

# The West African Vegetation Database

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**Abstract:** The West African Vegetation Database (<http://www.westafricanvegetation.org>; GIVD ID AF-00-001) is an online database that has been designed to securely store, edit and manage phytosociological and dendrometrical relevés from West Africa to provide data for research projects dealing with, but not limited to, plant communities, biogeography, population structure, and vegetation dynamics. An integrated access management system allows data owners to keep data private, to grant selected users access or to make data sets available to the general public. Data entry is possible online or in a local offline database that can be synchronized with the online database. The database allows the calculation of biodiversity indices and has several export options.

**Keywords:** data management; dendrometry; dry forest; Guinea Zone; intellectual property right; phytosociology; Sahel Zone; savanna; Sudan Zone; tree measurements; West Africa.

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## Introduction

West Africa covers an environmental gradient from the Sahara desert to the rainforests of Upper Guinea via steppes and savannas of the Sahel (Plate A) and Sudan (Plate B). Mountain chains, inselbergs and gallery forests (Plate C) interrupt the zonal patterns of vegetation. It is a region of rapid environmental change due to a growing population, over-exploitation, changing land use practices and climate change. These changes will have an impact on plant communities and species and consequently on people's livelihood and well-being, all the more in an area where wild plants are of high economic and cultural importance. To be able to conserve plant diversity and ecosystem goods and services, it is mandatory to have a good understanding and documentation of it. On the global level, this has been expressed by the Global Strategy for Plant Conservation (Secretariat of the CBD 2002), which explicitly includes the objective to "develop an integrated, distributed interactive information system to manage and make accessible information on plant diversity". While more and more collection data for the region has become available via GBIF, especially from the herbaria of Aarhus (AAU), Frankfurt (FR), Paris (P) and Wageningen (WAG),

the availability of vegetation data was very much limited up to now and often restricted to thesis papers that are not widely distributed. These data are rarely archived in digital form at the institutional level and therefore are frequently forgotten or lost when projects end or researchers leave science. To overcome this situation, we decided to develop an online platform for West African vegetation data, the West African Vegetation Database, in a collaborative effort of African and European partners involved in the BIOTA (<http://www.biota-africa.org>) and SUN (<http://www.sunproject.dk>) projects. The database is continuously updated and developed under UNDESERT (<http://www.undesert.neri.dk>).

Two workshops on biodiversity data have been held in November 2007 in Frankfurt am Main, Germany, and in June 2008 in Ouagadougou, Burkina Faso for capacity building on general concepts of biodiversity data, relational databases and collection management with partners of all involved institutions. During these workshops, the needs for an online database on West African vegetation data have been discussed, and a strategy for data entry and implementation of the database has been developed. These workshops have been important not only for establishing a good cooperation between

the partners, but also resulted in at least two important structural components of the database: (1) a data access rights management scheme to considerably increase acceptance of the database among local researchers (for a more thorough treatment of this aspect, see Janßen et al. 2011) and (2) a local offline database tool including a synchronisation feature with the online database and designed to cope with the frequently slow and unreliable West African internet connections.

## Structure

The West African Vegetation Database is an online database running on a central Microsoft SQL Server installation. Its data contents can be synchronized with and exported to the offline database VegDa 3.0 running on MS Access 2000. The data structure builds on the structure developed for VegDa (Schmidt 2006), a local vegetation database that originated in the BIOTA project and had two main purposes: (1) storing the data of the West African transect of BIOTA observatories (for the concept of these observatories, see Schmiedel & Jürgens 2005, Jürgens et al. 2012) and other project-related vegetation data and (2) collecting published data from the collaborating institutions in or-

der to get a sound base for biodiversity studies. Therefore from the start it was necessary to implement a structure able to handle different kinds of relevés. A nomenclatural list of species and infraspecific taxa including synonymy was taken from the African Plants Database (Conservatoire et Jardin botaniques de la Ville de Genève & South African National Biodiversity Institute 2009) and linked to a hierarchical series of tables for higher taxonomical units. Another table contains the relevé events with information about time, location, plot-related data, investigator, etc. These two central elements of the database are linked via two tables for species-based relevés (species inventories, phytosociological relevés according to different scales) and individual-based relevés (dendrometrical relevés), thereby connecting taxonomic names with relevé events and including observed values and eventually voucher specimens. In addition to this central structure, there are standard

lists of countries and administrative units, vegetation types (based on the recommendations and conclusions of the Yagambi conference, C.S.A./C.C.T.A. 1956), soil types (based on IUSS Working Group WRB 2007), structural parameters, etc. to be used in dropdown lists for error avoidance and establishment of a common terminology.

Access rights management is in the responsibility of data owners and allows individual relevés to be declared available to the general public, private (e.g. unpublished data), or shared with selected other users (e.g. cooperation projects) of the database. Regardless of access level, all users may read metadata, except coordinates, of all relevés in the database, so it is easy to identify potentially interesting data sets and, in turn, their owners as potential cooperation partners. However, users may only read detailed data, including species lists and cover values for own and public data sets and for data sets other

users share with them. These may be searched, added to a data clipboard and exported for analysis. There are several export options: (1) into VegDa 3.0, the local Access database, (2) into crosstables in comma separated text format that may be used, e.g., in software for community analysis and (3) into a Google Earth file for visualization of the relevé localities.

Biodiversity indices including species richness, Simpson, Shannon and Pielou's evenness (for phytosociological relevés) and measures such as density, trunk surface area, crown volume and wood volume (for dendrometrical relevés) are automatically calculated and can be downloaded as a comma separated text file. For index calculation, we followed Haeupler (1982) in converting Braun-Blanquet codes into percentage values using the midpoints of the pure cover classes and 0.01%, 0.2%, 2.5% for the classes r, +, 1.

<b>GIVD Database ID:</b> AF-00-001		<b>Last update:</b> 2012-05-09	
<b>West African Vegetation Database</b>			
<b>Scope:</b> The West African Vegetation Database has been designed to securely store phytosociological and dendrometrical relevés from West Africa to provide data for analyses of communities, biogeography, population structure, etc. An integrated access management system allows data owners to give access to selected users or the general public. Data entry is possible online or in a local database version to be synchronized with the online database.			
<b>Status:</b> emerging		<b>Period:</b> 1980-2009	
<b>Database manager(s):</b> Marco Schmidt (marco.schmidt@senckenberg.de)			
<b>Owner:</b> Senckenberg Research Institute			
<b>Web address:</b> <a href="http://www.westafricanvegetation.org/">http://www.westafricanvegetation.org/</a>			
<b>Availability:</b> free online		<b>Online upload:</b> yes	<b>Online search:</b> yes
<b>Database format(s):</b> MySQL		<b>Export format(s):</b> MS Access, CSV file	
<b>Publication:</b> Schmidt M. 2006. Pflanzenvielfalt in Burkina Faso - Analyse, Modellierung und Dokumentation. Dissertation J.W.Goethe-Universität, Frankfurt am Main. URL <a href="http://publikationen.ub.uni-frankfurt.de/volltexte/2006/3198/">http://publikationen.ub.uni-frankfurt.de/volltexte/2006/3198/</a> 188 p.			
<b>Plot type(s):</b> normal plots		<b>Plot-size range:</b> 25-10000 m <sup>2</sup>	
<b>Non-overlapping plots:</b> 12,000	<b>Estimate of existing plots:</b> 40,000	<b>Completeness:</b> 30%	
<b>Total plot observations:</b> 16,074	<b>Number of sources:</b> [NA]	<b>Valid taxa:</b> [NA]	
<b>Countries:</b> BF: 50.0%; BJ: 20.0%; NE: 15.0%; SN: 15.0%			
<b>Forest:</b> 33% — <b>Non-forest:</b> aquatic: 0%; semi-aquatic: 4%; arctic-alpine: 0%; natural: 38%; semi-natural: 17%; anthropogenic: 8%			
<b>Guilds:</b> all vascular plants: 70%; only trees and shrubs: 30%; non-terricolous taxa (epiphytic, saxicolous, lignicolous): 3%			
<b>Environmental data:</b> [NA]			
<b>Performance measure(s):</b> presence/absence only: 10%; cover: 75%; measurements like diameter or height of trees: 15%			
<b>Geographic localisation:</b> GPS coordinates (precision 25 m or less): 70%; point coordinates less precise than GPS, up to 1 km: 10%; small grid (not coarser than 10 km): 15%; political units or only on a coarser scale (>10 km): 5%			
<b>Sampling periods:</b> 1980-1989: 10.0%; 1990-1999: 40.0%; 2000-2009: 50.0%			
<i>Information as of 2012-07-17; further details and future updates available from <a href="http://www.givd.info/ID/AF-00-001">http://www.givd.info/ID/AF-00-001</a></i>			

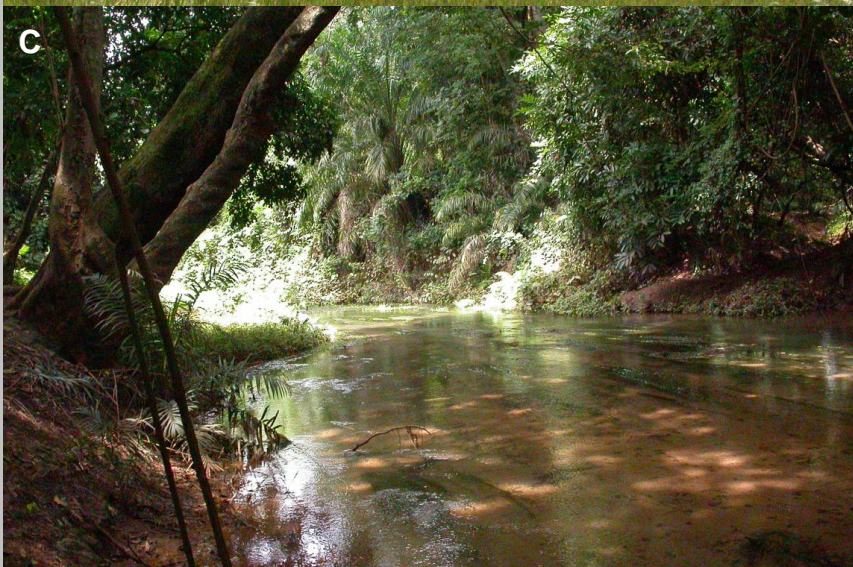


Plate: Vegetation types featured by the vegetation-plot database GIVD AF-00-001.

A: Tiger bush with its alternating bands of dense woody vegetation and bare ground is widely distributed in the Sahel (Photo: M. Schmidt).

B: A bowal in the *Forêt Classée de Dindéresso* near Bobo-Dioulasso. The shallow soil above lateritic crusts is often waterlogged during the rainy season and extremely dry during the dry season. The typical vegetation are grass savannas, woody plants are usually absent from these habitats (Photo: M. Schmidt).

C: Gallery forest in the *Forêt Classée du Kou* near Bobo-Dioulasso. Gallery forests of the Sudanian Zone contain many elements of the more humid Guinean Zone and are local hotspots of plant diversity (Photo: M. Schmidt).

## Contents

The database contains vegetation data from West Africa that have been digitized in the course of the SUN and BIOTA projects, mainly from research within these projects, the SFB 268 (for an overview of cooperations between Frankfurt and West African universities, see Wittig et al. 2009) or from theses at the partner institutions (Guinko 1984, Lykke 1993, 1997, Kéré 1996, Küppers 1996, Böhm 1998, Denschlag 1998, Ataholo 2001, Sieglstetter 2002, Müller 2003, Krohmer 2004, Wala 2004, Legba 2005, Tenté 2005, A. Ouédraogo 2006, Schmidt 2006, Kirchmair 2008, Mbayngone 2008, Zwarg 2008, O. Ouédraogo 2009).

These studies were often geographically restricted, some of them had a national (Guinko 1984) or West African (Ataholo 2001) coverage. Thematically, they are diverse with some studies focusing on specific habitats, e.g. segetal (Ataholo 2001) or ruderal vegetation (Böhm 1998), bowé (Zwarg 2008), gallery forests (Lykke & Goudiaby 1999) or termite mounds (Kirchmair 2008), others on the local diversity of plant species and communities (e.g. Küppers 1996 in the Gobnangou hills and Müller 2003 in the Sahel of Burkina Faso).

Therefore, data is often geographically clustered with sampling hotspots separated by wide unsampled areas. The same is true for the habitats. Savannas and dry forests typical for the respective vegetation zone are usually well sampled, while azonal habitats or degraded sites are only occasionally covered within our database. A more detailed analysis of sampling patterns in Burkina Faso can be found in Schmidt et al. (2010b).

The earliest relevés of the database are from the 1980s, and even though most of these are not georeferenced to an exact location, they still have the potential for reinvestigations to get information on vegetation change and the impact of land use and climate change. Very promising in this context would also be a joint analysis with data of the FLOTROP database (Daget 2012).

New contributions of relevé data to the West African Vegetation Database are therefore highly welcome. Database managers can be contacted via the website (<http://www.westafricanvegetation.org>).

## Analysis

Most analyses using our vegetation database focused on species distributions and geographical patterns of biodiversity. Due to the heterogeneous sampling patterns, this usually required the use of species distribution models. Distributions of the genus *Acacia* (Wittig et al. 2004) and the family *Combretaceae* (Thiombiano et al. 2006) as well as patterns of vascular plant diversity (Schmidt et al. 2005) and functional traits in the biogeography of grasses (Schmidt et al. 2011) have been described for Burkina Faso at the country scale. High resolution satellite data as predictors were used to model diversity patterns for Burkina Faso's largest legally protected area, the "Réserve sylvo-pastorale et partielle de la faune du Sahel" (Schmidt et al. 2008, König et al. 2009). Distribution changes of woody species due to land use change have been modeled with high resolution satellite data for an area in northern Benin (König et al. 2007).

The previous studies mainly profited from the high amount of occurrence data, without using the informations on co-occurrence and community composition inherent to vegetation data. Such analyses have been an integral part of the original studies, but remain underexploited at the level of the vegetation database, exceptions are a study on the West African BIOTA observatories (Schmidt et al. 2010a) and a comparison of two observatories of the Fada N'Gourma area with different land use regimes (Hahn-Hadjali 2006).

Other studies made use of tree measurements: changes in woody vegetation and species composition have been investigated in Sahelian Burkina Faso (Lykke et al. 1999) and fire-disturbed savannas in Senegal (Lykke et al. 1998, Lykke et al. 2002).

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