen tree species *Cryptosepalum exfoliatum* ssp. *pseudotaxus* with its microphyllous, compound leaves dominates extensive areas mostly on poor ferralitic soils. It has been cited to be intolerant of fire (Timberlake & Chidumayo 2011) and hence is often associated with sparse undergrowth but thick moss layers and lianas. The evergreen canopy creates rather moderate and humid microclimatic habitat conditions and thus facilitates the occurrence of species related to central African forests (Fig. 1, 2 and 3).

Miombo forests dominated by deciduous tree species: This type of Miombo is composed of tree species losing

their leaves for a period of some months during the dry season. The dominance of the canopy species depends on local abiotic conditions and changes from *Brachystegia spiciformis* to *Julbernardia paniculata* together with various other woody species (Fig. 4).

Miombo forests dominated by *Julbernardia paniculata*: This vegetation unit covers the drier, southernmost belt of the Angolan Miombo woodlands and represents the southern limit of Miombo *sensu stricto*. Altitudes in this vegetation zone are considerably lower and hence these areas receive less precipitation. Woodlands are dominated by *Julbernardia*



Fig. 1: Miombo forest with *Cryptosepalum exfoliatum* ssp. *pseudotaxus* with dense moss layer on the ground and stems covered by lichens at the core site of Cusseque (photo: R. Revermann).

paniculata and *Brachystegia bakeriana* is strongly represented in the sub canopy. Tall shrubs of *Diospyros batocana* and *Copaifera baumiana*, amongst others, form the understorey (Fig. 5).

Woodlands on Kalahari sand

The drier woodlands south of the Miombo belt are classified by Olson et al. (2001) as the Zambezian *Baikiaea* Woodlands ecoregion. Vegetation structure changes profoundly, from a rather closed canopy in Miombo to a more savannah like structure with large crowns of individual trees and huge gaps in between. Consequently, a shrub and grass layer with a dense ground cover establishes. Although *Baikiaea plurijuga* is the eponymous species, these

woodlands are composed of a multitude of tree species such as *Burkea africana*, *Pterocarpus angolensis*, *Erythrophleum africanum*, *Schinziophyton rautanenii*, and *Guibourtia coleosperma* (Fig. 6).

***Baikiaea-Burkea* woodlands (dense):** Within the Okavango Basin this vegetation unit has a very restricted spatial extent. In the communal area of Savate it is set apart from the surrounding open woodlands by a thicket-like understorey characterized by shrubs and small trees of *Croton gratissimus*, *Combretum celastroides* and *C. engleri*, while *Baikiaea plurijuga* represents the only emergent canopy tree species.

***Baikiaea-Burkea* woodlands (medium dense):** This is the typical woodland of the middle reaches and of the Caiundo and

Mashare region, often known as “Kavango woodlands”. *Pterocarpus angolensis*, a valuable timber species, frequently occurs here as well as *Schinziophyton rautanenii*, the Manketti tree, which is valued for its oil rich fruits (Fig. 7).

***Baikiaea-Burkea* woodlands (open):** Whilst similar in species composition to the above mentioned unit, these woodlands are dominated by fire tolerant species or species adapted to browsing by livestock such as *Gymnosporia senegalensis*, *Diplorhynchus condylocarpon*, and *Strychnos cocculoides*. The canopy is far less closed and hence ground cover by shrubs and grasses increases.

Mixed *Burkea* woodlands (with *Terminalia sericea*): Mixed Kavango woodland, usually resulting from land use or limiting environmental conditions. On sandy soils *Terminalia sericea* stands form extensive shrublands tolerating droughts and temporary waterlogging (Fig. 8).



Fig. 2: Dense Miombo forest north-east of the core site of Cusseque (photo: M. Finckh).



Fig. 3: *Warneckea sapinii*, a typical species of intact Miombo forests in the Angolan Highlands (photo: M. Finckh).

Other woodlands

Mixed woodlands (including *Colophospermum mopane*): To the east of the Panhandle and the Delta, the *Baikiaea* woodlands give way to another vegetation unit, the *Colophospermum mopane* woodlands, which are often associated with comparatively clay rich soils (Fig. 9).

Open and degraded woodlands (on sandy soils): This unit contains unspecified woodlands that have a low coverage due to constraining environmental conditions or degradation by human overexploitation. The central highland in the provinces of Bié and Huambo provide many examples where anthropogenic activities have been intense since early colonial times and lead to degraded woodland remnants.

Thornbush savannah dominated by *Acacia* spp.

West of the Delta and to the south of the Kavango Region in Namibia a profound change occurs as the climate becomes more arid and a thornbush savannah develops. Depending on local soil conditions and land use, species composition and vegetation structure change from thornbush savannah with seasonally dense grass layer, to a medium dense thornbush savannah and to a sparse thornbush savannah not further specified

here. The class **sparse shrubland or urban and cultivated areas** subsumes areas depicting a high fraction of bare soil (Fig. 10).

Shrub grasslands

Burkea-Baphia shrublands: Open savannah-like stands of *Burkea africana* with *Baphia massaiensis*, *Combretum* species and further small tree species occur especially on dry Kalahari sands in northern Cuando Cubango.

Open shrublands on sandy soils: This unit comprises various types of shrublands of the study area, including in pans.

***Parinari capensis* grasslands (on humid sands):** These grasslands are intermingled with various dwarf shrubs, most prominently *Parinari capensis* and *Syzygium guineense* ssp. *huillense*. They occur on sandy plains in the larger valleys of southern Bié and northern Cuando Cubango featuring deep, sandy, leached soils exhibiting hydromorphic features in the lower soil horizons. Similar grasslands cover large surfaces in Moxico (e.g. the Cameia National Park) and Zambia (e.g. Liuwa Plains National Park) west of the Zambezi river (Fig. 11 and 12).

***Cryptosepalum maraviense* grasslands:** Locally, this vegetation unit is referred to as “Anhares de Ongote” or

“Cassamba”. It covers the mid- and footslopes of the tributaries of the upper catchment in the Miombo region especially on ferralitic soils. The drastic change of its appearance throughout the season is striking. In the late rainy season these areas resemble grasslands dominated by tall grasses. However, after the fires of the dry season, dwarf shrubs resprout and dominate the landscape for several months (Fig. 13).

Forest grassland ecotone (with *Cryptosepalum maraviense*): This unit comprises various types of ecotones between the Miombo woodlands and open grasslands in the upper basin, frequently located on the midslopes. Tree species include *Monotes glaber*, *Uapaca kirkiana*, *U. nitida* and *Terminalia brachystemma*. The soil is normally covered by *C. maraviense* (Fig. 14).



Fig. 4: Miombo forest dominated by deciduous tree species in the Municipality of Mumbué (photo: M. Finckh).



Fig. 5: Miombo forest dominated by *Julbernardia paniculata* south of Longa (photo: R. Revermann).

Wetlands

Seasonally flooded grasslands and reedbeds: This unit subsumes the various wetland types along permanently flowing water courses, ranging from seasonally flooded grasslands to permanently flooded *Cyperus papyrus* and *Phragmites* swamps and the open water of the channels within the Okavango Delta. In this region vegetation patterns are governed by the prevailing flood regime. However, this depends on small differences of topography and hence changes over short horizontal distances. The resulting patchy distribution of vegetation units is not captured by the rather large spatial resolution of the MODIS sensor (Fig. 15).

Wet grasslands and peatlands: On the one hand, this unit comprises peatbogs forming at valley bottoms of small tributaries in the upper basin. They are perennially wet and fed by drainage interflow from the sandy topsoils of the hills. In most cases they are dominated by sedges and typical peatbog species like *Drosera* spp. On the other hand, this unit also comprises the open plains and platforms at the sources of the Okavango River in the Highland of Bié. Impeded drainage and high precipitation in the rainy season lead to temporarily waterlogged soils. No woodlands can establish under these conditions but humid grasslands form with strongly humose topsoils dominated by dwarf-shrubs and small trees of the genera *Protea*, *Parinari*, or *Syzygium* (Fig. 16 and 17).



Fig. 6: *Baikiaea-Burkea* woodlands cover extensive areas along the Cubango River in southeast Angola (photo: M. Finckh).



Fig. 7: *Baikiaea-Burkea* woodlands (medium dense) with *Schinziophyton rautanenii*, in the core site of Caiundo (photo: R. Revermann).



Fig. 8: Mixed *Burkea* woodlands with *Terminalia sericea* east of the Panhandle (photo R. Revermann).



Fig. 9: Mixed woodlands including *Colophospermum mopane* east of Seronga (photo: R. Revermann).



Fig. 10: Medium dense thornbush savannah (photo: M. Finckh).



Fig. 11: *Parinari capensis* grasslands in the Longa Valley (photo: M. Finckh).



Fig. 12: *Syzygium guineense* ssp. *huillense*, a typical species of the *Parinari capensis* grasslands (photo: M. Finckh).



Fig. 13: Late dry season aspect of *Cryptosepalum maraviense* grasslands at the core site of Cusseque (photo: M. Finckh).



Fig. 14: Forest grassland ecotone (with *Cryptosepalum maraviense*) at the core site of Cusseque (photo: M. Finckh).



Fig. 15: Seasonally flooded grasslands and reedbeds at the Cuito River, south of Nankova (photo: M. Finckh).



Fig. 16: Wet grasslands at Luassingua River, south of Baixo Longa (photo: M. Finckh).



Fig. 17: Peatlands in the valley of the Chingueia River, at the core site of Cusseque (photo: M. Finckh).

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