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Influence of land use practices on plant species richness and growth forms in Nzoia River Drainage Basin

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ABSTRACT

The land use activities along River Nzoia Drainage Basin include intensive agricultural practices such as cultivation along the river banks, over grazing, deforestation and draining of wetlands for crop production. These activities have an impact on plant species richness. We quantified the effects of land use practices on plant species richness in Nzoia River Drainage Basin in Bungoma East District. Land use practices along the drainage basin were identified by actual surveying. Plant species were identified through quadrat method. Simpson's diversity index was then used to determine the plant species richness and species richness in each sample plot. Data was subjected to Analysis of Variance to test for the difference between treatment means at 5% level of significance and correlations analysis performed for significant land use practices and plant species richness. Land use practices identified included cultivation and grazing. Undisturbed sites were treated as control sites in the study. A total of 119 plant species from 27 families were recorded. Herbaceous plant species belonging to the following families; Asteraceae, Poaceae, Convolvulaceae, Solanaceae, Amaranthaceae, Commelinaceae and Moraceae comprised more than 65% of the total flora. Cultivation had a significant influence on species richness with a mean value of - 0.07929. Cultivation had negative correlation on plant species richness.

Introduction

Land use changes in East Africa have transformed land cover to farmlands, grazing lands, human settlements and urban centers at the expense of natural vegetation. These changes are associated with deforestation, biodiversity loss and land degradation. A synthesis of results of long term research by an interdisciplinary research has revealed linkages between land use change, biodiversity loss and land degradation (Maitima et al. 2009). These findings show that as native vegetation is lost, indigenous biodiversity and plant cover are also lost. These studies also found out that pastoralism maintains native plant and animal species more effectively than crop cultivation and farmers who grow many crops conserve native plant species better than those who grow only one crop. Increased crop diversity encourages regeneration of indigenous plant species. The decline of plant species richness in Nzoia River Drainage persists and cascade to the rural majority who become perfect culprits of these detrimental changes. This calls for a paradigm shift in land use practices that reflect opportunities for conservation of floral diversity as well as increasing the level of food production to enhance food security. Odira et al. (2010) have clearly demonstrated that land use practices have undergone numerous changes in the recent past. For example, forest cover decreased markedly between 1970 and 1986 by 48.3%. This was attributed to deforestation, weather changes, and effects of urbanization and population growth. The study revealed that numerous plant species were lost in the process of change in the land use practices (Lobe 2004). However the situation changed between 1980 and 2000, when there was an increase in areas under forest cover by 41.3% (Myers 2007)

Studies carried out in Uganda by Eilu et al. (2003), on the effects of traditional farming on floral diversity have shown that traditional farming supports more plant species and should therefore be encouraged. The study found out that small scale farmers embrace conservation of floral diversity than large scale farmers perhaps, because most small scale farmers do not use agro- chemicals which significantly affect plant species richness. Historically, humans have increased agricultural outputs by bringing more land into agricultural production (Lambin et al. 2003). The declining yields in crops have forced people to cultivate more land to meet their food needs (Kaihura and Stocking, 2003). Consequently, conflicts over the use of land have intensified due to increased demand for land by different sectors of the economy.

Vegetation degradation results from the loss of nutrient-rich litter and microorganisms that decompose organic matter. The loss of shade accelerates leaching, soil erosion and drying up of soils. The hard surface caused by baking impedes water infiltration causing excess runoff and flooding. In addition to the effects on the local vegetation and hydrology, forest removal additionally influences atmospheric composition, evapotranspiration, and precipitation, all of which combined lower indigenous plant species richness and provides opportunities for invasive species (Withgott and Brennan 2011).

Cattle grazing have generally been believed to be a threat to biodiversity in regions threatened by exotic species invasion and lacking native wild grazers. Cattle have, however, been shown

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to produce the type of disturbance that helps maintain diverse floral communities (Jaymee, 2004). Besides, increased soil compaction by cattle can have a negative effect on the growth of young tree seedlings and on productivity Klaas et al. 1986. Studies on the effects of livestock grazing on plant species richness and biomass, revealed that herbaceous plant species increased by more than 50% (Kamau 2004). Additionally, it has been demonstrated that there is a higher diversity and a more even distribution of species in grazed than in un-grazed sites (Kamau 2004). Biomass and woody vegetation cover on the other hand, were greater in sites with no grazing (Maitima et al. 2009). Other studies have shown that pastures (planted and native) supported more weeds than other land uses and only occasionally were homes to plant species of conservation value (Maitima et al. 2009). One of the major impacts of heavy grazing is a shift in floral composition as evidenced by replacement of perennial shrubs with annuals (Lobe 2004).

The objective of this study was quantified the effects of different land use practices on floral diversity in Nzoia River Drainage Basin (NRDB). This area was chosen because it is traversed by the river Nzoia that empties its waters into the Lake Victoria and is undergoing rapid changes in land use practices. Knowledge of how these practices affect plant species richness is important in futures conservation management decisions.

Study Site

Nzoia River Basin lies between latitudes 10 30'´N and 00 05´ S longitudes 34^0 and 35^0 45' E (figure 1). The Nzoia River originates from Cherengani Hills at a mean elevation of 2300 m above sea level and drains into Lake Victoria at an altitude of 1000 m above sea level (Nzoia River Basin Management Initiative 2006). It runs approximately south – West and measures about 334 km with a catchment area of about 12,900km^2, with a mean annual discharge of 17777×10^6 m^3. The study site was located in Bungoma East sub-county that extends between longitudes 34º34'00" to 34º51'30"E and latitudes 0º23'00" to 0º37'30"N. Nzoia River drains south westerly through the sub-county and is fed by many tributaries among them Kuywa river whose wetlands have completely been drained by sugarcane cultivation.

The Nzoia River Drainage Basin is of great economic importance at local as well as national levels especially in such sectors as agriculture, tourism, fishing and forestry (NRBMI 2006). It is also the main source of water for domestic, (rural and urban water supply), agriculture and commercial sectors, as well as for very important industrial establishments in Western Kenya, namely Pan Paper Mills, Nzoia Sugar Company, Mumias Sugar Company, and West Kenya Sugar. In addition there are numerous minor sugar factories, coffee roasters and wood processors (NRBMI 2006). The local communities provide labour to these industries from which they obtain income to supplement those from their subsistence activities. The main challenges in the basin include soil erosion and sedimentation, deforestation, flooding, wetland degradation, pollution and solid waste, river bank cultivation, sand harvesting, brick making, human-wildlife conflict and loss of some plant species (NRBMI 2006).

Data collection and analysis

Land use Practices

Primary data on land use practices was obtained through a ground survey of the study area to identify the current land use practices. Three main study sites were selected: Kakimanyi which was characterized by maize and sugar cane cultivation, grazing, while some areas in this study site were totally undisturbed; Nambalayi which was characterized by heavy cultivation of sugarcane and maize, and horticulture. There were also grazed and undisturbed sites; Kuywa which had a number of activities that were aimed at livelihoods. They included sand harvesting, cultivation maize and sugar canes, grazing, burning of the land and some totally undisturbed areas that are reserved for cultural practices. Secondary data on land use practices was additionally obtained from technical reports and local authorities.

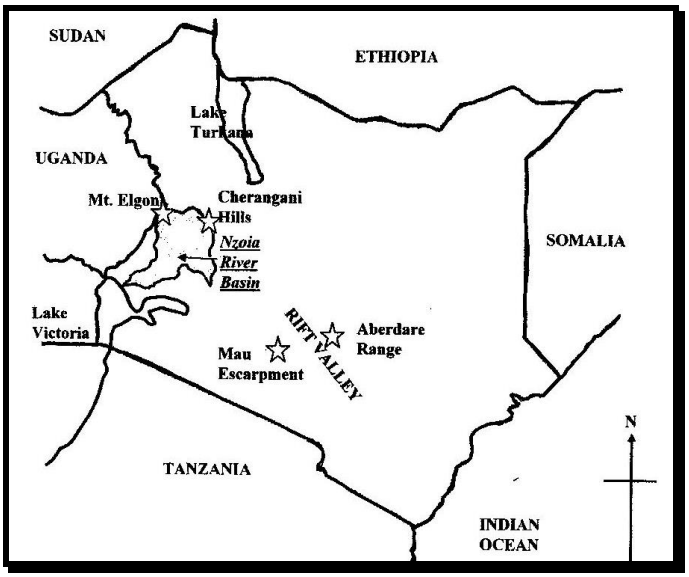

Figure 1: A map of Kenya showing the location of the Nzoia River Basin (Source: NRBMI 2006).

Plant Species Richness

Line transects and quadrat methods were used to estimate the plant species richness. The quadrats used for various plant forms were as follows; annual and grass plants 1mx1m; Shrubs 10mx10m, while for large plants quadrats of 20mx20m were used. Quadrats were placed in randomly selected areas under three selected land use practices: grazing, cultivation and undisturbed in the three main study sites. Plants in every quadrat were identified and counted. Growth forms were also quantified. Plants that could not be identified on site were preserved for later identification at the East African Herbarium.

Data was subjected to Analysis of Variance to test for the difference between treatment means at 5% level of significance. Correlation and regression analysis was used to determine the relationship between land use practices and plant species richness using STATISTICA software (version 8.0) and SPSS software.

Results

Land use Practices

Nzoia River Drainage Basin (NRDB) is characterized by various land use practices namely; crop production (sugar cane, maize and various horticultural crops), livestock grazing and brick making. At the three main sites sampled (Kakimanyi, Nambalayi and Kuywa), cultivation, grazing, and brick making were the main land use practices recorded. Some areas in the study sites were totally undisturbed because they are reserved for cultural practices and were treated as control sites during the study.

Plant species Richness

A total of 119 plant species from 26 families were recorded in the three study sites. The herbaceous plant species belonging to *Asteraceae, Poaceae, Convolvulaceae, Solanaceae, Amaranthaceae, Commelinaceae* and *Moraceae* comprised more than 65% of the total flora. There were a total of 19 families of plants at cultivated sites, with *Asteraceae* family comprising 41.2% followed by *Poaceae* that had 14.05%. At

grazed site, 19 families of plants were also counted and out of the 19 families *Poaceae* family alone accounted for 43.60% of the plant species that were recorded. This was followed by *Commelinaceae* family that had 23.40%. In undisturbed site, 25 plant families were recorded. In comparison to the total number of plant families recorded during the study, undisturbed site represented 89.7% of the plant families. Among the 25 plant families recorded *Solanaceae* family comprised of 13.7%, followed by *Asteraceae* family with 13.2%.

Figure 1, 2 and 3show the total numbers of plant families recorded at the various sites. The error bar graphs show the occurrence of different plant families in the specified study site.

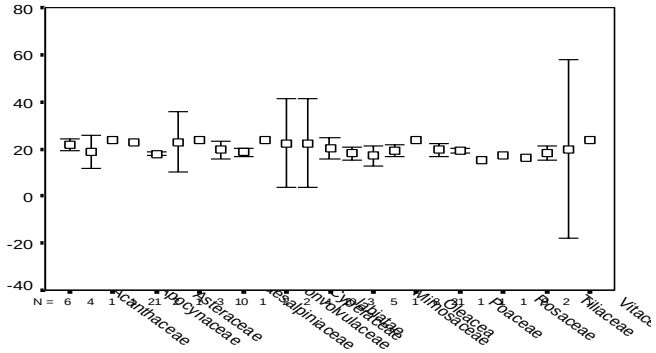

Figure 2: Plant families at the Kuywa site.

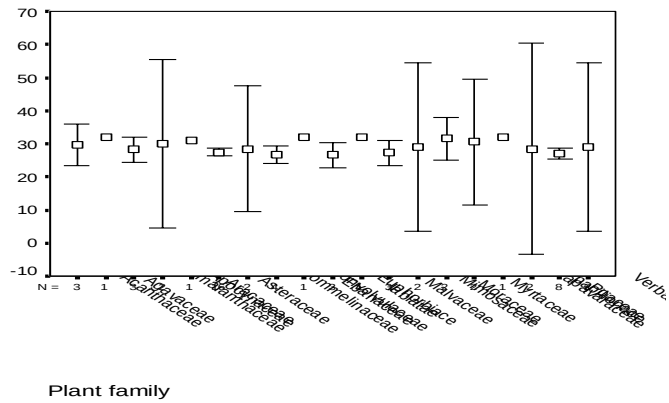

Figure 3: Plant families at the Nambalayi site

Analysis of variance was performed between land use practices and plant species richness and species richness. It revealed that cultivation as land use practice had a significant effect on plant species richness with an average mean of -0.08 in table 1.0 below

When land use practices were correlated with and plant species richness using Pearson's product, there was a slight significant negative correlation with plant species richness (r=-0.3152; p=0.0126) and plant species richness (r= 0.0126; p=0.0232).

Table 1: Effect of land use practice on plant species richness and richness

	Cultivated	Grazed	Undisturbed
Species richness	-0.08b	0.01a	-0.02a
Species richness	2.63 a	2.81a	2.72 a

Means followed by the same letters (a or b) within a row are not significantly different (p ≤ 0.05), while those with different letters within a row are significantly different.

Plant species growth forms

Five main growth forms were recorded. These were trees, shrubs, herbs, grasses, climbers and creepers. Herbs were the dominant ground cover under the three land use practices followed by shrubs, grass, trees climbers and creepers respectively in all the three study sites (figure 4, 5, and 6).

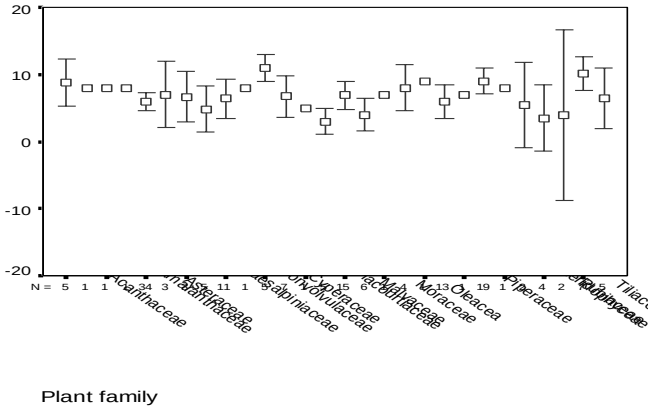

Figure 4: Plant families at the Kakimanyi site

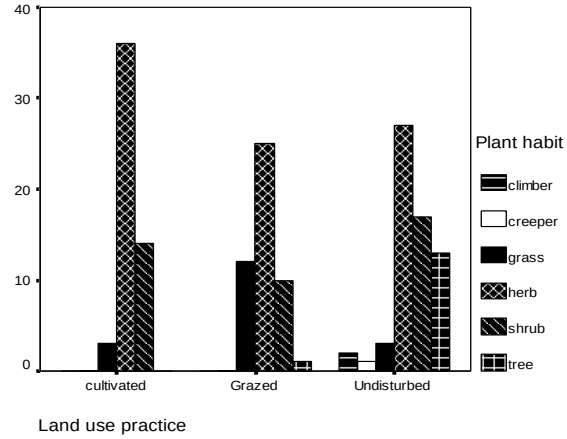

Figure 5: Percentage of plant growth forms on various land use practices at the Kakimanyi study site.

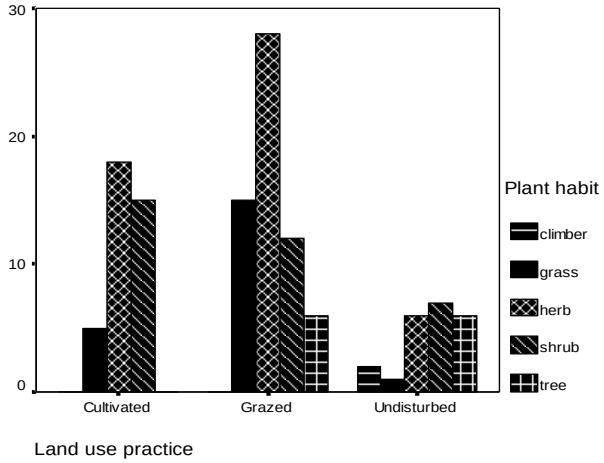

Figure 6: Percentage plant growth forms on various land use practices at the Kuywa study site.

Discussion

Cultivation and plant species richness

Results clearly show that cultivation as a land use practice has a negative impact on plant species richness. There was a negative correlation between land cultivation and plant species richness. The results indicate that areas under cultivation have very low plant species richness and most plant species in these areas were invasive species. Invasive species tend to dominate disturbed ecosystems, competing and displacing the native species. This may explain the low species richness recorded in the cultivated areas (Huenneke et al. 1990).

Grazing and plant species richness

Grazing as a land use practice did not have significant effects on plant species richness. These findings contradict those of Marty (2004) who observed that grazing maintained high species richness and it is practiced as a technique of preserving plant species richness and conservation values of grassland and pastures in England. Their findings are, however, for areas that are for purely grazing like the result we obtained that are based on seasonal grazing after each harvesting season. For grazing to have a significant effect on plant species richness, the intensity and duration of grazing are the key factors that determine the effects on plant species richness and even soil properties (Maitima et al. 2009).

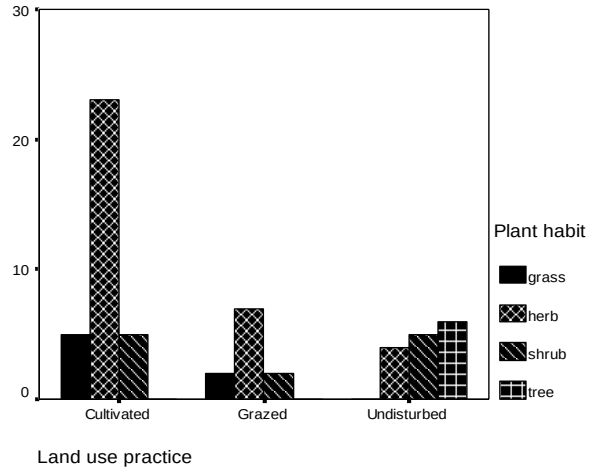

Figure 7: Percentage of plant growth forms on various land use practices at the Nambalayi study site.

Land Use Practices and Plant growth forms

Results obtained in the study reveal that there is a relationship between the land use practices and the plant growth forms. These observations are in agreement with those of Grubb (1987) and Goodland (1971) who found a positive relationship between tree species richness and soil fertility, and a negative relationship between herb species richness and soil fertility. Grubb (1987) proposed that these relationships could be explained by the fact that herbs have more potential for competitive exclusion and establishment in gaps than trees. Our study reveals that cultivation as land use practice significantly favours herbaceous plants than trees, climbers and lianas. This is attributed to the fact that during cultivation trees are usually cleared which therefore gives an opportunity for herbs to dominate and cover the space since their lifecycle is shorter compared to trees, lianas, creepers and climbers.

Conclusion and Recommendations

This study identified the major land use practices within the River Nzoia Drainage Basin. These are grazing and cultivation mainly of sugarcane and maize. Horticulture and brick making were also identified as minor land use practices. Cultivation had a significant effect on plant species richness. Heavy cultivation lowers plant species richness and increases species richness of purely invasive plants. Land use practices can be said to be the major causes of change in plant species richness and composition in this area.

The ever rising rate of human population growth, demands that emphasis be placed on better land use practices that do not threaten plant species richness and are sustainable.

Attempts must be made to restore the degraded areas in order to reduce pressure on remaining natural habitats. Sound management of biological as well as non- biological resources is essential for the overall preservation of biological diversity in this region.

There is need to involve the local community in all conservation plans and programs. All conservation strategies should be economically viable, ecologically sustainable and culturally acceptable. The policy makers, development planners, conservation scientists and managers should therefore cooperate with the local community to foster a common approach to land use practices, conservation of biodiversity and economic development.

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