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Do floristic composition, plant species abundance and vegetation structure in Sudanian wetlands vary according to conservation status?

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In Sahel, wetlands are particularly endangered hence practical knowledge for their sustainable management is needed. The aim of this study was to compare plant community structure between protected and unprotected wetland bank stands in eastern Burkina Faso. Phytosociological and dendrometrical parameters were carrying out in adult trees, seedling individuals and herbaceous species. Discrimination of plant communities and diversity indices were calculated for each group.Weibull distributionwas used to comparethe diameter structures. The results shows that plant communities located in riverbanks of unprotected wetlands have a greater specificheterogeneity.They are rich inannual speciesand in species with a wide distribution. Finally their woody stands are characterized by lower basal areas than unprotected wetland riverbank stands. Plant community stands in riverbanks of protected wetlands were better preserved but some disturbances were noticed. Furthermore, juvenile plants of the two siteswere threatenedand this may affect in long term, the relative stability of these trees stands as revealed by Weibull distribution. Further study should focus on wetlands riverbanks seedling status in order to propose restoration strategies.

Key words:Burkina Faso, degradation, biodiversity, ecosystems, wetlands.

INTRODUCTION

Wetlands are complex ecosystems whose functions require practical knowledge for their sustainable management. According to the Ramsar Convention, wetlands include areas of marsh, permanent or temporary water, including their adjacent shores (Ramsar, 2013). The wetlands were identified to be a key landscape feature with substantial regulatory controls on environmental vitality (Naiman *et al*., 2010). The structural originality and diversity of riparian forest ecosystems can be explained by sediment transport of the river and the specific microclimate induced by the flow of water (Natta, 2003; Naiman *et al*., 2008). Moreover, these sites are often sacred woods protected by customs (Sokpon and Agbon, 1999; Savadogo *et al*., 2013)

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The presence of vegetation protects the riverbanks from erosion, regulates water quality, sediment deposition and contributes to the conservation of biodiversity (Belem, 2001, 2008; Naiman *et al*., 2008). In semi-arid Sudanian zones, including the Sahel, besides their ecological service, riparian ecosystems are found to have a high socioeconomic value. They provide timber and non-timber forest products to local populations (Natta, 2003). Moreover, this semi-deciduous vegetation is grazed during the dry period by livestock (Savadogo *et al*., 2007).

Wetlands are usually classified as endangered ecosystems, particularly in the Sahelian countries. Especially in African rural areas, wetlands may be degraded because of the pressure for their use (Boukpessi, 2003; Kaboré *et al*., 2013). Most riparian forests located outside protected areas are cleared for agriculture and market gardening (Fontes and Guinko, 1995). Increasingly, intensified management of watershed is being advocated in Burkina Faso (SP/CONEDD, 2010). In Burkina Faso, several studies have treated the topic of riparian vegetation (Belem, 2001, 2008; Savadogo *et al*., 2007; Sambaré *et al*., 2010, 2011; Kaboré *et al*., 2013). Wetlands are subject to fire disturbance with less frequency than elsewhere in the landscape due to their relative high density of the vegetation. Indeed, wetland ecosystems contain specific species and the importance of their biodiversity attracts the interest of people (Dan, 2009). The overgrazing of these sites (especially during the dry season) intensifies their degradation (Savadogo *et al*., 2007). Semi-arid Sudanian wetland vegetation is composed of semi-deciduous forests, woodlands and savannas located in the banks of rivers, streams, and semi-permanent water points. From a microtopographical perspective, Sambaré *et al*. (2010: 2011) distinguished three different types of micro-sites corresponding to the habitat of specific biodiversity in Burkina Faso. These were specifically, the watersheds with shorter or longer flood duration, the banks with a medium flood duration and adjacent land rarely flooded. The negative impact of climate change (drought or prolonged flooding of the riverbanks) or human pressure (agriculture, livestock, fuel wood cutting), lead to the degradation of semi-arid Sudanian wetlands plants communities structure. These disturbances threat the diversity and reduce the ecological resilience at the local scales (Assogbadjo and Sinsin, 2002).

Insufficient knowledge about semi-arid Sudanian wetland functions and related products limits their effective conservation (SP/CONEDD, 2010; Wetlands International, 2003; Sally *et al*., 1994). Biodiversity characterization is an effective way to assess land degradation and identify conservation strategies (Pueyo *et al*., 2006). Human disturbances on these biological reserves can be revealed using floristic analysis (Pueyo *et al*., 2006; Liu *et al*. 2009; Dossou *et al*., 2012). In Burkina Faso, previous studies in wetlands plants communities topic, have focused on the distribution of riparian vegetation according to phytogeographical sectors (Fontes and Guinko, 1995), establishment of taxonomic and structural characteristics of certain riparian vegetation (Belem, 2001, 2008; Da, 2006), the impact of the orientation of the flow on the flora of riparian forests (Kaboré*et al*., 2013), analysis of plant diversity according to wetland types, microtopography and phytogeographical sector (Sambaré *et al*., 2010, 2011). Even though the riparian forest biodiversity has been studied, there is paucity in knowledge of the impact of conservation status on wetland phytodiversity at a local level.

The objective of this study is to compare the diversity and the structure of plant communities in wetland riverbank stands of protected and unprotected areas. We hypothesize that, the diversity and the dynamic of semi-arid Sudanian riparian forest plants depend on the conservation status.

MATERIALS AND METHODS

Study Area

The study area is located in the South-East of Burkina Faso, in the provinces of Gourma and Kompienga (Figure 1). It comprises the Partial Wildlife Faunal Reserve of Pama and the surrounding agroecosystems. Pama partial wildlife reserve (223.500 ha) is established since 1955 and is classify by International Union of Conservation of Nature (IUCN) as part of the protected (fourth category).Because of the agricultural potential of this region, there is an increasingly migration of populations from other provinces of the country to the study area. A strong correlation between environmental degradation and human pressure is observed in this region over the past two decades (PRIPODE, 2006; Soulama *et al*., 2015).

Largely located in the north Sudanian sector, a small part of the study area belongs to the south Sudanian district (Fontes and Guinko 1995). The unimodal rainfall pattern is characterized by annual rainfall (June to October) between 700 and 1000 mm. Temperature fluctuates between 25 ° C and 39 °C. The vegetation is dominated by savannas and some dry forests such as riparian forests and gallery forests (Hahn-Hadjali, 1998; Mbayngone *et al*., 2008b). The landscape is flat with elevations between 250 and 300ma.s.l. and is dominated by a vast plateau and granite hills and inselbergs. The main soils are ferruginous leached soils with the presence of hydromorphic soils along river banks (Mbayngone *et al*., 2008b).

Pama Reserveis rich in bird and wildlife. The most common mammals are elephant (*Loxodonto africana*), lion (*Panthera leo*), buffalo (*Syncerus caffer*), the roan antelope (*Hippotragus equinus*), hartebeest (*Alcelaphus buselaphus*), bushbuck (*Tragelaphus scriptus*),

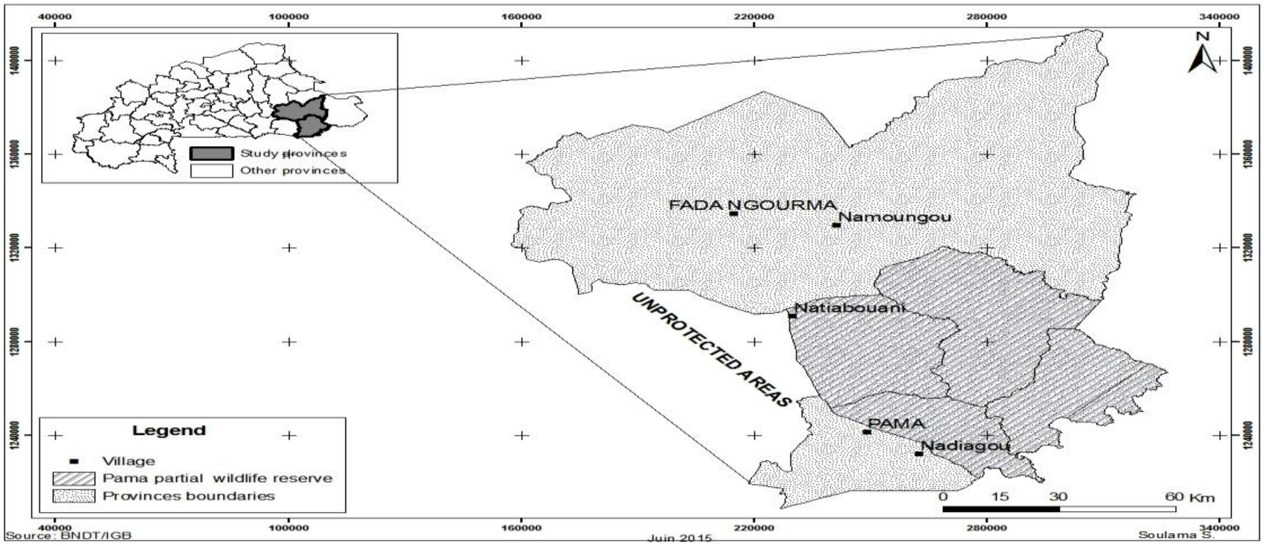

Figure 1: Study area

warthog (*Phacochoeurus aethiopicus*), waterbuck (*Kobus ellipsiprymnus), the cob redunca* (*Redunca redunca*), common duiker (*Cephalophus grimmia*), the ourebi (*Ourebi ourebi*), the patas monkey (*Erythrocebus patas*), the baboon (*Papio anubis*), vervet monkey (*Cercopithecus aethiops*) and hippopotamus (*Hippopotamus amphibius*).
Peoplemainlypracticerain-fedagricultureandmarket gardening, livestock breeding, fishing or hunting. Agriculture is characterized by a low level of mechanization.

Data Collection

To assess the impact of humans on plant communities, we sampled vegetation characteristics from two areas with different conservation status. The first site is PamaFaunal wildlife reserve which is strictly protected against human activities. The second site is located outside the reserve where human population and livestock have unrestricted access to ecosystem resources. Floristic data were recorded at the end of two consecutive rainy seasons (September-October 2011 and 2012). Phytosociological data were collected in 60 plots of 50 m × 20 m for woody vegetation. Within each plot a sub-plot of 10 m × 10 m was established for the herbaceous inventory and two sub-plots of 5 m × 5 m for tree regeneration assessment (Ouédroago, 2006; Kaboréet *al*., 2013). Individuals of tree species were classified as mature trees if their Diameter at Breast Height (DBH) was ≥ 5 cm and seedlings otherwise. All species were recorded following the nomenclature applied in the International Plant Names Index (www.ipni.org).

Species Diversity Analysis

Factor analyses by Detrended Correspondence Analysis (DCA) were first performed using PCOrd 6.0.DCA is a technical analysis of indirect environmental gradients. The objective of the DCA was to rank plant groups in relation to their conservation status.
Floristic diversity was assessed using Shannon–Weiner's diversity index (H'), Pielou evenness (E), Jaccard dissimilarity index (D) and the biological spectrum or phyogeographical spectrum. These indices are defined respectively by the following equations:

$$H = -\sum_{i=1}^{S} pi \ln pi \quad \text{Eq. (1)}$$

Where pi is the relative abundance of species i and S the number of species. The relative abundance has been calculated using Braun-Blanquet (1932) abundance-dominance coefficients.

$$E = \frac{H}{\ln S} \qquad \text{Eq. (2)}$$

Abundance Analysis and Determination of Diagnostic Species

The structure of the frequency of plants was determined using species frequency of occurrence. The frequency of occurrence of a given species is the ratio expressed as a percentage of the number of records where this species is noted with the total number of such records (Dajoz, 2006).

$$F = \frac{P_a}{P} x100 \quad \text{Eq. (3)}$$

F is the occurrence frequency of the species, Pa is the total number of records containing a particular species, and P is the total number of records.

Dajoz (2006) has distinguished three groups of species according to their frequency: the species of the first group are called constants (common species) when they are found in 50% or more surveys in the same community; those in the second group are accessories because they are only present in 25-49% of the surveys; finally, accidental species have an occurrence frequency below 25%.

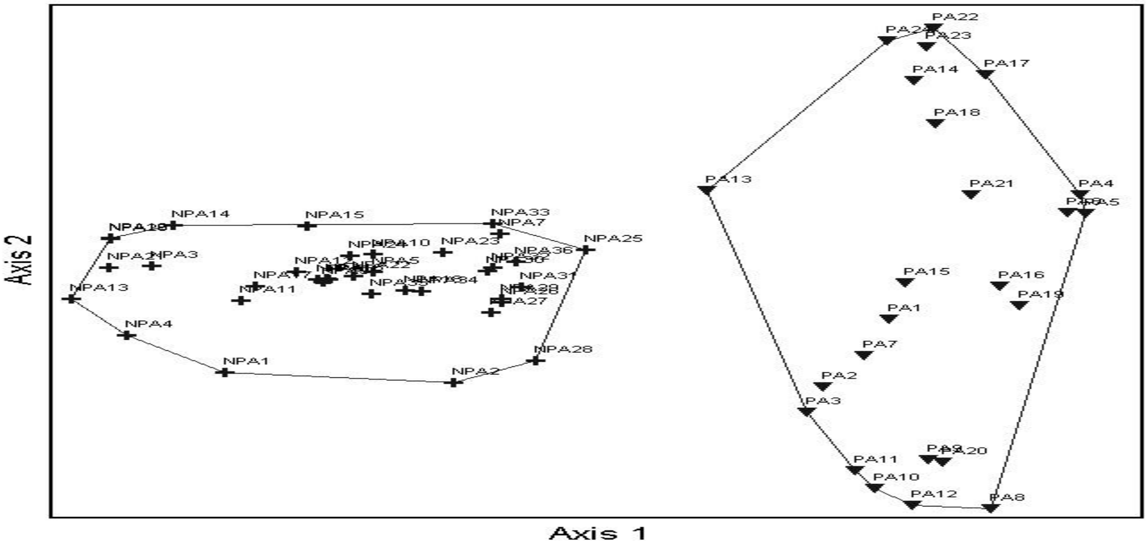

Figure 2: Ordination diagram of 60 plots based on the protection status: PA: protected riverbank plant communities (24 plots); NPA: unprotected riverbank plant communities (36 plots).

Diagnostic species or characteristic species were ascertained by fidelity determination through the method of Dufrene and Legendre (1997). The concept of diagnostic species, measure the co-occurrence of species in vegetation units is closely associated with fidelity. The fidelity concept is a comparison between the observed species frequency measurement in a vegetation unit (Chytry *et al*., 2002; Willner *et al*., 2009).

Structure Analysis

Structural characteristics were computed for each plot. The structural parameters used in this study are species abundance, density and diameter at breast height (DBH) of woody species equal or greater than 5 cm (dbh ≥ 5 cm). Moreover, quantitative inventory of the regeneration stratum (dbh< 5 cm) based on counting and measurement of the height of individuals. Basal area (BA) was computed through the following formula:

$$BA = \frac{10000\pi}{4s}\sum_{i=1}^{n} di^2 \qquad \text{Eq. (4)}$$

Dbh data of all trees (dbh ≥ 5 cm) were computed and assembled in diameter classes of regular interval of 5 cm. The density of individuals per diameter class and per wetland management regime was also computed. The Weibull theoretical distribution model was used as indicator for population structure. The observed shape was adjusted to the 3-parameter Weibull theoretical distribution (Rondeux, 1999):

$$f(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1} \exp\left[-\left(\frac{x-a}{b}\right)^{c}\right] \text{Eq. (5)}$$

Where x is the tree diameter; a = position parameter (= 5 cm); b = scale parameter linked to the central value of diameters; c = shape parameter of the structure.

For each wetland type, diameters of trees were used to estimate the parameters b and c of Eq. (5) based on the maximum likelihood method. The adjustment of the Weibull distribution to the histograms helped in describing and interpreting the shape of the stem diameter structures. MINTAB 14 was used for stem diameter distribution analysis and ANOVA tests were used to compare groups.

RESULTS

Floristic composition, diversity and life forms

The results of the DCA applied to the matrix of 60 plots × 329 recorded species, show the distribution of wetland adjacent plant communities depending on the conservation status. The plots established in wetland banks are divided into two clusters (Figure 2). Plots which have been established in non-protected wetland shores were assembled in the left and plots obtained from protected wetland shores were in the right.

Table 1: Axes characteristics

Axis	Eigenvalue	Gradient Length	CPVE	Totalinertia
1	0.65	4.06	0.38	7.94
2	0.44	3.54	0.43	

CPVE : Cumulative percentage of variance explained

In the protected wetland, a total of 177 species (dbh ≥ 5 cm) distributed in 121 genera and 49 families were identified while in the unprotected wetland, 294 species belonging to 59 families and 187 genera were identified. The most common plants families found in riverbanks were

Table 2: Structural characteristic of wetlands riverbanks plants communities' types

	Label	Herbaceous stratum				Woody stratum			
		Protected area	unprotected area	F [1; 58]	P	Protected area	unprotected area	F [1; 58]	Prob.
Families richness	Fam	20	37			35	35		
Genera	Gen	68	121			55	70		
Total species richness	TSR	93	189			84	105		
Species richness average per plot	RSM	14.75 ± 0.03	36.58 ± 0.03	72.15	0,000	17.83 ± 0.04	19.28 ± 0.03	0.587	0.447
Shannon index	H' (bit)	4.15 ± 0.007	4.75 ± 0.004	58.04	0,000	4.07 ± 0.007	4.20 ± 0.005	10.36	0.002
Pielou index	E	0.92 ± 0.001	0.91 ± 0.001	4.86	0.031	0.92 ± 0.002	0.90 ± 0.001	13.95	0,000
Jaccard index	Cs	0.4	0.4			0.7	0.7	-	-

Probability values were derived from ANOVA on data of the diversity parameters

Table 3: Most dominant families of wetland riverbank plants

Families	Herbaceous stratum: Protected area (%)	Herbaceous stratum: Unprotected area (%)	Families	Woody stratum: Protected area (%)	Woody stratum: Unprotected area (%)
Poaceae	37.63	27.51	Leguminosae	22.62	28.04
Leguminosae	18.28	15.87	Combretaceae	15.48	12.15
Acanthaceae	4.30	5.29	Rubiaceae	5.95	8.41
Cyperaceae	4.30	5.82	Tiliaceae	5.95	4.67
Lamiaceae	4.30	3.17	Anacardiaceae	4.76	3.74
Rubiaceae	4.30	3.70	Euphorbiaceae	3.57	3.74
Others	28.88	38.63	Others	41.66	39.25

Leguminosae and Combretaceaefor woody species and Poaceae and Leguminosaefor herbaceous (Table 3).The Poaceae family had the highest species diversity in the riverbanks within the Reserve (35 species) and in the unprotected area (50 species). Average values of diversity parameters were relatively different between plant communities of the two wetland types (Table 2).Shannon-Weaver diversity indices (H ') and Pielou evenness (E) vary slightly in the two sites. Regarding herbaceous species, Jaccardindex showed dissimilarity between the two sites (D = 0.40) while woodyspecies ofthesetwositeswerealmostsimilar(D=0.70).

Plant biological type analysis showed the dominance of Therophytes in wetland plant communities located in unprotected areas while Phanerophytes were dominant in protected wetland plant communities. Other life forms such as Chamaephytes, Hemicryptophytes, Geophytes and Helophytes were very poorly represented (Figure 3 A).Regarding plant geographical distribution aspects, Sudanian and Sudano-Sambesian species were the most common ones found in wetland riverbanks within protected areas while the Pantropical species of broad distribution were dominant in unprotectedriverbanks (Figure 3 B).

Species Occurrence and Diagnostic Species

The Figure 4 shows the importance of accidental species in wetland shores according to the status of protection while Figure 5 shows the distribution of species richness according to the frequency of families. Families with one or two species were very common (left part of the curve) while families with many species (e.g. >10) were quite rare. In PamaReserve riverbanks, 27 families (56 % of families)had only one species while in unprotected riverbanks about 24 families (41 % of families) had only one species. Among the accidental species, more than 53 species (32 herbaceous, 21 woody) were recorded only one time in the wetland located in the Reserve while in non-protected area wetland banks, this number was 77 species (51 herbaceous, 26 woody). The diagnostic species at both sites are given in Table 4 below.These diagnostic species show a strong presence of species of dry ecological environments and grazing indicator species.

Structural Analysis

Table 5 gives means of structural parameters (basal area, adult plants and seedling density) between plants

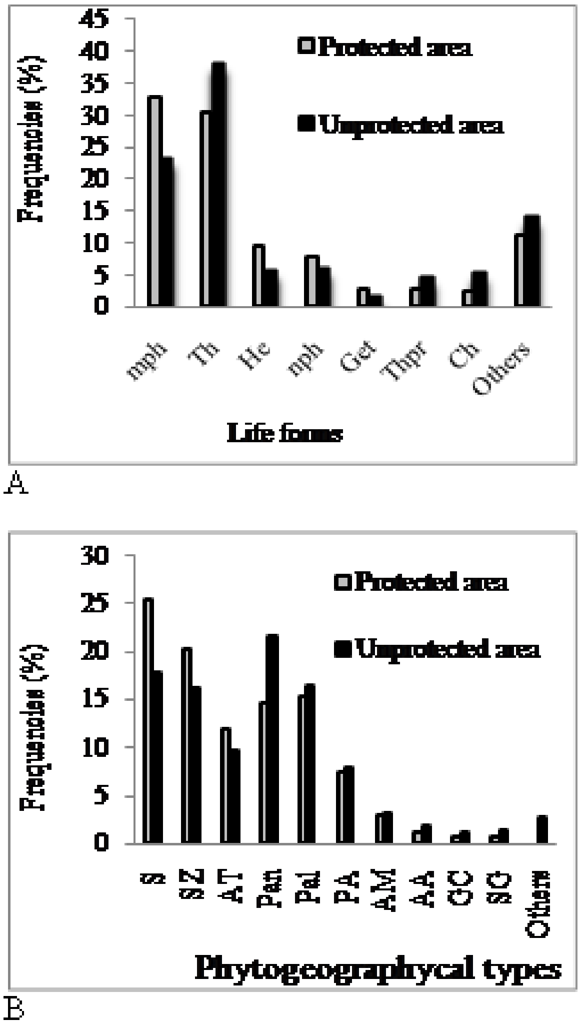

Figure 3: Life forms (A) and phytogeographical types (B) according to sites status

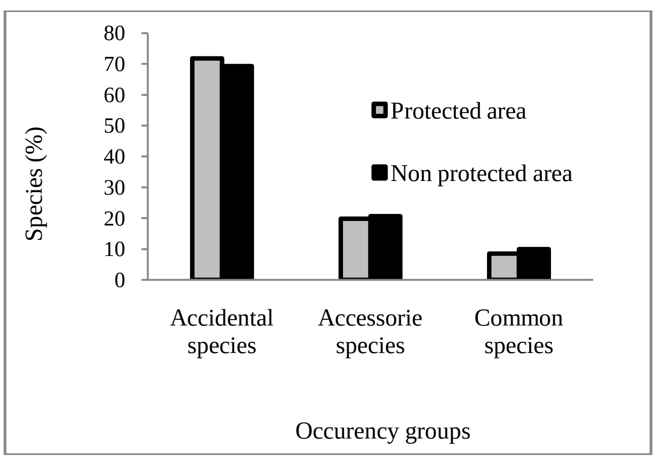

Figure 4: Speciesimportance based on theiroccurrenceatthewetlands banks

communities in protected and non-protected wetlands riverbanks. The basal area was higher in protected wetlands banks than in non-protected wetlands banks. Butadult woody plants density and seedling density did not vary significantlybetween protectedandunprotectedwetlands shores. On the other hand, individuals of 0-5 cm height class were more abundant than those with height >5 cm($F_{[1, 198]}$ = 48.2, P = 0.000). Their respectivedensitiesaveraged11236± 10990 individuals/haand 3340± 2925individuals/ha.

Regarding the structure of plant groups, our results showed that the shape parameter of the Weibull distribution is less than 1 for all plant groups(Figure 6).Wetland bank woody plants located in both types of sites were characterized by multi-species, with different ages and a predominance ofyoung individualsor small diameter.

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DISCUSSION

Species Richness

Theordination allows the understanding of the relationship between vegetation and environment (Bouxin, 2008).Protected wetland riverbank plant communities were discriminated between non-protected ones; by DCA results (Figure 2).Axis 1 can be interpreted as a human pressure gradient. The wetlands sites located outside protected areas were more degraded than those inside Pama Reserve regarding composition, richness and basal areas of plant communities. This was confirmed by the beta diversity index (Jaccard index) which states that the difference between these species from two sites is mainly due to the contribution of herbaceous flora (D = 0.4). The woody flora did not vary significantly between the two sites (D = 0.7).Plants communities located in non-protected wetland riverbanks were richer in species (1.66 times), genera and families, than protected areas. Regarding the herbaceous layer, the averagespecies richnessper plotis2.48times higherin unprotected riverbank plant communities. As for woody plants, there was no significant difference in the average species richness between the two sites (P =0.45).The Poaceae family displays an important role in the species richness distribution between the two sites because it had the highest number of species while most families had only one or two species.

There was a significant difference in the composition and the species richness between the two areas, especially in the grass layer (P < 0.000). Species richness is known to

Table 4: diagnostic species of riverbanks plants communities

Vegetation units	**Diagnostic species**	**IV (%)**	**P-value**
Wetlands banks located in protected area	*Anogeissus leiocarpa (DC.) Guill. &Perr.*	85.4	0.001
	Rottboellia cochinchinensis (Lour.) W.D. Clayton	64.6	0.001
	Andropogon gayanus Kunth	64.2	0.001
	Tephrosia bracteolata Guill. &Perr.	59.4	0.001
	Stereospermumkunthianum Cham.	57.9	0.02
	Andropogon pseudapricus Stapf	57	0.005
	Combretum adenogonium Steud. Ex. A. Rich.	49.7	0.006
	Pterocarpus erinaceus Poir.	39.5	0.006
	Andropogon tectorum Schum. & Thonn.	29.9	0.005
	Grewia cissoides Hutch. & Dalz.	29.5	0.032
	Indigofera colutea (Burm. f.) Merrill	29.4	0.003
	Sorghastrum bipennatum (Hack.) Pilg.	25	0.008
Wetlands banks located in unprotected area	*Pennisetum pedicellatum Trin.*	81.8	0.001
	Cassia obtusifolia L.	80.6	0.001
	Tephrosia pedicellata Bak.	77.6	0.001
	Triumfetta pentandra A. Rich.	76.1	0.001
	Setaria pumila (Poir.) Roem. Et Schult.	66.8	0.001
	Sida alba L.	66.3	0.001
	Leucas martinicensis (Jacq.) R. Br.	63.9	0.001
	Alysicarpus ovalifolius (Schum. & Thonn.) J. Léonard	61.2	0.001
	Balanites aegyptiaca (L.) Del.	61.1	0.001
	Digitariahorizontalis Willd.	61.1	0.001
	Sida urens L.	58.6	0.001
	Chloris pilosa Schumach.	58.3	0.001
	Corchorus tridens L.	55.6	0.001
	Dactyloctenium aegyptium (L.) Wild.	44.4	0.001
	Hyptis spicigera Lam.	53.9	0.002
	Ipomoea eriocarpa R. Br.	53.8	0.003
	Wissadula rostrata (Shumach.) Hook. f.	38.9	0.003
	Brachiaria lata (Schumach.) C.E. Hubbard	63.3	0.006
	Sporobolus pyramidalis P. Beauv.	46.5	0.006
	Eleusine indica (L.) Gaertn.	33.3	0.006
	Feretia apodanthera Del.	48.5	0.07
	Stylosanthes erecta P. Beauv.	38.9	0.007
	Acanthospermum hispidum DC.	36.1	0.007
	Mitracarpus scaber Zucc.	36.1	0.007
	Ziziphus mucronata Willd.	22.2	0.04

<1% significance level is retained from the Monte Carlotest

be higher in degraded forests than in non-degraded one. Previous studies have shown a correlation between site degradation and their specific heterogeneity (Devineau *et al*., 1997; Bangirinama *et al*., 2010). Thereby DCAandbeta diversity results above were confirmed; the wetlands sites located outside protected areas were more degraded than those inside Pama reserve, regarding plant communities' composition and richness. Given the Sahelian context where livestock and human pressure on the wetlands are important (Natta, 2003; SP/CONEDD, 2010), unprotected wetlands forest degradation, is essentially due to the anthropogenic effects (agriculture and overgrazing). These disturbances cause a regressive succession in plant communities (Do *et al*., 2011).

Table 5: Means and standard deviation of structural parameters of wetlands shores plants

Parameters	Protected area		Non-protected area			
	m	std	m	std	F	P
Basal area (m2/ha)	23.38	5.07	10.95	1.91	F [1; 58] = 6.85	0.01
Adult trees density (individuals/ha)	498.75	322.76	546.94	394.19	$F_{[1, 58]} = 0.25$	0.62
Seedling plants density (individuals/ha)	4967	3477	6371	6197	$F_{[1, 93]} = 1.60$	0.21

Probability values were derived from ANOVA on data of structure parameters
m:mean ; std: standard deviation

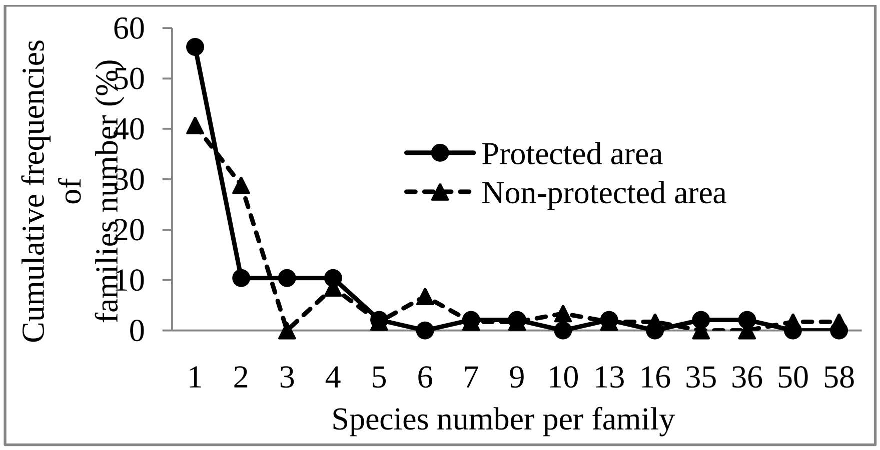

Figure 5: Distribution of species richness per family in wetlands banks according to their protection status

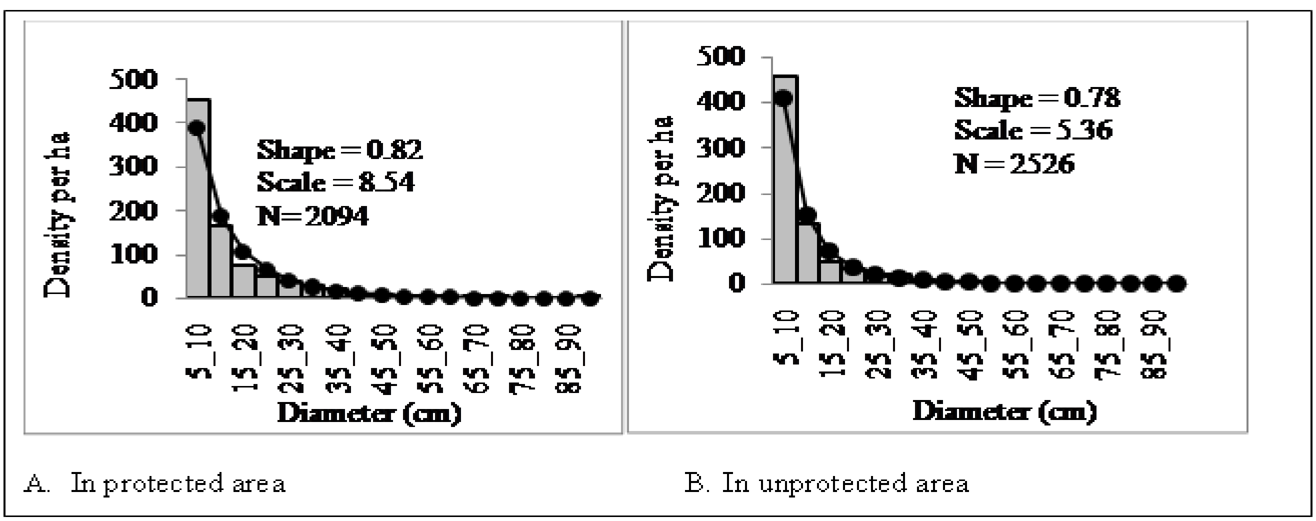

Figure 6: Diameter classes' distribution of wetland banks woody species

Openings in the canopy can lead to the growth of the new species that are more tolerant to light (Arim*et al*., 2006; Barima *et al.*, 2010).Grazing can increase species richness by importing seeds of weeds or woody species (Liehoun *et al.*, 2006; Savadogo *et al*., 2007; Bangirinama *et al*., 2010).

Life Forms, Species Occurrence and Diagnostic Species

Our results showed a dominance of Therophytes and widely distributed species (multi-regional African species, Pantropical, Paleotropical, Afrotropical, Afro-Malagasy and Cosmopolitan) in unprotected wetland banks while in protected wetland banks, Phanerophytes and Sudanian species were dominant. Previous results showed an increase in annual species and wide distribution species in case of site degradation (Fatunbi *et al*., 2008; O'Connor *et al*., 2011). For Devineau *et al*. (1997), a high proportion of species with wide distribution may be an indication of degradation because the flora loses its specificity. The Phanerophytes are normally adapted to the least disturbed areas (Havyarimana *et al*., 2013). Grazed areas are usually occupied byannualspecies which succeed the perennials (Sawadogo *et al*., 2005; César, 2005). Indeed, the large representation of *Hyptis suaveolens* and *Cassia obtusifolia,* reflects the importance of grazing in the unprotected wetland riverbanks (Aboh *et al*., 2008).These biologicalindicators suggest thatlivestockgrazing is the major causeof the degradation of the unprotected wetland riverbank flora. Furthermore, the presence of dry environments species among diagnostic species (*Balanitesaegyptiaca; Dactylocteniumaegyptium; Ipomoea eriocarpa; Chloris pilosa*) suggests that wetland banks of study area provide sanctuary for some endangered species (Devineau *et al*., 1997; Ewango, 2001).

Regarding protected riverbank flora the Poaceae such as *Andropogon gayanus, Andropogon pseudapricus, Andropogon tectorum; Rottboellia cochinchinensis,* were highly represented among indicators species. This suggests that these sites are old fallows (Fournier *et al*., 2001; Le Mire Pêcheux *et al.,*2000). Le MirePêcheux *et al*. (2000) note that beyond 20 years, if the environment is well preserved; the *Andropogon spp*. is replaced by competition. Thereby, *Andropogon spp*. should not normally be well represented in these protected wetlands riverbanks. Their presence reflects a relative disturbance of these sites. Furthermore, it is known that Sudanian wetlands are characterized by common species such as *Mitragyna inermis (Willd.) O. Ktze.*, *Vitex chrysocarpa Planch. ExBenth. Acacia polyacantha Wild., Cratevaadansonii D.C, Terminalia macroptera; Hypparenia ruffa* et *Vetiveria nigritana*. *L* (Fontes and Guinko, 1995; Devineau *et al*., 1997; Savadogo *et al*., 2007).The absence of these common species reflects a relative degradation of the protected wetlands riverbank flora. The dominant families of the woody stratum of these sites were Leguminosae (22.62%) and Combretaceae (15.48%). The Rubiaceae family is ranked in 3rd position with 5.95% representation in protected riverbanks plant communities. This result is different from the one of Kaboré *et al*. (2013) and Sambaré *et al*. (2010) who found in such wetlands vegetation that Rubiaceae and Caesalpiniaceae families predominate because of the permanent presence of moisture. The low representation of Rubiaceae and Caesalpiniaceae families in our study reflects the temporary nature of the moisture in our sites. This can also be explained by the difference in the sampling mode. Indeed, our study focuses on riparian vegetation of wetlands while the authors cited above were interested in any riparian vegetation (beds, depressions and banks). However, the large representation of Leguminosae and Combretaceae within protected wetland riverbank plant communities reflects a degradation of these wet ecosystems which are transformed gradually into savanna. Moreover, Mbayngone*et al*. (2008a) found that in Pama reserve Combretacea family dominate savanna woody stratum. Obviously wetlands riverbanks plants flora within protected areas is better preserved than that of the unprotected areas. However, signs of disturbances are revealed through the loss of its specificity. So far protected wetlands riverbanks plants communities contained a larger number of accidental species than unprotected wetlands riverbanks plants communities.That meansthere aremanyuncommonspeciesinthe wetlands riverbanks in the study area or new species are currently living there. Our results are similar to Masharabu (2011) who found that 73% of plant families of Ruvubu National Park (Burundi) had less than 3 species and gallery forests of this park contained 64% of accidental species.

Vegetation Structure

The basal area is the sum of cross-sections of trees in a given plant communities. Our results show that protected wetlands riverbanks plants communities had a recovery twice larger than unprotected ones. These results confirm that disturbance is higher inunprotected wetlands riverbanks plants communities. Human pressure would beat the origin of the structural differences in the plants communities of these two sites. In the Sahelian context characterized by water scarcity and poverty, the large ecosystem services provided by these wetlands accelerate their degradation (Natta, 2003; Savadogo *et al*., 2007; SP/CONEDD, 2010; Kaboré *et al*., 2013).

Regarding adult tree density and individuals' regeneration density, there was nostatistical differencebetween the two sites ($P > 0.05$). Like previous authors (Ouédraogo, 2006; Kaboré *et al*., 2013), in study area a difficulty for individuals of lower-height classes to grow, is noticed. This reveals that individuals from 0 cm to 50 cm regeneration classes are subject to disturbances which result in reduced recruitment rates. This situation can jeopardize the relatively good distribution of trees. Furthermore, the standard deviation was very high, indicating that the spatial distribution of juveniles was very disproportionate around the wetlands banks of the study area. Savadogo *et al*. (2007) explain the difficulties of regeneration in the non-protected wetlands banks stands by animals grazing and trampling. This finding can then extend to the activity of wild herbivores on individuals regeneration within protected wetlands banks (Gandiwa *et al*., 2011; Giliba *et al*., 2011). Moreover, inter-specific competition may disadvantage germination or growth of other species. Forest disturbance, characterized by a forest canopy opening up, led to an increase of light-tolerant species (light demanding species) and their richness in degraded forests. Indeed, the high density of the dominant species in gallery forests, coupled with the shading effect disadvantage certain species which juveniles may face difficulties to grow (Bokary *et al*., 2004; Barima *et al*., 2012). Besides, more or less prolonged flooding would be a constraint to other species (Sambaré *et al*., 2010).

According to Rondeux (1999), the distribution of stems per size category is an expression of stand structure. Our results show that wetlands banks woody plants located in both types of sites were characterized by multi-species, with different ages and a predominance of young individuals or small diameter. These findings are similar to those of Sambaré *et al*. (2011) and Kaboré *et al*. (2013) who also reported the structure in ``reversed J`` and a shape parameter of Weibull c < 1. In general, the prevalence of young individuals of woody species is an indication of a secondary forest caused by processes of natural or human disturbances of the original forest (Chok kalingam and DeJong, 2001).The woody plants communities of both types of wetlands were young with considerable mortality of younger individuals. The difficulty concerning recruitment from lower size classes to those above can eventually lead to the aging of the stands. Dossou *et al*. (2012) found a similar situation in the Agonvé swamp forest stands in Benin, where the presence of small diameter individuals cannot be interpreted as a good state of conservation of woody community species because of the particular pressure on certain species. Other environmental factors (soil, geomorphology, disturbance of particular species of these environments and their vulnerability at certain stages of their development) could affect our results particularly as our samples relate to wetlands of various characteristics.

CONCLUSIONAND RECOMMENDATION

Unprotected wetlands sites were more degraded than protected ones. Degraded riverbanks plants communities are characterized by lower basal area of trees, a greater specific heterogeneity, increasing of dry ecological environments species and grazing indicator species, increasing of Therophytes and large distribution species.
Both sites had a relative good tree diameter structure. Protected wetlands riverbanks plants flora is better preserved but it is losing its specificity. Thisis evidencedbyseedlings'growing difficulties, the increasing number of accidental species and the low representation of characteristic wetland species (Rubiaceae and Ceasalpiniacea families) in its flora.

Management strategies should pay attention to the species communities by taking into account wetlands riverbanks seedling protection and following up the natural stand patterns of these wet ecosystems.

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