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M. N. Nyaga
*University of Nairobi, Kenya*

S. M. Mureithi
*University of Nairobi, Kenya*

V. O. Wasonga
*University of Nairobi, Kenya*

O. K. Koech
*University of Nairobi, Kenya*



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Nyaga, M. N*; Mureithi, S. M; Wasonga, V. O and Koech, O. K

Department of Land Resource Management and Agricultural Technology (LARMAT), University of Nairobi, P.O. Box 29053, Nairobi, Kenya

*Corresponding author. Email: ngithimargeret@gmail.com

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## Abstract

Information on the state of woody vegetation of Rusinga Island is urgently needed in order to develop appropriate and effective conservation guidelines. Rusinga Island is an ancient historic area with numerous archeological sites and a bountiful of birdlife. However, the Island is characterized by highly degraded ecosystems from human disturbances such as cutting down of trees for fuel, construction poles, and overgrazing resulting in a remarkable degradation of flora, alteration of the ecosystems and loss of biodiversity. This study sought to determine the composition and diversity of woody plant species in Rusinga Island to understand the current status in order to develop appropriate and effective conservation measures since no such study has been conducted in the area before. Three hills (Ligongo, Agiro and Wanyama) were selected for sampling and demarcated into three study zones differentiated by the slope gradient and land use. A systematic random sampling approach was adopted to establish 98 sampling plots measuring 20 m x20 m (400m$^2$) for recording tree species and subplots of 10 m by 10 m within the main plots for recording shrubs and lianas across the three study zones at an interval of 200m. A total of 63 woody plant species belonging to 32 families and 51 genera were recorded, out of which 66.7% were trees, 31.7% shrubs and 1.6% lianas. The upper zones had significantly higher species diversity, species richness, evenness and abundance compared to the middle and lower zones. The lower zones depicted a lower abundance of plants and least similarities of species compared to the middle and upper zones. Development of appropriate conservation and management strategies is required in order to protect the woody plant resources from unsustainable human activities and to improve the natural diversity of the Island.

## Introduction

Biodiversity around the World is under threat due to anthropogenic influences and climatic changes, with the former being the major contributor to biodiversity losses over the years (Foody et al. 2003). Most of the wild plant species are facing threats from overexploitation since very few are cultivated (Schippmann et al. 2002) in addition to the increasing extraction pressure. In particular, woody plant species are threatened in different parts of the World. It is estimated that 10% of all plant species are threatened with the highest rates being of woody species in the tropics (Tabuti 2012). Woody vegetation plays vital roles in safeguarding the environment and quality of life through the removal of pollutants, offsetting carbon emissions, shading and cooling (Gao et al. 2013). Despite their importance, the natural forests are diminishing under pressures of deforestation and other human interferences leading to land degradation causing Global environmental problems (UNCCD 2003).

Information on species composition and diversity of an area is necessary for informed management in terms of economic value, regeneration capability and ultimately to sustainable conservation of biological

resources (Sarka and Devi 2014). However, no such analysis has been conducted on the floristic composition and diversity of woody plant species of Rusinga Island. Therefore, the present study sought to determine the composition and diversity of woody plant species in Rusinga Island to understand the current status in order to develop the most appropriate and effective conservation measures for the area.

## Methods and Study site

This study was carried out in Rusinga Island (0°35'–0°44' South; 34°11'–34°22' East) in Homa bay County, Kenya stretching over 44 $km^2$ with an elevation between 1100 m and 1300 m above the sea level (Opiyo et al. 2007; Osoro et al. 2016). The daily temperatures range between 16 and 34°C and tend to be higher during the dry months of June and October (Homan et al. 2015). Rusinga Island receives an annual rainfall of 800 to 1000 mm with an unequal distribution over the year greatly influenced by relief and altitude. The Island has two rainy seasons, the short rainy season which starts from October to December and the long rain season which is the most important season starts from March and ending in June but the seasons are highly unpredictable and variable with some years characterized by prolonged dry periods (Opiyo et al. 2007).

Rusinga Island's terrain is hilly and rocky with Ligongo hill being the main hill at the Centre of the island (Olanga et al. 2015).

Systematic sampling technique was used where three hills: Ligongo, Agiro and Wanyama hills were selected for sampling. The hills were further demarcated into three study zones: lower, middle and upper zones differentiated by the slope gradient, land use, and dominant vegetation types. On each hill, four transect lines cutting across the three study zones were demarcated starting from a common point at the apex of the hill and radiating to the four sides of the hill to the shores of the lake following the four compass directions (north, south, east, and west). In all study zones and hills, 98 sampling plots in total measuring 20 m x20 m (400$m^2$) for recording tree species and one subplot of 10 m by 10 m within the main plot for recording shrubs and lianas were systematically demarcated at every 200 m interval.

Shannon-Wiener Diversity Index (*H'*) and Shannon's evenness index (J) were used to estimate species diversity. Species richness was calculated using Margalef's diversity index (D) (Clifford and Stephenson 1975) while the similarities in species was calculated using Sørensen's coefficient (SC) (Sørensen 1948).

## Results

A total of 63 woody plant species belonging to 32 families and 51 genera were recorded in all of the 98 sampled plots. Trees, shrubs, and lianas were represented by 42 (66.7%), 20 (31.7%) and 1(1.6%) species, respectively. Out of the total number of plants recorded, 78% were indigenous with only 22% of exotic species. Plant family Euphorbiaceae recorded the highest number of species (8 species) followed by Mimosaceae (7 species); Caesalpiniaceae (6 species); Sapindaceae (5 species); Anacardiaceae, Apocynaceae, Bignoniaceae, Capparidaceae, Combretaceae, Flacourtiaceae, Meliaceae, Moraceae, and Tiliaceae (2 species each) with the other families represented by a single species.

The overall mean for Shannon's diversity index in all the three hills and study zones was 2.23. There was a significant difference($P<0.001$) in species diversity among the three study zones with the upper zone of Ligongo recoding the highest species diversity (3.04) and the lowest recorded in the lower zone of Wanyama hill (1.21). A one-way ANOVA test revealed that there was no significant difference in species evenness among the three study zones ($P=0.203$). The Shannon's evenness index ranged between 0.59 and 0.84 where the highest evenness index was recorded at the upper zones of Ligongo and Agiro hills (0.84) and lowest at the middle zone of Wanyama hill (0.59).

Woody plant species richness varied significantly in the three study zones (P=0.004) with the upper zone of Ligongo hill recording a significantly higher species richness (4.89) and the lowest richness recorded in the lower zone of Wanyama hill (1.03).

The highest species similarity index (Least dissimilarity) of 79.41 % was recorded between the upper zones of Ligongo and Agiro hill, while the lowest similarity index (highest dissimilarity) of 19.05 % was recorded between the lower zone of Wanyama hill and the upper zone of Ligongo hill.

## Discussion and conclusions

Plant family Euphorbiaceae recorded the highest number of species (8 species) followed by Mimosaceae (7 species). This is attributable to their adaptation to arid and semi-arid conditions which is a typical of Rusinga island. The Island is characterized by hot and dry climate relative to the rest of the country (Asinjo 2014). The upper zones were found to have more species richness followed by the middle zones and the least species richness was observed in the lower zones and the number of species found in any of the three study zones decreased from the lower zone to the upper zone. This was partially due to the activities that take place in different study zones thus causing the disappearance of woody species. For example, the lower zone is close to the shores of the lake and it is mainly characterized by farmlands where farmers tend to uproot most of the woody plants for ease of cultivation.

Overall in all the hills and study zones an average of 2.23 Shannon's diversity index was recorded in Rusinga Island. Ecosystems with Shannon-Wiener values greater than 2 are regarded as medium to highly diverse in terms of species (Giliba et al. 2011; Barbour et al. 1999), this implies that Rusinga island is a medium diversity ecosystem. The high species similarity index (Least dissimilarity) recorded between the upper zones of Ligongo and Agiro hill was probably due to the close proximity of the two hills whereas the high dissimilarity between lower zone of Wanyama hill and the upper zone of Ligongo hill may be due to lack of close proximity to each other, differences in altitudinal range, species composition and the levels of anthropogenic impact as observed by Tilahun et al.(2011) in a study conducted in Menagesha Amba Mariam Forest of Ethiopia. While conducting a study in Taita hills of Kenya, Omoro et al. (2010) found higher similarities in species in sites that were close to each other and attributed to similar mechanisms of dispersing seeds and similar soil seed bank.

Sustainable land management practices such as planting of multipurpose trees and protection of existing trees species in the lowlands and around homesteads and settlement areas is recommended for effective restoration of land cover as evidenced in highly disturbed areas with low plant cover within the lowlands and settlement areas than in less disturbed areas of the middle and upper zones of the study area.

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