ISBN: 2141 – 1778 jfewr ©2015 - jfewr Publications

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WOODY VEGETATION STATUS ON DIFFERENT ALTITUDINAL GRADIENTS OF AN ECOTOURISM DESTINATION: ARINTA WATERFALL, EKITI STATE, NIGERIA

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ABSTRACT

Altitude plays key roles in determining plant distribution and biodiversity patterns. The importance of vegetation should not be undermined because it is one of the primary factors that determine the eligibility of ecotourism sites. This study was undertaken at Arinta Waterfall, Ekiti State, Nigeria with an aim to determine the woody species composition, structure and the influence of altitude (<440m, 440m – 480m, >480m) on the floristic character of the study area. The Point Centered Quadrant method was employed. A total number of thirty-six (36) different woody species belonging to twenty seven (27) families of woody trees were recorded. Number of species, number of families, mean height and mean diameter at breast height were significantly different among the three selected altitudes (P≤0.05). Richness, Shannon Wiener diversity index, Simpson evenness index and mean tree canopy were not significantly different (P≥0.05). The vegetation of Arinta waterfall still possesses some potential for conservation purposes. Logging activities and agricultural activities are the major human threats at the site. Therefore, there is a need of re-orientation program for the host communities in order to change their value system into imbibing biodiversity conservation and ecotourism development. The supervising ministry on tourism and forestry in Ekiti State, Nigeria in charge of this site should take immediate step to halt further degradation of the habitat cover.

Keywords: Altitude, woody vegetation, waterfall, human activities, ecotourism

INTRODUCTION

Altitude - a measure of heterogeneity - had been demonstrated to be a major determinant of plant diversity (Pausas *et al.,* 2003; Vetaas and Ferrer-Cast ´an, 2008). It plays key roles in determining plant distribution and biodiversity patterns (Huebner and Vankat, 2003). The importance of vegetation should not be undermined because it is one of the primary factors that determine the eligibility of ecotourism site (Pandya *et al*., 2006). Ecotourism has attracted increasing attention in recent years, not only as an alternative to mass tourism, but also as a means of economic development and environmental conservation (Slinger-Friedman, 2009; Schaller, 2010; Stankov *et al.,* 2011). Being a nature based tourism; it takes into account the natural ecological attraction, their conservation and development. Its main aim is to safeguard the environment, making it beneficial to the local people by generating revenue and educating and serving the pleasure of the tourists.

The main drivers of deforestation in the country are agriculture, logging, and mining. Studies in the southern region have cited rapid population growth, agricultural expansion (e.g. cocoa belt of southwest Nigeria), use of fuel wood, and logging as major drivers of deforestation in the country (Olakunle *et al.,* 2011). Many communities depend on traditional methods of farming and face land use constraints. Population growth is stimulating agricultural expansion, thereby diminishing arable land and encouraging forest clearing. Rising prices of petroleum products, especially cooking gas and kerosene, have encouraged both rural and urban households to rely on fuel wood and charcoal as their main sources of energy (Famuyide *et al.,* 2011), leading to further deforestation.

Despite the strategic position and unique opportunity offered by Arinta Waterfall to the development of ecotourism in Ekiti State in particular and the region of South-West Nigeria in general, little or no information exist on the site. The knowledge of the interrelationship between its altitude and phyto-sociological characteristics are important to the maintenance of the site for sustainable ecotourism development. As a matter of fact, before any meaningful development of any natural resource, it is necessary to know about the vegetation that had supported and maintained the resource. There is the need to know the species composition, distribution, and the degree of the species abundance of the study area, in order to ensure the ecological integrity of the site. The study aimed at determining the woody species composition, structure and the influence of altitudinal gradients on the vegetation of the study area.

Methodology

Study Area

The study was carried out at Arinta waterfall, which is located in Ipole-Iloro Ekiti at about 6km North-West of Ikogosi in Ekiti-West LGA. It is situated within latitude 07.55289^{o} N and longitude 004.92757^{o} E and bounded on the east by Erin-Ijesa, on the East by Erin-Ijesa, on the South East by Ikeji-Ile, on the North by Efon Alaaye, on the east by Ikogosi/Erijiyan and the South West by Ogotun Ekiti (Odeyemi *et al*., 2011).

The study area enjoys a tropical climate with two distinct seasons - rainy season (April-October) and the dry season (Nov-March). Temperature ranges between 21^{o}C and 28^{o}C with high humidity. The southern wind and the northeast tide wind blow in the rainy and dry season respectively. The waterfall is characterized with surrounded large number of hills (UNEP, 2003).

Data collection and analysis

Sampling techniques

The Point Count Quadrat method was employed to determine the phyto-sociological characteristics of the woody vegetation. A total length of 450m was transverse. Three transects were marked on varied ranges of altitudes (Less than 400m, between 400m and 480m, above 480m) which were measured using Global Positioning System (Garmin Etrex 10), with a distance of 150m each. Stratified sampling technique was used to determine the point of measurement. Point quadrats were dropped at every 15m along each transect, with a total of thirty (30) points in the study. The following parameters were measured: woody species composition, frequency, height (in meters), diameter at breast height (in centimeters), canopy size (in meters), species richness, diversity and evenness. In each point, diameter at breast height (DBH) was measured with girth/diameter tape at 1.3m above ground level, canopy diameter was measured with meter tape while total height was measured with hypsometer (ForestryPro Model).

Tree species identification and classification

The botanical name of all trees encountered in each sample point was recorded for each of the study area. According to Lawal and Adekunle (2013), when a tree's botanical name was not known immediately, it was identified by its commercial or local name. Such commercial or local name was translated to correct botanical names using Keay (1989). The woody vegetation was classified into species and distributed into families.

Statistical analysis methods

R commander package in R software were used to compute the one-way analysis of variance in order to test for significant differences in tree height, DBH and canopy size among the three altitudes, including the construction of the DBH curves and height distribution of trees, while species richness, abundance, Shannon Wiener diversity index and Simpson evenness index were computed using BiodiversityR package. Where significant differences ($p < 0.05$) occurred, mean separation was carried out with Duncan's new multiple range test (DMRT).

Results

Tree growth variables in the three altitudinal gradients

Table 1 presents the phytosociological parameters of woody vegetation on altitude < 440m of Arinta Waterfall (at 95% Confidence limit). A total of forty (40) individual woody trees belonging to twenty (20) different Species and ten (10) families were observed. *Ricinodendron heudelotii* had the highest number of occurrence (5) with mean height (10.80 ± 2.56m), mean DBH (11.80 ± 4.04m) and mean canopy size (3.36 ± 0.74m). This is followed by *Sterculia tragacantha* (4) and *Celtis mildbraedii* (4). *Ceiba pentandra* had the highest mean height (51.90 ± 0.00m), while *Brachystelgia eurycoma* had the least mean height (2.90 ± 0.00m). The tree species with the maximum DBH is *Brachystelgia eurycoma* (52.78 ± 0.00m), while *Funtumia africana* had the minimum DBH (3.30 ± 0.00m). *Ceiba pentandra* had the widest mean canopy size (61.65 ± 0.00m) and the tree with least mean canopy size (1.40 ± 0.00m) is *Alstonei boonei*. *Danieli orgea, Funtumia africana, Garcinia kola* occurred thrice each, *Albizia zygia, Glyphaea brevis, Piptadeniastrum africanum, Zanthoxylum leprieurii* occurred twice each, while few other species occurred once.

Table 2 presents the Phyto-sociological parameters of woody vegetation on altitude 440m – 480m of Arinta Waterfall, Nigeria. A total of forty (40) individual woody trees belonging to seventeen (17) different Species and ten (10) families were observed. *Theobroma cacao* and *Albizia zygia* had the highest number of occurrence (8) with mean height (4.88 ± 0.67m), mean DBH (12.99 ± 3.68m) and mean canopy size (4.91 ± 0.48m) respectively. This is followed closely by *Theobroma cacao* which occurred eleven (11) times with the mean height (5.64 ± 1.00m), mean DBH (4.88 ± 0.67m), mean canopy size (1.92 ± 0.54m). *Albizia zygia* had the highest mean height (14.30 ± 3.25m) while *Glyphaea brevis* had the lowest mean height (1.20 ± 0.00m). The tree species with the maximum mean DBH (14.40 ± 3.61m) is *Pycnanthus angolensis* and the minimum mean DBH (1.60 ± 0.00m) is *Piptadeniastrum africanum.* The tree species with the widest mean canopy size (7.03 ± 1.84m) is *Albizia zygia* and the least mean canopy size (0.40 ± 0.00m) is *Zanthoxylum leprieurii*. *Funtumia africana, Pseudospondias microcarpa* and *Pycnanthus angolensis* occurred thrice each in the study area. *Berlinia auriculata*, *Cleistopholis patens* and *Cola hispida* occurred twice each, while few other Species occuring once.

Table 3 presents the Phyto-sociological parameters of woody vegetation on altitude > 480m of Arinta Waterfall, Nigeria. A total of forty-one (41) individual woody trees belonging to seventeen (19) different Species and fourteen (14) families were observed. *Boscia angustifolia* had the highest number of occurence of Eleven (11) with mean height

(9.75 ± 3.40m), mean Diameter at the breast height (10.27 ± 2.22m) and mean canopy size (6.22 ± 1.29m) respectively. This is followed closely by *Sterculia tragacantha* occuring Seven (7) times with the mean height (11.33 ± 2.12m), mean Diameter at breast height (15.67 ± 4.04m) and mean canopy size (7.23 ± 2.00m). *Melicia excelsa* had the highest mean height (40.50 ± 0.50) while *Drypetes gilgiana* had the least mean height (1.30 ± 0.00). The tree species with the maximum mean DBH (33.50 ± 6.50m) is *Melicia excelsa* and the minimum mean DBH (0.40 ± 0.00m) is *Brachystegia eurycoma*. *Albizia ferruginea* had the widest mean canopy size (22.50 ± 9.00m) and the least mean canopy size (0.90 ± 0.00m) is *Glyphaea brevis*. *Ricinodendron heudelotii* occurred thrice and *Albizia ferruginea*, *Melicia excelsa, Mitragyna stipulosa* and *Zanthoxylum leprieurii* occurred twice each, while few other species occuring once.

Variation among tree growth variables in the three altitudinal gradients

Table 4 presents the analysis of the tree growth variables of woody vegetation in the three different altitudes of Arinta Waterfall, Nigeria at 95% confidence limit. Altitude (440-480m) had the least mean height of woody tree species (2.70 ± 30.59m), while altitude (>480m) had the highest mean height (7.78 ± 1.79m). There was significant difference in the mean height of woody tree species among the three altitudes (P ≥ 0.05). Altitude (440-480m) had the least mean diameter at breast height of the woody tree species (3.43 ± 0.74m), while altitude (<440m) had the highest mean diameter at breast height (9.08±2.00m). There was significant difference in the mean diameter at breast height of the woody tree species among the three altitudes (P ≥ 0.05). It also presents that altitude (440-480m) had the least mean canopy cover of the woody tree species (1.54 ± 0.35m), while altitude (<440m) had the highest mean canopy cover (4.06 ± 1.70m). There was no significant difference in the mean canopy cover of the woody tree species among the three tributaries (P ≥ 0.05).

Figure 2 shows the diameter at breast height (DBH) curves for the three different altitudes in Arinta Waterfall, Nigeria, while Figure 3 depicts the height distribution of trees in the three different altitudes of Arinta Waterfall, Nigeria

Tree species diversity and abundance in the three altitudinal gradients

Table 5 presents the richness, abundance, diversity and evenness of woody tree species in the three different altitudes of Arinta Waterfall. Altitude 440-480m had the least richness of woody tree species seventeen (17), this was followed by altitude >480 nineteen (19), while altitude <440m had the highest richness of woody tree species twenty two (22). Altitude <440m had the least abundance of woody tree species thirty nine (39), this was followed closely by altitude 440-480m forty (40), while altitude >480m had the highest abundance of woody tree species forty one (41). Altitude 440-480m had the least diversity of woody tree species (2.51), this was followed closely by altitude >480m (2.52), while altitude <440m had the highest diversity of woody tree species (2.92). Altitude >480m had the least evenness of woody tree species (0.88), this was followed closely by altitude 440-480m (0.89), while altitude <440 had the highest evenness of woody tree species (0.94).

Discussion

Woody species composition of the site is very low and could not compare with many protected sites of Southwest Nigeria. This was evident in the total number of one hundred and twenty (120) individual woody trees belonging to thirty-six (36) different species and twenty seven (27) families of woody trees recorded in the plots sample, while fifty-three species of woody plants were recorded in Ologbo forest by Ogunjemite (2007). Sixty-seven (67) species in 25 families recorded by Oduwaiye *et al.*, 2002 in Okomu National Park - a strictly protected area in the same region. Thirty-three (33) each were recorded in Urhronigbe and Giligili forest reserves by Shell Petroleum Development in 2006. These are areas of special consideration for conservation purposes in this region, but the study area is yet to be given adequate attention by the Ministry of Tourism in Ekiti State, Nigeria – the government parastatal is the sole management of this tourist site. Its fate had been neglected to the hands of the host communities, thereby posing serious threats to its biodiversity. Also, the remnant vegetation of Arinta Waterfall was dominated by *Boscia angustifolia* and contained Red Data Listed species such as *Funtumia elastica*. This is an implication the study area had great conservation potentials. The vegetation of Arinta Waterfall is very important for the sustenance of the waterfall and serves as protection to its source.

The family Leguminosae is the most dominant in all the altitudinal gradients in Arinta Waterfall, Ekiti State, Nigeria. This family had the highest diversity of six and five species on altitudes <440m and 440m – 480m respectively, while family Leguminosae and Euphorbiaceae had the highest diversity of three species each on altitude >480m. According to Ihenyen *et al.,* (2009), the preponderance of occurrence of species in family Leguminosae with high diversity may be due to their method of seed dispersal. This explosive mechanism and wind disperse the seeds, they are carried far away from the mother tree where they germinate when conditions are suitable. But where dispersal is such that seeds are close to the mother trees, such seedlings may die due to competition for nutrients.

McLaughlin (1994) and Urban *et al.,* (2000) opined that geographic variation in altitude contributes strongly to landscape- and regional-scale differences in woody plant distribution and diversity patterns including species richness, and facilitates the compression of biotic communities into relatively constricted vertical spaces. Altitude is associated with the intensity of human-induced disturbances, microclimatic and geologic heterogeneity, increased area and geometric constraints (Nogu´es-Bravo *et al.,* 2008). Therefore, occurrence of *Theobroma cacao* in the altitudes 440m – 480m and >480m is a reflection that agricultural activities had taken place and this could had accounted for the decline in the evenness, richness, species and family diversity as the altitudinal gradient increases. This negated the assertions of Felger and Wilson (1994) that areas of higher topographic complexity support higher species richness. But, Lomolino (2001) pointed out that many components of climate and local environment (e.g. temperature, precipitation, seasonality and disturbance regime) vary along the elevation gradients and ultimately create the variation in species richness.

The intensity of human activities were more greater on altitude 440m – 480m as a result of intensified agricultural activities across the slope in the past in order to reduce water run-offs/erosion and recently, due to ecotourism development. Most visitors do climb to the middle course of the waterfall to experience its panoramic view and warm bath. Therefore, altitude 440m – 480m is well more impacted and devastated due to bush clearing in order to manage the ecotourism site.

Conclusion and Recommendation

Logging activities and agricultural activities are the major human threats to the vegetation of Arinta Waterfall site. A further degradation of the vegetation may seriously threaten the habitat and consequently destroyed the ecological integrity of the site. Therefore, measures should be taken to curb the exploitation of its vegetation. More researches should be carried out on Arinta waterfall and its vegetation to monitor the trend at which succession takes place and to know the effect of human activities around the waterfall. The conception by the natives of Ipole-Iloro (the host community) that the waterfall is their natural heritage and belonged to their forefathers had prompted them to misuse the ecotourism resources. Therefore, there is a need for re-orientation program in order to change their value system into biodiversity conservation and sustainable ecotourism development. The natives need to participate in the conservation education program so as to improve the resource users' understanding on the militating effect of vegetation depletion on the waterfall. Forest laws should be strictly enforced to prevent the illegal logging around the study area. Muchmore, forest guards should be deployed to prevent indiscriminate logging and agricultural activities. The supervising ministry on tourism and forestry in Ekiti State in charge of this site should take immediate step to halt further degradation of the habitat cover.

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