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Valley Bottom Wetlands Can Serve for Both Biodiversity Conservation and Local Livelihoods Improvements

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1. Introduction

Wetlands are among the world's most biologically productive ecosystems and rich in diversity of species and are very important storehouses of plant genetic material some of which are valuable resources for human wellbeing. The Great Ruaha River Basin covering about 6950ha forms one of the major and largest wetland systems composed of numerous ecologically and socio-economically important valley bottom wetlands in Tanzania. This study was conducted in the Ruaha River Basin to assess the contribution of the valley bottom wetlands to livelihoods and biodiversity conservation. Three sites were selected for ecological studies which include Uchindile with Mpombochi River and Isimani stream plus associated swamps, Idete with Idete River and associated swamps/streams and Mapanda with Mkungwe and Kinoga Rivers and associated swamps/streams. The five villages selected for the socio-economic study include Luganga, Matanana, Igowole, Kisada, Njiapanda and Nzivi villages within the little Ruaha sub catchment of the Great Ruaha River. The sites for ecological studies were stratified into broad vegetation types using existing topographic and land cover maps. This stratification gave several major vegetation types in which plant species were then assessed in systematically established temporary nested sample plots measuring 20 x 20 m. Each plant species encountered in each plot was identified and their percent cover estimated. For socio-economic studies the village register was used as a sampling frame, households were then randomly selected and a questionnaire administered to heads of the selected households. The questionnaire sought to get information on whether the household is involved in any kind of wetland utilization, socio-economic activities undertaken in the wetlands, costs and revenues associated with wetlands utilization. Further to questionnaire survey PRA techniques including Focus Group Discussions (FGD) were used to supplement information from household surveys. The ecological data were summarized into tables showing a list of different vegetation types and their species composition, abundance and dominance. The abundance and dominance of each species was determined from their percent cover estimates. Socio-economic data were analyzed and summarized into social economic activities undertaken by a household, agricultural utilization of wetlands and crops grown in dry/wet seasons and the proportional contribution of each wetland related socio-economic activities to household food security (food available for household consumption) and income. The economic benefits were assessed by using gross margin analysis, food available for consumption as indicator of food security was used to assess food security at household level; and the contingent valuation technique was applied to assess the value of wetlands services.

Compared to other habitat types the valley bottom wetlands are the major repository of biodiversity of both flora and fauna, yet they are the most intensively utilized habitats for livelihood enhancement and buffer against drought in the Ruaha River Basin' instead. It was observed that the biodiversity of the valley bottom wetlands is higher than that in any other ecosystem types within the basin in the same locality'. The valley bottom wetlands in these areas are also repositories of some threatened/endangered plant species such as *Prunus africana, Protea sp.* making them important habitats for biodiversity conservation. It was further observed that overall, the total use value of productive activities carried out in upland and valley bottom wetlands was Tanzanian Shillings (Tshs) 3,415,458 (US$ 2,732) per household per year of which 31% of the total economic benefits accrued from utilization of the valleybottom wetlands. Wetland based socio-economic activities included agricultural production (farming) practiced by over 98% of the population followed by livestock grazing and fishing. Wetland based socio-economic activities carried out in valley bottoms commonly known by local people as *vinyungu* contribute about 15% of household food and 55 - 95% of household income annually, equivalent to Tshs 3,234,721 (US$ 2,588). In this respect valleybottom wetlands contribute significantly to household economy and food security. Furthermore over 90% of the dry season agricultural production is associated with valley bottom wetlands. Given the direct benefits of valleybottom wetlands and potential contribution to livelihoods the livelihood potential may override the biodiversity values of these Valleybottom wetlands. If left unattended it is likely that the wetlands will be degraded thus loosing their biodiversity values. The dual value of valley bottom wetlands (biodiversity and household economy) makes them unique habitats requiring an integrated approach to ensure achievement of both without impairing the ecological integrity of these wetlands.

Wetlands are among the world's most biologically rich ecosystems with high species diversity (Mvena et al 1999; Yanda et al., 2005; Munishi and Kilungu, 2004; Munishi et al. 2005). Wetland ecosystems are second only to the rain forests in the number of wildlife and plant species that depend on them for feeding and habitat. Historically, wetlands have been regarded as wastelands but they can also be viewed as being among the last truly wild and untouched places in the world (Maltby, 1986) making them of high repository of biological diversity with most wetlands offering important habitats to a variety of fauna and flora.

It is well documented that In Sub Saharan African countries, wetlands have a considerable importance in provision of innumerable benefits like drinking water, routes for transport, harvestable plants and animals (Ramsar, 1997). Though not well quantified, Tanzania's wetlands contribute in diverse ways to livelihoods of many millions and are chiefly utilized for crop and livestock production (Kashaigili, 2006). Furthermore, wetlands provide income in both dry and wet years for fairly large number of people engaged in agriculture because of their available water and high soil fertility (Munishi, *et al*., 2003; Mkavidanda and Kaswamila, 2001; Masiyandima *et al.,* 2004; Kashaigili and Mahoo, 2005).

The principal vision of the Government of Tanzania (GoT) is to alleviate widespread poverty by improving several socio-economic opportunities, good governance transparency and by improving public sector performance through the National Strategy for Growth and Reduction of Poverty (NSGRP) or MKUKUTA. The 2025 country's vision overall goal specifically includes references to; 'sustainable development endeavours, on intergeneration equity basis, such that the present generation derives benefits from the rational use of natural resources of the country without compromising the needs of future generations' (ESP, 2003). Further more the National Strategy for Growth and Reduction of Poverty (NSGRP) or MKUKUTA recognize poverty as largely a rural phenomenon and that the rural poor depend solely or to a greater extent on natural resources (Bagachwa, 1994; DPG, 2005; PRSP 2000). Consequently the national environmental policy of 1997 and all the natural resource policies emphasize the clear cause-and-effect relationship between poverty and environmental degradation, and because of this they stress on the need for sectoral policies to address poverty issues by taking into account the need for wise use and sustainable resource exploitation (MNRT 2003).

Wetlands are amongst the most productive ecosystem in Tanzania and have significant economic, social, cultural and biological values (HOORC, 2002). Apart from agricultural use wetlands are considered useful as sources of a variety of natural resources of significance to human welfare. The Government of Tanzania has shown its commitment towards wise use of wetlands as stipulated in the Ramsar Convention and recognizes wetlands as significant natural resources with important ecosystem services and biological values by ratifying the Ramsar Convention on Wetlands in August 2000 (ESP, 2003).

Tanzania is endowed with exceptional wetland resources in which 10% of the country is covered by wetland ecosystems. These ecosystems in Tanzania range from large lake systems to river floodplains, deltaic mangrove formations and associated catchments (Maltby, 1986; Kamukara and Crafter 1993). Of the area covered by wetlands, 5.5% is occupied by four Ramsar sites namely Malagarasi/Moyovosi (32,500 Km^2), Lake Natron Basin (2250 Km^2), Kilombero valley floodplains (7,950 Km^2) and Rufiji-Mafia-Kilwa (5,969.7 Km^2) (MNRT 2003). Broadly the country is divided into nine drainage (river) basins which include Lake Rukwa, Lake Victoria, Lake Tanganyika, Lake Nyasa, Rufiji River, Pangani River, Ruvuma River and Southern Coast, Wami-Ruvu River and Internal Drainage basin. Each of these basins includes a network of rivers and inland valley bottom wetlands scattered throughout the country. These vast biologically rich resources in Tanzania are unique in their biodiversity values as well as support to local livelihoods (MNRT 2003, 2008, Munishi and Kilungu, 2004). The protection of these wetlands against biodiversity loss while maintaining their socio-economic value requires an integrated approach to management though currently protection for biodiversity conservation does not appear to be a serious alternative among majority of the society in Tanzania which jeopardizes future sustainability of these wetlands.

This papers presents results of a study to assess the role of wetland ecosystems in conserving plant diversity and contribution to livelihood enhancement in the Great Ruaha River basin Tanzania

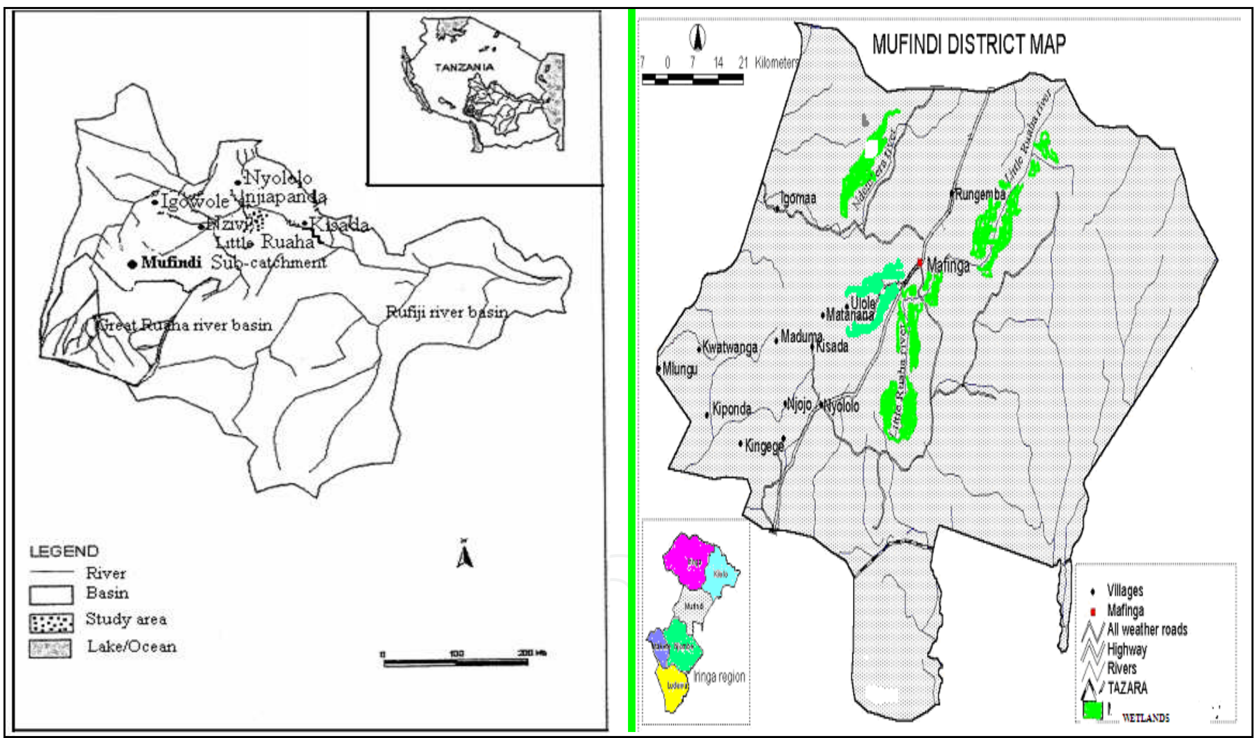
2. Materials and methods

2.1 Study sites

The study site was the Great Ruaha River Basin in Mufindi district, Iringa region (Figure 1). Mufindi District is one of the seven Districts in Iringa Region located in Southern Highland of Tanzania. Mufindi District lies between latitude 8^0.00' 9^0 15' South and longitude 34^0 35'–

35^0 55' East. The District is situated about 80 km from Iringa Municipality and boarders Iringa rural in the north, Kilolo in north east, Njombe in the south, Kilombero in the south east and Mbarali in the west. Administratively the District is divided into five (5) divisions, 28 wards and 132 villages. The wetlands of Little Ruaha River start from Bumilayinga, Nyololo, Mafinga and Ihalimba wards in Mufindi District (Fig. 1). The River further extends to Kilolo and Iringa Districts crossing the Ipogoro Bridge along the Dar es Salaam – Mbeya road before joining the Great Ruaha River at Mawande village. The entire catchment, lies between latitudes 7^o 15' and 8^o 35' south and longitudes 35^o 00' East covering 4900 km^2 and altitude of 600 m to 2100 m above sea level.

Selection of ecological study sites was based on the presence of and extent of valleybottom wetlands within the sites. For the social economic studies villages were selected for the study based on their proximity to wetland ecosystems. Three sites were selected for the ecological studies which include Uchindile with Mpombochi River and Isimani stream plus associated swamps, Idete with Idete River and associated swamps/streams and Mapanda with Mkungwe and Kinoga Rivers and associated swamps/streams. The five villages selected for the socio-economic study include Luganga, Matanana, Igowole, Kisada, Njiapanda and Nzivi villages within the little Ruaha sub catchment of the Great Ruaha River (Figure 1).



Ruaha Catchment in Mufindi District Tanzania — The Little Ruaha Wetlands in Mufindi

Fig. 1. Map of Mufindi District showing the Little Ruaha Wetlands System

3. Data collection

3.1 Ecological study

Prior to field surveys the areas were stratified into broad vegetation types using existing topographic and land cover maps. This stratification gave several major vegetation types including woodlands, grasslands, valley bottom wetlands/swamps undisturbed natural vegetation and plantations of different types. While in the field the broad types were further sub divided into sub categories depending on field conditions such as wooded grasslands, natural grasslands, pine plantations and eucalyptus plantations.

Temporary nested quadrats (sample plots) measuring 20 x 20 m (with nested subplots of 10m x 10m, 5m x 5m m, 1m x 1m and 0.5m x 0.5 m) were adopted and established systematically in clusters representing different vegetation types in each stratum on transect lines established along a predetermined compass direction. More than 100 plots were established in each site though the number of plots in each site differed depending on area and an adopted minimum sampling intensity of 0.01% ensuring a sufficient coverage and representation of each stratum. The location of each quadrat (plot) was recorded using Global Positioning System (GPS).

At each quadrat all the plant species encountered were identified, recorded and percent cover determined. For species that were difficult to identify in the field voucher specimens were collected and identified at the National Herbarium in Arusha Tanzania.

3.2 Socio-economic study

Multistage sampling was used where two divisions within the Little Ruaha sub catchment were selected randomly. Two wards were then selected randomly from each ward. For each ward two villages were selected randomly for the study. The nature of the distribution of wetlands in the Little Ruaha sub-catchment called for purposeful sampling of villages to be included in the study.The selection of villages was based on close proximity to the wetlands with the assumption that the respective communities were more involved with wetlands cultivation as compared to other villages. In this case, Matanana village (Bumilayinga Ward) being in the upper streams and Luganga village (Ifwagi Ward) on the lower stream of the catchment were sampled. Other villages included in the study are Nyololo Njiapanda (Nyololo Ward), Kisada (Bumilayinga Ward) Igowole and Nzivi (Igowole Ward). In each village the village register was used as a sampling frame, households were then randomly selected and a questionnaire administered to heads of the selected households. Households were taken as sampling units in this study and total of 93 households were sampled (44 and 49 households from Luganga and Matanana respectively). The questionnaire sought to get information on whether the household is involved in any kind of wetland utilization, socio-economic activities undertaken in the wetlands, costs and revenues obtained from wetland utilization. Further to questionnaire survey PRA techniques including Focus Group Discussions (FGD) were used as well as participant field observation to supplement information from household surveys.

4. Data analysis

4.1 Ecological data

All special features of interest in the area e.g. water sources, valley bottom wetlands, natural grassland ecosystem, miombo woodlands and wooded grasslands were identified and compiled into a lists with a descriptions of their species composition. The identified strata and field data were developed into tables showing a list of different vegetation types and their species composition, abundance and dominance. The abundance and dominance of each species was determined from their percent cover estimates.

4.2 Socio-economic data

Socio-economic data were analyzed and summarized into social economic activities undertaken by a household, agricultural utilization of wetlands and crops grown in dry/wet seasons and the proportional contribution of each wetland related socio-economic activities to household food security (food available for household consumption) and income. The economic benefits were assessed by using gross margin analysis, food available for consumption as indicator of food security was used to assess food security at household level; and the contingent valuation technique was applied to assess the value of wetland services. The gross margin analysis was computed as:

$$GM = TR - TC$$

where:

GM = Average gross margin (Tshs/kg) or (Tshs/month)
TR = Average total revenue (Tshs/kg) or (Tshs/month)
TC = Average variable total cost (Tshs/kg) or (Tshs/month)

The food available for consumption at household level was determined to be 300kg of cereal/ person/year. This figure was used to offset post harvest losses (storage loss and handling loss) (FAO, 1985; Ishengoma, 1998). Food available for consumption was obtained by subtracting the amount of food crop that was sold from the total food produced per person per year. Standardization of food available for consumption was done using adult equivalent scale considering age category (Ishengoma, 1998). In this case where the adult above 15 years old has unit equivalent of 1, ages 11 – 15 will have unit equivalent of 0.75 while children with age equal or less than 10 years will have unit equivalent of 0.36 (Ishengoma, 1998).

5. Results and discussions

5.1 Vegetation types and plant species composition

Several vegetation types were identified in the different sites. The major natural vegetation types identified included valleybottom wetlands, natural grasslands, wooded grasslands, and miombo woodlands. In addition planted exotic tree species formed specific vegetation types and included Eucalyptus and Pine Plantation. There was a big variation in plant species composition and richness in all sites studied with the different vegetation types having different species composition and richness within sites. The variation in composition is a reflection of high diversity of plants in the areas. In all three sites studied for plant species composition (Uchindile, Idete and Mapanda landscapes), valleybottom wetlands ranked the highest in plant species richness when compared with other natural vegetation and combined natural vegetation and plantation of exotic species. This general trend shows that valleybottom wetlands in the Ruaha River Basin will likely be the major repositories of biodiversity of plant species. By the fact that vegetation composition may be a reflection of other taxa in an ecosystem there is a high possibility that fauna diversity will follow the same trend. Because plants respond to multiple environmental factors both biotic and abiotic, this richness and diversity of species is a reflection of the heterogeneity of the areas, diverse vegetation types, habitats and landscapes that allow co-existence of species in heterogeneous landscape (Carson & Root, 2000; Franzén, 2004; Tetsuya & Kuniyasu, 2005; Munishi *et al*., 2007; Tomas & Frantisek 2008).

5.2 Plant species composition by vegetation types in Uchindile landscapes

Three natural vegetation types were identified in Uchindile including (i) Valley bottom Wetlands/Riverine/Riparian, (ii) Natural Grasslands and (iii) Wooded Grasslands. In addition to the natural vegetation there were two types of plantations which are among the major vegetation found on the landscape. These are (i) Pine plantations and (ii) Eucalyptus plantations. The number of plant species varied between vegetation types. In regards to the natural vegetation Valleybottom Wetlands have the highest number of species compared to all other vegetation types (Figure 3a). Further when we consider all the vegetation types Valleybottom Wetlands still rank the highest in plant species richness (Figure 3b). Previous studies have also shown the valley bottom/riverine/riparian vegetation to have higher species richness than the other types of vegetation (Munishi 2006, 2007). The significance of Valleybottom Wetlands in acting as refuge for most species becomes more apparent during the peak of the dry season in which there would definitely be higher species richness for both flora and fauna in valley bottoms because of the wetter conditions compared to the other areas. Most grasslands for example would have higher number of short-lived plant growth forms (annuals) during the rain season which disappear during the dry season.

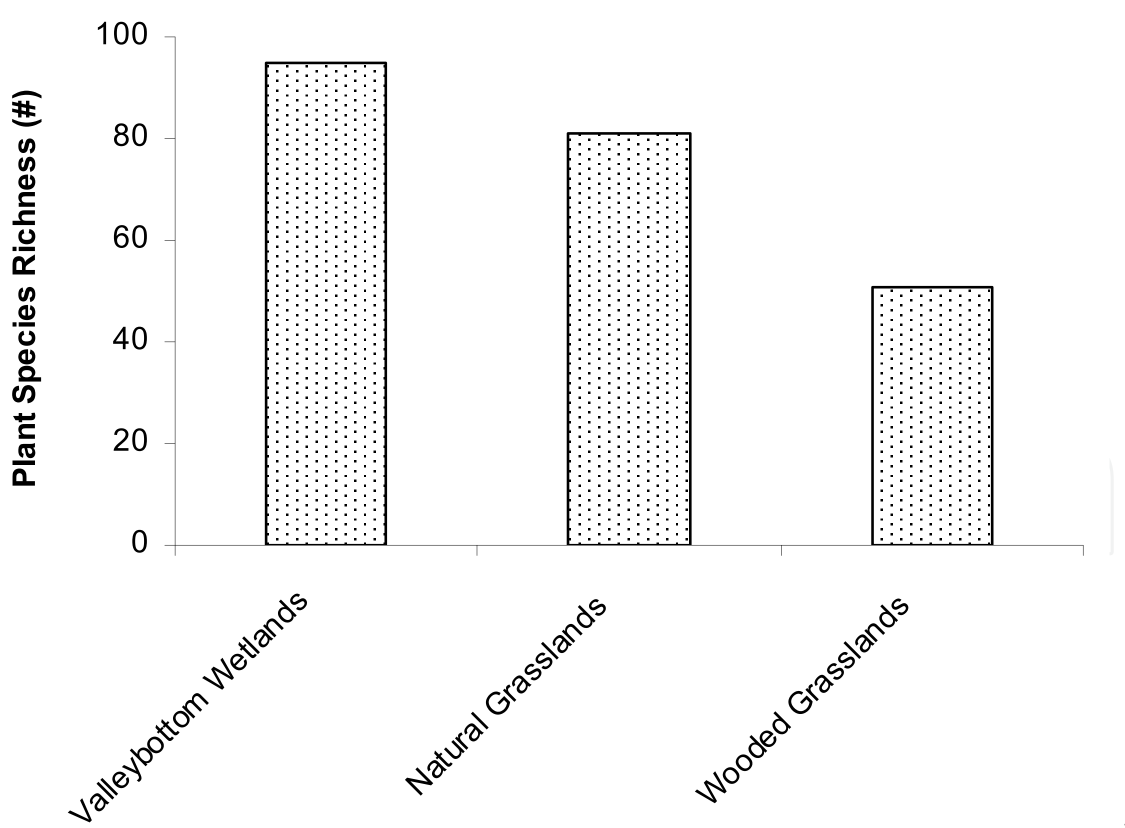


Fig. 3a. Average Number of Plant Species by Natural Vegetation Types in Uchindile

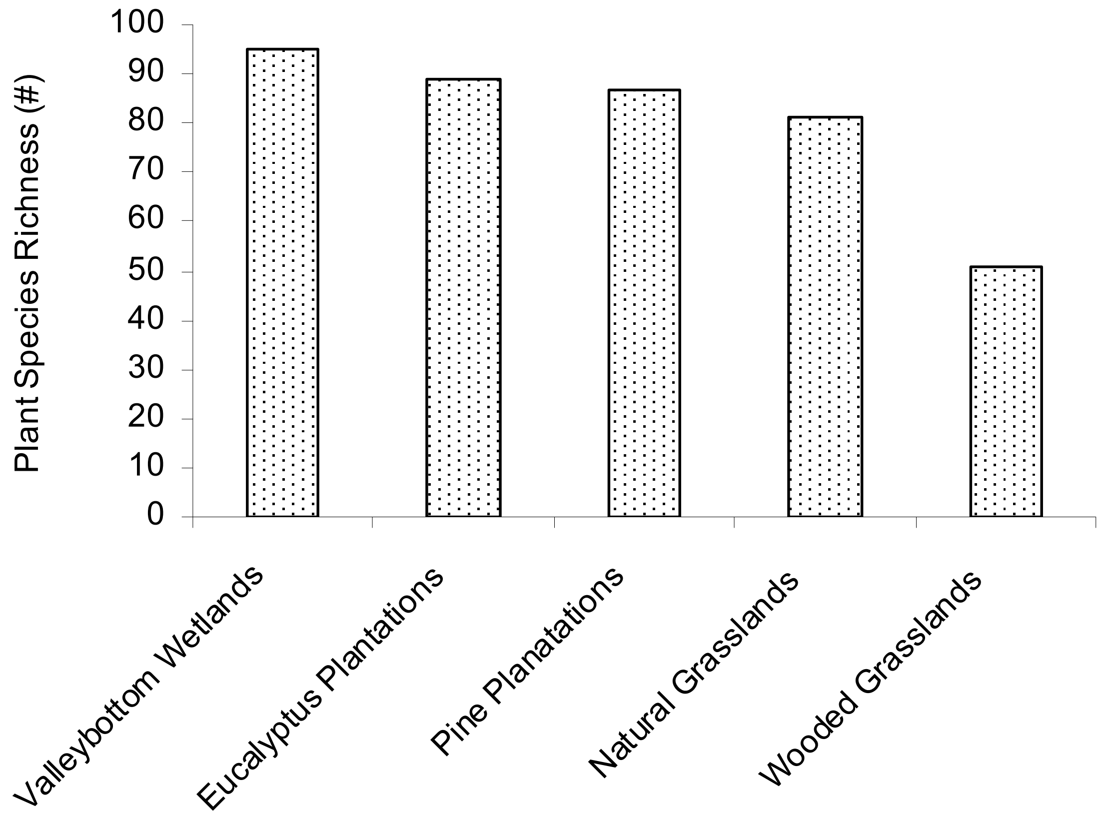


Fig. 3b. Plant Species Richness in all Vegetation Types in Uchindile

5.3 Species dominance in the different vegetation types in Uchindile landscapes

The Valleybottom Wetlands/Riverine Ecosystems were the most diverse compared to other vegetation zones of Uchindile with the most dominant species being *Cyperus papyrus, Cyperus dives, Cyperus corymbetes, Cyperus glaucophyillus, Cyperus articulates and Pteridium aquilinum.* In the natural grasslands the most dominant species were *Hyparrhenia filipendula* (Hochst.) Stapf, *Exotheca abyssinica* Anders, *Parinari curalellifolia* Benth, *Hyparrhenia cymabarica* (L.) Stapf, *Cymbopogon nardus* (Linn.) Rendle, *Protea madiensis* Oliv and *Vernonia sp*.. The wooded grasslands were dominated by *Loudetia simplex* (Nees) C.E.Hub, *Cymbopogon nardus* (Linn.) Rendle, *Protea madiensis* Oliv, *Psorospernum febrifugum* Spach. and *Melinis minutiflora* P.Beauv

5.4 Plant species composition by vegetation types in Idete landscapes

Four different natural vegetation types were identified in the Idete landscapes. These vegetation types include Valleybottom Wetlands/Riparian Areas, Natural Grasslands, Wooded Grasslands and Miombo Woodlands. Valleybottom Wetlands/riparian areas had the highest proportion of species compared to all other vegetation types followed by Wooded Grasslands. Miombo Woodlands and Natural Grasslands had almost the same species richness (Figure 4). These findings indicate that the wetland ecosystems are the most diverse followed by wooded grasslands.

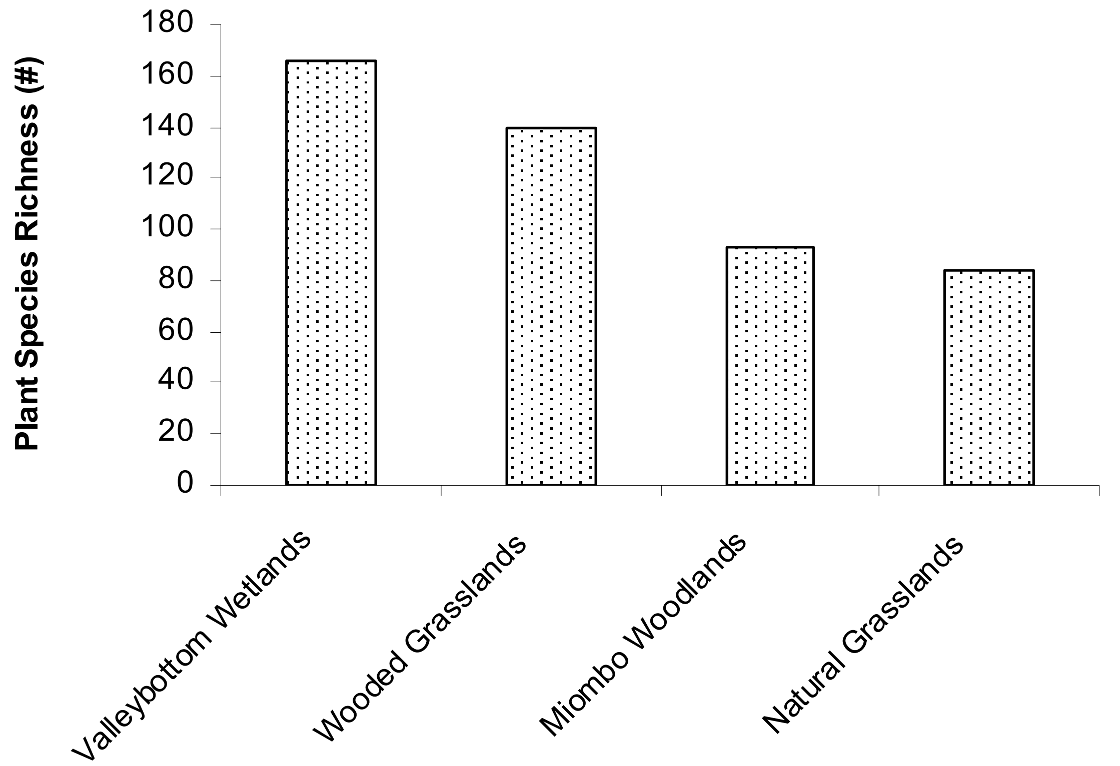


Fig. 4. Plant species richness in different natural vegetation types of Idete Landscapes Iringa Tanzania

5.5 Plant species dominance in the different vegetation types of Idete landscapes

The most dominant species in the Idete landscapes were F*icus lutea, Loudentia simplex* (Nees) C.E Hubbard, *Nymphaea nguchali, Prunus africana, Themeda triandra* Forssk, *Cymbopogon excavatus, Cynodon sp, Panicum maximum* Jacq, *Faurea saligna* Harvey., *Oxtenanthera abyssinica, Vernonia sp, Dombeya rotundifolia* (Mast) Planch, *Erythrina abyssinica* D.C.*ssp abyssinica, Macaranga capensis, Sorghum bicolor, Annona senegalinsis Pers, Bersama abyssinica, Catha edulis* (M.Vahl.) Forssk, *Cyperus ajax* C.B. Clarke, *Osmunda regalis L.Cynodon sp, Parinari curatelifolia, Setaria sphacelata, Syzygium cordutum* Hochst ex Krauss *and Cyperus ajax* C.B. Clarke. The riverine vegetation closely associated with the Valleybottom wetlands category was mainly dominated by *Prunus africana, Bridelia micrantha, Macaranga capensis, Khaya anthotheca, Cartha edulis, Syzygium cuminii, Syzygium guinensis, Harungana madagascariensis, Myrianthus hostii, Tralepisium madagascariensis, Rauvolfia cafra and Ficalhoa laurifolia.* This vegetation type contains some elements of endangered plant species such as *Prunus africana* which also have medicinal value for the treatment of prostate cancer.

Grasslands were the largest vegetation type in the Idete landscape, dominated by the grass family (Poaceae) with grasses growing to more than 1m tall. Based on species abundance expressed as percent cover the major species in this vegetation type were *Hyparrhenia rufa (Nees) Stapf, Diheteropogon ampelactens, Faurea saligna Harvey, Cymbopogon excavatus, Hyparrhenia sp., Pteridium aquilinum, Londetia simplex (Nees) C.E Hubbard, Allophylus abyssinicus, Protea rupestris R.E.Fr.. Protea welwitschii Engl. Pygmaeothanmnus zeyheri, Syzygium guineense (Willd.) DC, Themeda triandra Forssk* and *Vitex mombassae Vatke.* This vegetation type is a home for rare/threatened species such as *Protea rupestris R.E.Fr.* and *Protea welwitschii Engl.*

The Miombo woodlands in this landscape is dominated by *Brachystegia microphylla Harms., Uapaca kirkiana, Eragrostis sp, Periploca linearifolia* Dill.& A.Rich, *Aristida sp, Combretaum molle, Loudentia simplex* (Nees) C.E Hubbard, *Myrica salicifolia* A.Rich, *Sparmannia ricinocarpa* (Eckl & Zey) Kuntize, *Faurea saligna* Harvey., *Osyris lanceolata* Hochst. & Stend., *Parinari curatelifolia* Planch.ex Beth., *Protea welwitschii* Engl. and *Protea rupestris* R.E.Fr.. The dominant species in the Wooded Grasslands include *Hyparrhenia rufa (Nees) Stapf, Aristida sp, Psorospermum febrifugum* Spach, *Bridelia micrantha, Eragrostis sp, Vernonia lasiopus* O.Hoffm. *Protea rupestris R.E.Fr., Protea welwitschii* Engl., *Cartha edulis, Cymbopogon excavatus, Pteridium aquilinum, Melinis minutiflora* P. Beauv., *Allophylus abyssinicus, Apodytes dimidiata* Arn., *and Vitex mombassae* Vatke.

5.6 Plant species composition by vegetation types in Mapanda landscapes

A total of 320 plant species belonging to 96 families were identified in the Mapanda landscapes which is a reflection of the heterogeneity of the landscape and habitats. Three natural vegetation types were identified in Mapanda which include Valleybottom Wetlands, Wooded Grasslands and Natural grasslands. In addition two vegetation types of planted exotic species were identified as among the major cover types in the landscape. These are Eucalyptus and Pine plantations. Among the natural vegetation types Valleybottom Wetlands had the highest plant species richness (Figure 5a) followed by Wooded grasslands. Of all vegetation types combined Valleybottom Wetlands still rank the highest in species richness (Figure 5b), showing the value of wetland ecosystems as repositories of species in the landscape.

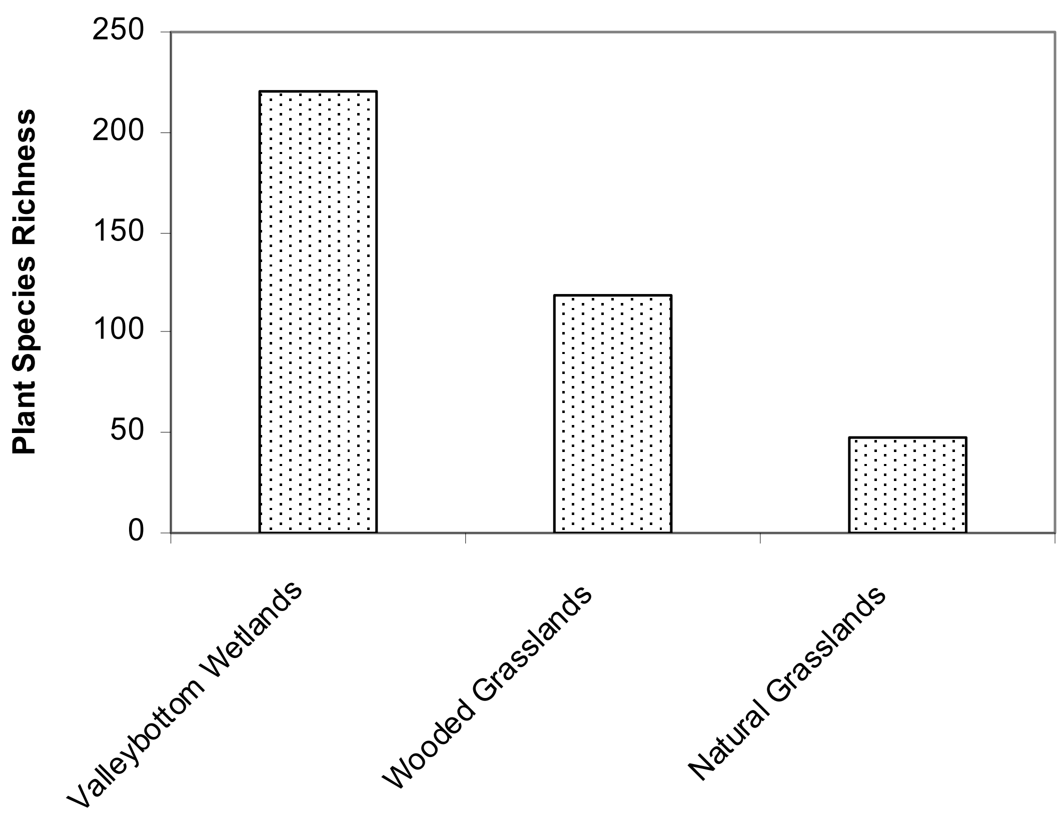


Fig. 5a. Plant species richness in different natural vegetation types of Mapanda Landscapes Iringa Tanzania

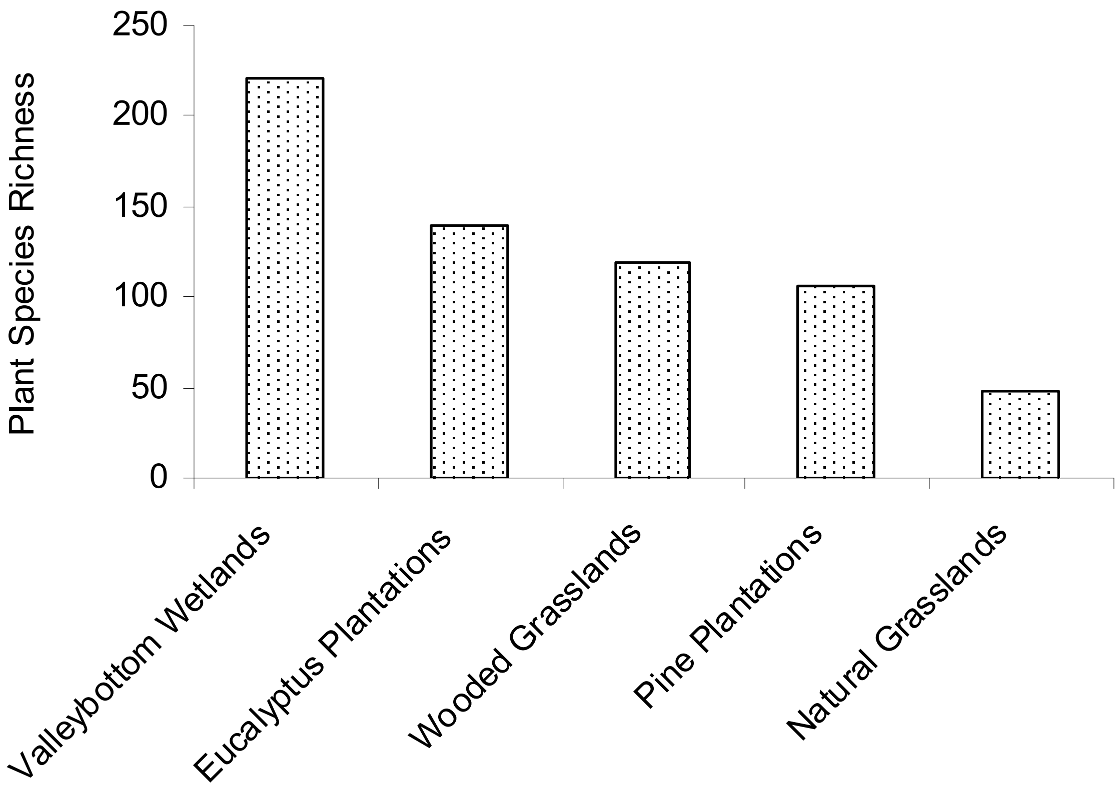


Fig. 5b. Plant Species Richness in all Vegetation Types of Mapanda Landscapes Iringa Tanzania

5.7 Species dominance in the different vegetation types in Mapanda landscapes

The Valleybottom wetlands are dominated by *Hyparrhenia cymabarica* (L.) Stapf, *Dichanthium foveolatum* (Del.) Roberty Clayton & Renvoize, *Syzygium cordatum* Hochst. ex Krauss, *Gnidia glauca* (Fresen.) Gilg. and *Kotschya strigosa* Benth. The most dominant plant species in the natural grasslands include *Cymbopogon nardus* (Linn.) Rendle, *Fadogia odorata* K.Krause and *Hyparrhenia cymabarica* (L.)Stapf,. The Wooded Grasslands were dominated by *Cymbopogon nardus* (Linn.) Rendle, *Loudetia arundinacea* (Hochst. ex A.Rich.) Steud, *Hyparrhenia cymabarica* (L.)Stapf, *Dolichos sericeus* E.Meyer, *Dichanthium foveolatum* (Del.) Roberty Clayton & Renvoize, *Multidentia crassa* (Hiern) Bridson & Verdc and *Protea madiensis* Oliv.

5.8 Socio-economic values of valleybottom wetlands in the Little Ruaha River

Tanzania's wetlands contribute in diverse ways to livelihoods of many millions and wetlands are chiefly utilized for crop production and livestock. An assessment of wetland contribution to livelihoods in 6 villages of the Little Ruaha sub catchment of the Great Ruaha River showed that the total use value of productive activities carried out in upland and valley bottom wetlands was Tanzanian Shillings (Tshs) 3,415,458 (US$ 2,732) per year per household in which 31% of the total economic benefits accrued from utilization of Valleybottom Wetlands. Wetland based socio-economic activities included agricultural production (farming) practiced by over 98% of the population followed by livestock grazing and fishing. Wetland based socio-economic activities carried out in valley bottoms commonly known by local people as *vinyungu* contribute about 15 of household food and 55

- 95% of household income annually, equivalent to Tshs 3,234,721 (US$ 2,588). In this respect Valleybottom Wetlands contribute significantly to household economy and food security. Planning for wetland friendly agricultural activities is pertinent in order to ensure wetlands conservation and sustainable contribution to household economy and food security without impairing the ecological integrity of the wetland ecosystems.

It has been argued that wetlands make appreciable contribution to rural livelihoods in terms of direct cash income and contribution to food security (Mkavidanda and Kaswamila, 2001; Munishi and Halima 2004), and many households that live close to wetland ecosystems in Tanzania and elsewhere utilize wetlands in coping strategies during times of drought and food scarcity. Differences in environmental and socio-economic conditions however result into significant variation in patterns of use between one area and another. The significance of wetlands in agricultural production, poverty reduction and contribution to rural livelihoods have variously been emphasized (Mkavidanda and Kaswamila, 2000; Ngailo et al., 2002; Munishi and Kilungu 2004). The wide range of economic benefits accrued from wetland ecosystems in Tanzania have been iterated (MNRT 2007). It is argued that often overlooked, unappreciated, taken for granted and therefore unmanaged the ecosystem services provided by wetlands in Tanzania include hydro-power production in which 95% of the hydropower production is from wetland related flows. Further 95% of domestic, irrigation, industrial and livestock water is from wetlands, 80% of traditional irrigation schemes depend on wetlands, 95% of rice and vegetable production depends on wetlands, about 850,000 ha of wetlands have potential for future irrigation, 95% of wildlife and wildlife corridors/game migration routes depend on wetlands, 66% of rural animal protein is derived from livestock grazing, game meat or fisheries, 95% of the 25 million livestock is maintained through dry season pastoralism in wetlands, 95% of coastal and wildlife tourism depends wetlands and 33% of the country's GDP depends on wildlife and wetland tourism. Other studies have shown that cultivation of paddy rice in wetlands of Bahi Tanzania contributed significantly to household food security generating 65.4% of total household food crop production compared to other crops grown in drier areas adjacent to the swamp (Rweyemamu, 2009, Munishi et al, – in press). Fishing in this case played a substantial contribution to household food security through household consumption of 10% of fish caught. For household income, sales of paddy rice from the swamp contributed 59.6% while fish sales contributed 36% of the total annual household income. Multiplier activities emerging during fishing season facilitate income to a wider group of communities and on average, 56.2% of the population depend on the swamp for daily socio-economic activities associated with generation of household food and income. The Bahi swamp and related products therefore play a significant role in enhancing local livelihoods for the adjacent communities. Planning for wise use of the swamp in respect of the dominant socioeconomic activities was seen as a means to improve its contribution to livelihoods.

6. Conclusions

Given the direct benefits of Valleybottom wetlands and potential contribution to livelihoods the livelihood potential may override the biodiversity values of these Valleybottom wetlands. If left unattended it is likely that the wetlands will be degraded thus loosing their biodiversity values. The dual value of valley bottom wetlands (biodiversity and household economy) makes them unique habitats requiring an integrated approach to ensure achievement of both without impairing the ecological integrity of these wetlands.

7. Acknowledgements

We acknowledge financial support from the Royal Norwegian Government for the Project NUFU-TZ 2007/10229 without which this study would have been impossible. Thanks to Sokoine University of Agriculture for institutional support in undertaking the NUFU Project and this study.

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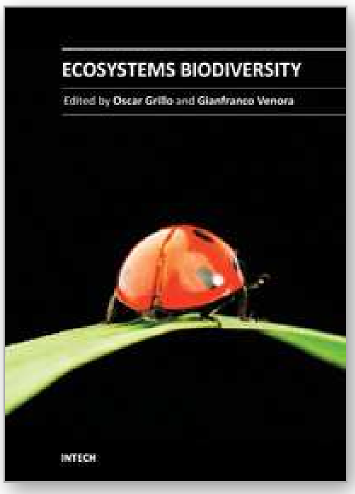

Ecosystems Biodiversity

Edited by PhD. Oscar Grillo

ISBN 978-953-307-417-7

Hard cover, 464 pages

Publisher InTech

Published online 16, December, 2011

Published in print edition December, 2011

Ecosystems can be considered as dynamic and interactive clusters made up of plants, animals and micro-organism communities. Inevitably, mankind is an integral part of each ecosystem and as such enjoys all its provided benefits. Driven by the increasing necessity to preserve the ecosystem productivity, several ecological studies have been conducted in the last few years, highlighting the current state in which our planet is, and focusing on future perspectives. This book contains comprehensive overviews and original studies focused on hazard analysis and evaluation of ecological variables affecting species diversity, richness and distribution, in order to identify the best management strategies to face and solve the conservation problems.