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A Vegetation Map of Stamford Farm in Mvurwi, Mashonaland Central Province, Zimbabwe

Mushore, J*. Alufasi, R*. Tazvivinga, A*, Kubiku, F*. and Hove, C*
Bindura University Of Science Education, Department of Biological Sciences, P. Bag 1020, Bindura, Zimbabwe.
Corresponding author E-mail : jmushore@yahoo.com

Abstract
The factors underlying tree species and tree size class distribution at Stanford Farm in Mvurwi, Zimbabwe were investigated. Quadrats were laid along belt transects running from a hilltop down a vlei leading to a dam. In each quadrat, tree species and height, soil moisture and depth, as well as rockiness were determined. Human disturbance was also assessed through counting the number of stumps per quadrat. The farm recorded a high species diversity with ten different species identified. It was also noted that soil characteristics determined tree species as well as size class distribution.
Keywords: Human disturbance, Rockiness, Simpson's index of diversity, soil depth, soil moisture, tree height, tree species

1. Introduction

The environment in which an organism is found is determined by a range of physical and abiotic factors such as light, heat and moisture [9]. In addition, vegetation distribution in most areas is determined primarily by climate and soil type. Trees may grow well in aquatic environments (hydrophytes), while some are adapted to living in wetlands (mesophytes), and yet others are adapted to dry-land life (xerophytes), and some are salt tolerant (halophytes).

Plants grow together in recognizable patterns often with the same neighbours whenever they are found [12], just as people live together in their communities. The condition of vegetation in a stand, landscape or region is a product of an interplay of several forces. Disturbances such as landslides and agricultural activities, destroy vegetation and alter soil and landform characteristics [12]. Such disturbed environments have the potential to develop another plant community through succession. The new plant community established differs markedly from the original.

Species have right to existence because they has value, value that may be completely independent of their usefulness to people or any other species [1]. They have value simply because they are part of life. Trees have value to humans and animals which include, medicinal, aesthetic, ecological, utilitarian, nutritional and for energy purposes. Therefore, it is imperative to conserve the trees found in an area.

Vegetation mapping is an important tool for the characterization, evaluation and implementation of management plans for natural areas. It normally presents valuable information for understanding the flora found in an area and also helps to find out factors that affect the floral distribution. Vegetation mapping also help to come up with possible strategies for conservation.

1.1 Aim of the study

The main aim of this study is to determine the factors underlying distribution of trees at Stanford Farm (Mvurwi)

1.2 Objectives of the research

This research seeks to:

- Identify tree species found in Stanford Farm.
- Determine the size-class distribution of trees in Stanford Farm.
- Investigate the factors affecting distribution of trees on the study site.

1.3 Research questions

This research seeks to answer the following questions:

- What tree types are found in the study area?
- What is the size-class distribution of trees in this area?

- What factors are affecting distribution of trees on the study site?

1.4 Hypothesis of the study

The distribution of trees at Stanford farm has no pattern.

1.5 Significance of the study

People have a tendency to use natural resources unsparingly without consideration of other benefits that they stand to lose should the resource get depleted. Tree cutting, mainly for firewood used to treat tobacco as well as domestic use appear to be outcompeting other benefits that may accrue to the community should they use the resource sparingly. This research was motivated by the need to determine what is where, how much of it and what is its status given the existing circumstances where there is need for firewood and construction poles. The Zimbabwean land reform has increase usage of firewood for tobacco curing as well as construction poles for erecting new structures for the new farmers. It is against this background that an inventory of tree species in the study area was done, to provide a picture of the extend of deforestation if former commercial farms.

The study [2], will assist in coming up with an inventory on, what is where? How much of it and its status? It can also be used as a basis for future Forest Policy and or Agriculture Policy. The research outcome will help in conservation of some endangered tree species for maintenance of biodiversity and the promotion of ecotourism.

2. Methods and Materials

2.1 Study design

The was conducted as a case study. Case study research methods as defined by [13] are empirical enquiries that investigates contemporary phenomenon within their real life contexts. In case studies, the boundaries between phenomenon and context are not clearly evident and multiple sources of evidence are used. A case study is therefore an in depth study of a particular situation, which is used to investigate trends. It's a method used to narrow down a very broad field of research into an easily researchable topic. It will not completely answer a question, but will give some indications and allow further elaboration and hypothesis creation on a subject. Both qualitative and quantitative approaches were used. According to [4], qualitative research helps to develop concepts and theories that help us to understand the social world. It is also used to explore and understand people's beliefs, experiences, behaviour and interactions. It also enables in depth study.

2.2 Study site

The study was conducted at Stanford Farm in Mvurwi, Mashonaland Central Province, Zimbabwe. The area lies along the Guruve, Harare road. Geographically, the area is in Agricultural Region 2 of Zimbabwe, an intensive crop farming region, where maize, groundnuts and tobacco are the major crops grown. The rain season falls between the months of November and March each year, the remaining eight months are dry. Mean annual temperature as low as 13.9 ^{0}C are recorded during the cold season, while in summer season mean annual temperatures can record up to 25 ^{0}C.

2.3 Sampling of plants

A belt transect was laid in an area between a dam and a small mountain, with a well defined fairly steep gradient . The distance between the banks of the dam and the summit of the small mountain is 0.5km. Two transect lines of 500m each spaced 15m apart were established, using strings, starting from the top of a small mountain to the dam. A square of 15m×15m, done using strings, was used to plot the quadrats along the belt transect. The quadrats were numbered A-F starting from the top of the small mountain. Quadrat A was at the top of the mountain, B was midway down the mountain, C at the foot of the mountain, D just adjacent to the mountain, E near the dam and F close to the dam. The allocation of the quadrats allows for a purposive sampling as each quadrat has characteristics that were different from each other.

In each quadrat types of trees found, height of each tree, soil depth, rockiness and soil moisture were determined.

2.4 Measurement of tree height

A tree was considered to be of height 2m or above. The height of each tree in the quadrat was estimated directly using a measuring pole of 2m long [10]. The pole was placed by the side of each tree in order to determine whether the plant qualifies to be a tree or it is a bush. Using the 2m long pole the height of taller trees was

estimated and direct measurement was done on slanted trees or smaller trees [11]. Height measurements were done starting from the base of the tree trunk to the topmost part.

2.5 Simpson's diversity index

Simpson's Diversity Index was used to estimate diversity of tree species in the study area. The number of individuals of each species present in the quadrats was noted. Simpson's Diversity Index for tree species within each quadrat, was determined using the formula below:

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)} \qquad (1)$$

n= the total number of organisms of a particular species.

N= the total number of organisms of all species

2.6 Measuring of soil moisture

The soil samples were collected from each quadrat at three points along a line drawn diagonally from one corner of the quadrat to the other through the centre. A spade was used to take the soil sample to the depth of the root zone which was approximately 23cm. A kilogram of soil from each of the three sampling points was extracted and the soil was mixed. These soil samples were packed in polythene bags and tied so that they would not lose moisture. The packaging was marked according quadrat from which they were taken. The samples were taken to the laboratory where soil moisture levels were determined using standard soil moisture determination procedure. The percentage water content was calculated using the following formula:

$$\frac{\text{mass of soil sample from the field} - \text{mass of soil sample after heating}}{\text{mass of soil sample from the field}} \times 100\% \qquad (2)$$

2.7 Human disturbance on tree distribution

The human disturbance on trees was measured by counting the number of tree stumps in a quadrat and the information was recorded on a table against each respective quadrat.

2.8 Rockiness

Visual assessment was used to estimate the level of rockiness of each quadrat. The linket scale was used to establish the rockiness of the soil in each quadrat as described below [8]. The level of rockiness in each quadrat was recorded using the scale below.

Scale	Description
1.	very rocky
2.	rocks close to each other
3.	moderately rocky
4.	least rocky

2.9 Soil depth

A soil profile pit measuring 0.5m×0.5m was dug to the subsoil level in each quadrat. The pits were then covered after the recording was done for environmental reasons. The soil depth in each quadrat was recorded using the Linkert scale as shown below:

Scale	Description
0cm-5cm	very shallow
5cm-10cm	shallow
10cm-20cm	deep
Above 20cm	very deep

2.10 Tree types

Tree genus and species were identified using [5] series booklet. Trees whose identity were difficult to establish were taken to the national Herbarium for identification. Direct counting was done to determine number of trees of a particular type in each quadrant. Recording was done according to tree species.

2.11 Data analysis

Tables were mostly used to present results of the investigation. Descriptive statistics was used to present results.

3. Results

3.1 Tree species found at Stanford Farm

Table 1. Tree types found in Stanford farm.

Tree type	Quadrat
Syzygium guineensic	E, F
Ficus capensis	F
Ficus burkei	F
Brachystegia bohenii	A, C ,E
Dicrostachys cinerea	D
Julbernadia globiflora	B, C, D
Piliostigma thonningii	D
Parinari curatellifolia	A
Brachystegia speciformis	A, B, C
Flacourtia indica	E

Ten different tree species were found in the study area.

3.2 Simpson index of diversity

Table 2. Simpson's index of diversity per quadrat.

Quadrat	Simpson index of diversity
A	0.32
B	0.96
C	0.85
D	0.64
E	0.62
F	0.64

The study area has high species richness as shown by the diversity indices for the six quadrats. On average the diversity index for the study area is 0.67, which is quite high.

3.3 Average tree height

Table 3. Average tree height per quadrat

Quadrat	Average tree height (m)
A	3.4
B	2.8
C	2.6
D	2.7
E	2.5
F	2.2

Quadrat F has the least average tree height (2.2m) while quadrat A has the highest average tree height (3.4m). A tree height range of 1.22m was observed among the quadrats.

3.4 Average soil moisture

Table 4. Average soil moisture per quadrat

Quadrat	Average soil moisture (%)
A	3.2
B	6.9
C	11.2
D	18.7
E	24.5
F	29.9

The least average soil moisture was recorded at the top of the mountain (3.2%) while the highest average soil moisture was recorded close to the dam (29.9%). Average soil moisture increased from the top of the mountain to the dam.

3.5 Rockiness

Table 5. Rockiness recorded in each quadrat.

Quadrat	Linkert rating
A	1
B	2
C	3
D	3
E	4
F	4

The rockiest quadrat was at the top of the mountain while the two quadrats close to the dam were the least rocky.

3.6 Soil depth

Table 6. Shows soil depth per each quadrat

Quadrat	Rating
A	Very shallow
B	Shallow
C	Deep
D	Deep
E	Very deep
F	Very deep

The soil depth of quadrat A was very shallow while quadrat E and F were very deep.

3.7 Human disturbance

Table 7. Percent human disturbance.

Quadrat	Human disturbances per quadrant %
A	80.0
B	70.0
C	38.5
D	55.5
E	33.3
F	22.1

Most cutting down of trees was on top of the mountain while least tree stumps were found near the dam.

4. Discussion

Ten tree species are found in the study area. The area is rich in species diversity. The Simpson's index of diversity for the area was found to be 0.67. The spatial location of different species differs with *Brachystegia specififormis, Julbernadia globiflora and Brachystegia bohenii* being predominantly found on the mountain from the top to the base of the mountain, where conditions were fairly xeromorphic, while *Piliostigma thonningii, Dicrostachys cinerea* and *Flacourtia indica* were found in the other three quadrants sampled in a sloppy open spaced between the mountain foot and the dam, an area considered to be mesophitic. *Ficus burkei, Ficus capensis* and *Syzygium guineensic* were only found on quadrat F which is closest to the dam suggesting that these tress prefer wetter parts of the environment. This suggests that these three types require plenty of water their growth, quadrat F had a moisture content of 29.9%. From the investigation, roughly three distinct tree communities were identified mainly on the basis of water availability in the soil. Plant communities [6; 3] closely reflect soil depth and drainage of their habitats. Swampy gallery forest occurs along streams where the water table is always high, while drier gallery forest occurs on somewhat better drained soils such as margins of the wet gallery and headstream catchments. Soil depth and rockiness determine the water supply and therefore shape the pattern of vegetation. *Brachystegia speciformis* and *Brachystegia bohenii* appear to be drought tolerant as they are found in abundance in the first three quadrants from the mountain top, whose moisture content were 3.2%, 6.9% and 11.2% respectively. *Julbernadia globiflora* was abundant in quadrat C and also appeared in quadrat D implying that it requires more moisture for its growth compared to *Brachystegia speciformis* and *Brachystegia bohenii*.

Brachystegia speciformis and *Brachystegia bohenii* appear to do very well on rocky and shallow soils while *Ficus capensis, Syzygium guineensic* and *Ficus burkei* prefer none rocky soils which are very deep. This suggest that *Ficus capensis, Syzygium guineensic* and *Ficus burkei* need to grow very deep roots compared to *Brachystegia speciformis* and *Brachystegia bohenii*. *Julbernadia globiflora* require moderately deep and rocky soils, the same requirements needed by *Flacourtia indica* and *Dicrostachys cinerea*. Rockiness affects both soil depth and moisture as rocky sites usually have shallower soils with low moisture. This in turn would influence the tree species that grow on such places as well as their state and condition. Rockiness declined with distance from the mountain summit, influencing change in vegetation in the process.

The tallest trees were on the mountain top while the shortest ones were close to the dam. This could be due to the fact that trees in the vlei are easily accessible hence most large trees would have been harvested. Trees close to the dam could also face other disturbing factors that could limit their growth, factors such as flooding of dam or swamping of the area around the dam could limit the growth of the trees. Also in the event of the outbreak of fire, trees growing close to the dam suffer most as there is a lot of fuels such as grasses to support the fire. A number of factors promote variation in sizes of plant populations. One such factor is that relative growth rate is genetically determined. It is also important to note that the time of germination relative to that of neighbours is a major determinant of future growth patterns. In addition, the size of the unoccupied space in which plants germinate has a significant effect on their subsequent growth. Distance, size, species and spatial arrangement of neighbours as noted by [7] account for much of the variation in plant sizes.

The highest numbers of tree stamps were recorded in the vlei supporting the fact that this area is easily accessible normally harvesting of trees target the largest as they provide more fuel wood for curing tobacco, fire wood and pole for construction.

5. Conclusion and Recommendations

Distribution pattern of trees is affected by soil moisture, depth and rockiness. The study revealed three communities identified as the drought tolerant, moist loving and moderatly moist loving. It appears that the availability of soil water is the prime determinant of plant community structure. Further studies can be done to establish the individual uses of the different tree species with a view to determine reasons for harvesting.

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