



# Global Biodiversity

Volume 3

Selected Countries in Africa



*Editor* T. Pullaiah

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## **Volume 3**

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## **Volume 3**

Selected Countries in Africa

*Edited By*

**T. Pullaiah, PhD**



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# Abbreviations

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AAs	authorized association
ABS	access and benefit sharing
AGEOS	The Gabonese Agency for Space Studies and Observations
AIDS	acquired immune deficiency syndrome
ANB	National Biosafety Authority
ANEAFPF	The National Agency for the Execution of Activities of the Forest-Wood Sector
ANPA	The National Agency for Fisheries and Aquaculture
ANPN	The National Agency of National Parks
AOAD	Arab Organization for Agricultural Development
APGRC	Agricultural Plant Genetic Resources and Research Centre
ARC	Agricultural Research Centre
ARI	Animal Research Institute
BNARI	Biotechnology and Nuclear Agricultural Research Institute
CAWM	College of African Wildlife Management MWEKA
CBD	Convention on Biological Diversity
CFR	Cape Floristic Kingdom
CITES	Convention on Trade in Endangered Species
CNB	National Biosafety Committee
CNDD	National Commission for Sustainable Development
CONSERE	Higher Council of Natural Resources and the Environment
CPMR	Centre for Plant Medicine Research
CR	critically endangered
CREMA	Community Resource Management Areas
CRI	Crops Research Institute
DBEB	Department of Botany and Environmental Biology
DD	data deficient
DE	Department of the Environment
EEZ	Exclusive Economic Zone
EGA	Environmental General Authority
EHF	Ebola hemorrhagic fever
EIA	environmental impact assessment
EN	endangered
ESC	Ecological Monitoring Center
EVD	Ebola virus disease

FC	Forestry Commission
FNC	Forest National Corporation
FORIG	Forestry Research Institute of Ghana
GBIF	Global Biodiversity Information Facility
GCA	Game Controlled Areas
GCFB	Guinea-Congo Forest Biome
GHG	green house gases
GPRS	Ghana Poverty Reduction Strategy
GRs	Game Reserves
GSBAs	Globally Significant Biodiversity Areas
IAS	Invasive Alien Species
IBA	Important Bird Area
IOC	International Ornithological Committee
ITCZ	Intertropical Convergence Zone
IUCN	International Union for Conservation of Nature
IUCN	The International Union for the Conservation of Nature
KNUST	Kwame Nkrumah University of Science and Technology
LC	least concern
LDCs	least developed countries
LEAP	List of East African Plants
LKHP	Lower Kihansi Hydropower Project
MBREMP	Mnazi Bay and Ruvuma Estuary Marine Park
MEA	Multilateral Environmental Agreements
MIMP	Mafia Island Marine Park
MPAs	Marine Protected Areas
NAPCP	National Program of Action to Combat Desertification
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Ngorongoro Conservation Area
NCAA	Ngorongoro Conservation Area Authority
NE	not evaluated
NFI	National Forest Inventory
NFP	National Forestry Program
NIP	National Irrigation Program
NT	near-threatened
NWFP	non wood forest products
OKNP	Outamba Kilimi National Park
PA	Protected Areas
PADP	Protected Areas Development Program

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PNBC	National Park of Basse Casamance
PNDS	National Park of Saloum Delta
PNIM	National Park National of Madeleine Islands
PNLB	National Park of Langue de Barbarie
PNNK	National Park of Niokolo-Koba
PNOD	National Birds Park of Djoudj
PRSP	Poverty Reduction Strategy Paper
RFFN	Ferlo Nord Wildlife Reserve
RNICS	Nature Reserve of Community Interest of Somone
RNP	Popenguine Nature Reserve
ROK	Ornithological Reserve of Kalissaye
RPS	Rangeland Development Strategy
RSFG	Special Wildlife Reserve of Gueumbeul
SARI	Savanna Agricultural Research Institute
SNE	National Environment Strategy
TaCMP	Tanga Coelacanth Marine Park
TanBIF	Tanzania Biodiversity Information Facility
TAWA	Tanzania Wildlife Management Authority
TAWIRI	Tanzania Wildlife Research Institute
TFAP	Tanzania Forestry Action Plan
TKA	traditional knowledge associated
TWS	Tiwai Wildlife Sanctuary
UAE	Useful Agricultural Surface
UCC	University of Cape Coast
UNFCCC	United Nation Framework Convention on Climate Change
VHFs	viral hemorrhagic fevers
VU	vulnerable
WD	Wildlife Division
WMAs	Wildlife Management Areas
WWF	World Wide Fund





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# Preface

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The term 'biodiversity' came into common usage in the conservation community after the 1986 National Forum on BioDiversity, held in Washington, DC, and publication of selected papers from that event, titled *Biodiversity*, edited by Wilson (1988). Wilson credits Walter G. Rosen for coining the term. Biodiversity and conservation came into prominence after the Earth Summit, held at Rio de Janeiro in 1992. Most of the nations passed biodiversity and conservation acts in their countries. Biodiversity is now the buzzword of everyone from parliamentarians to laymen, professors, and scientists to amateurs. There is a need to take stock on biodiversity of each nation. The present attempt is in this direction.

The main aim of the book is to provide data on biodiversity of each nation. It summarizes all the available data on plants, animals, cultivated plants, domesticated animals, their wild relatives, and microbes of different nations. Another aim of the book series is to educate people about the wealth of biodiversity of different countries. It also aims to project the gaps in knowledge and conservation. The ultimate aim of the book is for the conservation of biodiversity and its sustainable utilization.

The present series of the four edited volumes is a humble attempt to summarize the biodiversity of different nations. Volume 1 covers *Biodiversity of Selected Countries in Asia*, Volume 2 presents *Biodiversity of Selected Countries in Europe*, Volume 3 looks at *Biodiversity of Selected Countries in Africa*, and Volume 4 contains *Biodiversity of Selected Countries in the Americas and Australia*. In these four volumes, each chapter discusses the biodiversity of one country. Competent authors have been selected to summarize information on the various aspects of biodiversity. This includes brief details of the country, ecosystem diversity/vegetation/biomes, and species diversity, which include plants, animals and microbes. The chapters give statistical data on plants, animals, and microbes of that country, and supported by relevant tables and figures. They also give accounts on genetic diversity with emphasis on crop plants or cultivated plants, domesticated animals, and their wild relatives. Also mentioned are the endangered plants and animals and their protected areas. The book is profusely illustrated. We hope it will be a desktop reference book for years to come.

Biodiversity of some countries could not be presented in this book. This needs explanation. I tried to contact as many specialists as possible from these countries but was unable to convince these experts to write chapter on biodiversity of their country.

The book will be useful to professors, biology teachers, researchers, scientists, students of biology, foresters, agricultural scientists, wild life managers, botanical gardens, zoos, and aquaria. Outside the scientific field it will be useful for lawmakers (parliamentarians), local administrators, nature lovers, trekkers, economists, and even sociologists.

Since it is a voluminous subject, we might have not covered the entire gamut; however, we tried to put together as much information as possible. Readers are requested to give their suggestions for improvement for future editions.

I would like to express my grateful thanks to all the authors who contributed on the biodiversity of their countries. I thank them for their cooperation and erudition.

I wish to express my appreciation and help rendered by Ms. Sandra Sickels, Rakesh Kumar, and the staff of Apple Academic Press. Their patience and perseverance has made this book a reality and is greatly appreciated.

—*T. Pullaiah, PhD*

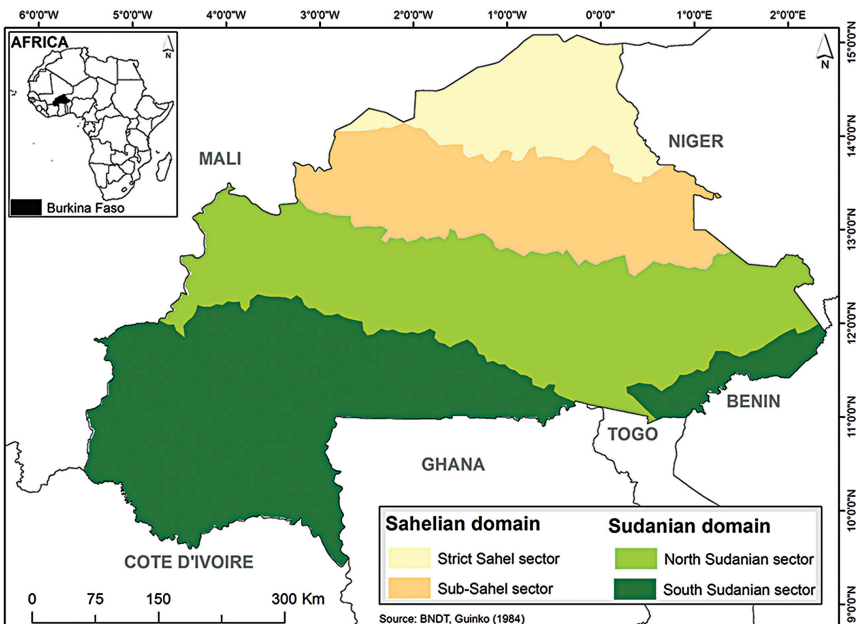
# Phytodiversity of Burkina Faso

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## 1.1 About Burkina Faso

Burkina Faso is a landlocked country located in the heart of West Africa with an area of around 274,200 km<sup>2</sup>. Its neighboring countries are Niger in the East, Benin, Togo, Ghana, and Ivory Coast (Côte d'Ivoire) in the South and Mali in the North (Figure 1.1). The relief is relatively flat with some sandstone cliffs in the West (Banfora) and the East (Gobnangou). The Mouhoun, the Pendjari, the Comoé, the Nazinon, and the Nakambé are the main rivers encountered in the country. The soils are predominantly ferruginous and raw mineral.



**Figure 1.1** Phytogeographical map of Burkina Faso (Source: Guinko, 1984).

Based on annual average rainfall distribution Burkina Faso is divided into three ecoclimatic zones: the Sahelian zone in the northern part of the country, with annual rainfall of 300–600 mm; a transitional Sudano-Sahelian zone in the central region, with a total rainfall of 600–900 mm; and the Sudanian zone in the southern part, with annual rainfall of 900 to 1,100 mm. Therefore, the country's landscape, vegetation types and species diversity reflected such climate gradient.

Regarding the vegetation, the country is subdivided into two phytogeographic domains (Sudanian and Sahelian domains) and each domain into two sectors (Figure 1.1). The Sudanian domain, which covers the Southern and Central parts of the country includes the South-Sudanian and North-Sudanian sectors. The northern part is covered by the Sahelian domain divided into two sectors (sub-Sahel and strict Sahel) according to the zonation done by Guinko in 1984. These vegetation types range from the shrubsteppe in the northern part, to the islands/patches of dense forests in the southern part of the country.

## 1.2 Status of Ecosystems in Burkina Faso

In the following paragraphs, the different vegetation types encountered in Burkina Faso from the south to the north are presented based on our own field observations and studies as well as on literature (Guinko, 1984; Ouédraogo, 2006; Ouedraogo et al., 2009; Thiombiano and Kampmann, 2010; Project BKF/015 – IFN 2 et IGB, 2015; Nacoulma, 2012; Gnoumou, 2013; Sambare, 2013; Traoré, 2013; MEEVCC, 2017).

### 1.2.1 Islands of Dry Deciduous Forests

These stands are encountered in the wettest part of the country (southern part) where the annual rainfall can reach 1,000 mm with more than 90 rainy days. The main stands are located in protected areas, particularly in the classified forest and partial wildlife reserve of Comoé Léraba. At the country level, the area of these islands is quite negligible. These islands are the most dense vegetation types found in Burkina Faso (Figure 1.2) with about 1,000 trees or shrubs per hectare and a basal area of 38 m<sup>2</sup>/ha. The mean total height of trees is 16 m with a rate of cover ranging from 97 to 100% (Gnoumou, 2013). The flora of these particular forests is characterized by a rich group of woody species (*Guibourtia copallifera*, *Gardenia nitida*, *Strychnos usambarensis*, *Alafia scandens*, *Landolphia hirsuta*, *Dalbergia hostilis*, *Salacia pallescens*, *Strophanthus sarmentosus*, *Ceiba pentandra* and *Mallotus oppositifolia*) as



**Figure 1.2** Islands of dry deciduous forests of *Guibourtia copallifera* (Photo Credit, Thiombiano A., 2010).

well as herbaceous species (*Cissus petiolata*, *Commelina africana*, *Commelina subulata*, *Cyathula prostrata*, *Cyperus diffusus*, *Doryopteris kirkii*, *Elytraria marginata*, *Malaxis chevalieri*, *Hibiscus surattensis*, *Oplismenus hirtellus* and *Pouzolzia guineensis*). These forests are rich in azonal species, which are characteristics of wetter regions and are extremely vulnerable to disturbances such as bushfires and selective harvesting of wood. In unprotected areas, these forests were almost degraded by farmers in favor of farms and other plantations such as the cashew tree (*Anacardium occidentale*).

### 1.2.2 Woodlands

Woodlands occur mainly in the southern part of Burkina Faso with rainfall about 800 to 1,000 mm per year. According to the phytogeographical subdivision, woodlands are essentially confined to the south-Sudanian sector. In the protected areas of the Eastern region, cords of woodlands are found along the drains and valleys at river basins level (Ouédraogo, 2009). Woodlands represent the second most forested type of vegetation in the country (Figure 1.3) with sometimes densities reaching 556 trees per hectare and a basal area of 22 m<sup>2</sup>/ha (Table 1.1a). The density of juveniles is very heterogeneous. Values can be very variable from one woodland to another one



**Figure 1.3** Woodland (Photo Credit, Thiombiano A., 2012).

(1,890 to 16,600 individuals/ha). The mean volume of wood is estimated at 28 m<sup>3</sup>/ha. Woodlands can store up to 52 Mg C/ha (Ouédraogo et al., 2009, Traoré, 2013; MEEVCC, 2017). The mean height of trees can reach sometimes 14 m according to Ouédraogo (2009).

The dominant and characteristic species such as *Anogeissus leiocarpa*, *Isobertinia doka*, *Pterocarpus erinaceus*, *Azelia africana*, *Cola cordifolia*, *Khaya senegalensis*, *Diospyros mespiliformis*, *Mitragyna inermis*, *Tamarindus indica* reflect the physiognomy of woodlands (Ouédraogo, 2009; Gnoumou, 2013; Traoré, 2013; [Table 1.1a](#)). The herbaceous layer of these vegetation types is characterized by *Wissadula amplissima*, *Setaria barbata*, *Achyranthes argentea*, *Desmodium velutinum*, *Hoslundia opposita*, *Peristrophe bicalyculata*, *Capparis sepiaria*.

The continuous extension of agricultural lands coupled with the uncontrolled and fraudulent exploitation of Woodlands' species (e.g., *Pterocarpus erinaceus*) lead to the confinement of these vegetation types in protected areas and sacred woods.

By comparing data from Ouadba (1997) cited in the country monograph of the biological diversity in 1999 to recent data from the land occupancy database (Project BKF/015 – IFN 2 et IGB, 2015), the area covered by

woodlands in Burkina Faso drastically decreased from 287,000 ha to 7,658 ha (MEECV, 2017) indicating a loss of 97.33% of their total area within 15 years. These vegetation types are present in the form of relics and are generally found in the Boucle du Mouhoun, Cascades, South-Center, Eastern, Hauts-Bassins, and Southwestern regions.

### 1.2.3 Savannas

The savanna in its multiple faces is the most common vegetation type found in Burkina Faso with an area of 11,392,033 ha representing 41.7% of the country's total area (MEEVCC, 2017). It includes a tree and/or shrub layer scattered in a continuous grass cover. The tree species' rate of cover in savannas ranges from 2 to 50%. In fact, the savanna contains a rich floristic procession forming a continuum from the North-Sudanian to the South-Sudanian sector. There is a high diversity of savannas due to the diversification of habitats varying from lowlands to hills and other armored hillocks.

Overall, there are three types of savannas that can be distinguished in Burkina Faso. They are tree savannas, shrub savannas, and grass savannas. Another type namely savanna woodland, which describes a type of vegetation at the transition between savannas and forests might be observed. However, this savanna woodland is often merged into the large set of tree savannas.

#### 1.2.3.1 Savanna Woodlands

In Burkina Faso, savanna woodlands are encountered in the North and South Sudanian sectors with a more pronounced presence in the western part than in the Eastern part of the country. Trees' rate of cover in this vegetation type reaches 45% with a mean height of 8 m for native trees species (Figure 1.4). The density of trees is about 468 individuals /ha with a basal area ranging from 7 to 13 m<sup>2</sup>/ha (Table 1.1a). Juveniles are proliferating in this savanna with densities varying from 15,512 to 28,424 juveniles per hectare (Traoré, 2013). Considering the flora, these savannas are distinct in the tree layer by species such as *Isobertinia doka*, *Daniellia oliveri*, *Pterocarpus erinaceus*, *Vitellaria paradoxa*, *Burkea africana*, *Terminalia avicennioides* and also by *Acacia gerrardii* more specifically in the National Park of Arly located in the Eastern region of the country. The herbaceous vegetation of savanna woodlands is dominated by *Andropogon gayanus*, *Hyparrhenia involucreta* and *Andropogon pseudapricus* (Ouédraogo, 2009; Nacoulma, 2012).





**Figure 1.4** Savanna woodland of *Terminalia avicennioides* (Photo Credit, Ouedraogo O., 2009).

Statistics data on the evolutionary trend of savanna woodland are almost nonexistent. However, they could present regressive tendencies similar to the woodlands especially given that they colonize rich soils, exposing these vegetation types to the farming activities.

### 1.2.3.2 Tree Savannas

These vegetation types are found in the North and South Sudanian sectors. The grass cover is continuous with variable height and coverage depending on the location in the protected or nonprotected environment (Figure 1.5). The herbaceous layer reaches 2 m with 80% of coverage in a well-protected environment without grazing (case of protected areas in Eastern region). However, in the communal areas, the herbaceous layer hardly reaches 45 cm due to the intensity of grazing. The woody species that characterize tree savannas are *Vitellaria paradoxa*, *Lannea acida*, *Terminalia avicennioides*, *Daniellia oliveri*, *Anogeissus leiocarpa*, *Burkea africana* and *Pterocarpus erinaceus* (Traoré, 2013). *Andropogon gayanus*, *Andropogon pseudapricus*, *Hyparrhenia involucrata*, *Spermacoce stachydea* are the prominent herbaceous species found in these savannas (Ouédraogo, 2009). The density of the trees is

estimated at 645 individuals/ha and a basal area of 11 m<sup>2</sup>/ha with a volume of wood of 30 m<sup>3</sup>/ha (Table 1.1a). This vegetation type has the highest abundance of juveniles (31,412 individuals/ha). The mean carbon sequestered by woody species in this savanna is estimated at 68.65 t/ha (MEEVCC, 2017).

Tree savannas represent about 16% (4,291,000 ha) of the total area of the country (Ouadba, 1997). In 2012, they accounted for 4.8% (1,316,101 ha) of the total area (MEEVCC, 2017), revealing a critical loss of 69% (between 1997 and 2012) of the original area.

### 1.2.3.3 Shrub and Grass Savannas

Shrub and grass savannas occur in the same phytogeographical zone on 10,075,932 ha representing 36.9% of the country total area (MEEVCC, 2017) and the essential of Burkina Faso vegetation. In terms of flora, shrub (Figure 1.6) and grass (Figure 1.7) savannas are characterized by the following woody species: *Acacia seyal*, *A. dudgeoni*, *Detarium microcarpum*, *Balanites aegyptiaca*, *Vitellaria paradoxa*, *Combretum glutinosum*, *C. nigricans* (Table 1.1a). The herbaceous layer consists mainly of *Andropogon pseudapricus*, *Loudetia togoensis*, and *Pennisetum pedicellatum*. The density of shrubs and some trees reach 667 individuals/ha with a small basal area of 5 m<sup>2</sup>/ha (Ouédraogo, 2009; Traoré, 2013; Table 1.1a). The density in juvenile individuals is, however, remarkable (21 331 individuals/ha). As for the volume of wood, it remains low at about 20 m<sup>3</sup>/ha. Moreover, the amount of carbon sequestered is about 40 t/ha (MEEVCC, 2017).

A variant of these savannas, which are in fact grass savannas (Figure 1.7), occupies lowlands and large alluvial plains with a woody cover rate less than 2%, a low density of shrubs (ca. 92 individuals/ha) and basal area of 3 m<sup>2</sup>/ha (Ouédraogo et al., 2008). Current climatic data, land use patterns, geographic distribution of species, and floristic composition indicate a trend toward the sahelization of Sudanian domain. The areas remain virtually unchanged with a decrease of 1% (-109,068 ha). Even though the significant difference is not observed at the physiognomy level within shrub savannas considerable changes on the floristic level are reported.

### 1.2.4 Steppes

The steppes are vegetation types that are specific to the Sahelian phytogeographic domain, recorded both in sub-Sahelian and Sahelian strict sectors. They are easily identifiable on the field by a scattered tree and/or shrub layer with a discontinuous grass cover whose mean height hardly exceeds 40 cm.



**Figure 1.5** Tree savanna of *Sterculia setigera* (Photo Credit, Thiombiano A., 2010).



**Figure 1.6** Shrub savanna (in the foreground) (Photo Credit, Ouedraogo O., 2009).



**Figure 1.7** Swampy shrub savanna with grassy tendency of alluvial plains (Photo Credit, Ouedraogo O., 2009).

This vegetation type covers an area of 4,676,134 ha or 17.2% of the total area of Burkina Faso (MEEVCC, 2017). Steppes are recognizable by a very remarkable discontinuity between the green islands. These vegetation types consist of woody and herbaceous species of high fodder quality supporting the livestock breeding, one of the main activity of rural populations in the Sahel. In this area, two types of steppes were recorded: the trees steppe and shrubs or grassy steppes.

#### 1.2.4.1 Trees Steppe

Tree steppes are sparse vegetation including generally small trees (Figure 1.8) with a low rate of woody cover. They are more common in the sub-Saharan sector and cover an area of 178,189 ha, or 0.7% of the total area of the country (MEEVCC, 2017). The characteristic species of tree steppes are: *Pterocarpus lucens*, *Combretum micranthum*, *Grewia flavescens*, *Commiphora africana*, *Acacia erythrocalyx*, *Acacia tortilis*, and *Dalbergia melanoxylon*. In the herbaceous layer, there are *Schoenefeldia gracilis*, *Pennisetum pedicellatum*, *Senna obtusifolia*, *Zornia glochidiata*, *Aristida adscensionis*, *Aristida kerstingii*, *Eragrostis tremula*, and *Digitaria ciliaris* (Tindano et al., 2015; Zerbo et al.,



**Figure 1.8** Tree steppe (Photo Credit, Thiombiano A., 2012).

2016). The tree density is about 434 individuals/ha and a basal area of 4 m<sup>2</sup>/ha with a volume of wood equals to 12 m<sup>3</sup>/ha (Table 1.1a). The carbon content sequestered by these vegetation types is 22 t per hectare. Juvenile recruitment reaches 5,144 individuals per hectare (MEEVCC, 2017).

#### 1.2.4.2 Shrub and Grassy Steppes

This type of vegetation is most prevalent in the strict Sahel over an area of 4,497,945 ha or 16.5% of the country's total area. It consists of shrubs scattered in the discontinuous grass cover (Figure 1.9). The rate of cover is low and varies between 10 and 30%. The height of herbaceous layer exceeds 60 cm and is composed mainly of annual species such as *Schoenefeldia gracilis*, *Zornia glochidiata*, *Cenchrus biflorus*, *Aristida adscensionis*, *Aristida kerstingii*, *Eragrostis tremula*, *Panicum laetum*, etc. The woody species characterizing shrub and grassy steppes are generally *Acacia seyal*, *Acacia tortilis* var. *raddiana*, *Balanites aegyptiaca*, and *Acacia laeta* (Table 1.1a).

The density of shrub steppes in the Sahel is 305 individuals/ha with a low basal area (3 m<sup>2</sup>/ha) (see Table 1.1a). Regeneration is also low with 790 juveniles/ha. The volume of wood is estimated at 5 m<sup>3</sup>/ha. The shrub and



**Figure 1.9** Shrub and grassy steppe (Photo Credit, Thiombiano A., 2005).

grassy steppes sequester only 9 t of carbon per hectare (MEEVCC, 2017). The steppe landscape consists only of a relic of woody and herbaceous species that have been able to adapt to the high pressure of grazing and the aridity of the climate. Glacis and wetlands of the steppes are increasingly invaded by *Senna obtusifolia*, a species with low forage value. The occurrence and invasion of this species might be an indicator of the stage of steppes' physical degradation.

Referring to the statistics of the 1999 monograph and data from the land occupancy database in 2012, only steppes among the different types of vegetation in Burkina Faso experienced a significant increase in their area of about 290% (+3,476,134 ha). Thus, much of the savannas have been converted into steppes, which indicates a high state of degradation of the country's vegetation.

### **1.2.5 Tiger Bush**

The tiger bush forms a band of vegetation confined to the north of Gorom-Gorom. This type of vegetation is characterized by a succession of bare soil and covered areas with wood cover rates that can vary from 55 to 90% (Figure 1.10). Established in the lowlands with sandy-clay soil, these tiger bush



**Figure 1.10** Tiger bush (Photo Credit, Ouedraogo A., 2005).

are characterized by species such as *Acacia ehrenbergiana*, *Ziziphus mauritiana*, *Bauhinia rufescens*, *Calotropis procera*, *Piliostigma reticulatum*, *Dichrostachys cinerea*, *Guiera senegalensis*, *Boscia angustifolia*, *Boscia senegalensis*, *Maerua crassifolia*, *Commiphora africana* (Ouédraogo, 2006 [Table 1.1a](#)). Tiger bush is relatively unaffected by the human pressure in the strict Sahel, but is severely affected by drought, which causes severe mortality of trees and shrubs (Ouédraogo, 2006).

### **1.2.6 Riparian Forests**

The riparian forests refer to the vegetation type developing along the rivers (Sambaré, 2013). Based on the structural and ecological characteristics, the riparian forests are divided into two main types: gallery forests and riparian strips.

The gallery forests consist of a strip of vegetation strictly linked to the river, and constitutes the interface between the river and the surrounding vegetation ([Figure 1.11](#)). They are found mainly along the permanent and semipermanent rivers of the Sudanian domain such as Mouhoun, Nazinon, Comoé, and Pendjari. The area covered by gallery forests is quite small and estimated at 121,151 ha which represents 0.4% of the country total area (MEEVCC, 2017). The gallery forests of the North-Sudanian sector are dominated by *Pterocarpus santalinoides*, *Mitragyna inermis*, *Diospyros mespiliformis*, *Daniellia oliveri*, and *Anogeissus leiocarpa*. In the South-Sudanian sector *Berlinia grandiflora*, *Vitex chrysocarpa*, *Syzygium guineense*, *Dialium guineense*, *Cola laurifolia*, *Morelia senegalensis*, *Diospyros mespiliformis*,



**Figure 1.11** Gallery forest along Pendjari river (Photo Credit, Ouedraogo O., 2009).

and *Carapa procera* are prominent (Sambaré, 2013). The density of gallery forests is 438 individuals/ha and the basal area is 22 m<sup>2</sup>/ha. These types of forests can sequester 50 t of carbon per hectare. There are nearly 29,108 juveniles/ha in gallery forests of Burkina Faso (MEEVCC, 2017). The riparian strips consist of a thin band of vegetation more or less narrow, located along the drainage axis. They are often encountered along the permanent and semi-permanent rivers of the Sahelian domain such as Sirba and Gourol. The thin vegetated band is often dominated by *Anogeissus leiocarpa*, *Acacia seyal* and *Mitragyna inermis* (Table 1.1b). The dominant species in riparian strips are: *Diospyros mespiliformis*, *Piliostigma reticulatum*, *Anogeissus leiocarpa*, *Balanites aegyptiaca* and *Acacia raddiana* in the strict Sahel sector. In the Sub-Sahel sector, *Acacia seyal*, *Piliostigma reticulatum*, *Balanites aegyptiaca*, *Mitragyna inermis* and *Acacia sieberiana* are the dominant woody species found in riparian strips. The riparian strips of the Sahel have a mean density of 233 individuals/ha with a basal area of 8 m<sup>2</sup>/ha (Traoré, 2013). Concerning the regeneration, there are nearly 7,404 juveniles per hectare.

At the level of riparian forests, the loss of biodiversity is especially accelerated by the construction of the facilities such as bridges and hydro-electric and hydro-agricultural developments that cause changes in hydrological regimes. Thus, the riparian forests have lost over the last two decades more than the half (55.12%) of their area since 1997 (Ouadba, 1997; MEEVCC, 2017).



**Table 1.1a** Vegetation Types of Burkina Faso and Their Characteristics

Vegetation types	Phytogeographic sectors	Rainfall (mm)	Area according to the land occupancy database (ha)	Density (trees and shrubs/ha)	Basal area (m <sup>2</sup> /ha)	Characteristic plant species
Island of dry deciduous forest	South-Sudanian	1000	–	1,000	38	<i>Guibourtia copallifera</i> , <i>Gardenia nitida</i> , <i>Dalbergia hostilis</i>
<b>Woodland</b>	South & North-Sudanian	800–1000	7,658	556	22	<i>Anogeissus leiocarpa</i> , <i>Isoberlinia doka</i> , <i>Pterocarpus erinaceus</i>
<b>Savanna woodland</b>	South & North-Sudanian	700–1000	–	468	7–13	<i>Vitellaria paradoxa</i> , <i>Burkea africana</i> , <i>Terminalia avicennioides</i>
<b>Tree savanna</b>	South & North-Sudanian	700–1000	1,316,101	645	11	<i>Vitellaria paradoxa</i> , <i>Lannea acida</i> , <i>Daniellia oliveri</i>
<b>Shrub &amp; grass savannas</b>	South-Sudanian, North-Sudanian & Sub-Sahel	500–800	10,075,932	667	5	<i>Acacia seyal</i> , <i>Acacia dudgeoni</i> , <i>Combretum glutinosum</i> , <i>Andropogon pseudapricus</i> , <i>Loudetia togoensis</i>
<b>Tree steppes</b>	Sahel	300–400	178,189	434	4	<i>Acacia tortilis</i> , <i>Dalbergia melanoxylon</i> , <i>Balanites aegyptiaca</i>
<b>Shrub &amp; grassy steppes</b>	Sahel	300–400	4,497,945	305	3	<i>Schoenefeldia gracilis</i> , <i>Zornia glochidiata</i> , <i>Cenchrus biflorus</i>
<b>Tiger bush</b>	Sahel	300–400	–	–	–	<i>Bauhinia rufescens</i> , <i>Guiera senegalensis</i> , <i>Boscia angustifolia</i> , <i>Boscia senegalensis</i>

Source: Ouédraogo (2006, 2009); Thiombiano and Kampmann (2010); Project BKF/015 – IFN 2 et IGB, (2015); Gnoumou (2013); Traoré (2013); MEECV (2017).

**Table 1.1b** Vegetation Types of Burkina Faso and Their Characteristics

Vegetation types	Area (ha)	Tree density (ind./ha) (These values given by the expert are very low!)	Basal area (m <sup>2</sup> /ha)	Characteristic plant species
Riparian strip	–	233	8	<i>Anogeissus leiocarpa</i> , <i>Acacia seyal</i> , <i>Mitragyna inermis</i>
Gallery forest	121,151	438	22	<i>Pterocarpus santalinoides</i> , <i>Mitragyna inermis</i> , <i>Diospyros mespiliformis</i> , <i>Daniellia oliveri</i> , <i>Berlinia grandiflora</i> , <i>Syzygium guineense</i> , <i>Carapa procera</i>

Source: Traoré (2013).

### 1.3 Status of Phytodiversity in Burkina Faso

The state of knowledge about plant species in Burkina Faso reveals relatively advanced investigations for vascular plants grouped in the Spermatophyta (subphylum of Angiospermae and Gymnospermae). However, the data on the lower plants (Bryophyta, Lycopodiophyta and Equisetophyta) are limited and almost nonexistent.

#### 1.3.1 Pteridophyta (Ferns)

The current botanical inventories reveal 26 species of ferns and relatives recorded in Burkina Faso (Thiombiano et al., 2012). They are distributed over 14 genera and 12 families (Table 1.2).

#### 1.3.2 Gymnospermae

The flora of Burkina Faso does not contain spontaneous species of Gymnosperms. Existing Gymnosperm species are all introduced and used as ornamental plants. Therefore, documentation on these species is very

**Table 1.2** Number of Fern Species Per Taxonomic Group

<b>Branch</b>	<b>Class</b>	<b>Order</b>	<b>Family</b>	<b>Genera</b>	<b>Species</b>			
Pteridophyta	Pteridopsida	Pteridales	Adiantaceae	<i>Adiantum</i>	2			
				<i>Doryopteris</i>	1			
	Filicopsida	Hydropteridales	Azollaceae	<i>Pityrogramma</i>	1			
				<i>Azolla</i>	1			
				<i>Isoetes</i>	3			
				Polypodiales	<i>Bolbitis</i>	1		
					<i>Nephrolepis</i>	2		
				Osmundaceae	<i>Osmunda</i>	1		
					<i>Parkeriaceae</i>	1		
				Lycopodiopsida	Lycopodiales	<i>Thelypteridaceae</i>	<i>Thelypteris</i>	2
						<i>Lycopodiaceae</i>	<i>Lycopodiella</i>	1
				Equisetopsida	Salviniales	<i>Selaginellaceae</i>	<i>Selaginella</i>	1
<i>Marsileaceae</i>	<i>Marsilea</i>	6						
Total	4	8	<i>Ophioglossaceae</i>	<i>Ophioglossum</i>	3			
			12	14	26			

Source: Thiombiano et al. (2012).

limited. [Table 1.3](#) shows a total of 6 woody species of Gymnosperms belonging to 5 genera, 2 families, 2 orders and 2 classes (Soma 2012; Thiombiano et al., 2012). Among these species, 5 were assessed by the IUCN Red List and ranked under the status of Least Concern (LC). Only *Araucaria excelsa* (Lamb.) R. Br. has not been evaluated. However, it appears in the IUCN catalog (The IUCN Red List of Threatened Species, 2017).

### 1.3.3 Angiospermae (Dicotyledonous and Monocotyledonous)

The flora of Burkina Faso is dominated in term of species diversity and richness by the subphylum of Angiospermae including Monocotyledonous and Dicotyledonous classes. This total flora of the country is evaluated to 2,067 species, which include 124 cultivated species (Thiombiano et al., 2012). The 1943 noncultivated species of vascular plants (herbaceous and woody) belong to 738 genera and 133 families (Zizka et al., 2015). Indeed, according to Thiombiano et al. (2012), 531 species compose the woody flora representing 25.69% of the country's local flora. The remaining 74.31% represents the herbaceous flora mainly dominated by Poaceae, Legumes, and Cyperaceae. Poaceae one of the main symbol of savanna ecosystems reveals 10 tribes, 85 genera, and 316 species.

**Table 1.3** List of Woody Gymnosperm Species in Burkina Faso

Scientific name	Family	Order	Class
<i>Abies alba</i> Miller	Pinaceae	Pinales	Pinopsida
<i>Abies grandis</i> (Douglas ex D. Don) Lindley	Pinaceae	Pinales	Pinopsida
<i>Araucaria excelsa</i> (Lamb.) R. Br.	Pinaceae	Pinales	Pinopsida
<i>Cupressus sempervirens</i> L.	Pinaceae	Pinales	Pinopsida
<i>Cycas revoluta</i> Thunb. [cult.]	Cycadaceae	Cycadales	Cycadopsida
<i>Encephalartos transvenosus</i> Stapf & Burtt Davy	Cycadaceae	Cycadales	Cycadopsida

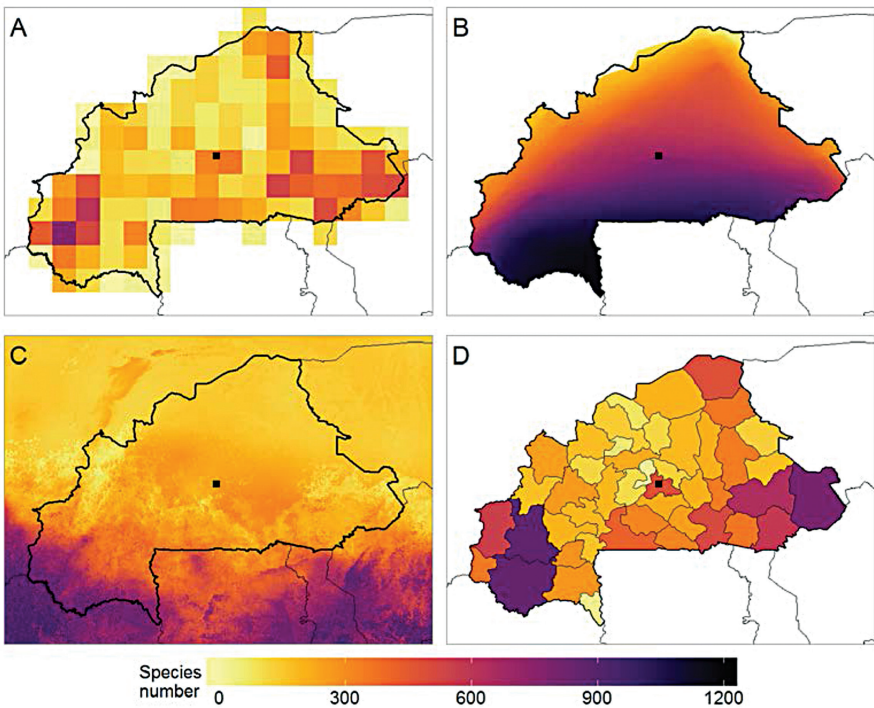
[cult.] = cultivated.

Source: Soma (2012); Thiombiano et al. (2012).

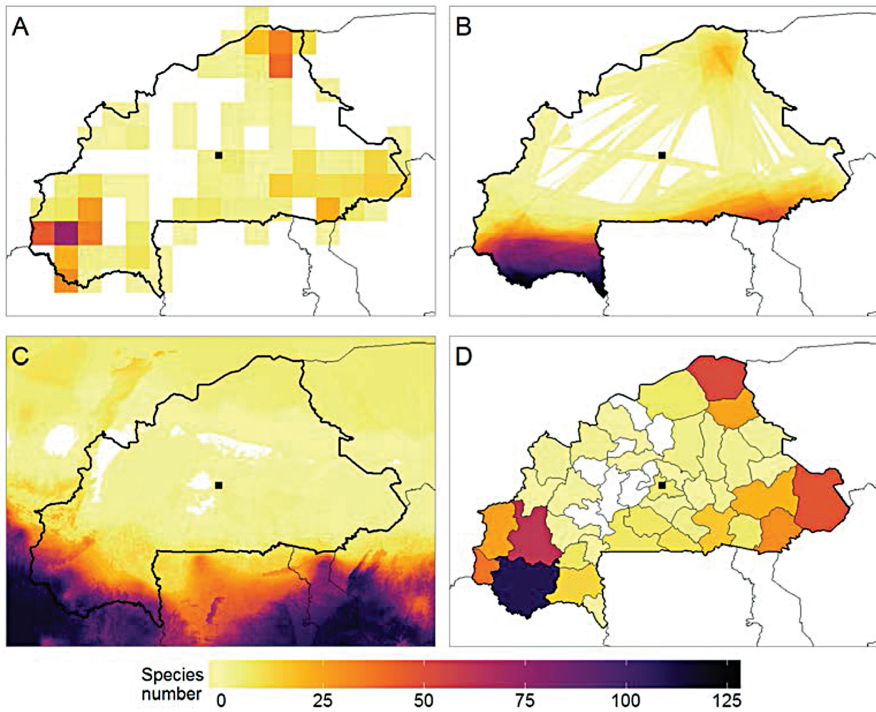
## 1.4 Hotspots of Burkina Faso

Based on different scenarios (Figure 1.12) recent investigations highlight two hotspots of plant diversity (in terms of plant species richness) were identified in Burkina Faso: the Southwest around the sandstone massif of Mount Ténakourou in the Kéné Dougou province and the Southeast around the W National Park (Schmidt et al., 2017).

These investigations also identified the most southern part of the country as hotspots for threatened and endangered species (Figure 1.13A–D; Schmidt et al., 2017).



**Figure 1.12** Vascular plant species richness in Burkina Faso [Note the diversity hotspots in the southeast and southwest of the country. A: Species number based on occurrence records; B: Based on overlaid Extent of Occurrence; C: Based on the modeled distribution of 1,107 species; D: Per political province based on occurrence records (Schmidt et al., 2017 *Zootaxa*)].



**Figure 1.13** Potentially threatened and near-threatened vascular plant species in Burkina Faso [The colors indicate the number of species classified as potentially Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near-Threatened (NT). A: Species number based on occurrence records; B: based on overlaid Extent of Occurrence; C: based on the modeled distribution of 1,107 species; D: per political province based on occurrence records (Schmidt et al., 2017, Zootaxa)].

## 1.5 Endemic Species

The flora of Burkina Faso dominated by therophytes and phanerophytes has a wide distribution in Africa and is representative of West African flora. This might be explained by the general monotonous relief of the country even though, mountains have been recognized as the endemic center of biodiversity. Consequently, there is a low presence of endemic species in Burkina Faso, which is a general characteristic of West African savannas (Zizka et al., 2015). However, the country has 7 endemic species that are present in West Africa (Table 1.4; Thiombiano et al., 2012; Sakandé et al., 2016). The Figures 1.14–1.15 and 1.16–1.17, respectively, illustrate some species

**Table 1.4** Endemic Species of West Africa Present in Burkina Faso

Species	Family	Areas of endemism
<i>Batopedina tenuis</i> (A.Chev. ex Hutch. & Dalziel) Verdc. Endemic to the West African Sudanese plateaus	Rubiaceae	Ghana and Burkina Faso.
<i>Borassus akeassii</i> Bayton, Ouédr. & Guinko	Areaceae	From Senegal to Burkina Faso
<i>Brachystelma simplex</i> Schltr. Subsp. <i>banforae</i>	Apocynaceae	Côte d'Ivoire, Nigeria, Burkina Faso
<i>Isoetes jaegeri</i> Pitot	Isoetaceae	Burkina Faso
<i>Pandanus senegalensis</i> Huynh	Pandanaceae	Burkina Faso, Mali, Senegal
<i>Panicum nigerense</i> Hitchc.	Poaceae	Mali, Niger, Burkina Faso, Nigeria
<i>Polycarpaea billei</i> J.-P. Lebrun	Caryophyllaceae	Senegal, Mali, Côte d'Ivoire, Ghana, Togo, Burkina Faso

Source: Thiombiano et al. (2012); Sakandé et al. (2016).



**Figure 1.14** *Batopedina tenuis* (A.Chev. ex Hutch. & Dalziel) Verdc (Photo Credit, Thiombiano A., 2010).



**Figure 1.15** *Borassus akeassii* Bayton, Ouédr. & Guinko (Photo Credit, Thiombiano A., 2010).



**Figure 1.16** *Pandanus senegalensis* Huynh en Inflorescence (Photo Credit, Thiombiano A., 2010).





**Figure 1.17** *Pandanus senegalensis* Huynh in fructification (Photo Credit, Thiombiano A., 2010).

*Batopedina tenuis*; *Borassus akeassii* and *Pandanus senegalensis* (Figure 1.18). Among these species, only *Isoetes jaegeri* Pitot is endemic to Burkina Faso. This fern was collected from the Banfora Cliffs (Toussiana) in the Comoé's Province (Zizka et al., 2015).

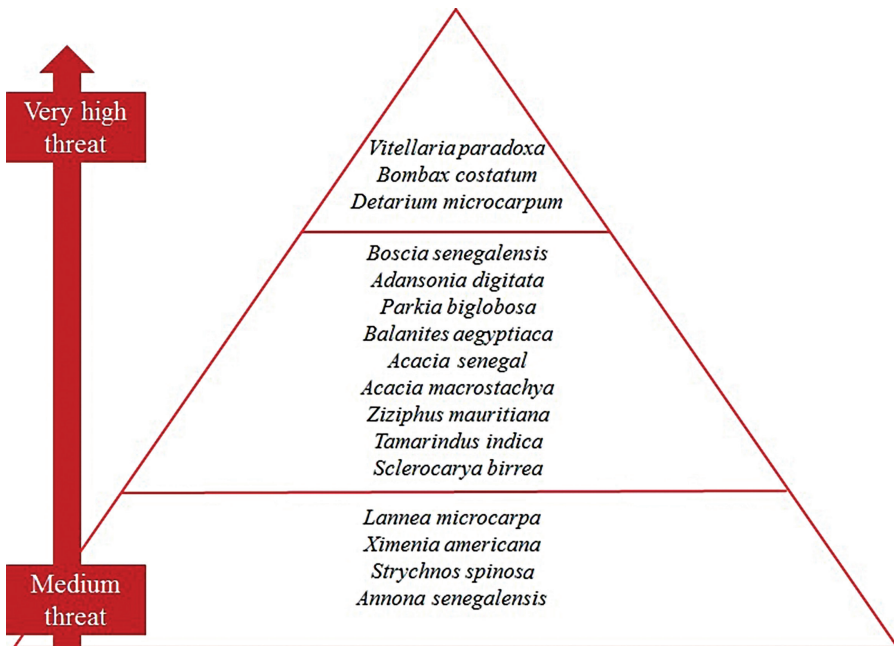
## 1.6 Threats

The main threats of phytodiversity in Burkina Faso are rank from natural to anthropogenic constraints as well as combined factors. Indeed, the decline in rainfall, drought and soil depletion and climate change has been reported as the main threats (Mbayngone and Thiombiano, 2011; Gaisberger et al., 2017). The rainfall shortage leads to mortality of nonresistant species like *Pterocarpus lucens* and *Dalbergia melanoxylon* (Hahn-Hadjali and Thiombiano, 2000). For these species, large cemeteries of stand dead wood might be observed in the northern part of the country as a result of consecutive periods of drought.

At the species level, climate change, the reduction or even disappearance of certain habitats and human pressure are the main causes of threat that impact negatively many species in the country different climate zones (Thi-

ombiano and Kampmann, 2010). Some plant species are heavily threatened either because the climatic conditions do not allow their regeneration, or due to the overexploitation (Hahn-Hadjali and Thiombiano, 2000; Thiombiano and Kampmann, 2010; Gaisberger et al., 2017). Specially, the widely collection of vital parts such as the roots (*Securidaca longipedunculata*, *Sarcocephalus latifolius*, *Parinari curatellifolia*), the flowers (*Bombax costatum*, *Annona senegalensis*), the seeds (*Vitellaria paradoxa*, *Parkia biglobosa* and *Acacia macrostachya*), the shoots (*Borassus aethiopum*) and leaves (*Adansonia digitata*, *Azzeria africana*) might be detrimental to targeted species. Other human factors influencing the survival of plant species are the uncontrolled bush fires which, whatever their regime that lead to selection in the flora by eliminating the most sensitive species over the years (Thiombiano and Kampmann, 2010; Gaisberger et al., 2017).

Considering the combined threats in the country, a number of food tree species (16 species) are highly threatened over large areas of their distribution (45 to 78% of the area); on average 60.5% of the distribution area of these tree species is highly threatened (Gaisberger et al., 2017). The [Figure 1.18](#) presents the threat level of these food tree species calculated from a

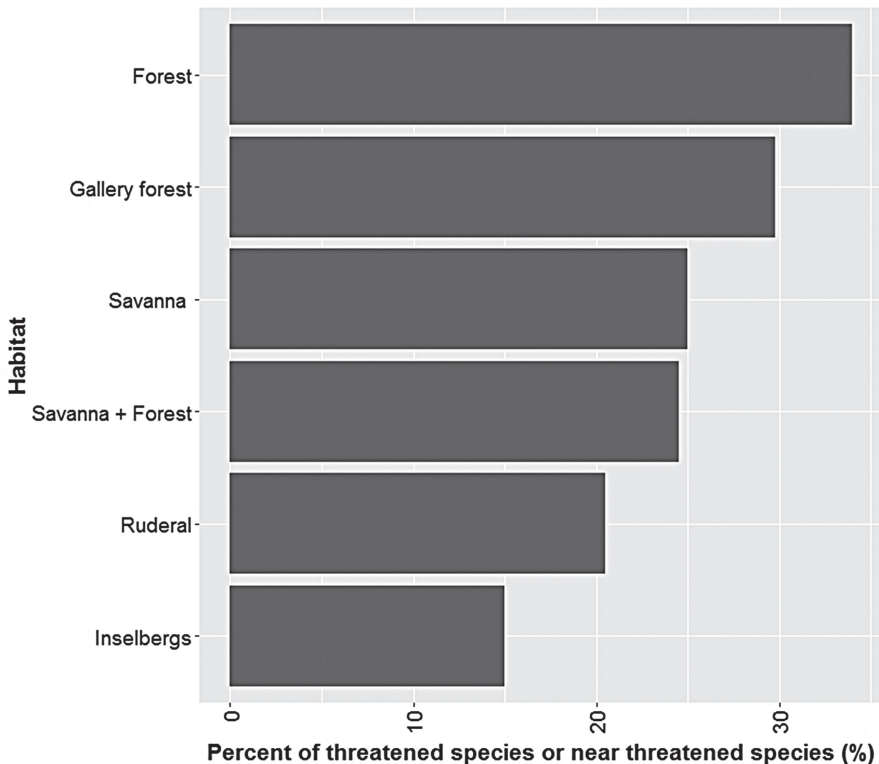


**Figure 1.18** Threat level of 16 food tree species Reprinted from (Gaisberger et al., 2017 <https://creativecommons.org/licenses/by/4.0/>).

combination of several factors (overexploitation, overgrazing, bush fires, cotton cultivation, and climate change).

Among the 20 most species-rich plant families in Burkina Faso, Apocynaceae, Lamiaceae, Euphorbiaceae, Phyllanthaceae, Malvaceae had the highest proportion of species classified as threatened or near threatened (Schmidt et al., 2017). While considering the life forms, these authors found that Geophytes and Hemicryptophytes had the highest proportion of threatened or near threatened species. However, the magnitude of threat is related to their respective habitats. Thus, of all habitats, forests and gallery forests have the highest proportion of potentially threatened or near-threatened species (Figure 1.19; Zizka et al., 2015; Schmidt et al., 2017).

Indeed, the abuse and uncontrolled use of chemical products including systemic pesticides in cotton cultivation in Burkina Faso is another devastating phenomenon that seriously threatens habitats and their biological



**Figure 1.19** Percent of threatened or near-threatened species in Burkina Faso according to their habitats (Schmidt et al., 2017, Zootaxa).

diversity. Illiteracy, poverty and the vulnerability of rural populations lead to unsavory practices in the use of chemical products. Commonly farmers use pesticides intended for cotton production or other prohibited products in food crop fields, cash crops and even market gardening near watercourses, which compromises undeniably the viability of aquatic biota and ecosystems. More than 60% of the country (representing up to 25% of the southern part) is under chemicals threat.

In recent years, Burkina Faso has experienced a mining boom, where the country is ranked fourth in Africa for gold production, and it has the third highest exploration activity in the continent; production is expected to continue its rapid growth (Gaisberger et al., 2017). However, the ranging is not without consequences on ecosystems and biodiversity. The influence of mining activities includes habitat destruction in the mining sites and habitat degradation in the surrounding areas (Gaisberger et al., 2017). Mining is both a direct driver of deforestation through the physical encroachment of quarries on forest or vegetated lands, and also an indirect factor of forest resource degradation (Gaisberger et al., 2017) through the openings of tracks and the installations of facilities mostly spontaneous in the case of artisanal mining sites. The use of persistent hazardous chemical products (mercury, cyanide, etc.) renders the soils of exploited sites unproductive for many years after closure of the mine (MEEVCC, 2017). Similarly, the different watersheds adjoining these mining sites are strongly affected. Thus, animal mortality near to their watering has been noticed through some gold mining sites. Around such sites, soil contamination caused death and a virtual absence of plant regeneration. Actually, with the expansion of mining sites throughout the country, some protected areas are under threat.

## 1.7 Conservation Status of Woody Species in Burkina Faso

The International Union for the Conservation of Nature (IUCN) has set up criteria for classifying species into nine categories. However, like many other countries, several taxa in Burkina Faso have not been assessed by the IUCN Red List. The status of each of the 531 woody species recorded in the country was verified by introducing their scientific name (the Latin binomial) on the IUCN site (<http://www.iucnredlist.org/search>). Of these 531 species in, only 32 species (6.03%) were assessed by the IUCN red list against 491 species (92.47%), which were not evaluated. Only one species (0.19%) had no sufficient data to be evaluated (Table 1.5). However, 8 species (1.51%)

do not even appear in the IUCN catalog. Those are *Abrus melanospermus* Hassk, *Acacia hockii* De Wild, *Euphorbia poissoni* Pax, *Ficus scott-elliottii* Mildbr. & Burret, *Manilkara multinervis* (Baker) Dubard, *Philenoptera cyanescens* (Schumach. & Thonn.) Roberty, *Pouteria alnifolia* (Baker) Roberty, *Pseudoceadrela kotschy* (Schweinf.) Harms (The IUCN Red List of Threatened Species, 2017).

In addition, from one locality to another, species have not the same status. For instance, a species may be threatened in a neighboring country and not in Burkina Faso. Likewise, a species may be classified as threatened in the IUCN Red List and not threatened in a given country (Neuenschwander et al., 2011). [Table 1.6](#) shows the respective conservation status of the 32 woody species in Burkina Faso, assessed by IUCN.

Based on the occurrence number of each species, Schmidt et al. (2017) ranked 350 species (both woody and herbaceous), representing 18% of the national flora as potentially threatened (CR = 20 species, EN = 150 species, VU = 93 species) or potentially near-threatened (NT = 87 species) in accordance with the nine IUCN categories. Of these species, 117 are woody and subwoody (CR = 06 species, EN = 42 species, VU = 32 and NT = 37) ([Table 1.7](#)). For these authors, potentially threatened and near-threatened species are highly concentrated in the southern part of the country.

Finally, the previous classification has defined the status of species according to the ecological zones. This classification was based on the ecology of the species, the human pressure and the structures of populations in the different plant communities (Thiombiano and Kampmann, 2010).

**Table 1.5** Proportion of Woody Species in Burkina Faso Assessed By IUCN

Status according to IUCN	Absolute values	Relative values (%)
Evaluated	32	6.03
Data Deficient (DD)	1	0.19
Endangered (EN)	4	0.75
Least Concern (LC)	17	3.20
Minor risk/Least Concern (LC)	1	0.19
Minor risk /Near-threatened (NT)	1	0.19
Vulnerable (VU)	8	1.51
Not evaluated (NE)	491	92.47
Not listed in the IUCN catalog	8	1.51

**Table 1.6** Conservation Status of 32 Woody Species in Burkina Faso According to IUCN

Species	IUCN status
<i>Acacia ehrenbergiana</i> Hayne	Least Concern (LC)
<i>Azelia africana</i> Sm. ex Pers.	Vulnerable (VU)
<i>Albizia ferruginea</i> (Guill. & Perr.) Benth.	Vulnerable (VU)
<i>Bauhinia purpurea</i> L.	Least Concern (LC)
<i>Borassus aethiopum</i> Mart.	Least Concern (LC)
<i>Borassus akeassii</i> Bayton, Ouedr. & Guinko	Least Concern (LC)
<i>Calamus deerratus</i> G.Mann & H. Wendl.	Least Concern (LC)
<i>Cissus doeringii</i> Gilg & M.B randt	Least Concern (LC)
<i>Cissus rufescens</i> Guill. & Perr.	Least Concern (LC)
<i>Dalbergia melanoxylon</i> Guill. & Perr.	Minor risk/Near-threatened (NT)
<i>Desmodium barbatum</i> (L.) Benth.	Least Concern (LC)
<i>Detarium microcarpum</i> Guill. & Perr.	Least Concern (LC)
<i>Dichrostachys cinerea</i> (L.) Wight & Arn.	Least Concern (LC)
<i>Diospyros ferrea</i> ssp. <i>ebenus</i> (Thwaites) Bakh.	Endangered (EN)
<i>Elaeis guineensis</i> Jacq.	Least Concern (LC)
<i>Erythrina senegalensis</i> A. DC.	Least Concern (LC)
<i>Isoberlinia doka</i> Craib & Stapf	Least Concern (LC)
<i>Khaya grandifoliola</i> C.DC.	Vulnerable (VU)
<i>Khaya senegalensis</i> (Desr.) A.Juss.	Vulnerable (VU)
<i>Leptoderris brachyptera</i> (Benth.) Dunn	Least Concern (LC)
<i>Mimosa pudica</i> L.	Least Concern (LC)
<i>Pavetta lasioclada</i> (K. Krause) Mildbr. ex Bremek.	Vulnerable (VU)
<i>Philenoptera laxiflora</i> (Guill. & Perr.) Roberty	Least Concern (LC)
<i>Pteleopsis habeensis</i> Aubrév. ex Keay	Endangered (EN)
<i>Pterocarpus lucens</i> Lepr. ex Guill. & Perr.	Least Concern (LC)
<i>Pterocarpus santalinoides</i> DC.	Minor risk/Least Concern (LC)
<i>Raphia sudanica</i> A. Chev.	Data Deficient (DD)
<i>Terminalia ivorensis</i> A. Chev.	Vulnerable (VU)
<i>Vepris heterophylla</i> (Engl.) Letouzey	Endangered (EN)
<i>Vitellaria paradoxa</i> C.F.Gaertn.	Vulnerable (VU)
<i>Warneckea fascicularis</i> (Planch. ex Benth.) Jacq.-Fél.	Endangered (EN)
<i>Xylopia elliotii</i> Engl. & Diels	Vulnerable (VU)