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Amel Hassan Abdallah[1]
and
Daafallah Ali Ibrahim,
Khartoum University, Sudan

Ecotaxonomical studies of Musawarat Elsufra (an archeological site northern Sudan)

[1] **Botany Department,** Faculty of Science, University of Khartoum
P.O. Box321, Sudan, Email: amel762003@yahoo.com

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Abstract

Purpose This research was carried out in Musawarat El Sufra, an archaeological site 180km north of Khartoum, to compare the past and present vegetation of the area.

Methodology Standard sampling methods were applied to study the vegetation cover. Six field surveys were conducted during the years 2005 and 2006. Three quadrats (50x50m) were chosen to investigate the present vegetation by taking the mean of 20 small quadrats 1m2 each. The mean density, frequency and composition were calculated.

Findings The vegetation analysis revealed that there were 23 species belonging to 14 families. The dominant families were Poaceae, Nyctaginaceae, Aizoaceae and Capparaceae. The most dominant species in the area were Panicum turgidum, Boerhavia erecta, Zaleya pentandra and Aristida adscensionis. Statistical analysis showed that there was no significant difference between the two seasons studied with respect to plant variables measured . The means density, frequency and composition were ,1.13 12.67 and 5.16 respectively in 2005, and 8.62 ,1.26 and 10.97 in 2006.
Value: Continuous assessment of vegetation cover was needed to show if change in plant cover ultimately leads to land degradation and an arid environment.

Keywords Vegetation cover, Musawarat Elsufra, Environmental change

Introduction and literature review:

Many ecologists view vegetation as a component of the ecosystem that displays the effects of other environmental conditions and historic factors in an obvious and easily measurable manner (Moore and Chapman, 1986). The careful analysis of vegetation is therefore used as a means of revealing useful information about other components of the ecosystem.

Research on dry lands is of crucial importance since improper uses of the environment lead to land degradation, the end result of which is desertification.

All reports on natural resources written over the last 40 years agree that vegetation cover is being reduced and that its nature is changing. Destruction of the biological potential of the land can ultimately lead to desert-like conditions.

According to Dalby et al. (1977) semi-arid lands are changing to desert-like conditions at the rate of 0.3% annually.

Gibbon and Pain (1988) stated that the semi-desert area in the Sudan is 1,191,000km², which represent 60% of the total area of Sudan.

The increase in animal and human population and injudicious use of technology may lead to over-grazing, over-cultivating and wood cutting. According to the world map of desertification defined by the United Nations Conference on Desertification (1977), the whole of Sudan is exposed to hazards of desertification except small areas of high rainfall, woodland Savannah.

Kassas (1956) studied the plant growth west of Omdurman. He showed that a close relationship existed between the plant growth and landforms.

Halwagy (1961), studying the vegetation of the semi-desert north of Khartoum, found that plant cover depends to a considerable extent upon the soil texture. Sand seems to favour richer annual growth while perennials increase on clays. Hills are barren but become thinly clad with vegetation where sheets of sand drift have accumulated. Slope also influences vegetation cover, while khors support dense and rich vegetation. The two factors, soil texture and slope, act through their influence on water supply.

Bari (1992) studied the changes in vegetation of Sudan with special reference to the Savannah zone. She concluded that the agricultural practices, felling, over-grazing, trampling, and the drop in well levels are the main reasons for changes towards aridity.

Madani (1997) studied the vegetation of the Elrawakeeb Area west of Omdurman Khartoum state. Her quantitative analysis of the data showed a clear variation in vegetation related to the effect of man and grazing, in addition to the aridity caused by sand deposited with time in the form of small mobile dunes. Hassan (1999) reported that the respondents perceived the change in vegetation cover in the light of its composition, density, disappearance of some species, decrease in the number of many types of trees and grasses, and the emergence of new unpalatable plants. This change in plant cover ultimately led to land degradation and an arid environment.

Developing countries are now more conscious about environment problems. For this reason, our main objective of this study is to measure the environmental changes that took place in the study area, Musawarat Elsufra, and try to find the causes of these changes by:

a. Vegetation analysis of the present conditions applying standard sampling methods;

b. Soil analysis using standard analytical techniques.

Methodology:

Study Area

The area covered in this study is located east of the Sufra wadi and 65km from the ancient Merwe Town, latitude 16º 22` North, and longitude 33º 22` East. Muswarat Elsufra (Great Enclosure) is located some 15km east of Nagaa and 30km from the Nile. It is one of the sites of the great Meroitic civilization from the 4th century B.P. Sampling:

Six visits have been conducted (one every two months) starting in September2005 and ending in September 2006. Three quadrats (50x50m) were chosen to investigate the present vegetation by taking the mean of 20 small quadrats 1m2 each. The mean density, frequency and composition were calculated. All materials collected were mounted on herbarium sheets and then deposited at the Khartoum University Herbarium (KUH) Department of Botany. Identification of all materials was carried out using the available relevant African floras paying special attention to scientific publications of Sudan and the neighbouring countries. Also, confirmation was carried out for the taxa by comparing them with previously identified material deposited at the same herbarium.

Ecological parameters:

The area studied was divided into three sectors and each sector (50x50m) randomly selected 20 small quadrats. A detailed survey was therefore carried out whereby 60 randomly selected quadrat ($1m^2$) were examined in the three sectors. Data were recorded as count per quadrat and then analysed for the density, frequency, composition and species richness according to Kent and Coker (1992).

Measurements of similarity and dissimilarity:

Similarity indices measure the degree to which the species composition of quadrats or sample matches is alike. Dissimilarity Coefficients assess the degree to which two quadrats or samples differ in composition. It follows that dissimilarity is the complement of similarity. The coefficient values range from 0 (complete dissimilarity) to 1 (total similarity).

The Jaccard Coefficient:

$$\text{Similarity} = \frac{a}{a+b+c}$$

$$\text{Dissimilarity} = \frac{b+c}{a+b+c}$$

Degree of Association:

The degree of association between species using χ^2 method according to Kent and Coker (1992): the nature of association was determined by calculating the expected frequency of the joint occurrence as follows:

The expected frequency of the joint occurrence

$$= \frac{(a+b)X(a+c)}{N}$$

Positive association was marked out when the expected frequency exceeded the observed one.

Results:

Vegetation analysis:

Twenty-three species belonging to fourteen families were recorded in the study area. A list of plant species, their families, Arabic names, local names, life form and palatability are made and presented in Table 1. The dominant families were Poaceae, Nyctaginaceae, Aizoaceae and Capparaceae. The most dominant species in the area were Panicum turgidum, Boerhavia erecta, Zaleya pentandra and Aristida adscensionis.

The flora found in the study area was classified into trees, shrubs and herbs. The percentage of each type of the flora is different in the two rainy seasons of 2005 and 2006. The trees represent (3.3%) and (1.5%) from the total number of the plant species while shrubs represent (0.58%) and (0.46%) and herbs (96%) and (98%) in the two rainy seasons respectively.

Vegetation Parameters in the Study Area:

Statistical analysis showed that there was no significant difference between the two seasons studied with respect to plant variables measured. The mean density, frequency and composition were 1.13, 12.67 and 5.16 respectively in 2005, and 1.26, 8.62 and 10.97 in 2006. The method used was that according to Fowler and Louis (1990).

Measurements of Similarity and Dissimilarity:

The Jaccard Coefficient:

$$\text{Similarity} = \frac{a}{a+b+c}$$

$$S = \frac{8}{8+19+9}$$

$$S = 22.2\ \%$$

$$\text{Dissimilarity} = \frac{b+c}{a+b+c}$$

$$D = \frac{19+9}{8+9+19}$$

$$D = 77.8\ \%$$

The dissimilarity is higher than the similarity, showing that the two quadrat were different in composition.

Degree of Association:

The analysis of association between the plant species Boerhavia erecta Panicum Turgidum: The degree of association between species using the chi square χ^2 method: presence or absent data entered in 2x2 contingency tables for a combination of species in pairs as follows:

The degree of association was calculated using following formula for the two seasons:

χ^2 = (|ad –cb| -0.5n) ²xN
(a+c) x (b+d)x (a+b)x(c+d)
(I30x32-7x51I)-60)2 x120 = 35381880
=3.65
37x83x81x39 9701289
χ^2 =3.65
χ^2 = 3.841 (from the table)

The nature of association was determined by calculating the expected frequency of the joint occurrence as follows:

The expected frequency of the joint occurrence:

$$= \frac{(a+b) \times (a+c)}{N}$$

$$\frac{(30+51) \times (30+7)}{120} = 24.9$$

The direction of the trend of association between P.turgidum and B.erecta are positively associated for the quadrat sized used.

Table 1. *Flora Found in the study area:*

No	Scientific name	Family	Arabic Name	Local Names	Adaptation to arid Enviroment	Life span	Life form
1	*Acacia tortilis subsp. tortilis (Hochest)*	Mimosa-ceae	Samor	Samor	Grey bark, spiny tree.	Perennial	Tree
2	*Cadaba fari-nosa. Forsk*	Cappara-ia-ceae	Sarih	Kaadora	Small hairy succulent leaf.	Perennial	Shrub
3	*Panicum turgidum. Forsk*	Poaceae	Tumam	Tumam or Tapas	Surviving with Dormant buds.	Perennial	Undershrub
4	*Cynodon dacty-lon.L.(pers.)*	Poaceae	Najila	Najila	Perennial with rhizome.	Annual	Herb
5	*Fagonia cretica.Sensu ASchweiber*	Zygophy-llaceae	Umshuwika	Umshuika	Spiny bushy plant.	Perennial	Woody spiny herb
6	*Tribulus ter-esteris.L.*	Zygophyl-laceae	Dresa	Dresa	Mat forming, strong tap root.	Annual	Herb
7	*Capparis deciduas. Forsk.*	Capparaia-caeae	Tundub	Tundub	Small green leave and photo-synthetic bark.	Perennial	Tree or Shrub
8	*Boerhavia repens.L.*	Nyctagi-na-ceae	Wafarcori	Wafarcori	Spreading out, strong tap root.	Annual	Herb
9	*Citrullus colocynthis. Schrad*	Cucurbita-caeae	Hundal	Hundal	Trailing prostrate plant.	Annual	Herb
10	*Euphporbia aegyptiaca. Boiss*	Euphorbia-ceae	Lebaina	Umelbaina	Reddish green, White milk juice, strong tap root.	Annual	Herb

Table 1. *Flora Found in the study area:*

No	Scientific name	Family	Arabic Name	Local Names	Adaptation to arid Enviroment	Life span	Life form
11	*Zaleya pentandra. (L.)Jeffer*	Aizoaceae	Rabaa	Shara	Greyish green, mat forming, strong tap root.	Annual	Herb
12	*Indogifera hochstettri. Bak*	Fabaceae	Dahassir	Dahasir	Greyish green, much smaller, prostrate and tap rooted.	Annual	Herb
13	*Setaria vertisilata. L. (Beav.)*	Poaceae	Lossieg	Lossieg	Surviving with dormant buds.	Annual	Herb
14	*Corchorus tridens.L.*	Tiliaceae	Mulukhia	Farea	Strong taproot, many seeds.	Annual	Herb
15	*Corchorus depressus. (L.)Christens*	Tiliaceae	Mulukhia	Setih	Prostrate strong tap root.	Annual	Herb
16	*Aristida adscensionis L.*	Poaceae	Humra Gubbish	Gubbish	Variable in vegetative parts, dormant buds.	Annual	Herb
17	*Oldenlandia herbacea.(L.) Roxb.*	Rubiaceae	N.A	N.A	Small linear to lanceolate leaves.	Annual	Herb
18	*Maerua crassifolia. Forsk*	Capparida-ceae	Sarah	Sarha, kabira	Greyish bark, dense foliated, tough twisted branch.	Perennial	Tree or Shrub
19	*Sorghum urpureoseiceum. (Hochst)*	Poaceae	N.A	Garaza	Surviving with dormant, silky below the node buds.	Perennia	Herb
20	*Balanites aegyptiaca. (Del.)*	Euphorbia-ceae	Lebaina	Umelbaina	Reddish green, White milk juice, strong tap root.	Annual	Herb
21	*Pallenis cyrenaica*	Astraceae	N.A	N.A	Hairy leaves.	Annual	Herb

No	Scientific name	Family	Arabic Name	Local Names	Adaptation to arid Enviroment	Life span	Life form
22	*Pallenis cyrenaica*	Astraceae	N.A	N.A	Hairy leaves.	Annual	Herb
23	*Boerhavia erecta.L.*	Nyctagina-ceae	Turba	Turba	Strong tap root.	Annual	Herb

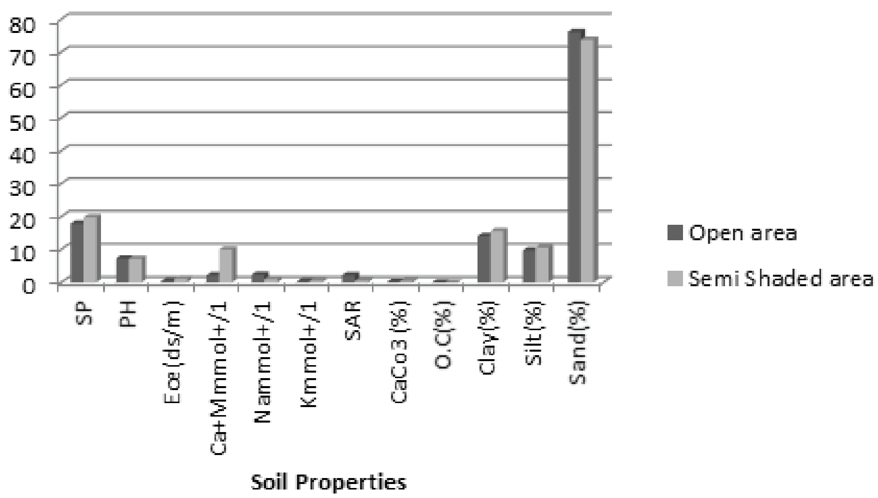

Figure 1. *Means of soil properties in open and semi shaded area*

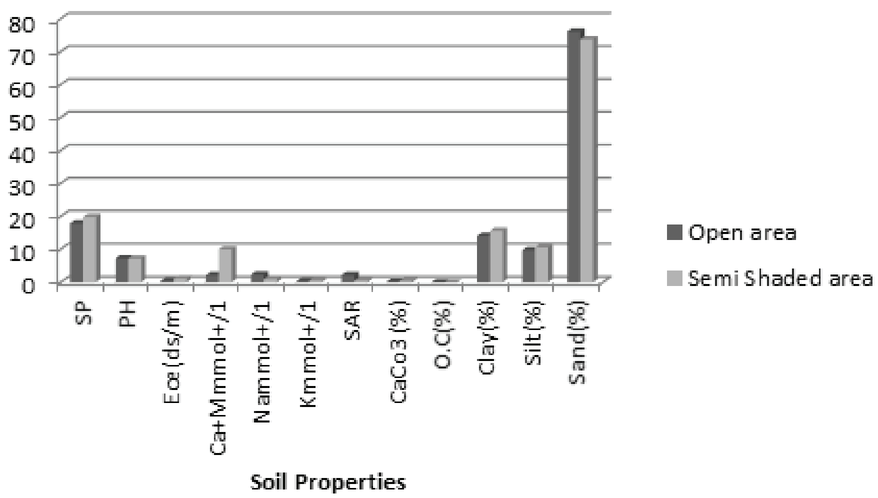

Figure 2. *Mean Annual rainfall for Musawarat Elsufra over 30 years (2006-1976)*

Discussion and Conclusions:

Fourteen plant families, including twenty three species, were recorded in the study area. All the species were adapted to an arid environment and all had different modifications to avoid a shortage of water in the dry lands.

The present vegetation of Musawarat Elsufra, which is located in the north east of Khartoum state, showed different considerations from that recorded by Halwagy (1961) who studied the same area. This is manifested in two ways: some new species were recorded while others had disappeared. The dominant tree species recorded by Halwagy (1961) had been replaced by others and with light frequency. This is in agreement with Madani (1997) who noted that the vegetation of the Elrawakeep area was significantly different from that recorded by Kassas (1956). She found clear evidence that during this 40-year period there was a fluctuation in the vegetation with marked differences in species composition. She attributed the differences to over-grazing. In the case of Musawarat this is aggravated by the impact of man in the area. This is in line with Hassan (1999) who reported that the respondents perceived the change in vegetation cover in the light of its composition, density, disappearance of some species, decrease in the number of many types of trees, grasses, and the emergence of unpalatable plants.

Change in plant cover ultimately leads to land degradation and an arid environment. Hassan (1999) also indicated that gradual elimination of plant cover increased wind velocity. Furthermore, poorly structured soil can form a sealing top crust during early rains, which reduces infiltration of later rain water into the soil. The cycle continues: less moisture content means more soil erosion and poor plant life.

Conclusions:

• The flora found in the study area was classified into trees, shrubs and herbs, and the percentage of each type of flora was recorded. It was observed that only trees, perennials and unpalatable plants were found during the dry period.

• Vegetation analysis revealed that there is no significant difference between the two seasons with respect to plant variables measured, and that rainfall and soil texture were the important factors affecting plant distribution.

• Comparing physical and chemical properties of open and semi-shaded areas showed that the semi-shaded areas were more fertile, more saturated and had less sandy soil (sandy loam).

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About the authors

Amel Hassan Abdallah is a lecturer at the University of Khartoum, Faculty of Sciences, Department of Botany, Sudanese. She has published a number of papers. She is a Member of the Sudanese Natural Heritage Society, and a Member of Young Women's Conservation Biologist (YWCB) in Africa. She won the Minister of Higher Education Prize for academic excellence awarded by the Sudan Natural Science Institute in 2001, and one the El Zubair Prize for scientific innovation and excellence awarded by the Association of the Promotion of Scientific Innovation in 2007. Her main interests are plant ecology, and environmental microbiology.

Dafaalla Ali Ibrahim is associate Professor, University of Khartoum, Faculty of Sciences, Department of Botany, Sudanese. He received candidatus scientarium from the University of Bergen, Norway. He was a general director of Taaseel directorate, Ministry of Higher Education and Scientific Research 2009-2001. He is a Co-author of the Integrated Dictionary of Biological Terms. His main interests are plant ecology and conservation biology.