

Factors Affecting Natural Regeneration and Distribution of Trees Species in El-Nour Natural Forest Reserve

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Abstract - The present study was conducted in El-Nour Natural Forest Reserve to assess the effects of lightning, winds, illicit cutting and overgrazing as unfavorable factors affecting the natural regeneration in addition to tree species diversity in El-Nour Natural Forest Reserve. For data collection and depending on species and soil types more than 200 samples (205) were taken covering the whole forest area. In each sample plot, diameters at breast height over bark (dbh) were measured for all mature trees by using tree caliper and diameter tape for large trees (more than 95cm), and total tree height (h) for the largest four trees by using Suunto Clinometer. Damages by man, wind, lightning, domestic animals, insects and diseases were also monitored, counted and recorded in each sample plot. The collected data were analyzed using Computer Packages SPSS 16, past program and Microsoft Excel of Office 2013. Average of diameter at breast height (dbh), height (h), basal area (b) and volume (V) were calculated as well as relative frequency (RF), relative abundance (RA) and relative dominance (RD) for each species. Scattered plots and trend graphs were fitted to examine the effect of different selected agents on the natural regeneration and distribution of tree species in this forest. The occurrence of species within a sampled area shown a considerable variation where relative frequency change in descending order for the following species, *Acacia seyal var seyal*, *Combretum hartmannianum*, *Terminalia laxiflora*, *Terminalia brownii*, *Sterculia setigera*, *Anogeissus leiocarpus*, *Sterculia africana* and *Acacia seyal var fistula* respectively. Man represents the most damaging agent for most trees particularly those used for charcoal production as it represent a source of income generation. Lightning and winds damaged mainly *Combretum hartmannianum*, *Anogeissus leiocarpus*, *Sterculia africana* and *Sterculia setigera* as tallest trees in the forest. The severity of damages caused by animal and insects were less than that of former agent, however, it alter the new regeneration in the forest floor. One of the important new finding of the study was the crown damage (new shoot removal) of *Sterculia*

setigera and *Sterculia africana* as fodder for domestic animals. This new deviation may referred to the obvious increase in domestic animals around the forest as well as, the considerable numbers of nomads that passing through the forest and sometime camping inside the forest for many days and damaged it stock. The study recommends that, intensive awareness program for local people around the forest is necessary to reduce this increasable pressure on the forest, as well the participation of local people in forest activities. Also some damaged compartments in the forest should be fenced against domestic animals to facilitate the natural regeneration.

Key words: Natural distribution, natural regeneration, and illegal felling.

I. Introduction

Forests are usually very large in term of land area with very large number of various types of species of different sizes and qualities. For each individual tree in these forests a continuous and up-to-date record is needed for its dbh, height, form factor, age, quality...etc. If this effort is considered for the whole forest, huge amount of fund and long period of time will be needed to prepare and execute a single forest inventory [1]. Lightning or electrical current passes from the trunk of the tree through the roots and dissipates in the ground. Major Root damage from electricity may cause the tree to decline and die without significant aboveground damage. Lightning causes serious aboveground damage in rough bark trees. The leaves in smooth bark trees may wilt and the tree might die, serving trees have the chance to regain their leaves in the following growing season. [2].

Land-cover change is a pervasive phenomenon, brought about by both human and natural alteration of landscapes. Studying land-cover change is

important because it helps explain; the types of changes that are occurring, the rates at which they are occurring, and the places where specific land-cover changes are occurring on the landscape [3]. Understanding the spatial, temporal, and thematic dynamics of land-cover change facilitates research and development of hypotheses about the major drivers and consequences of change, helps define future scenarios, and is useful in understanding impacts on other ecosystem resources [3].

Understanding of the dynamics of the forest can help to increase the productivity, to maintain species composition, to the financial inputs, and to develop prescription for silvicultural operations. Continuous monitoring of the forest stands on a long-term basis is useful to document the vegetation dynamics satisfactory [4].

The term 'disturbance' refers to events that relatively quickly change forest structure so that space and resources are released and the micro-climate is altered. In natural forests, variability in disturbance dynamics profoundly affects diversity by producing a variety of habitat types to which the native species have evolved and adapted [5]. In Sudan forests are important sources of food, timber, firewood, and habitat. Fuel-wood supply amounts to more than 80% of the energy needs [6]. Forests also provide fodder for livestock, non-wood forest products such as honey, gum Arabic, tubers and roots, wildlife, aromatic and medicinal plants. Moreover, forests contribute to desertification control, soil fertilization, watershed protection and climate change mitigation [7]. Increased pressure on forests due to high dependency on forests as a source of energy, and rapid increase of population, degradation and desertification problems, decrease in agricultural productivity, limited government budgets and other environmental problems all together make the researches on tree dynamics and human disturbances an urgent targeting research. Natural forests in Sudan facing many problems ranging from overgrazing and over-exploitation due to irrational felling and harvesting particularly, in Blue Nile State where the forest products represent the main source of income for local people. These activities directly altered the natural regeneration, trees species distributions and eventually, the natural dynamics of these forests.

The present study attempt to assess the effects of lightning, winds and illicit cutting as unfavorable factors influencing the natural regenerations in El-Nour Natural Reserved Forest as well as, the tree species diversity and dynamics.

II. Materials and Methods

Study area

The present study was conducted in Blue Nile State, at El-Nour Natural Reserved Forest which is located between longitudes $11^{\circ} 48' 19''$ N and $11^{\circ} 53' 30''$ N and latitudes $34^{\circ} 28' 47''$ E and $34^{\circ} 32' 35''$ E with total area of 11100 feddan [1]. The forest characterized by diversity in species composition ranging from small deciduous shrubs to evergreen mature trees, with 55 woody plant species belonging to 36 genera and 18 families [8]. The dominant species are *Sterculia setigera*, *Combretum hartimannianum*, *Acacia seyal* var *seyal*, *Terminalia brownii*, *Terminalia laxiflora*, *Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Combretum micranthum* and *Lannea fruticosa* [9]. The endangered woody plant species in El-Nour Natural Reserved Forest assessed in previous studies includes *Adansonia digitata* Linn, *Balanites aegyptiaca* (L.) Del., *Boswellia papyrifera* (Del.) Hochst, *Dalbergia melanoxylon* Guill. & Perr, *Grewia flavescens* Juss, *Grewia mollis* Juss, *Grewia tenax* Ascher & Schweinf., *Lonchocarpus laxiflorus* Guill. & Perr, *Piliostigma reticulatum* (DC.) Hochst, and *Xeromphis nilotica* Stapf. [10].

Data collection

The forest was divided according to species type into two main sections from north to south, section A is characterized mainly by Acacia trees while section B include other broadleaved species. These two sections were further subdivided in to three subsections depending on soil type from east to west namely; clay soil type, mixed soil type (sandy-clay), and sand soil type, respectively. 105 samples were taken in an east-west direction by using circular systematic sampling technique. The utilized distance between each adjacent surveying line is 200m, while the distance between each two circular sample plots is 100m with 35m as circle radius. In the northern and southern parts of the forest, cluster sampling with quadrat area of 1600m^2 ($40\text{m} \times 40\text{m}$) were applied, where 50 quadrats were measured in each part separately.

In each sample diameter at breast height over bark (dbh) were measured for all mature trees by using tree caliper and diameter tape for large trees (more than 95cm), and total tree height (h) for the largest four trees by using Suunto Clinometer. Damages by man, wind, lightening, domestic animals, insects and diseases were also monitored, counted and recorded in each sample plot.

Statistical analysis

The collected data were analyzed using Statistical Packages for Social Studies (SPSS 16), Past program and Microsoft Excel (Office 2013). The collected data were covered diameter at breast height (dbh), height (h), and the calculated parameters include Basal Area (BA), Relative Density (RD), Relative Frequency (RF), Relative Abundance (RA) and Importance Value Index (IVI). These parameters are defined as follows: BA area occupied by stem of a given species (measured at breast height), RD number of trees of a given species /total number of trees of all species x100, RF number of times a species occurs /total number of species x100, RA total basal area of a species/basal area of all species x 100, and the IVI sum of RD+RF+RA.

The IVI value of a given species, expressed as a percentage of the total IVI for all species in an area, was regarded as a measure of its ecological significance [11, 12]. Scattered plots and trend graphs were fitted to examine the effect of different selected agents on natural regeneration, distribution and

dynamics of tree species in El-Nour natural reserved forest.

III. Results and Discussions

Results reveal that, El-Nour Natural Reserved Forest was subjected to both naturally occurring disturbances (fire, winds and lightning) and human disturbances (illegal cutting and overgrazing). The occurrence of species within a sampled area showed a considerable variation (relative frequency and abundance) as well the basal area of species, Table (1). The relative frequency change in descending order for the following species *Acacia seyal* var *seyal*, *Combretum hartmannianum*, *Terminalia laxiflora*, *Terminalia brownii*, *Sterculia setigera*, *Anogeissus leiocarpus*, *Sterculia africana* and *Acacia seyal* var *fistula*, respectively. Table (2) represents the overall percentage of damage caused by each agent and the affected portion of the tree. Figures 1 and 2, describe the percentage and frequency of damages caused by man for each species, while Figures 3 and 4 shows the types and severity of damage for all examined agent.

Table (1): Relative frequency, abundance and dominance; and means of dbh, height, basal area and Volume

Species	RF	RA	RD	Mean dbh	Mean h	Mean b	Mean V
<i>Acacia seyal</i> var <i>fistula</i>	6.751	0.186	0.349	15.45	5.20	1.874	3.703
<i>Acacia seyal</i> var <i>seyal</i>	14.768	0.199	0.349	16.50	6.40	2.137	5.198
<i>Acacia senegal</i>	5.063	0.084	0.349	10.50	5.60	0.865	1.842
<i>Anogeissus leiocarpus</i>	7.595	3.539	1.222	35.74	14.67	10.029	55.912
<i>Balanites aegyptiaca</i>	5.063	1.240	1.047	33.50	10.20	8.810	34.146
<i>Combretum hartmannianum</i>	10.127	17.009	5.935	38.12	14.99	11.409	64.971
<i>Combretum micranthum</i>	3.376	0.246	0.175	28.00	7.60	6.154	17.774
<i>Dalbergia melanoxylon</i>	0.422	0.052	0.175	12.00	4.50	1.130	1.933
<i>Lannea fruticosa</i>	5.063	0.558	0.349	29.00	8.20	6.602	20.571
<i>Lannea microcarpa</i>	3.797	1.094	1.047	23.33	6.67	4.274	10.827
<i>Lannea schempri</i>	2.954	1.211	0.524	33.10	10.83	8.601	35.406
<i>Lonchocarpus lansifolus</i>	0.844	0.447	0.175	35.00	10.00	9.616	36.542
<i>Sclerocarya birrea</i>	1.688	9.813	1.571	48.42	14.46	18.404	101.12
<i>Sterculia africana</i>	7.173	32.561	82.019	60.81	13.183	29.027	145.41
<i>Sterculia setigera</i>	7.595	25.244	2.793	59.50	12.011	27.791	126.84
<i>Terminalia brownii</i>	8.439	0.499	0.175	39.00	12.40	11.940	56.261
<i>Terminalia laxiflora</i>	9.283	6.017	1.746	42.20	13.35	13.980	70.918

Table (2): Overall Percentages of Damages for Different Agents

Agent	Man				Wind	Lightening	Animals	Insects	Diseases
	Crown	Stem	Branches	Whole Tree	Whole Tree	Whole Tree	Stem	Stem	Crown
Damage Percentage	20.181	16.867	14.458	42.47	3.916	0.602	0	1.205	0.301

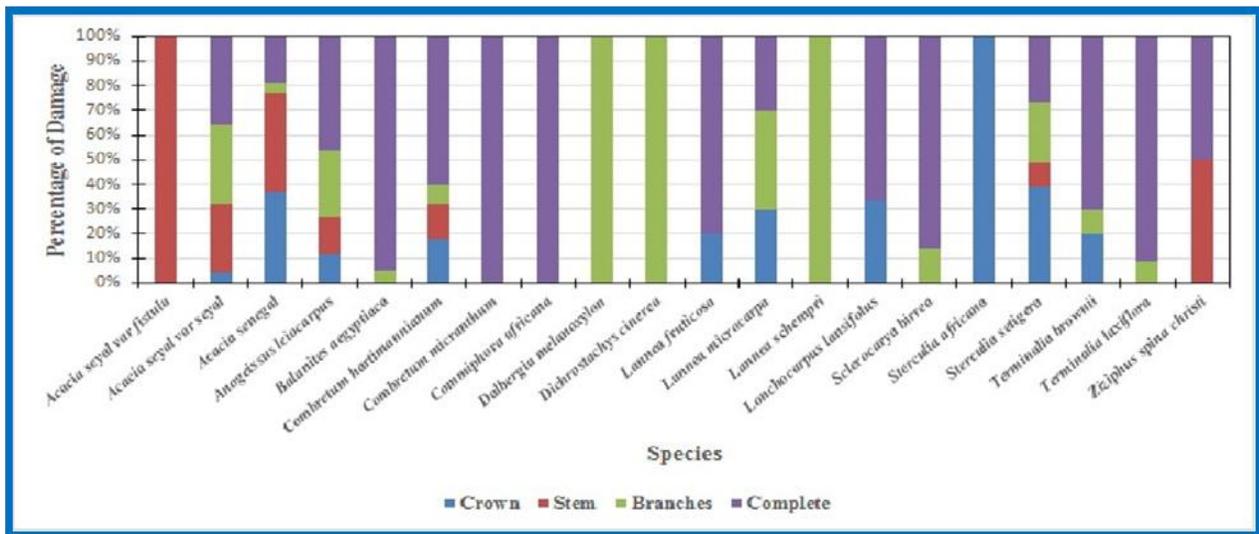


Figure (1): Damage caused by man per species in Percentage

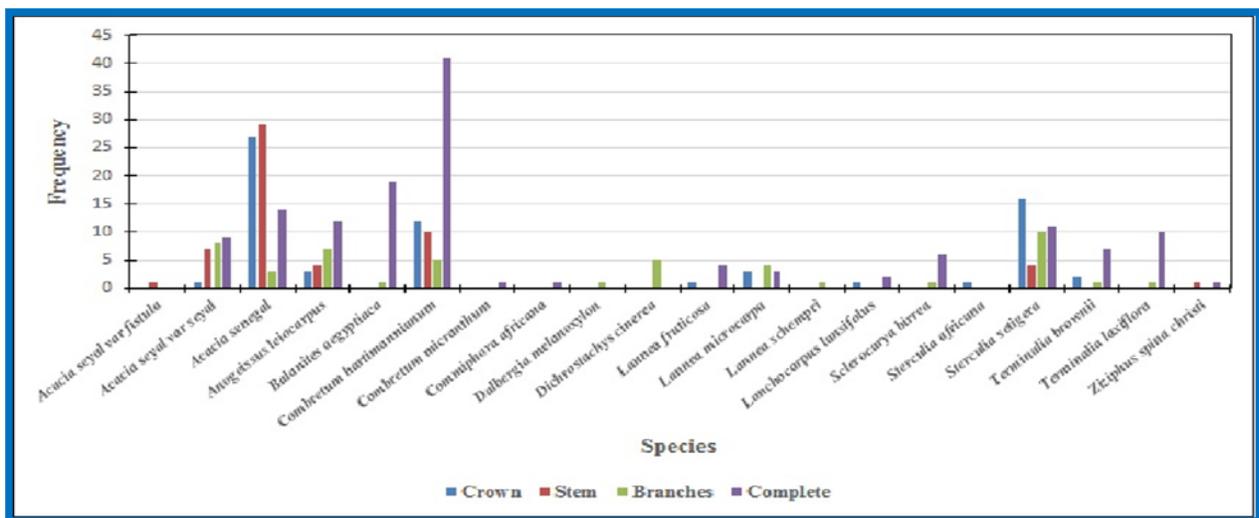


Figure (2): Damage caused by man per species in Frequency

Man remains the very dangerous agent that harmful the forest where more than 93% of damage was caused by man (Table 2). This critical and complex situation may results from continuous migration from

far marginalized area to small villages around the forest because of war. Jobless and very traditional income generation forms also directly participated in worsening this situation and left a forest in its present

condition. Within man damage, complete removal of tree form more than 42%, followed by crown, stem and branches, respectively (Table 2). This result consistent with that concluded by reference [13] where they mentioned that, the major disturbing factors in this forest were found to be illicit tree felling and overgrazing caused by domestic animals especially by goats. However, this same agent is found to be very important in the spread of other species in the forest.

Figure 3 and 4; show the severity of illegal complete felling, where the curves reached higher points. One of the important new finding of the study was the crown damage (new shoot removal) of *Sterculia setigera* and *Sterculia africana* as fodder for domestic animals. This new deviation may referred to the obvious increase in domestic animals around the forest as well as, the considerable numbers of nomads that passing through the forest and sometime camping inside the forest for many days and damaged it stock.

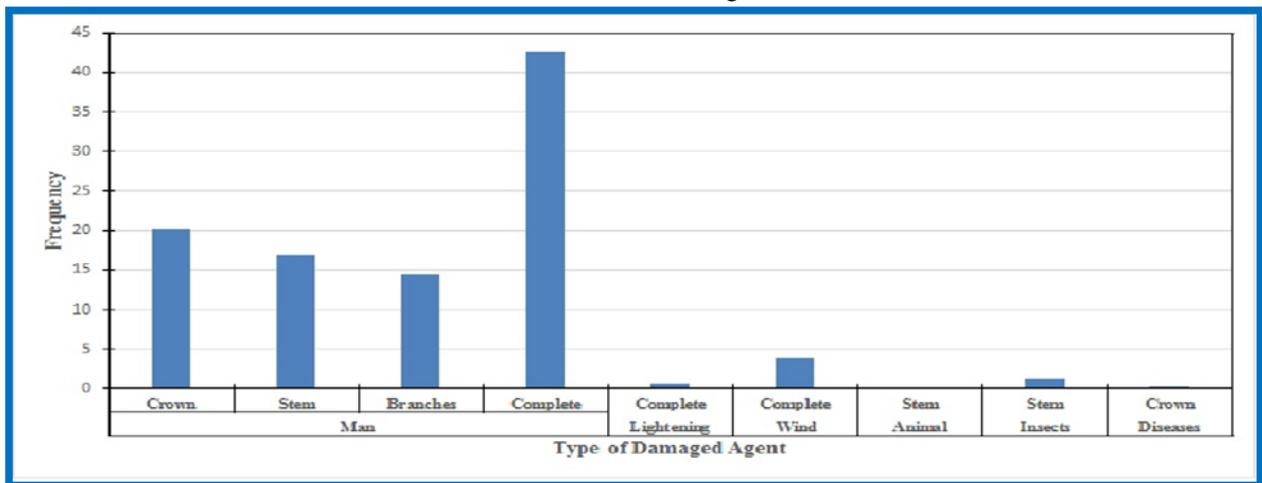


Figure (3): Illustration of All damaged agents per all studied species

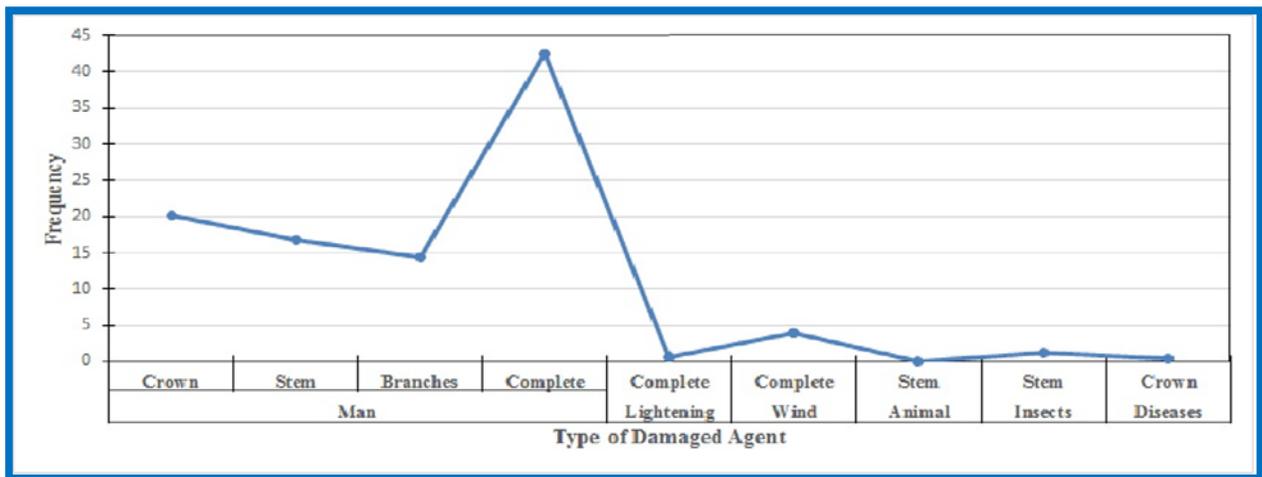


Figure (4): Linear representation of damage severity for all agents

Most damaged trees by complete illegal felling were *Combretum hartmannianum*, *Acacia senegal*, *Balanites aegyptiaca*, *Anogeissus leiocarpus*, *Terminalia species* and *Sterculia setigera* (Figure 2). This due to fact that, most of these species were used for both, animal fodder and fuel wood production as

well as, building materials. On another hand, lightening mainly related with *Combretum hartmannianum*, *Anogeissus leiocarpus*, and *Sterculia setigera* due to it height. The distribution of species in El-Nour natural reserved forest was generally related with soil type

and continuous human activities. *Acacia seyal var seyal*, *Acacia seyal var fistula*, *Acacia senegal* and *Balanites aegyptiaca* were mainly dominating the area of clay soil type. *Terminalia brownii*, *Terminalia laxiflora*, *Sterculia setigera*, *Sterculia africana* and *Lonchocarpus lansifolus* usually dominating the area of sandy soil, while *Combretum hartmannianum*, *Anogeissus leiocarpus*, *Lannea fruticosa*, *Lannea schempri*, and *Sclerocarya birrea* were distributed in mixed soil areas. Other species were randomly scattered in small number among these three soil types.

IV. Conclusion and recommendation

V. References

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- El-Nour Natural Reserved Forest was seriously damaged by direct and indirect human activities particularly, illegal felling and overgrazing. These activities disturbed the natural distribution of species within the forest and so the forest dynamic. Weak forest management and supervision as well, the lack of proper management plan and awareness raising programs paved the way for this degraded situation in the forest. It necessary to recommend that, the present monitoring and supervision method is not active, therefore, the management plan must be revised to protect and conserve the present stock as well, to rehabilitate the forest.
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