Diversity Indices of a Typical Tropical Watershed in Anambra State Nigeria

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Abstract. The indices of Diversity that were employed in this study included: Species Richness, Shannon wiener Diversity index and Evenness. The sites that made up this watershed include the forest site – which was dominated by trees, climbers and shrubs, forb population was highly insignificant, while the grasses were represented by only two species – *Panicum maxima* and *Imperata cylindrica*. The short term fallow site was dominated by forbs and grasses; shrubs, climbers and trees were not significantly represented. The long term fallow site was dominated by forbs, shrubs and grasses; trees and climbers were sparse. The current usage farming site was dominated by forbs, trees were absent in this site.

Keywords: Diversity indices, Typical, Tropical, watershed

1 INTRODUCTION

Anambra State has many watersheds. In the past, these watersheds were rich in biodiversity (unique plants, and of course the associated animals). These resources were appreciated because of the income they generated. After the discovery of crude oil in Nigeria, systematic destruction of biodiversity reached its zenith owing to anthropogenic factors particularly urbanization.

The bane of most tropical watersheds especially in Africa is paucity of not just plant and animal species, but useful ones. Species richness, Shannon index and evenness are all compromised. For this particular watershed generally, grasses and forbs dominated almost all sites. This is an aberration because timber and other forest species from Anambra State in times past, were regarded worldwide for their relevance as industrial raw materials. *Milicia excelsa, Nauclea diderichii, Khaya ivorensis, Ceiba pentandra, Canarium scheweinfurthii, Terminalia superba, Triplochyton sclerenxylon, Mansonia altissima* etc. the only panacea towards reversing this trend is that useful trees should be planted en-masse in all communities in this state. Useful shrubs, climbers, grasses and forb species that are going extinct should also be resurrected.

1.1 Statement of the problem

In parts of southeast Nigeria, Anambra State for instance, population explosion, rise in and unplanned industrial, infrastructural and agricultural development together with other unacceptable environmental practices gave rise to exacerbated watershed degradation. This has continuously impacted negatively on watershed sustainability (particularly water safety and biodiversity).

1.2 Objective of the study

The objective of the study is to: Ascertain the Diversity indices of the watershed.

2 LITERATURE REVIEW

Most watersheds in southeastern Nigeria were originally forested watersheds. Overpopulation, overcultivation, overgrazing, overharvesting of useful species, shifting cultivation, deforestation, and unplanned infrastructural development, all have collectively and independently contributed in reducing most of these forested watersheds into degraded, depauperized watersheds. The implication also is that the rich natural resources that are associated with forests are lost. According to Otegbeye and Onyeanusi (2006), "Deforestation is not only the removal of forest cover naturally or by human activities by felling of trees, but also removal of shrubs, lanes, grasses, and other plants from the forest". The United Nations System in Nigeria (UNSN) in their common country assessment of 2001, reports that the total area occupied by reserved forests in Nigeria was approximately ten per cent of the total land mass in 1977. This is considerably lower than forest estate covers of at least 25 per cent that obtains in many other countries in line with international standards. The proportion is reducing by the day as less than one per cent of forest areas cleared for domestic and commercial purposes get reforested. (Otegbeye and Onyeanusi, 2006). As deforestation takes its toll on our watersheds, they become extremely depleted in terms of biodiversity. This is the bane of most watersheds in southeastern Nigeria. The watershed under study (the Amawbia watershed) is a case in point. It has suffered from deforestation, soil degradation and general bioresource depletion. In the 1980s, about 400 hectares of forest and woodland out of every 1000 hectares suffered from deforestation while only 26 hectares were reforested on an annual basis (these days little or no reforestation is done (emphasis mine). According to the FAO, (1985). the remaining forest area in Nigeria will likely disappear by 2020 if the current rate of forest depletion continues unabated. The value of lost forest cover has been estimated at USS $750 million annually at 1989 prices, (Otegbeye and Onyeanusi, 2006). As vegetation disappears, the water and other resources of the watershed gradually vanish into thin air and the watershed becomes history. Annual rate of deforestation of woodlands (watersheds) averaged 3.5 percent in the 1980 to 1990 period. The southern rainforest which covers only 2 percent of the total land area in Nigeria, is being depleted at an annual rate of 3.5 percent. Large-scale deforestation in the south, particularly in the lowland forest areas, has resulted in a number of other problems including flooding, sheet, and gully erosion, as well as siltation of rivers (and streams, emphasis mine) that sometimes constitute the only source of water for domestic use, (Otegbeye and Onyeanusi, 2006). Siltation has been responsible for the disappearance of many watersheds, particularly in Anambra state, since the country's independence in 1960, and the local population have often attributed it to-anger of the gods, witchcraft activities and enmity of neighbouring clans. Other practices that contribute to vegetation destruction (watershed degradation) in Nigeria (particularly in Anambra State-emphasis mine) include intensive grazing, persistent bush burning, and reduction in, or absence of fallow periods, as well as extension of agricultural activities into less favoured, often environmentally fragile areas. The end result of deforestation, intensive grazing, bush burning, over ploughing and over cultivation is severe land degradation. In general, vegetation removal accelerates rainfall runoff and increases soil erosion, diminishing land productivity and aggravates local flooding. Severe land degradation has also resulted in desertification (UNSN,2001). Deforestation brings about serious ecological and socioeconomic problems some of which include wood shortage, food shortage, flooding, erosion, siltation of rivers, streams, destruction of wildlife habitats and increased poverty, especially in rural communities. All these bring to the fore the need for sustainable forest management which is the maintenance of environmental integrity to meet the needs of the present, and leaving enough in quantity and quality to satisfy the needs of the future generations (Otegbeye and Onyeanusi, 2006). The two primary natural production resources that determine agricultural potential are soil and water. Soil is acknowledged as the base for support and nutrition while its water content is basically responsible for facilitating nutrient utilization (Momodu, 2000). However, due to human activities soil and water are rarely in adequate supply to maximize

agricultural production. This is one of the major problems encountered in the watershed. Where soil and water are available, their quality renders them not very useful for productive activities. Land (watershed) degradation involves the physical removal of soil by water and wind, particularly through the process of soil erosion which results in reduction of both land surface and the quality of the soil with dire consequences on plant growth and the entire ecosystem. The various erosive powers of these agents results in sheet, rill, splash and gully erosion. The Amawbia watershed is a source of subsistence to low income dwellers associated with it. It provides food, shelter, fodder, industrial raw materials, herbal medicine, fuel wood et cetera. Over 70 percent of Nigerians live in the rural areas and almost all the rural families use fuelwood energy for their domestic needs. Fuelwood gathering is non-selective and almost all woody species can be exploited for the supply of fuel energy (Otegbeye and Otegbeye, 2002). Forest (watershed) resources generate wealth and support in diverse ways to the communities that make use of them. The livelihood is of the rural people revolve round the forest (watershed). The rural people process and trade in watershed products to earn extra cash income. For their household needs and, in some cases, they save to meet future needs. Apart from forests providing foods, herbs for medicine, fodder and fuelwood, a good number of Non-wood forest. Products (NWFP), are also gathered, processed, and sold to generate extra income. In addition, many rural and urban dwellers earn income from these activities (Otegbeye and Onyeanusi, 2006).

2.1 Typical floral Resources found in Anambra watersheds include:

Trees - *Milicia excelsa, Ceiba pentandra, Mangifera indica, Senna siamea, Pentaclethra macrophyla, Tetrapleura tetraptera, Anthocleista djalonensis, Elaeis guineenses, Dialum guineense, Zanthaxylum zanthaxyloides, Musanga cecropoides, Alstonia boonei, Dacryodes edulis.*

Shrubs – *Alchornea cordifolia, Sarcocephalum laxiflora, Annona senegalensis, Uvaria chamae, Vernonia amygdalina, Chromolaena odorata,Manihot esculenta, Riccinus Communis,* (Nigeria Natural medicine Development, Agency (2008).

Climbers – *Telfeiria occidentalis, Luffa cylindrica, Peuraria phaseoloides, Cissus araliodes, Mucuna pruriens, Desmodium scorpiurus.*

Grasses - *Imperata cylindrica, Panicum maximax, Paspalum scrobiculatum, Pennisetum polystachion, Hackelochloa granularis, Cymbopogon giganteus, Andropogon gayanus* and *Andropogon tectorum (Akobundu and Agyakwa, 1998).*

Forbs – *Aspilia africana, Synedrela nodiflora, Emilia coccinea, Ageratum conyzoides, Sida acuta, Spermacoce ocymoides, Mitracarpus villosus, Amarantus viridis, Gomphrena celosiodes, Aspilia bussei, Tridax procumbens, Cleome rutidosperma, Euphorbia hirta (Akobundu and Agygkwa, 1998).*

Diversity Index: A diversity index is a quantitative measure that reflects how many different types (such as species) there are in a dataset and simultaneously takes into account how evenly the basic entities (such as individuals) are distributed among those types. (Wikipedia, 2014). The value of a diversity index increases both when the number of types increases, the value of a diversity index is maximized when all types are equally abundant. When diversity indices are used in ecology, the types of interest are usually species, but they can also be other categories such as genera, families, functional types or haplotypes. The entities of interest are individual plants or animals, and the measure of abundance can be, for example, number of individuals, biomass or coverage. In demography, the entities of interests can be people, and

the types of interest, various demographic groups. In information science, the entities can be characters and the types the different letters of the alphabet. The most commonly used diversity indices are simple transformations of the effective number of types (also known as "true diversity"), but each diversity index can also be interpreted in its own right as a measure corresponding to some real phenomenon (but a different one for each diversity index). (Wikipedia, 2014)

Richness: Richness simply quantifies how many different types the dataset of interest contains, for example, species richness (usually notated S) of a dataset is the number of different species in the corresponding species list. Richness does not take the abundances of the types into account, thus it is not the same thing as diversity, which does take abundances into account. However, if true diversity is calculated with 9=O, the effective number of types (D) equals the actual number of types (R).

Shannon Index: The Shannon index has been a popular diversity index in the ecological literature, where it is also known as Shannon's diversity, the Shannon-Wiener index, the Shannon-Weaver index and the Shannon entropy.

3 MATERIALS AND METHODS

Shannon Wiener Diversity Index

Shannon-Wiener Index is denoted by H=Sum (pi) x In(pi)

Sum	=	summation
Pi	=	Proportion of total sample represented by species: Divide no of individuals of a species: by total number of individuals of all the species
S	=	Number off species = Species richness
Hmax	=	In S maximum diversity possible
E	=	Evenness = Hmax / InS

4 RESULTS

Table 1: Shannon Wiener and other Diversity Indices for the floral resources of the watershed.

S/N	Site	Flora	Species Richness		Shannon Weiner Diversity Index (H)		Evenness (E)	
			Rainy	Dry	Rainy	Dry	Rainy	Dry
A1	Forest (Flat)	Trees	25	25	2.69	2.69	0.84	0.84
2	Forest (Flat)	Climbers	6	3	1.03	0.23	0.57	0.21
3	Forest (Flat)	Shrubs	7	6	1.09	1.08	0.56	0.69
4	Forest (Flat)	Grass	2	2	0.63	0.63	0.91	0.91
		TOTAL	**40**	**36**				
B1	Short term fallow	Trees	7	7	1.61	1.61	0.83	0.83
2	Short term fallow	Shrubs	3	3	0.94	0.58	0.86	0.53
3a	Short term fallow	Grass	24 Flat Slope 12 12		2.03	2.08	0.82	0.84
3b	Short term fallow	Grass		19 Flat Slope 12 07	1.83	1.66	0.74	0.85
4a	Short term fallow	Forb (in families)	31 Flat Slope 16 15		1.62	1.24	0.58	0.46
4b	Short term fallow	Forb (in families)		27 Flat Slope 18 09	2.01	1.36	0.70	0.62
		TOTAL	**65 58 (Flat)**	**56 43 (Slope)**				
C1	Long term fallow (slope)	Trees	1	1	-	-	-	-
2	Long term fallow (slope)	Climbers	1	-	-	-	-	-
3	Long term fallow (slope)	Shrubs	2	3	0.69	0.85	1	0.77
4	Long term fallow (slope)	Grass	10	3	1.47	0.14	0.64	0.13
5	Long term fallow (slope)	Forbs (in families)	15	15	2.52	2.55	0.93	0.94
		TOTAL	**29**	**22**				
D1	Current usage farming (slope)	Climbers	3	3	0.95	0.99	0.86	0.90
2	Current usage farming (slope)	Shrubs	4	4	1.08	1.07	0.78	0.77
3	Current usage farming (slope)	Grass	4	5	1.05	1.32	0.76	0.82
4	Current usage farming (slope)	Forbs (in families)	24	15	1.90	1.64	0.60	0.60
		TOTAL	**35**	**27**				
E1	Current usage farming (Flat)	Climbers	2	2	0.64	0.60	0.92	0.87
2	Current usage farming (Flat)	Shrubs	3	3	0.96	1.03	0.87	0.94
3	Current usage farming (Flat)	Grass	5	4	1.00	1.37	0.62	0.99
4	Current usage farming (Flat)	Forbs (in families)	17	16	2.07	2.39	0.73	0.86
		TOTAL	**27**	**25**				

5 DISCUSSIONS

Table 1 effectively captures the Shannon Wiener and Diversity indices for the floral resources of the watershed. Starting with species Richness, it is clearly evident that the forest site was the most tree species rich, followed distantly by shrubs, climbers and grasses species in that order. Forbs were not present in the site. Reverse was the case at the short term fallow site

where the forbs represented the most species rich, followed distantly by the grasses, the trees, and shrubs. Climbers were not present in the site. The forbs also dominated the long term fallow site followed by the shrubs, with trees and climbers being at par. The grass population though was more in the rainy than in the dry seasons. Generally the forbs dominated the current usage farming slope and flat sites being more preponderant in the rainy than in the dry season. This was followed by grass, climber and shrub in that order. Trees were not seen in this site. The forbs again were dominant over all the other species with the number of rainy season species dominating. The tree species had the highest Shannon Wiener diversity Indices (2.69) for the forest site while the grasses had the least indices (0.63). The highest indices (2.07, 2.08) for the short term fallow site was given by the grasses, while the lowest indices was given by the shrubs (0.94; 0.58). For the long term fallow site, the highest indices were given by the forbs (2.52;2.55), while the grasses at the dry season recorded the lowest index of (0.14). The forbs of the current usage farming site had the highest indices (2.07; 2.39), while the climbers had the lowest indices (0.64;0.60). The grasses had the highest evenness indices (0.91) for the forest site, while the climbers had the lowest (0.21). Grasses had the highest evenness indices (0.82;0.84), for the short term fallow site while the forbs had the lowest indices (0.46). The shrubs had the highest indices (1.00) for the long term fallow site while the grass had the lowest index (0.13). The climbers had the highest evenness indices (0.86;0.90) for the current usage farming site, while the grasses had the lowest index (0.62).

6 **CONCLUSION**

Trees were 25 at the forest site; 7 at the short term fallow sites, 1 at the long term fallow site and none at the current usage farming site. Climbers were 6 at the forest site, none at the short term fallow site, 1 at the long term fallow site, and 3 at the current usage farming site. Shrubs were 7 at the forest site, 3 at the short term fallow site, 2 at the long term fallow site and 4 at the current usage farming site. Grasses were 2 at the forest site, 24 at the short term fallow site, 10 at the long term fallow site, and 4 at the current usage farming site. Forbs were absent at the forest site, 31 at the short term fallow site, 15 at the long term fallow site, and 24 at the current usage farming site. Overall species population for the watershed is 196 for the rainy season and 166 for the dry season. Species Richness, Diversity indices and evenness were all too poor for this watershed. This is an indication of very low Diversity reflecting massive degradation of tropical watersheds. Massive replanting of economically viable species is the only way out

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