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RESEARCH ARTICLE

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Factors influencing the range shift of plant species in wetlands, Northern Region (GHANA)

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ABSTRACT

The study examined the role of anthropogenic disturbances in the range shift of aquatic plants in six wetlands. It was conducted over a 2-year period. The prevalence index method was used to determine the range shift of plant species. An ordination technique was used to determine the environmental factors that influenced species range shift and distribution. Of the 40 species sampled, we detected that obligate species constituted 35%, while facultative wetland species and obligate upland species were 40% and 27.5% respectively. Animal dung was identified as one major source of upland species shift into the wetlands, as14 seedlings that germinated from this mediumwere identified to bethe same species sampled across the six wetlands. Plant range shift was influenced by environmental disturbances such as grazing, farming, bushfire and hydric soil nutrient status namely; magnesium,nitrogen, phosphorus, potassium and soil pH. These variables correlated significantly (p>0.05) with axis 1 and axis 2, and accounted for 61.29% of the total variance in species range shift. Plant range shift may be attributed more to human-led activities than climatic variability factors.

Keywords: species range shift, indicator status, endozoochory, environmental factors, ordination techniques

INTRODUCTION

Observations of plant range shifts in line with climate change have been well documented in numerous scientific studies [1, 2, 3]. [4-5] suggest that the interaction between disturbance regime and biotic factors may possibly override climatic variables in explaining species distribution. Studies have shown that organisms invade into areas of favorable environment, while range contractions occur in the face of deteriorating conditions [6]. Directional migrations of sedentary organisms like plants are the result of dispersal and extirpation and are usually slow because they are often long-lived and have short dispersal distances [6]. Plant range shift have hardly observed except where ruderal species are introduced outside their native range [7]. The causes of species range contraction and expansion are rarely known with certainty because most biogeographical methods are descriptive [6]. However, the [8] has stated that anthropogenic disturbances cause more rapid deterioration and loss of wetlands, leading to species range shift than natural causes. For instance [9] observed that over time, plant species in wetlands may shift as native species decline and are replaced by species that take advantage of high nutrient levels to increase growth. A 50 year of floristic dynamicsmonitoring at different spatio-temporal scales in Rome's archeological sites has shown that over 40% of species disappeared due to environmental disturbances [10].Vascular flora survey in the Tiber River-Rome has indicated a decrease in species richness, composition and structure in the last 30 years as a result of human influences [11].Species such as *Phragmitesaustralis* has been reported to establish well in high nutrient loadings wetlands [12]. The impacts of herbivory on the willow- *Salix arizonica* were greater at the southern margin of its range than in the center [13]. Of the 10% of the Ghana's total land surface occupied by wetland ecosystems [14] the coastal wetlands (e.g., Sakumo lagoons, Muni and Mukwe wetlands) have attracted a lot of scientific work, with much emphasis on the impacts of environmental drivers on wetland biodiversity [15] compared to Northern Guinea Savannah wetlands. Furthermore, there is no scientific investigation to determine the influence of environmental drivers of change on the range shift of plant species in the Northern Guinea Savannah, since wetlands in this Region are poorly studied from a geographical range shift approach [3, 16]. Therefore gaining a deeper understanding of factors accounting for plant range shift may help minimize current or reverse future trend, since most wetland species are noted to be sensitive to changes in their habitat conditions. Furthermore, it will be useful to have a suite of some plant species that can serve as indicator to either current or future anthropogenic disturbances thresholds.

The main goal of this study was to investigate the major environmental factors influencing the range shift if plant species in six wetlands in the Northern Region of Ghana. We addressed the following two questions. (1) Identify which plant species were classified as obligate species (hydrophytes) and facultative species? and (2) which environmental factors were the principal drivers of species range shift?

MATERIALS AND METHODS

2.1. *Site description*

The study area is located in the Northern region of Ghana, between 8^0N, to Lat. 11^0N. The co-ordinates of the six wetlands are as follows: Wuntori (N09^0 08.335' W00^{0}1 09^0.685'); Kukobila (N10^0 08.723' W000^0 48.179'); Tugu (N09^0 22.550' W000^0 35.004'); Bunglung (N09^0 35.576' W000^0 47.443'); Adayili (N09^0 41.391' W000^0 41.480') and Nabogo (N09^0 49.941' W000º.51.942'), see Fig. 1. There is extensive floodplain along the course of the Volta and Nasia Rivers, which has overtime become incised and modified through meandering and aligning along various topographic features. This has led to the development of streams that have diverted from the main White Volta [17]. The landscape is gently undulating, with broad and poorly drained valleys and a crest of the scarp forms the northern boundary of the Nasia River [17]. The fine sandy loam soils are from upper Voltaian sandstone, while the iron pan concretion and the yellow sandy loams soils are from the Lower Voltaianshales and alluvial floodplains and slougths. The vegetation cover is a mixture of grassland dominated by *Deplachne fusca*(L.) P. Beauv. exStapf.and *Echinochloa pyramidalis* (Retz.)P. Beauv.)and woodland (e.g., *Vitellariaparadoxa*) interspersed with shrubby communities of *Mitragynainermis* and *Vitexcrysocarpa*(Planch. ex Benth.). The trees are relatively short with thick bark and occlusions, signifying their adaptation to the cyclical dry season with bush fires. Altitude is 108 – 138 meters above mean sea level. The hydrological regimes of the six wetlands under study were typical of permanent wetlands, whose depth at low tide did not exceed 2 m on average. All the wetlands were within the catchment of the main White Volta River or its tributaries. Wetland areas were measured on spot and Landsatimages using Google Earth Pro. Software. They were as follows: (a) Wuntori =7.7 ha; (b) Kukobila = 8.9 ha; (c) Tugu = 2.7; (d) Nabogo = 7.9 ha; (e) Adayili = 6.7 ha and (f) Bunglung = 11.05 ha (see Fig. 1).

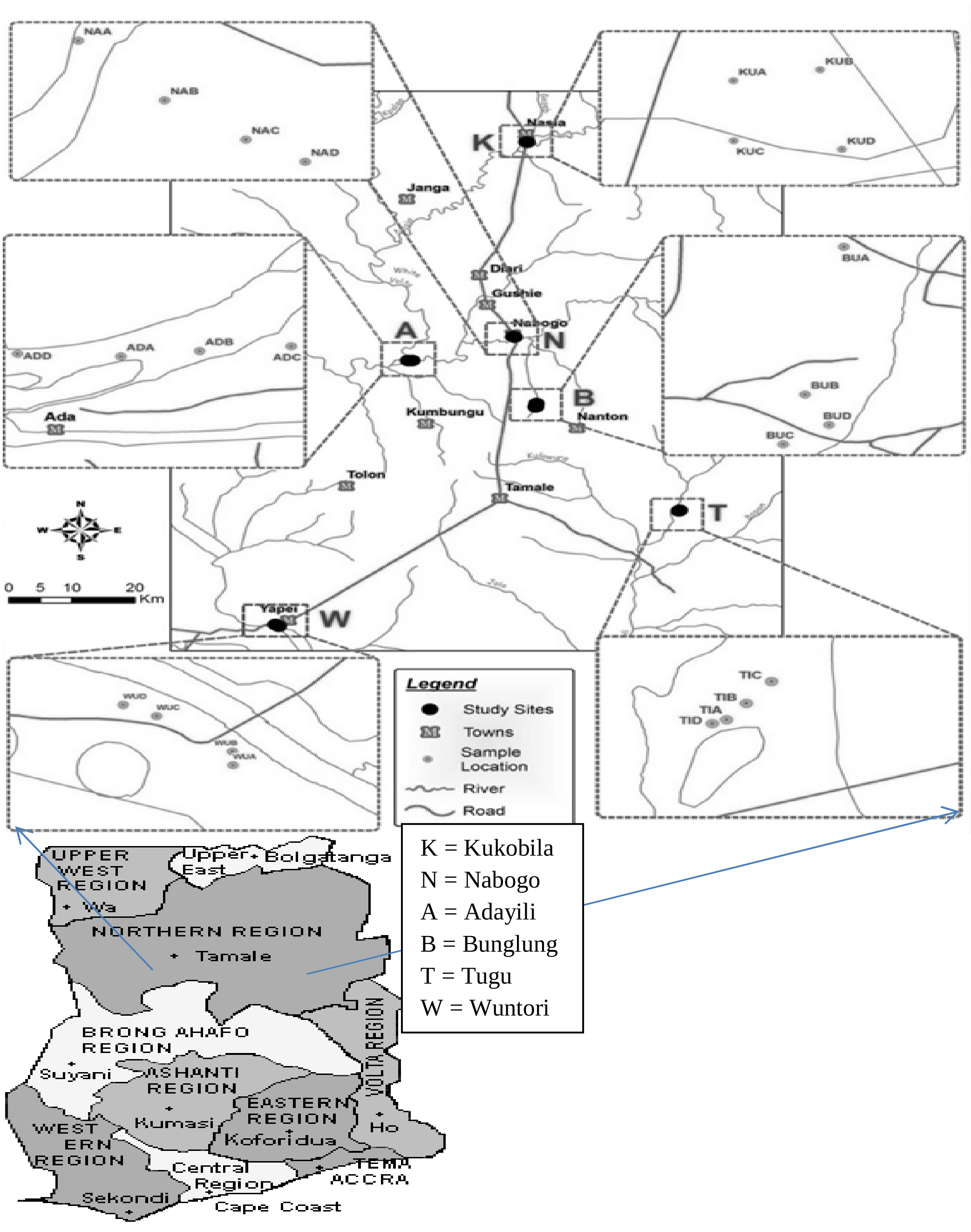

Figure 1: Map of the study areas, showing the location of the wetlands in the floodplains of the White Volta River catchment, Northern Region

2.2.*Vegetation sampling techniques*

Sampling of aquatic plants was carried in each of the 24 Modified-Whittaker plots [18]over a 2-year period. The Modified-Whittaker plot is a vegetation sampling design that is used to assess plant communities at multiple scales. Four Whittaker plots were randomly laid in each of the six wetlands, bringing the total to 24 plots. Plots were laid along an environmental gradient of the vegetation type being sampled, in order to register majority of species heterogeneity. The Domin-Krajina cover abundance scale was used to estimate ground cover[see 19]. Plants were identified up to species level, with the aid of manuals developed by [20], [21] and [22]. The sites ware located ~ 60 km radius of the Tamale weather Station.

To determine whether plant species present were typical wetlands plants or from terrestrial systems, the Prevalence Index method [23] was employed to classify the weighted average of indicator status of sampled species as follows: obligate plants (OBL) = 1.0;facultative wetland plants (FACW) = 2.0;facultative plants (FAC) = 3.0; facultative upland plants (FACU) = 4.0 and obligate upland plants (UPL) = 5.0. Obligate wetland plants – (i.e. hydrophytes with >99% probability of occurring in wetlands); facultative wetland plants- (usually found in wetlands with an estimated probability of 67% - 99% occurrence, but occasionally found in uplands); facultative plants- (having 34% - 66% equal chance of occurring in wetlands); facultative upland plants - (usually occur outside wetlands, but occasionally found in wetlands, and obligate upland- (occur only in uplands[24]. In addition to the indicator status categories, positive (+) sign was used toindicate allfacultative species categories with a frequency towards wetter ends (more frequently found in wetlands) and the negative (-) signwith a frequency towards drier ends (less frequently found in wetlands) [24]. Plant species on each plot were identified, counted and classified under the different species indicator status, to determine their relative abundance. Total number of species in each indicator status category wassubsequently divided by the total number of plots on which they were sampled, in order to obtain the average for each plot. Plots that score < 3.0 were considered to be obligate wetland plants (OBL) and those that score >3.0 were designated as upland plants(FACW; FAC; FACU and UPL categories), that may have migrated into the wetlands over time. We further counted species from each of the indicator status category and expressed it as a percentage of the total species sampled, in order to determine whetherthe wetland plant communities arepredominantly hydrophytic. Our values obtained were used to compare with the standard value of >50%cumulative cover of OBL, FACW or FAC species present in a site [23]. To avoid duplication of species count, species of the same type that were already identified and counted in previous plots, were not recorded in subsequent plots in which they occurred.

To determine one of the modes that accounted for species range shift into wetlands, livestock droppings from the 24 sample plots were collected and sun dried in each sampling season. The droppings were subsequently broken into smaller clumps and placed on 24 soil medium containers each. Watering of the droppings was carried out in the morning at 7 am and in the evening at 5 pm daily, so as to enable plant seeds that may be embedded in the droppings to germinate. After 5 to 6 days, seeds that germinated into seedlings were identified and categorized as obligates, facultative and upland species. This experiment was to confirm whether grazing activities by livestock could have partly contributed in the range shift of plant in the six wetlands.

2.3.**Assessment of environmental variables**

Random soil samples were taken with soil augur at a depth of 15 cm, using the zigzag sampling method[25]on each Modified-Whittaker plot [18]. The plot measures 20 m x 50 m (1000 m^2) and contains three different sizes of nested subplots. A 5 m x 20 m (100 m^2) subplot was placed at the centre of the plot, while two 2 m x 5 m (10 m^2) subplots were placed in opposite corners of the plot. The remaining ten of 0.5 m x 2 m (1 m^2) subplots are placed at the edges of the main plot. Three composite samples were taken from three different 25 cores in each plot. Samples were put in transparent polyethylene bags and labeled according to the code assigned to each plot and taken to the laboratory to analyze the presence of Nitrogen, Phosphorus, Potassium, Magnesium, Calcium and soil pH, using atomic absorption spectroscopy (AAS) techniques [26]; [27]. Organic carbon was determined using the Walkley-Black method [28, 29]. All analyses were carried out at the Savanna Agricultural Research Institute (SARI) at Nyankpala in the Northern Region.

A proposed land index score, known as Land disturbance index score (LDI) was used to estimate the intensity or the extent of impact of environmental drivers of change (farming activities, grazing intensity, erosion and bush fire). This proposed LDI, followed similar disturbance index used by [30]. Assessment of the area disturbed was carried out within 1.2 km radius starting from the hydric delineated zone of the wetland. This is because all land use activities mentioned were observed within this radius following a preliminary survey of the wetlands. The LDI is computed as Land area of wetland disturbed over the total area of the Whittaker plot (1000 m^2) multiplied by 100%. Below is the proposed land index score:

$$LDI = \frac{Ld}{Tw} \times 100$$

where

Ld is land area disturbed by farming activities, grazing intensity, erosion and bush fire and Tw = Total area of the Whittaker plot.

LDI scores were assigned as follows: 1-20% = 1, 21-40% = 2, 41-60% = 3, 61-80 = 4 and 81-100% = 5. A score of 1 is interpreted as less disturbed, 2-3 as moderately disturbed and 4-5 as highly disturbed.

2.4.**Data analysis**

A Canonical correspondence analysis (CCA) [31] was performed to determine the relationship between environmental drivers of change and the biological species data, using two analytical packages of the Environmental community analysis version 1.3 (ECOM.exe). A One-way ANOVA was used to determine if environmental variables differed significantly from one wetland to the other, using SPSS version 16.0.

RESULTS

A total of 40 plant species belonging to 18 families were registered across the six wetlands. Herbaceous, grasses and tree cover constituted 72.72%, 27.27% and 0.01% respectively. The matrices of the species-site biplot generated by the CCA revealed that magnesium, fire and soil pH for axis I and farming activities, potassium, phosphorus and nitrogen for axis II, were the most important environmental factors that influenced the distribution and range shift of plantamong the wetlands(Fig. 2; Table 1). The first two axes accounted for 61.29% of the variation in the weighted averages of the 40 species in relation to 11 environmental factors (Table1). Cumulative percentage variances for axes I and II together accounted for more than 50% of the range shift variation in ground cover data. Thereforeaxes III and IV as recommended by [31]were not considered.

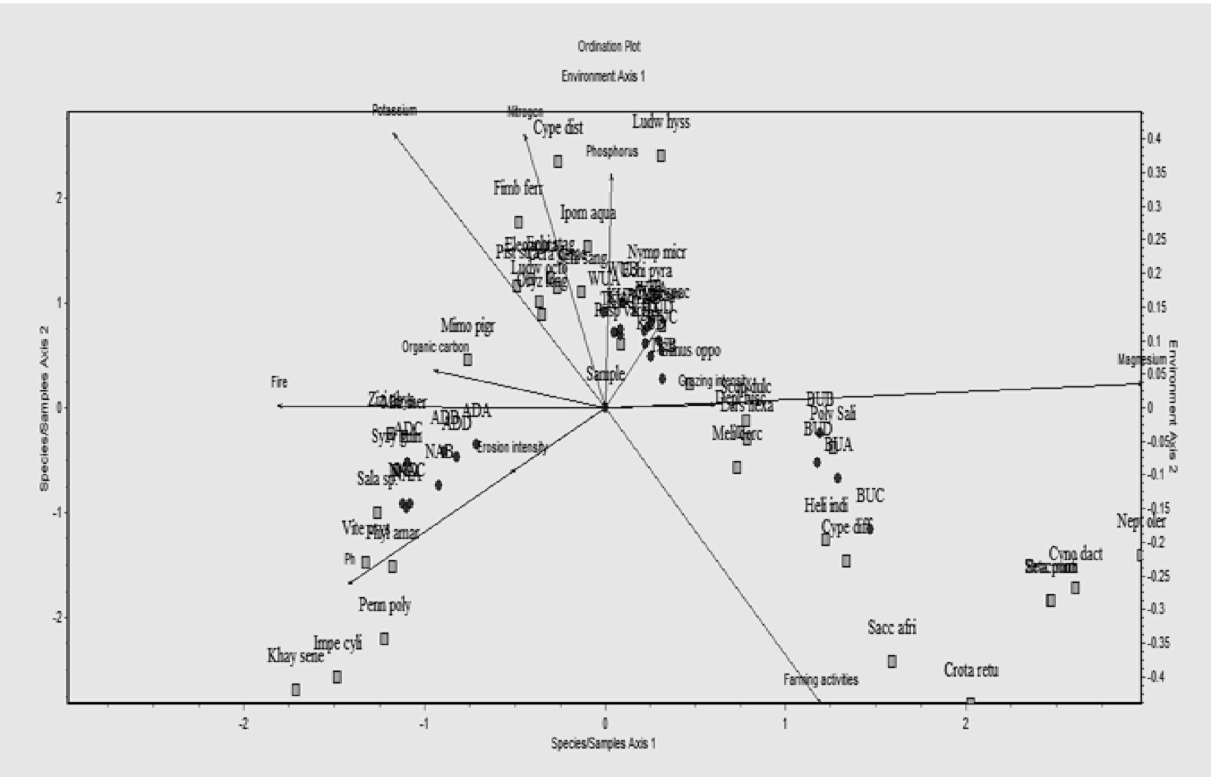

Figure 2: Canonical correspondence analysis (CCA) ordination diagram, showing the influence of environmental factors on species range shift, explained by the first two axes (Axis I =24.84 & Axis II =36.45) and accounted for 61.29%cumulative percentage variance across the six wetlands (R^2 = 0.61, p<0.05). The filled squares represent abbreviated plant species(e.g., *Ceratophyllum demersum* = Ceraderm), the circles represent sample sites and the arrows represent each of the environmental variables plotted pointing in the direction of maximum change of explanatory variables across the six wetlands.The abbreviations denote different sample plots in the six wetlands. WUA-WUD = Wuntori wetland at Yapei; TUA-TUD = Tugu wetland; KUA-KUD = Kukobila wetland; BUA-BUD = Bunglung wetland; ADA-ADD = Adayilli wetland and NAA- NAD = Nabogo wetland

Table 1: Summary of CCA axis lengths for ground cover, showing the levels of correlation between axes and environmental gradients, percentage variance of species and species-environment relationships.
** Significant p<0.05*

	Axis1	Axis 2	Axis 3	Axis 4
Canonical eigenvalues for ground cover	0.73	0.34	0.20	0.17
Pearson correlation sp.-environmental scores	0.81	0.88	0.84	0.82
Cumulative percentage variance	24.84	36.45	43.16	48.74
% variance explained	24.84	11.6	6.71	5.84
Number of species (response variables)	40			
Number of environmental variables	11			
Total variance in species data	2.951			
pH	-0.37*	-0.26	0.07	-0.02
Organic carbon	-0.24	0.06	0.15	0.11
Nitrogen	-0.12	0.41*	0.16	0.11
Phosphorus	0.01	0.35*	0.23	0.04
Potassium	-0.30*	0.41*	0.05	0.20
Calcium	0.09	0.13	-0.14	0.01
Magnesium	0.77*	0.04	-0.10	0.12
Fire	-0.47*	0.002	-0.20	-0.08
Grazing intensity	0.16	0.01	0.17	-0.19
Erosion	-0.13	-0.20	0.13	-0.07
Farming activities	0.31*	-0.44*	0.08	0.06

From the 24 Whittaker plots sampled, 10 plots recorded an average of 1.3 OBL species/plot, 2plots = 3.2 FACW species/plot, 4 plots = 3.25 FAC species/plot,2 plots = 4 FACU species/plot and 3 plots = 3.6 UPL species/plot (Tab 2). Obligate wetland species such as*Cyperusdistans*, *Nymphaeamicrantha* and *Ipomeaaquatica* from Wuntori, Tugu and Kukobila marshes, were relatively less represented and constituted 35% (13 sp.) of the total species sampled (Tab 3). Species from these wetlands were negatively associated with nitrogen, phosphorus potassium and fire on axis I, but positively associated with farming activities and grazing intensity. Obligate species were sensitive to bushfire and grazing intensity and this partly accounted for their less abundance.Facultative wetland species such as *Leersiahexandra*, *Ludwigia hyssopifolia* and *Echinochloa pyramidalis*were the most abundant and represented 40% (16 sp.)of the total species. These species have over the years adapted to wet conditions as result of modifications of their root and leaf system. The remaining three plant categories- facultative species, facultative upland species and obligate uplandspecies, were 35%(13 sp.),20%(8 sp.) and 27.5% (11 sp.)respectively (Tab3).The tendency of plant species from the four indicator status categories (FACW; FAC; FACU and UPL) to shift towards wetter areas were greater (+) compared to a shift towards drier areas (-) (F =3.33; p=0.117) (Fig. 3).

Woody plant species such as *Syzygiumguineense* and *Vitexcrysocarpa* with an average height of 5.6 m were the predominant species recorded in the forested wetlands of Adayilli and Nabogo, respectively. Kruskal-Wallis test showed significant differences (p<0.05) in plant species recorded in the 24 four Whittaker plots across the six wetlands.Species from these plant categories were mostly dry land weeds from the derived savannah and sampled from the Adayilli and Nabogoswamp forest and Bunglung artificial wetland. Adayilli and Nabogo swamp forests were located on the left half of the ordination diagram. Dominant species like *Imperata cylindrica*, *Pennisetum polystachion*,*Salaciarecticulate*,*Vitexcrysocarpa*and *Ziziphusabyssinica*, correlated negatively with fire, soil pH and erosion intensity and positively associated with farming activities along axis I. Soil pH and erosion intensity were strongly interrelated, which is indicative of the direct influence of erosion on soil pH.Most of the quadratsfrom theswamp forest wetlands were characterized bystream bank erosion with patches from current and previous burnt undergrowth. The eroded parts of the streambankhad less amount of ground cover and were mostly invaders.Although erosional features such as gullies and channel incision were prominent on the banks of the two swamp forest, their severity was not widespread as this was evident in the rather weak correlation on both axes I and II (Tab1). Incidences of bushfire were common, as farmers in the community periodically used fire to clear the grasses and shrubs along the stretch of the wetlands for farming purposes. The arable farms at Nabogo swamp forest for instance, were ~ 100 m away from the stream banks, while the dry season vegetable farms were ~ 20 m away from the main wetland zone. Canonical coefficients of these variables, correlated significantly (t = -0.6024; p<0.05) for axis I and axis II (approximate t-test, terBraak, 1987).

Bunglung wetland located on the right lower half of the CCA diagram,had species like *Sacciolepsis Africana*, *Crotolariaretusa*, *Helioptropium indicum* and *Cynodondactylon*that strongly correlated with magnesium and farming activities (p<0.05) along axis I. With the exception of fewer obligate species such as *Cyperusdifformis*, *Polygoniumsalicifolium* and *Neptuniaoleracea*present, the rest of the species were from derived savanna and mostly associated with ecological disturbances. Intensive farming activities, patchy condition and tree stumps were a major feature within a 100 m radius of the wetland. Soil structures in sample plots were disturbed due to animal trampling during grazing and watering.Majority of species not represented in the ordination diagrams grew in habitats with average conditions of the environmental factors investigated, whereas ubiquitous species that were near the centre of the CCA diagram (e.g., *Leersiahexandra*, *Mimosa pigra* and *Ludwigiaoctovalis*) showed their broad responses to almost all of the considered ecological variables.A few obligate species (e.g., *Ceratophyllum demersum, Eleocharis mutata* and *Nymphaeamicrantha*) of Kukobila, Wuntori and Tugunatural marshes and found on the upper centre of the CCA diagram, hadreasonably high nitrogen, phosphorus, potassium and calcium.There were few boulders and animal trampling in some plots at Kukobila wetland, while two plots in Wuntori wetland was characterized with scars of fire on the vegetation. Though these wetlands experienced some level of disturbances like bushfire and grazing, they were not severe and widespread. Two plots in Tugu wetland were marginally grazed with some isolated patchy conditions. A total of 14 seedlings that grew from animal dung were the same as some of the 40 species sampled in the wetlands and represented 35%. Examples were *Pennisetum polystachion*, *Setariapumila*, *Schizachyriumsanguineum*, *Echinochloa pyramidalis* and *Saciolepsisafricana*.

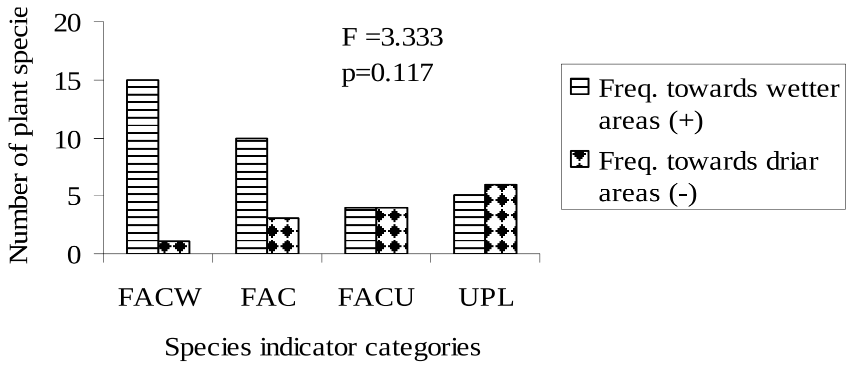

Figure 3: Indicator species status showing the frequency of species shift towards wetter and drier areas. The abbreviations denote the fallowing: Facultative wetland plants (FACW); Facultative plants (FAC); Facultative upland plants (FACU) and Obligate upland plants (UPL)

Table 2: Summary of indicator species categories, showing their relative abundance of dominance among the 24 Whittaker plots

Indicator species status	No. species	No. of plots dominated	Av. species/plot
Obligate wetland species (OBL)	13	10	1.3<3.0
Facultative wetland species (FACW)	16	5	3.2
Facultative species (FAC)	13	4	3.25
Facultative upland species (FACU)	8	24.0 >3.0	
Obligate upland species (UPL)	11	3	3.6
Number of Whittaker plots	24		

Table 3:Plant species showing the application of Cronk and Siobhan-Fennessy (2001) and Tiner (1999) model to categorize species that are typical wetlands plants and terrestrial species that are frequently found in wetlands. Indicators of frequency of species shift towards wetter areas is denoted by (+) sign and towards drier areas by (-) sign

Obligate wetland sp.	Facultative wetland sp.	Facultative sp.	Facultative upland sp.	Obligate upland sp.
Cyperusdifformis	*Cynodondactylon +*	*Brachiariamutica +*	*C. retusa*-*	*C. retusa*-*
Cyperusspacelatus	*Deplachne fusca*+*	*Crotalaria retusa*-*	*E. pyramidalis+*	*Deplachne fusca*+*
Cyperusdistans	*Echinochloa stagnina+*	*Cynodondactylon+*	*Imperata cylindrica*-*	*H. indicum*+*
Ceratophyllum demersum	*Echinochloa pyramidalis+*	*Deplachne fusca*+*	*H. indicum*+*	*I. cylindrica*-*
Eleocharis mutata	*Fimbristylisferruginea**	*E. pyramidalis+*	*Ludwigia hyssopifolia*+*	*Khaya senegalensis-*
Ipomeaaquatica	*Helioptropium indicum*+*	*H. indicum*+*	*Mormodicachrantia*-*	*L.hyssopifolia*+*
Ludwigiaoctovalvis	*Leersiahexandra*	*P. polystachion*-*	*P. polystachion *-*	*M. chrantia* -*
Neptuniaoleracea	*Ludwigia hyssopifolia*+*	*Salacia reticulate+*	*S. sanguineum*+*	*P. polystachion*-*
Nymphaeamicrantha	*Mitragynainermis+*	*Scopariadulcis*+*	*S. sanguineum*+*	
Oryzalongistaminata	*Mimosa pigra+*	*Schizachyriumsanguineum*+*	*S. pumila*+*	
Polygoniumsalicifolium	*Pennisetum polystachion*-*	*Syzygiumguineense+*	*Z. abyssinica-*	
Paspalumvarginatum	*Phyllanthusamarus+*	*Vitexcrysocarpa+*		
Pistiastratiotes	*Scopariadulcis*+*	*Ziziphusabyssinica-*		
	Setariapumila+*			
	Saciolepsis Africana +			
	Salacia reticulate +			
35%	40%	32.5%	20%	27.5%

** = dryland weeds of arable and plantation crops/derived savannah*

DISCUSSION

Some studies in recent times have indicated a shift in species range, in direct responses to climate change and other experimental warming simulations [32, 33]. However, the present study showed that a shift in wetland plant from their range was largely linked to the combined effects of human-led and ecological variables. This was evident from the assessment of plant-environmental relationship that accounted for 61.29% of the explained variance of the first two axes of the CCA ordination. The 13species classified as obligate wetland species and represented 35% of the 40 species sampled, fell short of the > 50% score thus indicating their less dominance and resilience to increasing disturbance, compared to the remaining 27 species from dry land arable crop fields and derived Savanna (Table 2). Secondly, this phenomenon suggests a gradual shift or reduction of obligate plants away from their natural habitats and the establishment of facultative plants. [34]reported that percent of taxa as obligate wetland plants is a measure of tolerance that should decrease with disturbance. Most of the facultative plant propagules from dry land derived savanna were found in littered animal dungs on the wetlands during grazing and watering and species thrived well in growth medium condition, by exhibiting high adaptive means, through a rapid reproductive and dispersal ability in their new wet environment. [35] noted that endozoochory - a dispersal processes in which livestock grazing essentially transports many seeds to points at varying distances from the parent plant and leave them in safe sites for germination is one of the noted mechanism for plant propagule dispersal. Ungulates such as deer and cattle are noted to be effective seed dispersers of grasses, herbs and trees, colonizing a wide array of new sites [36, 37]. [24]reported that these species had an estimated probability of 67% - 99% to occur in wetlands, but occasionally grow on uplands or terrestrial systems. The ability of some of the facultative plants to grow towards wetter areas could be due to the fact that over time, a good number of the dry land plant species became physiologically and morphologically adapted to the wetter conditions. Thus the sensitive nature of obligate plants (hydrophytes) to environmental changes such as farming activities, nutrient load, could have given a competitive urge to the facultative species dominance in colonizing the wetlands. [23]showed how this adaptive strategy may be possible physiologically through: germination flexibility; oxidized rhizosphere; accelerated stem growth; C4 photosynthesis and alternate metabolic pathways. While the morphologicaladaptation plant species to wet conditionsinvolves the development of shallow rooting system for gas exchange with the atmosphere; development of hollow stems to improve root aeration and the accumulation of CO_2 and development of air spaces in the roots and stems which allow diffusion of oxygen from the aerial portions of the plant into the roots.

The high soil nutrient load especially in the three standing marsh wetlands could be due to the cyclical deposits of decomposed plants, animal dung deposits and the transport of point source nutrients from nearby farmlands. Finally, the pockets of bushfires that occurred in some parts of the three wetlands could contribute in increasing the soil nutrient level, through ash deposits. [38] observed that soil nutrients levels increase after fire in wetlands. The abundance of species from the cyperaceae family (*Cyperusdifformis* Linn. and *Cyperusspacelatus*Rottb.) in all the three marshlands probably showed their positive responses to high amount of phosphorus, potassium and nitrogen availability. While [39] point out the importance of phosphorus in sustaining the growth of *Cyperus papyrus* dominated vegetation community, [40] rather showed the positive relationship between potassium and *Cyperus papyrus* growth performance. The dominance of facultative species in Bunglung artificial wetland may be attributed to their response to favourable response intense farming activities all year round. [40] also found cultivation as one of the determinants that contributed in explaining species assemblage and composition in wetlands areas of Uganda.
The fire occurrence in the two swamp forest wetlands, may explain why some of the quadrats lacked sufficient undergrowth, as a result of their inability to withstand intense fire. [41] measured the effects of prescribed fire on flowering of three wetland grasses (*Muhlenbergia capillaries*, *Paspalummonostachyum* and *Schizachyriumrhizomatum*) and found out that they all responded positively to fire, through a decrease in flowering. Such disturbances suggest a strong relationship between fire and plant species and could be used as a measure of the functional state of the wetlands.

The increase in grazing pressure in the wetlands, especially in the dry season period was probably due to the reduction of the rainy season period (4 months) and the increase of the dry season period (6-7 months). This led to the insufficient feed available to livestock during the wet season, leaving the wetlands as the only alternative source of grazing and watering point for both domestic and wild animals. [42] indicated that in agricultural landscapes, the stress posed by grazing pressure on wetlands, is of particular concern as domestic stock and feral grazing herds usually congregate in and around water areas. Though grazing intensity has the ability to transform the natural vegetation of wetlands, the impact may depend on how palatable the species is, the grazing regime, the period of grazing and the number of livestock occupying a unit space at a given time. This is because the extent of damage to soil structure by livestock trampling will be directly related to these factors mentioned above. In some cases grazing *per se* may not lead to a range shift in species, but the indirect effect on soil structural transformation (soil compaction) and plant removal through trampling, could result in a reduction of endemic species from their natural habitatsand at the same time encourage the recruitment of non-native species from nearby dry lands that have better resilience to disturbances and utilization of least availability of soil nutrient. [43] made similar observations and concluded that physical disturbances from livestock activities allowed non-native species like *Lythrumsalicaria* L. a Eurasian plant to get a foothold in North American wetlands and in the process, replace native species.[44] also observed that heavy human impacts generally reduce the number of native species in a community while encouraging the presence of alien species.

CONCLUSION

Generally, farming activities, fire, grazing, erosion and soil nutrient status were the main factors affecting species range shift. Comparatively, the facultative wetland plants were more than the obligate wetland plants (hydrophytes) suggesting a gradual range shift of obligate plants out of their natural habitats and the replacement of derived savanna plant species.Since most wetland species are noted to be sensitive to slight changes in their habitat conditions, it will be useful to have a set of some plant species that can be utilized as indicator to future anthropogenic disturbancesthresholds. Therefore all identified obligate species (hydrophytes) could be used as indicator species, to monitor their resilience to current and future changes in ecological variables and anthropogenic disturbances, by critically observing their abundance and spatial distribution across different wetland types.

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