

# THE STATUS AND DISTRIBUTION OF FRESHWATER BIODIVERSITY IN CENTRAL AFRICA

Brooks, E.G.E., Allen, D.J. and Darwall, W.R.T.



CENTRAL AFRICA



The IUCN Red List of Threatened Species™ Regional Assessment

# Chapter 7. The status and distribution of freshwater plants of central Africa

Ghogue, J.-P<sup>1</sup>

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The Africa freshwater ecoregions were primarily based on fish distributional data (Thieme *et al.* 2005; Abell *et al.* 2008). Defined as conservation units (Dinerstein *et al.* 1995), these ecoregions can not be taken as indicative for plants, as fishes and aquatic plants' distribution and ecological requirements do not necessarily overlap. Boundaries of these ecoregions are clearly different from White's phytochoria for the region (White 1983). These are instead floristic regions based on richness of their endemic floras at a species level. For practical reasons, while dealing with ecoregions and to allow further discussions, we will relay on White's phytochoria instead of freshwater bioregions.

## 7.1 Phytogeographical delineation

The central Africa assessment region derived from the watershed-based Pan Africa Freshwater Biodiversity Assessment (Figure 1.1) includes all or part of eight countries and encompasses six phytochoria (Figure 7.1; White 1983; Linder 2005): The Guineo-Congolian regional centre of endemism (I), the Zambezian regional centre of endemism (II), the Sudanian regional centre of endemism (III), the Afromontane archipelago-like regional centre

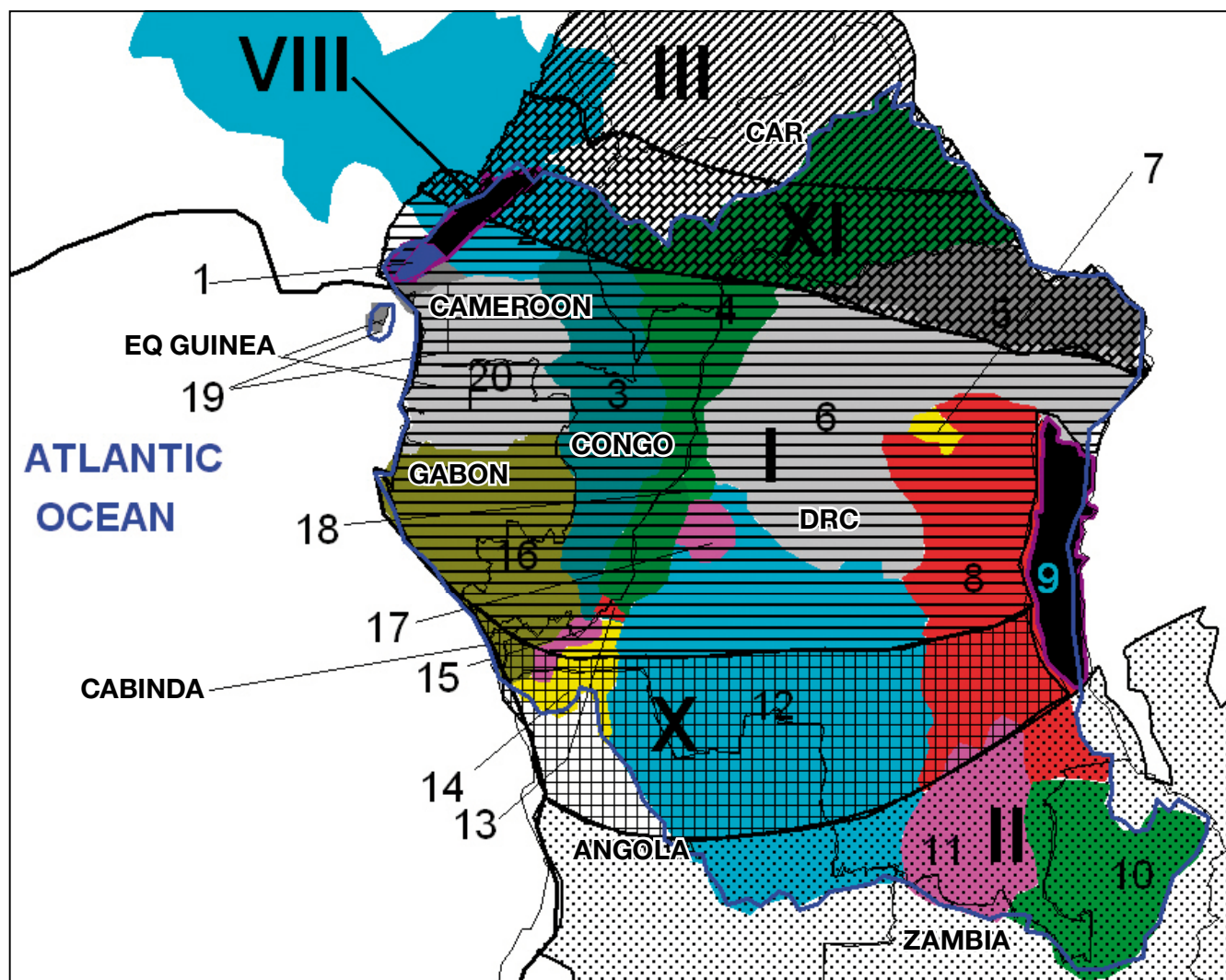
of endemism (VIII), the Guinea-Congolia/Zambezia regional transition zone (X) and the Guinea-Congolia/Sudania regional transition zone (XI). The region is mainly within the Congo basin although many rivers in the north, especially southern Cameroon (e.g., the Sanaga, Nyong, Ntem and Lokoundje Rivers) open directly to the Atlantic ocean, forming the "Atlantic basin" (Letouzey 1985).

## 7.2 Overview of the central African flora





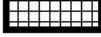




As for many parts of the continent, no regional Flora exists to date for the whole of central Africa. The *Flore d'Afrique Centrale* (formerly *Flore du Congo et du Rwanda et du Burundi*) series includes the Democratic Republic of Congo (DRC), Rwanda and Burundi only. The *Flora Zambesiaca* includes Mozambique, Malawi, Zambia, Rhodesia and Botswana and therefore covers just a small area of north-east Zambia within the central Africa region. The remaining floras of the region are national such as *Flore du Cameroun*, *Flore du Gabon*, *Flora de Guinea Ecuatorial* and the *Conspectus florae Angolensis*. All the above mentioned series are family (systematic)-based and none of them is complete. Typical thematic floras are nearly absent. Despite the publication of many

<sup>1</sup> The National Herbarium of Cameroon, PO Box 1601, Yaoundé – Cameroon.

Figure 7.1 Map of the central African Freshwater Ecoregions (Thieme *et al.* 2005) and the contours of the African phytochoria (White 1983). Map: © J.P. Ghogue.



#### A. Phytochoria

-  I. Guineo-Congolian regional centre of endemism
-  II. Zambezian regional centre of endemism
-  III. Sudanian regional centre of endemism
-  VIII. Afromontane archipelago-like regional centre of endemism
-  X. Guinea-Congolia/Zambezia regional transition zone
-  XI. Guinea-Congolia/Sudania regional transition zone
-  Countries border
-  Contour of the Afromontane achipelego-like Regional Centre of Endemism
-  Contour of the Central African freshwater assessment area

#### B. The Ecoregions

1. Western Equatorial Crater Lakes
2. Lower Niger – Benue
3. Sangha
4. Sudanic Congo – Oubangi
5. Uele
6. Cuvette Centrale
7. Upper Congo Rapids
8. Upper Congo
9. Albertine Highlands
10. Bangweulu – Mweru
11. Upper Lualaba
12. Kasai
13. Malebo Pool
14. Lower Congo
15. Lower Congo Rapids
16. Ogooue – Nyanga – Kouilou – Niari
17. Mai Ndombe
18. Tumba
19. Northern Gulf of Guinea Drainages – Bioko
20. Southern Gulf of Guinea Drainages

books (e.g. Chevalier 1913; Pellegrin 1924; Exell 1944; Silans 1958; Grandvaux Barbosa 1970; etc.), Checklists (Cheek 2004; Sosef *et al.* 2006; Onana *et al.* 2010) and many other publications, the current knowledge of the central African flora is still patchy.

Exclusively aquatic plants families are comparatively few. Most of the aquatic plants belong to families including also true terrestrial plants. Also, many aquatic plants can survive for a more or less long period on true terrestrial station.

This study was based on the definitions of aquatic plants established by Cook (1996, 2004) and we primarily based our investigation on a compiled list of aquatic plants families provided by the project. The 49 families included in our assessment are listed in Table 7.1.

### 7.2.1 The Guineo-Congolian regional centre of endemism

The Guineo-Congolian floristic region slightly extends into western Africa and is by far the most important in terms of wetlands species diversity, as it encloses more than half of the 20 freshwater ecoregions attributed to central Africa. There are about 8,000 vascular plant species in this phytochoria, of which more than 80% are endemic (White 1983).

Before deforestation became widespread, the greater part of this region was covered with rainforest and swamp forests (including riparian forests). The swamp forests are very different floristically, but are interconnected by a complex series of intermediates. Although occurring in the whole region, swamp forests are most extensively developed in the Zaire basin (White 1983).

Fifteen freshwater ecoregions are included in this phytochorion. They are:

**Lower Niger – Benue:** This ecoregion, made of tropical and subtropical floodplain rivers and wetland complexes, is mostly

represented in western Africa. In central Africa, it covers part of the Adamawa in Cameroon. Just to name a few, the true freshwater plants of this ecoregion are *Caldesia reniformis*, *Wiesneria schweinfurthii*, *Crinum natans*, *Aponogeton vallisnerioides*, *Dicraeanthus africanus*, *Ledermanniella cristata*, *Ledermanniella linearifolia*, *Ledermanniella sanagaensis*, *Ledermanniella thalloidea*, *Letestuellia tisserantii*, *Macropodiella pellucida*, *Saxicolella laciniata* and *Tristicha trifaria*.

**Sangha:** Permanent swamps increasingly dominate the landscape in the central and southern portions of the ecoregion. Periodically inundated swamp forest, large expanses of dense evergreen and deciduous rainforest and savannahs characterize the terrestrial landscape of the ecoregion. Some freshwater plants species of this ecoregions are: *Hygrophila uliginosa*, *Aponogeton troupinii*, *Aponogeton vallisnerioides*, *Anubias heterophylla*, *Lasimorpha senegalensis*, *Pistia stratiotes*, *Eclipta prostrate*, *Nesaea crassicaulis*, *Nesaea radicans* and *Rotala serpiculoides*.

**Sudanic Congo – Oubangi:** Aquatic plants are rather poorly represented in this ecoregion. This might be due to the under collection effort in CAR and in the two Congos. The few aquatic plants in this ecoregion include *Ranalisma humile*, *Utricularia gibba*, *Utricularia inflexa*, *Nymphoides forbesiana*, *Letestuellia tisserantii* and *Heteranthera callifolia*.

**Cuvette Centrale:** The vegetation of the ecoregion is primarily tropical rainforest. The following freshwater plants are found within this ecoregion: *Ranalisma humile*, *Crinum jagus*, *Grangea maderaspatana*, *Eclipta prostrate*, *Utricularia gibba*, *Utricularia foliosa*, *Utricularia inflexa*, *Utricularia gibba* and *Utricularia benjaminiana*.

**Upper Congo Rapids:** The vegetation of this ecoregion consists of primarily high tropical rainforest. The following freshwater plants are found in this ecoregion: *Crinum natans*, *Adenostemma perrottetii*, *Eclipta prostrate*, *Enydra fluctuans*, *Eichhornia natans*, *Eichhornia crassipes* and *Potamogeton octandrus*.

**Table 7.1 List of the 49 families of freshwater plants species assessed in central Africa.**

1	ACANTHACEAE	14	CRASSULACEAE	27	JUNCAGINACEAE	40	POLYGONACEAE
2	ALISMACEAE	15	CYPERACEAE	28	LABIATAE	41	PONTEDERIACEAE
3	AMARANTHACEAE	16	DROSERACEAE	29	LEMNACEAE	42	POTAMOGETONACEAE
4	AMARYLLIDACEAE	17	ELATINACEAE	30	LENTIBULARIACEAE	43	PRIMULACEAE
5	APONOGETONACEAE	18	ERIOCAULACEAE	31	LOMARIOPSIDACEAE	44	RANUNCULACEAE
6	ARACEAE	19	EUPHORBIACEAE	32	LYTHRACEAE	45	SCROPHULARIACEAE
7	AZOLLACEAE	20	GRAMINEAE	33	MARSILEACEAE	46	THELYPTERIDACEAE
8	CABOMBACEAE	21	HAEMODORACEAE	34	MENYANTHACEAE	47	TYPHACEAE
9	CAMPANULACEAE	22	HALORAGACEAE	35	NAJADACEAE	48	UMBELLIFERAE
10	CANNACEAE	23	HYDROCHARITACEAE	36	NYMPHAEACEAE	49	XYRIDACEAE
11	COMMELINACEAE	24	HYDROPHYLLACEAE	37	ONAGRACEAE		
12	COMPOSITAE	25	ISOATAACEAE	38	PLANTAGINACEAE		
13	CONVOLVULACEAE	26	JUNCACEAE	39	PODOSTEMACEAE		



**Upper Congo:** Riverine forests and swamps border the slow-flowing reaches. The terrestrial landscape undergoes a transition from savannah in the south to high equatorial forest in the north. The following freshwater plants are found in this ecoregion: *Crinum jagus*, *Crinum natans*, *Nymphaea maculata*, *Nymphaea nouchali*, *Eichhornia crassipes*, *Eichhornia natans*, *Heteranthera callifolia* and *Dopatrium macranthum*.

**Kasai:** With the exception of swamp forests in the lowermost river reaches, the vegetation of the ecoregion is primarily savannah with gallery forests lining the river valleys. The freshwater plants found in this ecoregion include *Limnophyton angolense*, *Lasiorhiza senegalensis*, *Grangea maderaspatana*, *Utricularia subulata*, *Rotala fontinalis*, *Nymphoides forbesiana*, *Nymphaea nouchali*, *Eichhornia natans* and *Potamogeton thunbergii*.

*Polygonum acuminatum* is one of the most common plants in wetlands and has a wide distribution. Photo: © J.P. Ghogue.



**Malebo Pool:** The ecoregion is defined by the extent of the Malebo Pool of the Congo River, located directly north of Kinshasa, spanning the border of the ROC and the DRC. The following freshwater plants species occur in the Malebo Pool: *Eclipta prostrata*, *Lasiorhiza senegalensis*, *Pistia stratiotes*, *Utricularia appendiculata*, *Utricularia gibba*, *Utricularia foliosa*, *Utricularia inflexa*, *Utricularia reflexa*, *Utricularia subulata*, *Nymphoides forbesiana*, *Buchnera capitata* and *Lindernia diffusa*.

**Lower Congo:** The terrestrial vegetation is a mixture of dense Guinean-Congolian moist forest and Guinean-Congolian grasslands. The freshwater plants of this ecoregion include: *Caldesia reniformis*, *Eclipta prostrata*, *Grangea maderaspatana*, *Utricularia benjaminiana*, *Utricularia gibba*, *Utricularia reflexa*,

*Ledermanniella cf. cristata* (VU). Memve'ele Waterfalls at Ebianemeyong near Nyabessan. Photo: © J.P. Ghogue.



*Ledermanniella linearifolia* (VU). Lobe waterfalls, 10 km South Kribi. This area is a famous tourist destination as the Lobe river goes directly into the sea through a series of waterfalls. It is unfortunately an important Podostemaceae collecting site in central Africa. Photo: © J.P. Ghogue.



*Dicraeanthus zehnderi* (CR) is only known from the Sanaga waterfalls at Edea and is one of the most threatened freshwater plant species in central Africa. Its range has been considerably reduced by a dam constructed about 30 years ago (now less than 100 m<sup>2</sup>). With the recent dam extension works, this species might be lost. Photo: © J.P. Ghogue.



*Nymphoides forbesiana*, *Najas graminea*, *Eichhornia natans* and *Heteranthera callifolia*.

**Lower Congo Rapids:** As the Congo River descends toward the Atlantic Ocean, the gallery forests line the rivers and tree-savannah vegetation covers the landscape. Some freshwater plants of this ecoregion include: *Crinum jagus*, *Eclipta prostrate*, *Grangea maderaspatana*, *Utricularia benjaminiana*, *Utricularia inflexa*, *Utricularia pubescens*, *Utricularia reflexa*, *Utricularia spiralis*, *Najas graminea*, *Nymphaea maculate* and *Eichhornia natans*.

**Ogooué - Nyanga - Kouilou - Niari:** The waters of this rainforest ecoregion are exceptionally rich in freshwater species. The following freshwater plants are found in this ecoregion: *Hypoestes potamophila*, *Crinum natans*, *Utricularia subulata*, *Nymphoides forbesiana*, *Nymphaea lotus*, *Ludwigia abyssinica*, *Persicaria senegalensis* and *Bacopa crenata*.

**Mai Ndombe:** Here *Crinum natans* is present as freshwater plant species, and naturally this ecoregion needs more collection effort as the freshwater aquatic plants are rather poorly mentioned.

**Tumba:** This ecoregion is defined by Lake Tumba and its adjacent swamp forests and lies near the equator within the DRC. The lake is surrounded by seasonal and permanent swamps and connects with the Congo River near its confluence with the Oubangui River. *Utricularia appendiculata*, *Utricularia benjaminiana* and *Utricularia subulata* are present as freshwater plants species in this ecoregion.

**Northern Gulf of Guinea Drainages – Bioko:** The ecoregion is located within an evergreen rainforest zone and includes parts of the Cameroonian highlands and mountain forests on Bioko. The following freshwater plants species are found in this ecoregion: *Crinum purpurascens*, *Pistia stratiotes*, *Struchion sparganophora*, *Monopsis stellarioides*, *Nymphaea lotus*, *Ludwigia octovalvis* and *Tristicha trifaria*.

*Eleocharis acutangula* (DD). This photograph was taken at a swamp near Douala, on the Edea –Douala highway in Cameroon. Photo: © J.P. Ghogue.



**Southern Gulf of Guinea Drainages:** In relation to plants, the southern Gulf of Guinea drainages ecoregion is the most well known of the whole central Africa biodiversity assessment area: most of the existing floras and checklists have been published within this ecoregion. Its membership with the generally rich Guineo-Congolian phytochoria might explain its high number of freshwater plants. They include: *Staurogyne letestuana*, *Ranalisma humile*, *Crinum purpurascens*, *Pistia stratiotes*, *Monopsis stellarioides*, *Utricularia subulata*, *Rotala welwitschii*, *Nymphoides indica*, *Najas marina*, *Nymphaea maculate*, *Ludwigia stenorraphe*, *Zehnderia microgyna*, *Polygonum acuminatum* and *Heteranthera callifolia*.

## 7.2.2 The Afromontane Archipelago-like Regional Centre of Endemism

This high altitude phytochorion made of Afromontane and Afroalpine communities, is distributed throughout the African continent and is mostly represented in the east (Ethiopia, Kenya and Tanzania), south-central (south-east DRC) and South Africa (Cap Peninsula). This formation also extends from western Africa to Cameroon, where it forms the western limit of the assessment area. In the Afromontane Regional Centre of Endemism there are at least 4,000 vascular plant species, of which around 3,000 are endemic or nearly endemic (White 1983). Two of the central African freshwater ecoregions fit into this phytochoria: the **Western Equatorial Crater Lakes** in Cameroon and the **Albertine Highlands** in the DRC.

**Western Equatorial Crater Lakes:** The general vegetation in the ecoregion consists of sub-montane forests between 900 and 1,800 m, and at higher elevations a mixture of montane elements including distinct montane forests and patches of montane grasslands, bamboo forests, and subalpine communities. The high altitude of this ecoregion gives birth to rapid rivers and waterfalls on volcanic rocks, therefore the true aquatic plants are dominated by the members of Podostemaceae family

*Stonesia ghoguei* (CR). This plant is known so far from the Tello waterfalls only, from an area less than 5 m<sup>2</sup>. The area is intensively grazed by cattle and is frequently visited by tourists. Photo: © J.P. Ghogue.





*Dicraeanthus africanus* (NT) at Mpume waterfalls at Makak. This is the largest Podostemaceae in central Africa (its flexible stem can grow more than one metre). Its distribution sporadically extends from Cameroon to Gabon. Photo: © J.P. Ghogue.

known to be exclusively associated to rapid waters. They are *Ledermanniella onanae*, *Ledermanniella variabilis* and *Macropodiella pellucida*.

**Albertine Highlands:** Vegetation varies across the ecoregion with elevation. Wet rainforest and semi-deciduous forest grow below the plateaus (elevation between 1,500–2,000 m asl), whereas the vegetation is primarily woody savannah at higher elevations on the plateaus. The following freshwater plants are found in this ecoregion: *Burnatia enneandra*, *Caldesia reniformis*, *Adenostemma perrottetii*, *Carduus nyassanus*, *Crassocephalum picridifolium*, *Crassocephalum picridifolium*, *Eclipta prostrate*, *Ethulia conyzoides*, *Lemna paucicostata*, *Nymphoides brevipedicellata*, *Nymphaea maculate*, *Nymphaea nouchali* and *Potamogeton schweinfurthii*.

### 7.2.3 The Guinea-Congolia/Sudania regional transition zone

This phytochoria, which separates the Guineo-Congolian and the Sudanian Regions, extends across Africa from Senegal to Western Uganda. The natural vegetation of this formation is various types of forests, however it has largely been destroyed by fire and cultivation, and is now mostly secondary and secondary wooded grasslands. This transitional zone is a mixture of about 2,000 species from Guineo-Congolian and Sudanian formations, or linking species with even wider distribution (White 1983). It encloses four of the central African ecoregions: **Lower Niger – Benue, Sangha, Sudanic Congo – Oubangi** and **Uele**. Except for **Uele**, the other three ecoregions extend into the Guineo-Congolian Regional centre of endemism which has been treated already in section 7.2.1.

**Uele:** A mosaic of Afromontane forest, gallery forest, wooded savannah, and grassland blankets the northern highlands of the **Uele** ecoregion. Savannas range from dense woodland to virtually treeless grassland. The freshwater landscape is dominated by the following plants species: *Wiesneria schweinfurthii*, *Crinum jagus*, *Aponogeton vallisnerioides*, *Enydra fluctuans*, *Utricularia*



*Ottelia ulvaeifolia*. This picture was taken in a stream near Bipindi. Photo: © J.P. Ghogue.

*subulata*, *Rotala stagnina*, *Nymphoides forbesiana*, *Nymphaea lotus*, *Nymphaea nouchali* and *Monochoria brevipedicellata*.

### 7.2.4 Zambezan Regional Centre of Endemism

This phytochorion extends from Atlantic Ocean in the west almost to the Indian Ocean in the east. It is the second largest phytochoria in Africa after the Sahara. The Zambezan Regional Centre of Endemism is characterized by the particular Zambezan vegetation (dry forest, woodland, thickets and grassland). It also probably has the richest and most diversified flora, and certainly shows the widest range of vegetation types. There are at least 8,500 vascular plant species of which c. 54% are endemic (White 1983). Within the central African assessment area, this phytochorion includes four ecoregions: **Upper Congo, Kasai, Bangweulu-Mweru**, and **Upper Lualaba**. The **Upper Congo** and **Kasai** overlap many phytochoria and have already been described above. The remaining ecoregions are described below.

**Bangweulu-Mueru:** This ecoregion is situated in the south-eastern corner of the DRC and north-eastern Zambia. The ecoregion is a component of the southern headwaters of the Congo River and include permanent swamps and shallow lakes of the Bangweulu-Mueru system. The following freshwater plants are found in this ecoregion: *Wiesneria schweinfurthii*, *Pancratium tenuifolium*, *Aponogeton vallisnerioides*, *Pistia stratiotes*, *Grangea maderaspatana*, *Triglochin bulbosa*, *Utricularia stellaris*, *Rotala serpiculoides*, *Nymphoides tenuissima*, *Najas pectinata*, *Nymphaea nouchali* and *Ludwigia leptocarpa*.

**Upper Lualaba:** The Upper Lualaba ecoregion lies within the Democratic Republic of Congo in the south-eastern portion of its Shaba Province and is dominated by a series of lakes. Among others, the following freshwater plants species are found in this ecoregion: *Wiesneria filifolia*, *Aponogeton vallisnerioides*, *Genlisea angolensis*, *Utricularia welwitschii*, *Rotala myriophylloides*, *Nymphoides brevipedicellata*, *Nymphoides forbesiana*, *Nymphoides indica*, *Nymphoides rautanenii*, *Najas*



*graminea*, *Potamogeton octandrus*, *Potamogeton schweinfurthii* and *Potamogeton thunbergii*.

### 7.2.5 The Guinea-Congolia/Zambezia regional transition zone

This transition zone separates the Guineo-Congolian and Zambezan regions and extends from the Atlantic Ocean to the Lake Tanganyika. There are about 2,000 vascular plant species, and very few of these are endemic. The greater part of this zone is today occupied by secondary grassland and wooded grassland dominated exclusively by Zambezan species (White 1983).

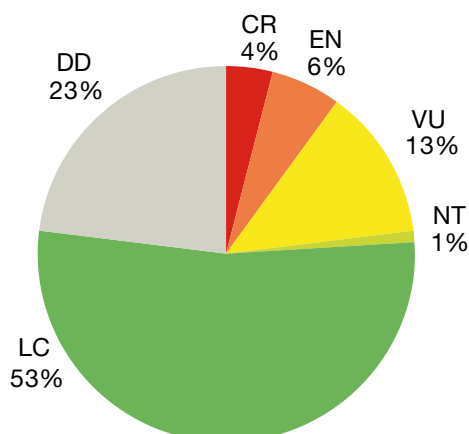
In the central Africa assessment area, this phytochorion covers four freshwater ecoregions: **Upper Congo, Kasai, Lower Congo and Lower Congo Rapids**. All of them overlap with the Guinea-Congolian phytochoria and have therefore been already described in the previous sections.

## 7.3 Conservation status (IUCN Red List Criteria: Regional scale)

A total of 435 freshwater plant species were initially identified within the central Africa region. Forty-three of these fell into the Not Applicable (NA) category and are not included in analyses. The regional Red List status of the remaining 392 species are given in Figure 7.2.

Fifty-three percent (209) of freshwater plants in central Africa are assessed as Least Concern (LC). A further six species (1%) are categorised as Near Threatened. Threats to freshwater biodiversity are mostly human induced and central Africa is generally under populated. Where present, the threat affects mostly the large rivers and large urban cities.

Figure 7.2 The proportion of aquatic plant species in each regional Red List Category in the central Africa region. IUCN Red List Category: CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient.



Eighty-nine (23%) of the species are not sufficiently documented to be given a conservation status, and are assessed as Data Deficient (DD). This is largely a result of species' under-collection or/and the difficulty of access to biological information (i.e. many museum collection have not been digitised and the information that they hold is generally unavailable).

Finally, 23% (88) of all freshwater plants assessed in central Africa are threatened. Most of the ecoregions supporting higher numbers of threatened species belong entirely or partially to the Guineo-Congolian Regional Centre of Endemism. The Guineo-Congolian phytochoria has long been recognized for its high level of endemism, most of its endemic species characterized by very restricted range, making them particularly susceptible to threats (such as pollution, uncontrolled exploitation and industrialization). A good demonstration of this is given by the Podostemaceae family constituting 29% of all threatened freshwater plants species in central Africa (Figure 7.3). Podostemaceae are submerged rheophytic herbs, growing in waterfalls and river-rapids. Their Area of Occupancy is generally narrow as they often occur in a single river and sometimes in only one waterfall.

Twenty-one families contain threatened species, and Figure 7.3 shows the total number of threatened species per family by threat Category. For the reasons already mentioned, the Podostemaceae family is the most represented in terms of threatened species and for all threat categories (29%), followed by the Cyperaceae (16%), the Eriocaulaceae (10%) and the Lythraceae (7%).

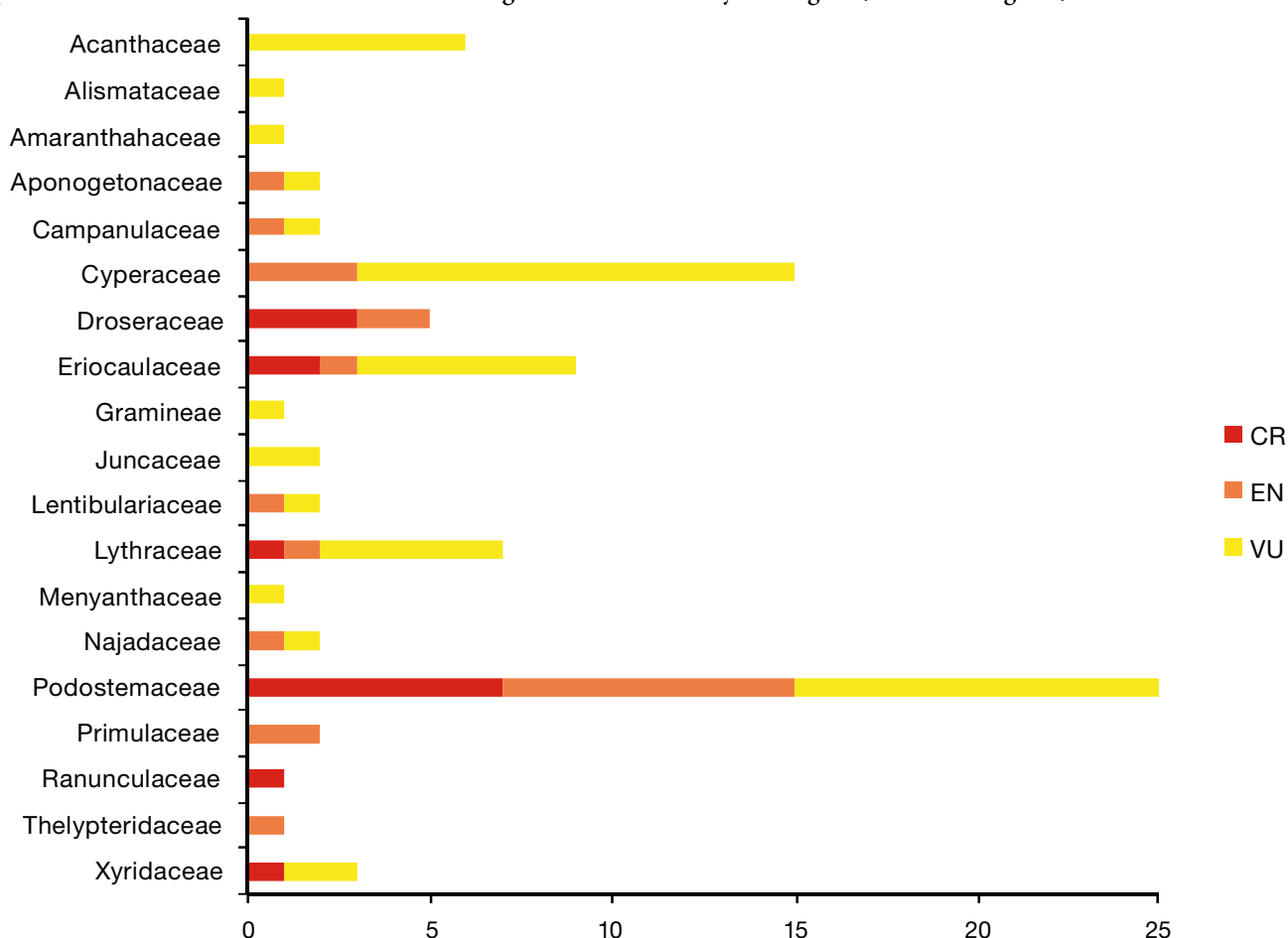
Five ecoregions have no threatened species at all. They are the **Upper Congo Rapids**, the **Albertine Highlands**, **Malebo Pool**, **Mai Ndombe** and **Tumba**. It is possible that in relation to plants, these generally narrow ecoregions are not large enough to constitute separate systems on their own. Also, all of them fall within DRC, where in general plants have been under collected.

*Ipomoea aquatica* Forsk. (Convolvulaceae). Here in University Lake at Yaoundé. Photo: © J.P. Ghogue.





Figure 7.3 Total threatened freshwater plant species in central Africa by families. A further 30 aquatic families have no threatened species within central Africa. IUCN Red List Categories: CR – Critically Endangered, EN – Endangered, VU – Vulnerable.



## 7.4 Freshwater plant diversity patterns and endemism in central Africa

Over the past decades, there has been renewed emphasis on locating centres of species richness or endemism, in attempts to optimize conservation strategies (Beentje *et al.* 1994; Linder 2001). For freshwater plants in central Africa, these two parameters, associated with regional threat level, will be highly relevant to the global prioritization of conservation efforts.

### 7.4.1 Freshwater plant diversity

The Mount Cameroon area is the most diverse in tropical Africa (Figure 7.4). This area includes Mt. Cameroon itself, the Korup forest and south to Libreville. The area immediately to the south, reaching to the Angolan border and inland to Kinshasa, is only slightly less diverse (Linder 2001). The ecoregions with the highest biodiversity are the **Southern and Northern Gulf of Guinea Drainages**, the **Western Equatorial Crater Lakes** and **Lower Niger Benue**. They all belong to the Guineo-Congolian Regional Centre of Endemism and their two related transitional zones, the Sudania and the Zambesia. They encompass four countries, mainly Cameroon south of the Adamawa, but also Gabon, Equatorial Guinea and western Republic of Congo. Some other small patches of high freshwater plants diversity are found in the

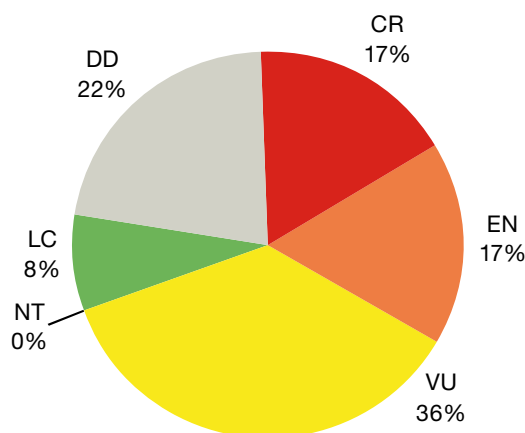
**Malebo Pool**, partly in the **Lower Congo** and **Upper Lualaba**, south west **Kasai** and to a lesser extent the Congo valley at the border between the two Congos.

### 7.4.2 Freshwater plant endemism

The rainforest centres from central to western Africa have long been recognized as centres of endemism (Linder 2001). Of these centres, the lower Guinea (Cameroon to Gabon) is regarded as having the highest number of endemic species. The endemic patterns of freshwater plants in central Africa generally follow that of the general vegetation (Figure 7.5). The ecoregions with the highest endemism are the same as for plant diversity, that is, the **Southern and Northern Gulf of Guinea Drainages**, the **Western Equatorial Crater Lakes**, **Lower Niger Benue** and to a lesser extent **Sangha**. This shows as stated by Linder (2001), that in central Africa, plant diversity and endemism are not truly independent. The ecoregions with highest endemism equally all belong to the Guineo-Congolian Regional Centre of Endemism and their two related transitional zones, the Sudania and the Zambesia.

Sixty species (15.3%) out of the 392 freshwater plants assessed are endemic to central Africa. Therefore, their regional red list assessment represents that of their global assessment.

Only 8% of those endemic plants are of Least Concern (Figure 7.6). This supports the previous statement that in the assessment area, there is a relationship between endemism and threat, with 70% of endemic species currently under global threat. Twenty-two percent (22%) of them have been assessed as Data Deficient. It is therefore urgent to collect more data in order to have a clear view of their true conservation status.



**Figure 7.6 Red List Categories of freshwater plants endemic to central Africa.** IUCN Red List Category: CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient.

## 7.5 Major threats to central Africa freshwater plants

The eternal problem of conservation is the incidence of regions of high biodiversity with regions with high human impact. Such biogeographic regions with a significantly high biodiversity which is subjected to human threat are termed ‘hotspots’. An index combining biodiversity and human impact has helped to redefine Africa’s hotspots of biodiversity (Küper *et al.* 2004). One of these hotspots covers (totally or partially) the **Southern and Northern Gulf of Guinea Drainages**, the **Western Equatorial Crater Lakes**, the **Lower Niger Benue** and in a lesser extent the **Sangha**. There is an evident overlap between the patterns of species richness and those of threatened species (Figure 7.7). Therefore, the freshwater plants diversity hotspot in central Africa should cover Cameroon south of Adamawa and east of the Cameroon system, the whole of Gabon and Equatorial Guinea and finally north west of the Republic of Congo (Figure 7.8).

The most significant threats to freshwater or wetland plant species in central Africa are human induced (Figure 7.9). Almost all categories of human activity induced threats to freshwater plants have been encountered in this assessment, including water and land pollution, human settlement, infrastructure development,

**Figure 7.4 Patterns of species richness of aquatic plants of central Africa, mapped to river sub-catchments.**

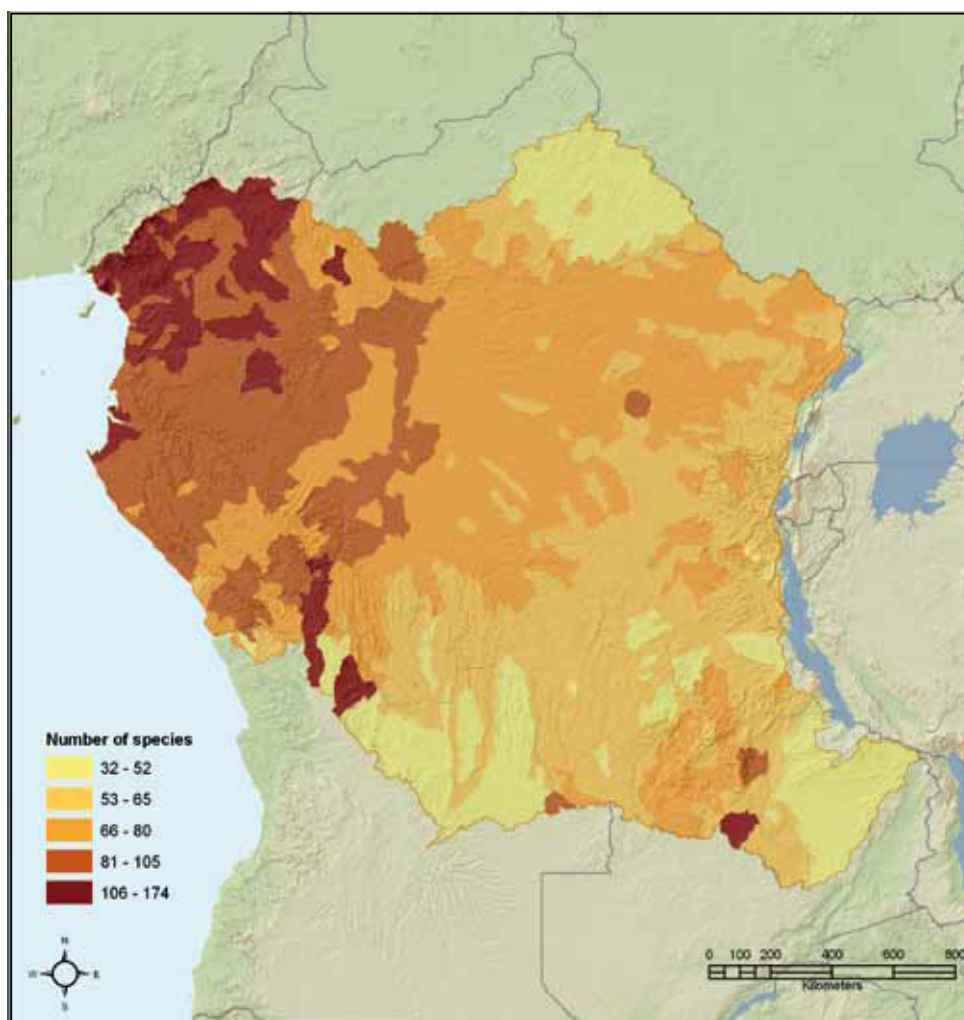


Figure 7.9 Percentage of aquatic plants species affected by threat categories in central Africa. Note that many species have more than one threat listed.

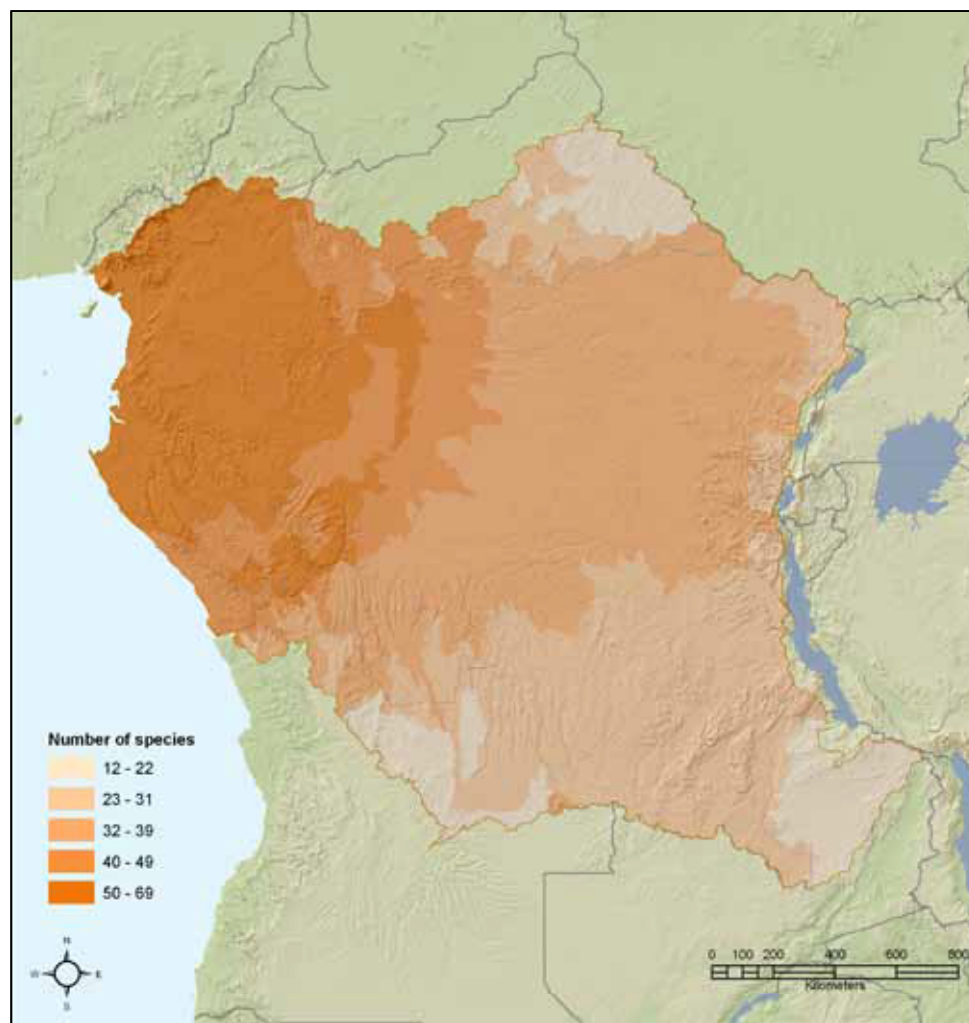
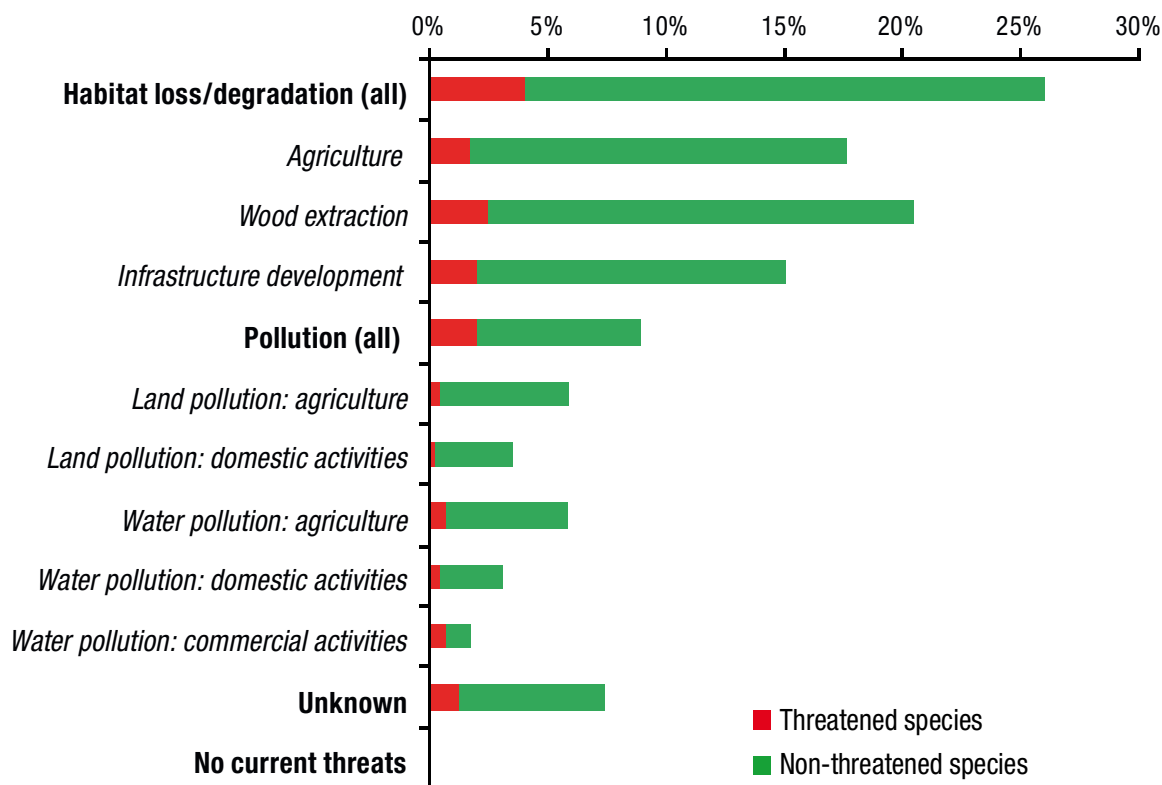


Figure 7.5 Endemic aquatic plants species richness in the central Africa region, mapped to river sub-catchments.



dam construction and agriculture, often leading to habitat degradation and loss.

## 7.5.1 Habitat degradation

### 7.5.1.1 Industrialization

Where environmental protection laws and regulations are absent, or for any reason are not implemented, waste waters and factory effluents, from mining as well as chemical industries such as soap and dye industries, enter directly or indirectly into nearby waterways. These waste waters and associated domestic waste waters cause the eutrophication of wetlands (small streams, rivers, lakes, marshes, swamps etc.). This can lead to the introduction and establishment of alien and native invasive species (see 7.5.2.1). In central Africa, the case is common in industrial cities such as Douala, Kinshasa, Brazzaville and Libreville.

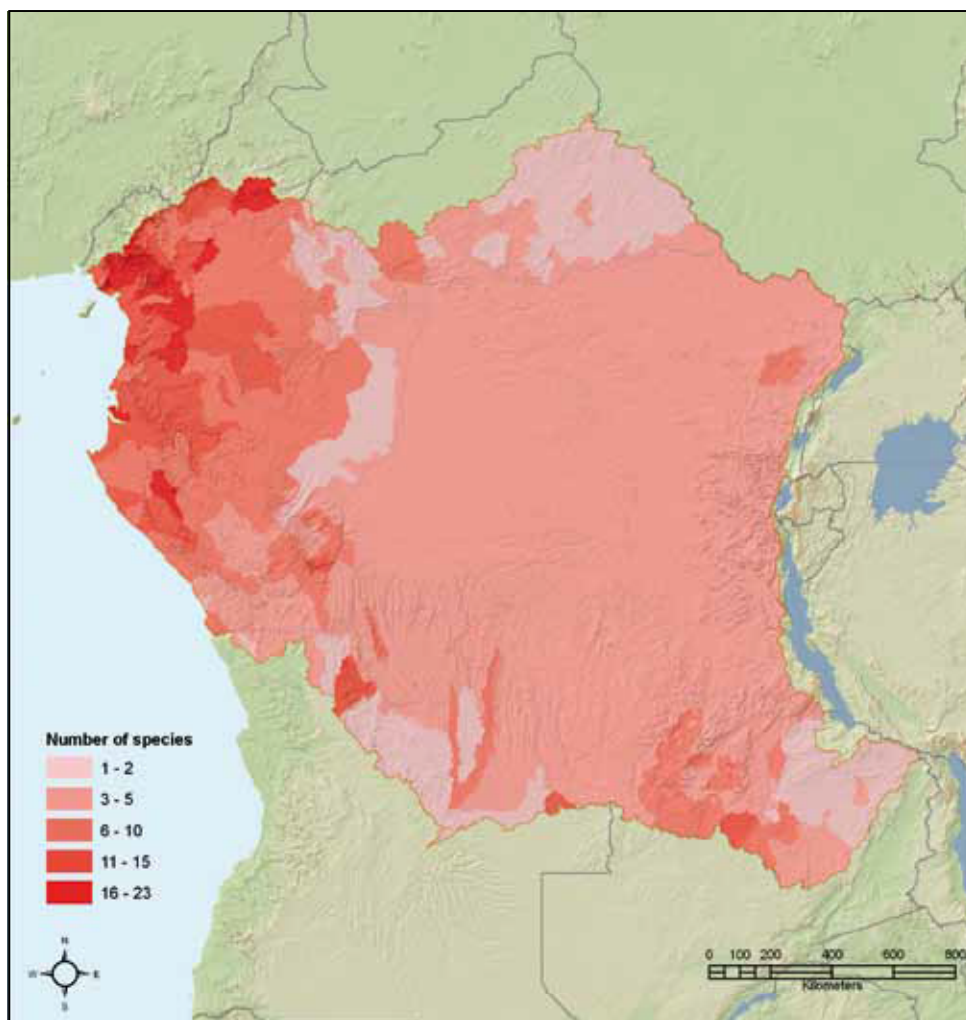
### 7.5.1.2 Urbanization

In most of the large towns and cities of central Africa, high human density is usually associated with intensive land use, and land's occupation laws and regulations are not always respected. Uncontrolled land occupation and exploitation is leading to an increasing problem of domestic waste handling and management.



Irrigation pipes in the highlands of Bafou (near Bamboutos Mountains). Photo: © J.P. Ghogue.

Figure 7.7 Threatened aquatic plants species richness in the central Africa region, mapped to river sub-catchments.





### 7.5.1.3 Agriculture

Agro-industry and market gardening can have long term harmful impacts on water quality and therefore affect freshwater biodiversity. These activities lead generally to water and land pollution. Both industrial agriculture and market gardening utilise high volumes of chemical fertilizers and pesticides, and are very demanding of water for irrigation, especially during the dry season.

After many years of market gardening with its negative impact on the environment, the composition of water in the rivers is strongly affected (Ghogue *et al.* 2010). For example, for many decades, intensive market gardening has been used in the highlands of western Cameroon, and industrial agriculture has been going-on in the lowlands south-west of same country around Limbe town (including rubber, banana, and oil palm plantations). Recently, the survey of very promising waterfalls and rapids showed no trace of Podostemaceae in these areas.

## 7.5.2 Habitat loss

Habitat loss in many cases is human induced and thus is similar to habitat degradation. There are multiple processes leading to habitat loss including the following:

### 7.5.2.1 Introduced species

Invasive plants can eventually lead to the total coverage of water bodies, supported by continuing habitat pollution. In such conditions, the reduction of species richness and diversity can reach 90% (Hejda *et al.* 2009). In central Africa, *Pistia stratiotes*, *Eichhornia crassipes*, *Cyperus papyrus* and to a lesser extent

*Lasiorhiza senegalensis* are the most important aliens responsible for water surface coverage and therefore biodiversity loss.

### 7.5.2.2 Human settlement

The establishment of new settlements and the expansion of existing townships often take place to the detriment of wetlands habitat. Swamps and other wet areas are dug, drained or filled for dwelling houses, industry establishment, agriculture or creation of recreation facilities (lawns, golf pitches and other recreation fields). The rivers shores are “done up” and waterproofed with concrete. Also, river courses are canalised and river banks concreted as part of flood defence works. Moreover, inadequate reforestation and plantation development will lead to increased water loss, resulting in dryer soils unsuitable for wetland species.

### 7.5.2.3 Infrastructure development

For transport reasons, many industries are developed along rivers, often leading to the disappearance of the original wetland vegetation. Good examples of this in central Africa are given by the Wouri River at Douala (Cameroon) and the Congo River at Brazzaville (Congo) and Kinshasa (DRC).

Dams are considered a solution to the serious energy shortages in central Africa, and there are many existing or proposed dams in almost all countries. Dams have been shown to have the potential for large impacts on freshwater plants, such as the Central Amazonian dams in South America (Quiroz *et al.* 1997). In Cameroon, eight endemic species are seriously threatened in two waterfalls of the Sanaga River (the Edea and Nachtigal falls); the former is already dammed and there is an advanced project of dam construction on the second. These species are *Dicraeanthus zehnderi*

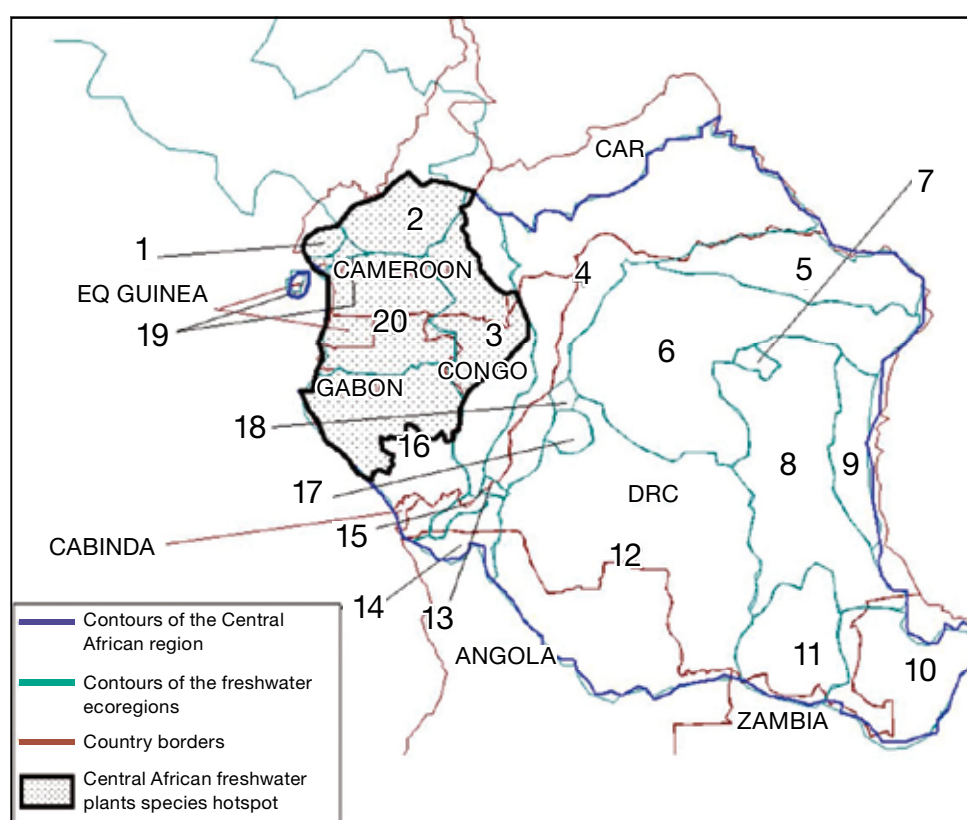


Figure 7.8 Map of the central African freshwater plant diversity hotspot, resulted from the superposition of the patterns of high diversity and threat.



(CR), *Winklerella dichotoma* (CR), *Zehnderia microgyna* (CR), *Ledermanniella sanagaensis* (CR), *L. schlechteri* (EN), *L. thalloidea* (CR), *Leiothylax quangensis* (EN) and *Letestuellia tisserantii* (EN). The first four species are endemic to the Sanaga River. The regional assessment for the conservation status of these species was carried out before the ongoing extension work on the Edea dam, which is expected to have further impacts on these species.

## 7.6 Utilisation of freshwater plants

The economic importance of freshwater plants in central Africa is considerable. Many aquatic plants have dietary and medicinal importance (accounting for 21% and 24% of utilised species respectively) for humankind as well as animals, and all parts of the plants can be used (tubercles, stems and leaves). They also

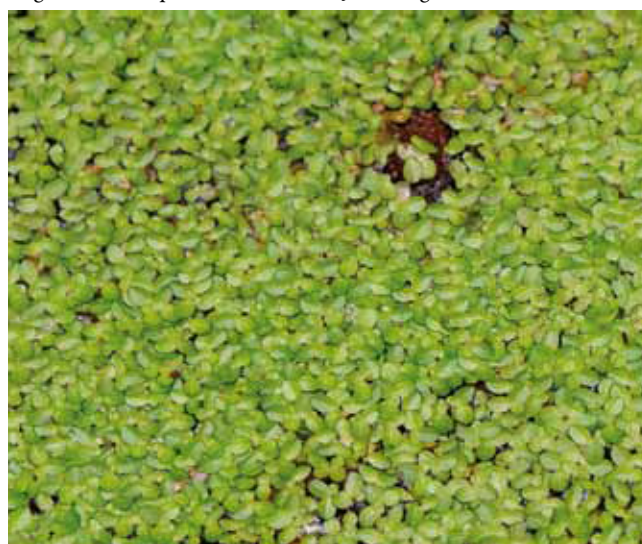
Polluted wetland around Nanga Eboko (East Cameroon), probably by a dyeing industry upstream. Note the deep black colour of the water.  
Photo: © J.P. Ghogue.



*Cyperus papyrus*, photographed in Yaoundé. This African native grows rapidly making it one of the most invasive plants of eutrophic wetlands. Photo: © J.P. Ghogue.”



*Lemna paucicostata*. Growing in a small stream at Yaoundé. This stemless floating plant is one of the best indicators of generally stagnant water's pollution. Photo: © J.P. Ghogue.





have cultural and spiritual importance, and are also used to produce ornaments and tools.

Twenty-nine out of a total of 50 (58%) freshwater plants families, comprising 89 species, have known uses. The most represented in term of number of plant species are Acanthaceae, Cyperaceae, Asteraceae, Araceae, Aponogetonaceae and Podostemaceae. About 45% of these species are totally aquatic (e.g. *Burnatia enneandra*, *Aponogeton abyssinicus*, *Lasimorpha senegalensis*, *Eclipta prostrate*, *Dicraeanthus africanus*, *Persicaria senegalensis*, *Eichhornia crassipes*, *Typha capensis* and *Xyris anceps*), while the remaining are wetland species. The most used central African freshwater plants are: *Cyperus papyrus* (VU), *Xyris anceps* (LC), *Pistia stratiotes* (introduced) and *Lasimorpha senegalensis* (LC).

## 7.7 Conservation recommendations

The proportion of Vulnerable species in central Africa is relatively high (13%). This is an alarm indicating that immediate action must be taken to deal with the factors /conditions resulting in the degradation and destruction of the habitats of freshwater plants, in order to avoid increasing the proportion of Endangered species (6%) or that of already Critically Endangered species (4%). Where applicable, if the threat pressure is maintained, the

species within the NT category might easily be upgraded to more threatened categories.

### 7.7.1 Data quality and availability

In all analyses on the central African freshwater plants, a key bias might result from the data quality. In fact, 23% of all species were assessed as Data Deficient. Once these species are better collected and documented, the updated data might change our current knowledge about the conservation status of the whole central African freshwater flora. For example, DRC is by far the largest country in central Africa, but important parts of the country lacks reliable data (Figure 7.11). Therefore, all conservation efforts in the country should take this fact into consideration. Our advice at this point is that more freshwater plants collection and documentation is urgently carried out in DRC.

The data availability is also a serious problem to freshwater biodiversity assessment in central Africa, because many historical collections are generally inaccessible. There are ongoing international projects aiming to solve this problem: The API (African Plants Initiative) aims to reproduce efficiently a set of images and associated informations of the type specimens of the African flora kept in northern and southern herbaria and to make them accessible through appropriate electronic and other means for use by everyone for scholarly purposes (Smith 2004).

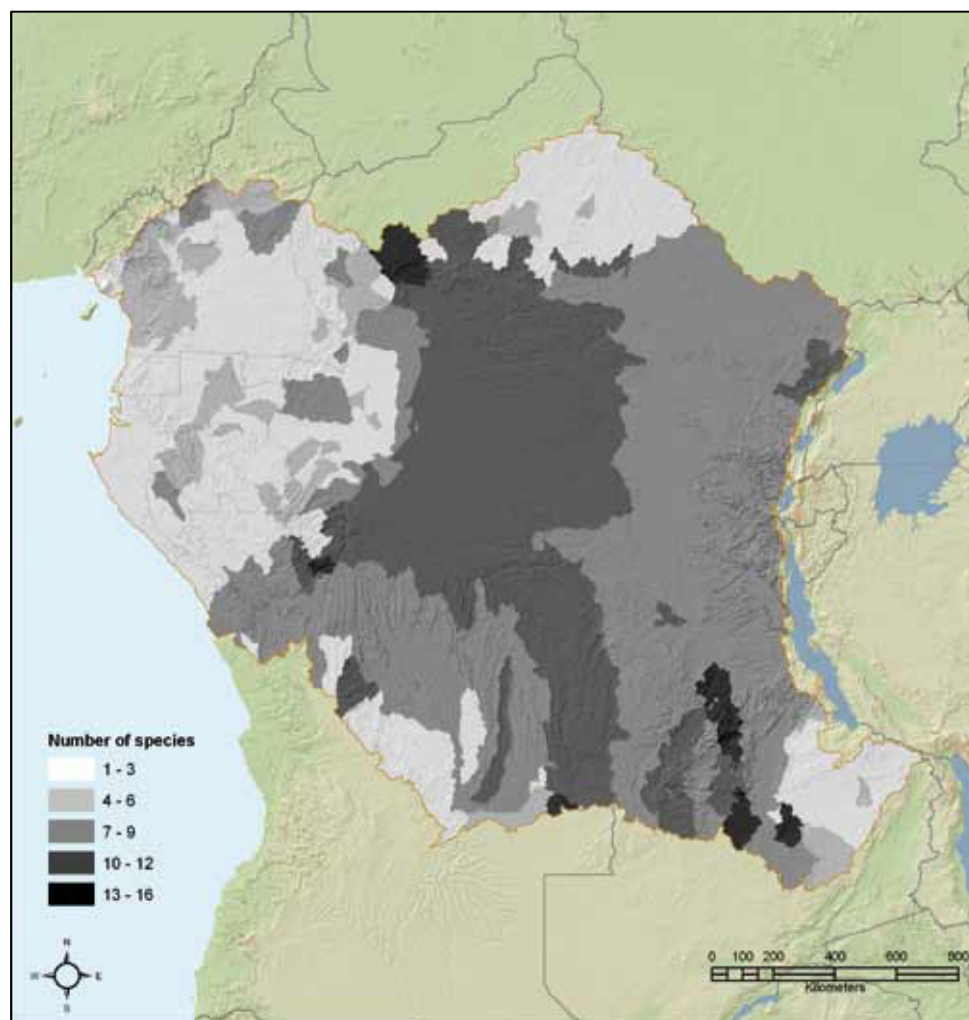


Figure 7.11 Data Deficient aquatic species richness in the central Africa region, mapped to river sub-catchments. Note that the Guineo-congolian's ecoregions have been relatively better explored and documented than those of DRC.

Also, GBIF is an international organization that is working to make the world's biodiversity data accessible everywhere in the world. GBIF and its many partners work to mobilize the data, and to improve search mechanisms, data and metadata standards, web services, and the other components of an internet-based information infrastructure for biodiversity. At this point, we encourage worldwide data holding institutions and individuals to join these initiatives to make the central African biodiversity information more accessible.

Thirteen (13) out of the 89 Data Deficient species are endemic to central Africa. They are *Adhatoda bolomboensis*, *Drosera elongata*, *Uapaca laurentii*, *Utricularia microcalyx*, *Xyris* species (*bampsii*, *densa*, *gossweileri*, *imitatrix*, *kundelungensis*, *kwangolana*, *lejolyana*, *popeana*, and *sanguinea*). It is therefore imperative that more data is collected for these species as many of them could already be seriously threatened.

### 7.7.2 Human welfare and conservation.

The human population of central Africa (this concerns the countries included in the watershed-based central Africa used in the frame of this study) is estimated to 148–152 million, with a mean population density of about 18–19 inhabitants/km<sup>2</sup> (PRB 2009, World Atlas

2010). Compared with other regions of the world and even with some countries, this population is rather low. In such conditions, the human's pressure on biodiversity in natural habitat is expected to be normally low. Nevertheless, the most important threat to freshwater or wetland plant species in central Africa has shown to be human induced. This is explained by the fact that about 74% of the population of the subregion live on less than 2\$US/day (PRB 2009) and there is a relationship between poverty and biodiversity loss (Adams *et al.* 2004; Fisher and Christopher 2007). Our recommendation at this point is addressed to governments of central Africa, as well as all decision makers, national and international stakeholders in the subregion: The current economical and financial policies should be revised and improved to ensure a better welfare of the population in central Africa.

### 7.7.3 Threats

The superposition of freshwater plant diversity patterns with threat patterns helped us delineating the contours of a freshwater phytodiversity hotspot in central Africa (Figure 7.8). This area is approximately one fifth of the whole central African area, but contains more than 70% of threatened freshwater plants. Our recommendation at this point is that freshwater conservation projects are immediately encouraged in this phytodiversity hotspot.

*Macropodiella heteromorpha* (VU). Here held by Hortense, guide and canoe driver on the Ntem River. The plant is collected at Memve'ele waterfalls at Ebianemeyong near Nyabessan. All the freshwater plants of these famous waterfalls are seriously threatened by an ongoing project of dam construction at the site. Photo: © J.P. Ghogue.





The most significant threats to freshwater plant species in central Africa are human induced, especially in the large rivers and in large urban cities. The following recommendations are made for governments, donors and stakeholders, directly or indirectly through conservation project makers:

- During the process of dam construction, prior to the project, Environmental Impact Assessments (EIA) must be carried out and the recommendations of the assessment report fully implemented. The experts carrying out the EIA should remember that there are plants living within the stream, and adequate technical measures should be planned to protect floral biodiversity before starting any construction work.
- For the already existing dams, a revised EIA should be urgently ordered and carried out in order to re-evaluate the impact of the dam on the biodiversity and the recommendations resulting from the assessment must be implemented.
- Agro-industry and market gardening in the long term reduce the water quality and therefore affect the freshwater biodiversity. Chemical fertilizers and pesticides should be restricted, and applied to crops only if absolutely essential.
- Town planning and land occupation in large urban cities should be sustained by strict laws, especially to reduce domestic waste issues, and be always supervised by qualified professionals.

- The non-existence or the non-implementation of environmental protection laws and regulations allows industrial wastes to reach wetlands leading to degradation of such habitats and subsequent invasion by native and alien aquatic species. The central African governments are aware that these laws and regulations should be strictly implemented.
- Central African governments should encourage the use of native species in the wetlands reforestation process to prevent soils drying out.
- Governments in each central African country should develop centres for aquatic and invasive plants, in order to centralise information sources, and monitor key populations.
- Out of the 21 threatened freshwater plants families, the Podostemaceae alone constitutes 29% of the total species. As the most important in terms of threaten species number, this freshwater plant family urgently needs special attention for conservation and projects should be encouraged in that direction.

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Lower Itimbiri, DRC. Photo: © K.-D. Dijkstra







*Eichhornia crassipes* (Water Hyacinth) is a superinvasive causing major degradation of water quality. Frequently covering the whole surface of the water, it prevents boat movement and threatens fisheries. Photo: © J.P. Ghogue.

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*Macropodiella pellucida* (EN). Taken at the Metchum waterfalls on the Bamenda–Wum road. This curious stemless flowering plant is endemic to Cameroon, but its occurrence might extent to East Nigeria. Photo: © J.P. Ghogue.



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