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Woody Vegetation Changes across the Wadi System to the Stony Hill Slopes in Zalingei Area, Darfur-Sudan

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ABSTRACT

This present study was fielded in the year 2013 in Zalingei area of central Darfur state; Sudan. The main objective of the study was to investigate the status of woody vegetation (trees and shrubs) in terms of diversity and distribution and compare it to Wickens, (1976). The study was also designed to identify the woody species in the area with emphasis to abundance, absolute abundance, relative abundance, dominance, relative dominance and importance value index for trees with DBH ≥ 7 cm. The study takes into account the woody vegetation's diversity and distribution based on soil types and topography. Reconnaissance survey was made to identify sites, and accordingly the survey area was stratified into eleven sites according to soil type, slope and distance from Wadi system. The systematic circular sampling design and the strip sampling were applied to inventory the woody vegetation. The study area was divided into seven ecological zones namely contemporary flood plain, lower terraces, upper terraces, clay plain, sedentary plain, lower hill slope and stony hill slope. The parameters measured included number of tree species per unit arrear and growth performance. The collected data was analyzed using SPSS and Excel. Simpson diversity index of woody species was calculated for the different sites. Moreover, Sorensen coefficient of similarity was calculated for similar terraces. Simpson Diversity Index was found to range between 0.15 and 1.Sorensen coefficient of similarity was found to range between 20% and 39 %. Results explain that Faidherbia albida dominated the contemporary flood plains, lower terraces Balanites aegyptiaca, Acacia seyal dominated the upper terraces. On the other hand, Acacia seyal dominated the clay plain. Albizia amara, Acacia Senegal dominated the sedentary plains. On the lower hill slopes Albizia amara, Acacia Senegal and Balanites aegyptiaca are dominant. Boswellia papyrifera, Albizia amara are dominant on stony hill slopes. The results show that on the average there are 67.3 tree/ha in the study area. After four decades of Wicken's findings, there appears a little change in the species composition of the area except for the appearance of Acacia Senegal however, the stocking densities dropped sharply and this is the main change together with the disappearance of some species such as Kenya sengealensis and Cordia Abyssinia.

Keywords: *Woody vegetation, geomorphology, changes, terraces, Wadi system, soil*

1. INTRODUCTION

The Sudan has underwent a series of change process including, desertification, climate change, population growth, urbanization, and conflicts. As a result of these major changes, peoples livelihoods have been affected greatly and many of them became more dependent on the natural environment. Many vegetation ecology studies had been conducted in the area, and these include the work of Lebon (1965) ,Wickens (1976), Miehe (1988), Adam (2003) and Elsiddig (2007) in additional to reports of (FAO ,1968 – HTS 1958,1977), all these studies show the impact of man and his grazing animals on the declining trend in the stocking density of woody vegetation and the natural environment at large . The rain fall in Jebel Marra massif and surrounding areas during (June/July/august and sometimes September) brings about local runoff feeding the many streams around the mountains watershed areas with water in a radial pattern forming Wadis systems, three main watershed areas can be defined in relation to the main Wadi system, namely the watershed areas of Wadi Elku system, the watershed areas of Wadi Ibra and the watershed area of Wadi Azum (Elsiddig, 2007).

2. WOODY PLANT OF THE AREA

Along its pathway, Wadi Azum supports millions of people and enriches biodiversity (Elsiddig, 2007). The large number of Wadi systems flowing westward and southward in the area south east and western Jebel Marra , including Wadi Azum, bear dense belts of trees dominated by Faidherbia albida associated with Khaya sengealensis, Cordia Abyssinia and Acacia sieberiana .on the upper slopes of Wadis, Ziziphus spina-christi, and Acacia seyal were found (Elsiddig, 2007). Lebon (1965) mentioned that sites on slopes of low hills of Zalingei have more diversified tree cover including, sclerocarya birrea, Acacia Senegal, Albizia amara, Dalbergia melanoxylon, Lanea fruticosa ,Lanea schimperi and Azanza garckeana. On the clay plain and red-brown drift soils of the upper basin of wadi Azum system the Acacia seyal- Balaniyes aegyptica forms a mosaic with Anogeissus association, with Acacia seyal dominating. Fig.1 below shows Schematic diagram of the Zalingei area. Lannea humilis may be locally dominant amidst what would otherwise be pure stands of rather stunted Acacia seyal is probably due to the shallow soil, often less than 1m deep, overlying the basement complex rocks.

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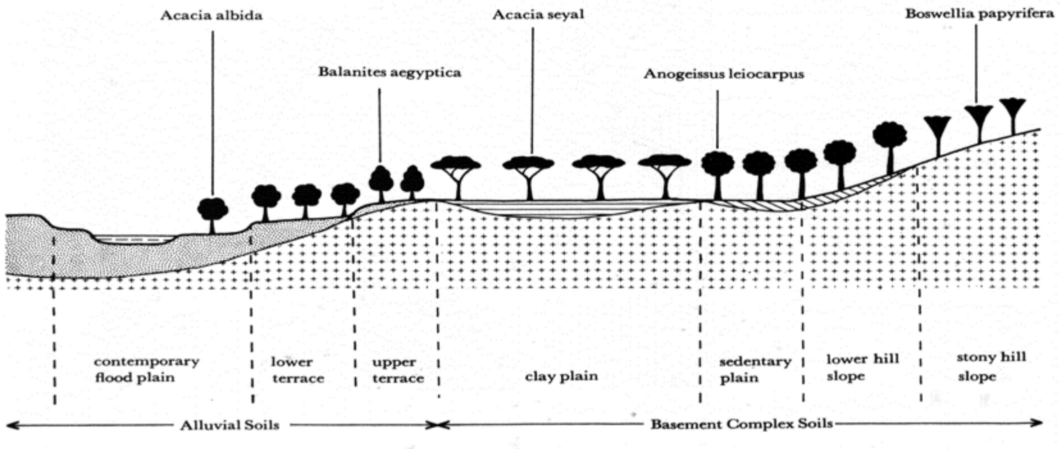

Fig 1: Schematic diagram of the Zalingei area showing the relationship between geomorphology, soil and vegetation adapted from Wickens (1976).

Wickens (1976) described the Faidherbia albida and Balanites aegyptiaca association on alluvial soils of the major Wadis (rivers) of Wadi Azum system, and on upper Azum catchment, upstream of Kurgula including Wadi Aribo, Gellimi and Uyer, the soils of the active flood plains are either bare of vegetation or carry a sparse cover of Saccharum spontaneum. The lower terraces are dominated by pure stand of Faidherbia albida, often forming a closed canopy. Minor associates are Ficus spp., Kigelia Africana, Cordia Abyssinia, Acacia sieberana and Acacia polyacantha. The drier soils of the upper terrace carry amore vegetation with Balanites aegyptiaca as the dominant species with Ziziphus spina-christi, Acacia gerrardii, Albizia amara and Combretum aculeatum also present. The largest and most important lowland association was Anogeissus leiocarpus association on basement complex soils, its best development is to be found on the sedentary soils of foothills between Zalingei and Arwala, where Anogeissus leiocarpus occurs in almost pure stands. The major tree associates of this community are Combretum glutinosum, Terminalia laxiflora, Sclerocarya birrea, Dalbergia melanoxylon and Dichrostachys cinera. On hill soils of the basement complex, found along southern and western fringes of the Jebel Marra massif with less water-demanding species: Anogeissus leiocarpus– Boswellia papyrifera, Terminalia brownii. Lannea fruticosa, Acacia gerrardii and Albizia amara. The hill crests are usually dominated by pure stands of Boswellia papyrifera, with Anogeissus leiocarpus on the flanks, and possibly thickets of Acacia ataxacantha at the foot of the slopes see Fig.2 Wickens, (1976).

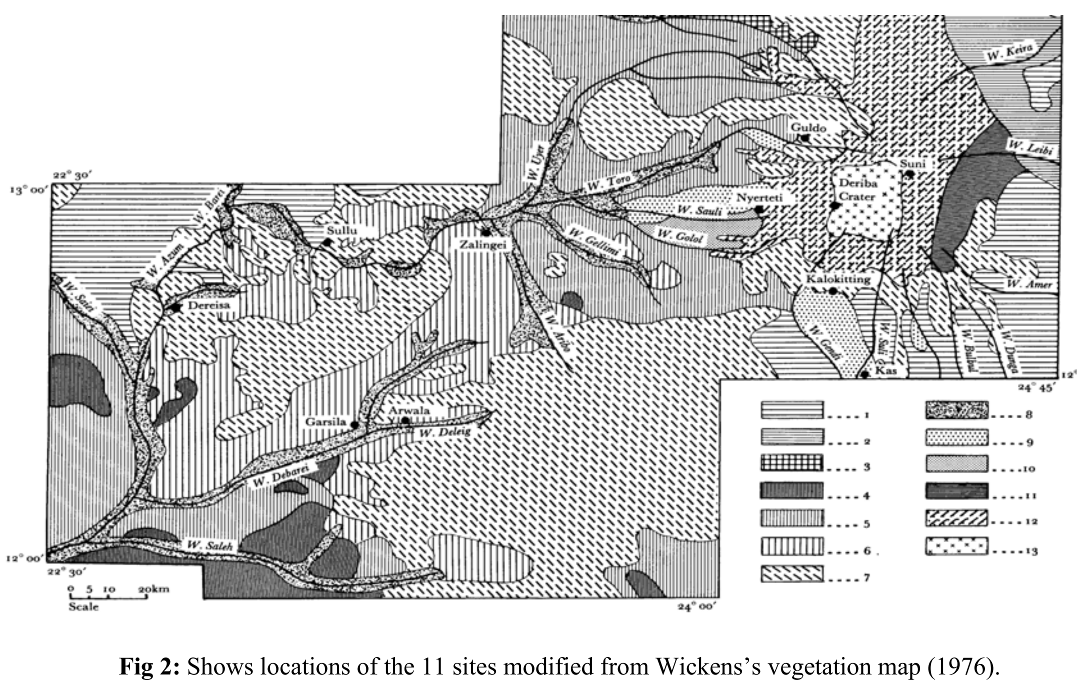

Fig 2: Shows locations of the 11 sites modified from Wickens's vegetation map (1976).

4. Acacia seyal – Balanites aegyptiaca on clay soil
5. Acacia seyal – Anogeissus leiocarpus mosaic on basement complex soils
6. Anogeissus leiocarpus on basement complex soils
7. Anogeissus leiocarpus – Boswellia papyrifera on basement complex hill soils
8. Acacia albida - Balanites aegyptica on alluvial soils

Location of the sites

3. MATERIAL AND METHOD

3.1 Reconnaissance Survey

Reconnaissance survey was carried out in the study area, during May and July 2013. The study area was stratified into eleven sites according to soil type, slope, and distance from Wadi system.

3.2 Description of the Sites

Eleven sites were selected for investigation. Site 1 is a contemporary flood plain on Wadi Gallabat of Traije administrative unit, with altitude of 999 m.a.s.l (Plate 4). Sites 2 and 3 represent lower terraces on Wadi Uyer Abata administrative unit with altitude of 960 m.a.s.l, and Wadi Aribo Zalingei with altitude of 902 m.a.s.l respectively (Plate 1). Sites 4 and 5 are upper terraces on Wadi Gellimi Zalingei with altitude of 922.2 m.a.s.l and Wadi Gallabat Traije with altitude of 1002 m.a.s.l respectively (Plate 2). Site 6 is clay plain on Wadi Uyer Abata administrative unit with altitude of 973 m.a.s.l (Plate 3). Site 7 is sedentary plain on Wadi Uyer Abata with altitude of 980 m.a.s.l (Plate 3). Site 8 and 9 are lower hill slopes on Wadi Uyer Abata with altitude of 993 m.a.s.l and Wadi Gallabat Traije with altitude of 1016 m.a.s.l respectively (Plate 4). Sites 10 and 11 are stony hill slopes on Wadi Gallabat Traje with altitude of 1112 m.a.s.l, and Wadi Azum Zalingei with altitude of 944.4 m.a.s.l respectively see (Table1) and Plate 2.

Table 1: Show the distances in km and the direction of sites from Zalingei town

No	Description	Abbreviation	Total area/ ha	Size of sample / ha	Distance and direction from Zalingei Km
1	Contemporary flood plain- Traje	CFT	10	0.5	1.5 S
2	Lower terraces - Abata	LTA	12	0.6	31 NE
3	Lower terraces - Zalingei	LTZ	10	0.6	26.5 S
4	Upper terraces- Zalingei	UTZ	42	2.1	11.5 E
5	Upper terraces - Traje	UTT	12	0.6	22 SW
6	Clay plain - Abata	CPA	12	0.6	36 NNE
7	Sedentary plain -Abata	SPA	42	2.1	34 NE
8	Lower hill slope Abata -	LHA	42	2.1	37 NE
9	Lower hill slope - Traje	LHT	42	2.1	24.5 SSW
10	Stony hill slope- Traje	SHT	10	0.5	25 SSW
11	Stony hill slope- Zalingei	SHZ	42	2.1	4 .3 N

3.3 Sampling Design

Using Global Positioning System (GPS), measuring tape and a compass, inventories were carried for the plots established in the eleven sites mentioned before; sites 4,7,8,9 and 11, each of them has a total area of 42 hectare (600 m × 700 m) with 21 sample plots equally distributed in three survey lines. The sample plots were circular in shape with a radius of 17.84 m (0.1 ha in area). In addition, the survey lines were drawn with seven sample plots per survey line. The distance between survey lines is 200 m and the distance between successive sample plots is 100 m. The distance from the outer survey lines to the borderlines is 100 m. each sample plot represents 2.1 hectares. In sites 2, 3, 5 and 6 the area occupied by trees was laid on strips, in the strip, sample plots were used and each of them consists of 6 hectare (200 m × 600 m) with 2 sample plots and the size of each sample plot is (5m× 600 m) along the site and the distance between the two sample plots is 100 m. The strip sampling was also applied for sites 1 and 10, but in a relatively smaller area, each of them consists of 5 hectare (200 m × 500 m) with 2 sample plots, Size of each sample plot is (5m× 500 m).

3.4 Parameters and Analysis of Data

In the eleven sites, the tree species were identified and recorded, all trees in the sample plots with dbh equal to or greater than seven centimeters were enumerated. The number of trees per ha was calculated. The species composition, the relative dominance, relative abundance, relative frequency and importance value indexes were calculated for all the specie using the formulas: Abundance (AB) = stem number of a given species per hectare. Absolute abundance (AAB) = number of individuals per species. Relative abundance (RAB) = percentage of each species of the total stem number per hectare. Frequency is defined as the probability or chance of finding an individual of a particular species in a given sample area or quadrate. (FR) = occurrence or absence of a given species in a sample plot .Absolute frequency (AFR) = percentage of occurrence (number of plots/all plots) .Relative frequency (RFR) = percentage of the total of absolute frequencies. Dominance = expression of the space that a given species occupies. Absolute dominance (BA) = the sum of the individual stem basal areas. Relative dominance (RBA) = percentage of a given species of the total stem basal area measured. Importance value index = sum of the relative abundance + relative frequency + relative dominance, these values were calculated for Boswellia plots by Adam (2003). The importance value index is a measure of ecological significance of a species in a certain forest type. It also expresses the dominance of a particular species in a stand (Adam, 2003).

Simpson Diversity index was used to measure the woody plants diversity. The value of this index ranges between 0 and 1. Within this index, 0 represents infinite diversity and 1 refers to no diversity. Where: Simpson diversity index is calculated using the formula below:

$$D = \sum n(n-1)/N(N-1)$$

Similarity coefficient between sites was calculate using Sorensen coefficient of similarity according to the following formula:

$$S = \frac{2a}{2a+b+c}$$

Whereas:

S= Sorensen coefficient of similarity.

a = number of species common to both quadrates or samples

b= number of species in quadrates/sample (1)

c = number of species in quadrates/ samples (2).

To give a percentage similarity the coefficient is multiplied by 100 (Mahmoud.2009).

4. RESULTS AND DISCUSSION

4.1 Distributions of Tree Species in the Study Area

In sites, 1, 2 and 3 the tree with the highest density was Faidherbia albida with 2.8 tree/ha, 1.8 tree/ha and 1.7 tree/ha respectively. Wickens (1976) also described the density of Faidherbia albida and Balanites aegyptiaca association on alluvial soils of Wadi Azum system as highest (fig 1, 2). The density of Ziziphus spina-christii and Ailanthus excels in site 1 was 2.1 tree/ha and 0.7 tree/ha respectively. The density of Kigelia Africana and Balanites aegyptiaca were 0.6 tree/ha see table 2. In site 4 and 5 it was found that the highest tree density (tree/ha) was Balanites aegyptiaca and Acacia seyal with 35.2 tree/ha and55.24 tree/ha respectively, also in site 4 the density of

Balanites aegyptiaca and Anogeissus leiocarpus were 3.5 tree/ha and 1.4 tree/harespectively table 3. In site 6 the highest tree density was calculated for Acacia seyal 128 tree/ha, Acacia Senegal 38 tree/ha, Acacia nilotica 26 tree/ha, Acacia girrardii was 12 tree/ha for Acacia nilotica, Balanites aegyptiaca, Ziziphus spina-christi the density was 10 tree per ha for each one. Moreover, the lowest tree density was calculated for Albizia anthelmintheca2 tree/ha (Table 4).

Table 2: Shows species composition, Abundance (AB), Absolute abundance (AAB), Relative abundance (RAB), Dominance (BA), Relative dominance (RB) on site 2

No site	species	AAB	AB	RAB	BA	RBA
1	Faidherbia albida	2	100	1.7	3.522	100
	Total	2		1.7	3.522	
2	Faidherbia albida	3	60	1.8	1.251	80.8
	Kigelia Africana	1	20	0.6	0.1451	9.4
	Balanites aegyptiaca	1	20	0.6	0.1520	9.8
	Total	5		3	1.548	
3	Faidherbia albida	4	50	2.8	2	62.5
	Ziziphus Abyssinia	3	37.5	2.1	0.9	28.1
	Ailanthus excels	1	12.5	0.7	0.3	9.4
	Total	8		5.6	3.2	

In site seven Albizia amara scored the highest density 52.4 tree/ha, followed by Acacia Senegal 29.5 tree/ha whereas Balanites aegyptiaca, Acacia girrardii, Acacia oerfota, Acacia nilotica Acacia seyal, and Acacia nubica, Albizia anthelmintheca , Anogeissus leiocarpus, Grewia mollis, Acacia laeta , Acacia mellifera , Xeromphis nilotica showed very low densities. This result indicates that Albizia amara and Acacia Senegal are positively associated see table 5.

Table 3: Show species composition, Abundance (AB), Absolute abundance (AAB), Relative abundance (RAB), Dominance (BA), Relative dominance (RBA) on site 4 and 5

No of sites	species	AAB	AB	RAB	BA	RBA
4	Balanites aegyptiaca	74	34.74	35.2	4.3	60
	Acacia sieberana	1	0.47	0.48	0.04	0.56
	Acacia nilotica	3	1.41	1.43	0.23	3.21
	Acacia Senegal	4	1.88	1.9	0.07	1
	Acacia seyal	116	54.5	55.24	2.07	28.9
	Ziziphus Abyssinia	15	7	7.14	0.46	6.42
5	Anogeissus leiocarpus	2	29	1.4	0.2	25
	Balanites aegyptiaca	5	71	3.5	0.6	75

Table 4: Show species composition, Abundance (AB), Absolute abundance (AAB), Relative abundance (RAB), Dominance (BA), Relative dominance (RBA) On site 6

Species	AAB	AB	RAB	BA	RBA
Acacia seyal	64	54.2	128	0.38	46.3
Acacia nilotica	13	11	26	0.11	13.41
Balanites aegyptiaca	5	4.2	10	0.04	4.9
Acacia Senegal	19	16.1	38	0.17	20.7
Acacia girrardii	6	5.1	12	0.06	7.3
Bauhinia rufescens	5	4.2	10	0.02	2.4
Albizia anthelmintheca	1	0.5	2	0.01	1.2
Ziziphus spina-christi	5	4.2	10	0.03	3.7
Total	118		236	0.82	

There are only two dominant species on site 8 namely Albizia amara 69.04 tree/ha and Acacia Senegal 30.84 tree/ha. Moreover, in site 9 the highest tree density (tree/ha) was Balanites aegyptiaca, 20 tree/ha followed by Acacia seyal 12.4 tree/ha, Anogeissus leiocarpus 6.2 tree/ha, Albizia amara 5.24 tree/ha and Acacia nilotica 2.9 tree/ha table 6. There is only one dominant tree species in site 10 namely Boswellia papyrifera 52 tree/ha followed by Lannea fruticosa 18 tree/ha, Dichrostachys cinerea 12 tree/ha and Acacia girrardii 8 tree/ha. And the dominant tree species on site 11 was Albizia amara 45.25 tree/ha followed by Balanites aegyptiaca 7.62 tree/ha and Acacia Senegal 6.19 tree/ha table 7.

Table 5: Shows species composition, Abundance (AB), Absolute abundance (AAB), Relative abundance (RAB), Frequency (FR), Relative frequency (AFR), Dominance (BA), Relative dominance (RBA) and Importance value index (IVI) On site 7

Species	AAB	AB	RAB	FR	AFR	RFA	BA	RBA	IVI
Balanites aegyptiaca	7	3.3	3.3	4	19.05	6.67	0.36	7.5	17.5
Albizia amara	110	51.1	52.4	14	66.67	23.36	3.18	66.4	142.2
Albizia anthelmintheca	4	1.9	1.9	1	4.76	1.67	0.12	2.5	6.07
Acacia girrardii	6	2.8	2.9	3	14.29	5.01	0.11	2.3	10.21
Acacia laeta	1	0.48	0.48	1	4.76	1.67	0.05	1.04	3.19
Anogeissus leiocarpus	4	1.9	1.9	3	14.29	5.01	0.28	5.85	12.76
Acacia mellifera	1	0.48	0.48	1	4.76	1.67	0.01	0.21	2.36
Acacia nilotica	5	2.3	3.38	4	19.05	6.67	0.04	0.84	9.9
Acacia oerfota	6	2.8	2.9	5	23.81	8.34	-	-	11.24
Acacia Senegal	61	28.5	29.5	16	76.19	26.29	0.56	11.7	97.44
Acacia seyal	6	2.8	2.9	5	23.81	8.34	0.08	1.7	12.94
Grewia mollis	2	0.9	0.95	2	9.52	3.34	-	-	4.29
Xeromphis nilotica	1	0.48	0.48	1	4.76	1.67	-	-	2.15
Total	214		62.2		285.5		4.79		

4.2 Simpson Diversity index

The value of diversity index is all most between 0.19 and 1. This is considered as a low diversity index. This indicates that the woody plant species of the area was affected by human activity. The highest diversity index was for site 9, with the value of diversity index of 0.19 followed by site 2 (0.30), 1(0.32), 6(0.34), 10(0.34), 7(0.35), 4(0.42), 8(0.48), 5(0.52) 11(0.56) and there is no diversity in site 3 (Table 8). The diversity index for the terraces ranged between 0.15 - 1. The highest diversity of terraces was for the lower terraces 0.15 followed by Lower hill slope 0.26, stony hill slope 0.33, clay plain 0.34 , sedentary plain 0.35, upper terraces 0.41 and contemporary flood plain 1. The sites of contemporary

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flood plain are sandy soil and represent the Wadi bed which is flooded during the rainy season, often there is one species here Faidherbia albida. Moreover, lower terraces are more fertilized due to deposition of alluvial soils (Table9).

Table 6: Shows species composition, Abundance (AB), Absolute abundance (AAB), Relative abundance (RAB), Frequency (FR), Relative frequency (AFR), Dominance (BA), Relative dominance (RBA) and Importance value index (IVI) On site 8 and 9

S #	Species	AAB	AB	RAB	FR	AFR	RFA	BA	RBA	IVI
8	Albizia amara	145	63.3	69.04	16	76	34.09	3.2	74	177.1
	Acacia Senegal	64	27.9	30.48	16	76	34.09	0.7	16	80.57
	Acacia girrardii	1	0.43	0.48	1	4.7	2.1	0.05	1.2	3.78
	Bauhinia rufescens	3	1.31	1.43	1	4.7	2.1	0.026	0.6	4.13
	Acacia nilotica	5	2.18	3.38	3	14.2	6.37	0.065	1.5	11.25
	Balanites aegyptiaca	1	0.43	0.48	1	4.7	2.1	0.006	0.14	2.72
	Acacia seyal	3	1.31	1.43	3	14.2	6.37	0.2	4.9	12.7
	Dalbergia melanoxylon	2	0.87	0.95	2	9.5	4.26	0.026	0.6	5.81
	Dichrostachys cinerea	3	1.31	1.43	2	9.5	4.26	0.017	0.39	6.08
	Acacia oerfota	1	0.43	0.48	1	4.7	2.1	-	-	2.56
	Acacia tortilis	1	0.43	0.48	1	4.7	2.1	0.025	0.58	3.16
	Total	229				222.9		4.315		
9	Ziziphus spina-christi	4	3.28	1.9	4	19.1	7.6	0.04	0.8	10.3
	Acacia Senegal	2	1.64	0.95	2	9.5	3.8	0.01	0.2	4.95
	Balanites aegyptiaca	42	34.43	20	8	38.1	15.1	1.58	31.41	66.5
	Acacia seyal	26	21.31	12.4	9	42.9	17	0.45	8.95	38.4
	Dalbergia melanoxylon	1	0.82	0.48	1	4.8	2	0.34	6.8	9.28
	Anogeissus leiocarpus	13	10.66	6.2	6	28.6	11.3	1.13	22.47	40
	Albizia amara	11	9.01	5.24	6	28.6	11.3	0.69	13.72	30.3
	Faidherbia albida	1	0.82	0.48	1	4.8	2	0.01	0.2	2.7
	Dichrostachys cinerea	4	3.28	1.9	2	9.5	3.8	0.02	0.4	6.1
	Acacia girrardii	5	4.1	2.38	3	14.3	5.7	0.07	1.39	9.5
	Acacia nilotica	6	4.92	2.9	4	19.1	7.6	0.16	3.18	13.7
	Lannea fruticosa	1	0.82	0.48	1	4.8	2	0.05	1	3.5
	Sclerocarya birrea	5	4.1	2.38	5	23.8	9.4	0.38	7.55	19.3
	Sterculia setgera	1	0.82	0.48	1	4.8	2	0.1	2	4.48
	Total	122		58.2		252.7		5.03		

Table 7: Show species composition, Abundance (AB), Absolute abundance (AAB), Relative abundance (RAB), Dominance (BA), Relative dominance (RBA) On site 4 and 10 and 11

No. sites	species	AAB	AB	RAB	BA	RBA
10	Boswellia papyrifera	26	54.2	52	1.37	76.1
	Lannea fruticosa	9	18.8	18	0.17	9.4
	Acacia Senegal	1	2.01	2	0.004	0.022
	Acacia seyal	1	2.01	2	0.23	12.8
	Dichrostachys cinerea	6	12.5	12	0.024	1.3
	Dalbergia melanoxylon	1	2.01	2	0.018	1
	Acacia girrardii	4	8.3	8	0.027	1.5
	Total	48		96	1.8	
11	Albizia amara	95	73.6	45.24	2.44	47.4
	Balanites aegyptiaca	16	12.4	7.62	2.34	45.4
	Dalbergia melanoxylon	1	0.78	0.48	0.05	1
	Combertum glutinosum	3	2.33	1.43	0.06	1.2
	Terminalia mollis	1	0.78	0.48	0.07	1.4
	Acacia Senegal	13	10.1	6.19	0.19	3.7
	Total	129		61.44	5.15	

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Table 8: Shows Simpson diversity index for the eleven study sites

No	Site	N	N(n-1)	$\sum n(n-1)$	Simpson's index
1	Lower terraces - Zalingei	8	56	18	0.32
2	Lower terraces -Abata	5	20	6	0.30
3	Contemporary flood plain --Traje	2	2	2	1
4	Upper terraces- Zalingei	213	45156	18970	0.42
5	Upper terraces -Traje	7	42	22	0.52
6	Clay plain -Abata	118	13806	4620	0.34
7	Sedentary plain- Abata	214	45582	15828	0.35
8	Lower hill slope -Abata	229	52212	24952	0.48
9	Lower hill slope -Traje	122	14762	2734	0.19
10	Stony hill slope Traje	48	2256	764	0.34
11	Stony hill slope- Zalingei	129	16512	9332	0.56

Table 9: Shows Simpson diversity index for the terraces

Site	N	N(n-1)	$\sum n(n-1)$	Simpson's index
Lower terraces	13	156	24	0.15
Clay plain	118	13806	4620	0.34
Sedentary plain	214	45582	15828	0.35
Lower hill slope	351	122850	31470	0.26
Upper terraces	220	48180	19732	0.41
Stony hill slope	177	31152	10124	0.33
Contemporary flood plain	2	2	2	1

4.3 Sorensen coefficient of similarity

Similarity coefficient between sites: Upper terraces- Zalingei and upper terraces –Traje, lower terraces –Abata and lower terraces – Zalingei , lower hill slope –Traje and lower hill slope –Abata and stony hill slope Traje and stony hill slope Zalingei for woody plant species are presented in table10. They were determined qualitatively (present and absent) and were found in the range between 20% and 39 %. These low similarities between sites based on the woody vegetation types might be attributed to the topography and soil types.

Table 10: Shows the similarity between sites

Family / species		Sites										
Family	**Latin name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Rhamnaceae	**Ziziphus spina-christi**				+				+			
Rhamnaceae	**Ziziphus Abyssinia**					+	+					
Anacardiaceae	**Anogeissus leiocarpus**			+					+	+		
Apocyanaceae	**Lannea fruticosa**								+			+
Anacardiaceae	**Sclerocarya birrea**								+			
Fabaceae	**Albizia anthelmintheca**			+	+							
Fabaceae	**Albizia amara**		+	+				+	+			
Fabaceae	**Dichrostachys cinerea**		+						+			+
Fabaceae	**Faidherbia albida**	+				+			+		+	
Fabaceae	**Dalbergia melanoxylon**		+					+	+			+
Fabaceae	**Bauhinia rufescens**		+		+							
Fabaceae	**Acacia seyal**		+	+	+		+		+			+
Fabaceae	**Acacia Senegal**		+	+	+		+	+	+			+
Fabaceae	**Acacia girrardii**		+	+	+				+			+
Fabaceae	**Acacia laeta**			+								
Fabaceae	**Acacia mellifera**			+	+							
Fabaceae	**Acacia nilotica**		+	+	+		+		+			
Fabaceae	**Acacia oerfota**		+	+								
Fabaceae	**Acacia tortilis**		+									
Fabacea	**Acacia sieberana**						+					
Rubiaceae	**Xeromphis nilotica**			+								
Tiliaceae	**Grewia mollis**			+								

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Combretaceae	**Combertum glutinosum**							+				
Combretaceae	**Terminalia mollis**							+				
Sterculiaceae	**Sterculia setgera**								+			
Balanitaceae	**Balanites aegyptiaca**	+	+	+			+	+	+	+		
Burseraceae	**Boswellia papyrifera**											+
Simaroubaceae	**Ailanthus excels**					+						
Bignoniaceae	**Kigelia Africana**	+										

Were site:

1= Lower terraces –Abata
2= Lower hill slope –Abata
3= Sedentary plain- Abata
4= Clay plain –Abata
5= Lower terraces – Zalingei
6= Upper terraces- Zalingei
7= Stony hill slope- Zalingei
8= Lower hill slope –Traje
9= Upper terraces –Traje
10- Contemporary flood plain–Traje
11= Stony hill slope Traje

4.3.1 Similarity between Upper terraces- Zalingei and Upper terraces –Traje:

a= 1 , b=6 , c=2

$$S = \frac{2a}{2a+b+c} = \frac{2x1}{2x1+6+2} = 20\%$$

4.3.2 Similarity between Lower terraces –Abata and Lower terraces –Zalingei:

a= 1 , b=3 , c=3

$$S = \frac{2 \times 1}{2 \times 1 + 3 + 3} = 25\%$$

4.3.3 Similarity between Lower hill slope –Traje and Lower hill slope –Abata:

a= 8 , 3=14 , c=11

$$\frac{2x8}{2x8+14+11} = 39\%$$

4.3.4 Similarity between Stony hill slope Traje and Stony hill slope Zalingei:

a= 2 , 3=7 , c=6

$$\frac{2x2}{2x2+6+7} = 23.5\%$$

5. CONCLUSION

The results show that Faidherbia albida is dominant on the contemporary flood plains, lower terraces and Balanites aegyptiaca, Acacia seyal are dominant on the upper terraces. Moreover, Acacia seyal dominated the Clay plains. This agrees with Wickens (1976) which described the Faidherbia albida and Balaniyes aegyptica association on alluvial soils of the major Wadi Azum system. The lower terraces are dominated by pure stand of Faidherbia albida, often forming a closed canopy. The drier soils of the upper terrace carry more vegetation with Balanites aegyptiaca as the dominant species with Ziziphus spina-christi, Acacia gerrardii, Albizia amara and Combretum aculeatum also present. The results indicate that Albizia amara, Acacia Senegal are dominant on the sedentary plain. This differs with Wickens (1976) who described the Anogeissus leiocarpus as dominant on the sedentary plains (Figure 3). On the lower hill slopes, this study found that Albizia amara, Acacia Senegal and Balanites aegyptiaca dominated. On the other hand, Boswellia papyrifera, Albizia amara dominated the stony hill slopes. The results show that there are 67.3 tree/ha for Zalingei area.

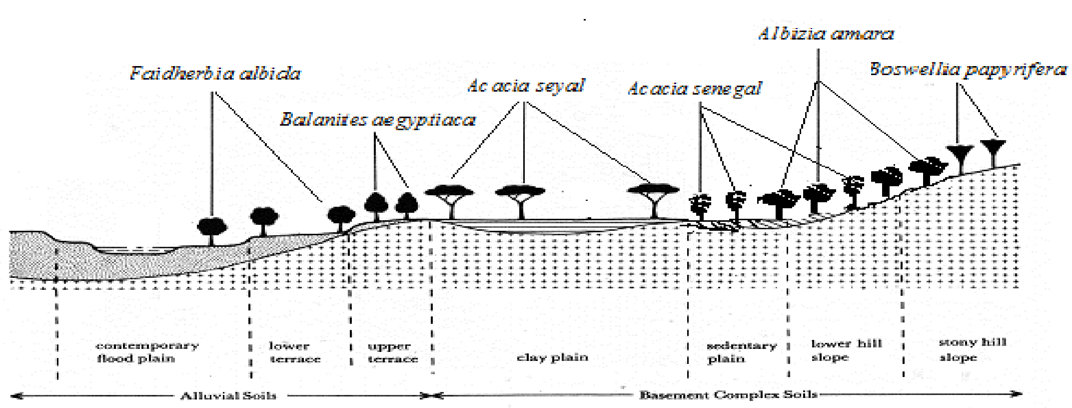

Fig 3: Schematic diagram across the Wadi system to the stony hill slopes in Zalingei area

REFERENCES

[1] ADAM, A. A., 2003. Some Aspects of Ecology and Management of Boswellia papyrifera del. (HOCHEST) In Jebel Marra Mountains; Dar Fur, Sudan. PhD Thesis Submitted to the University of Khartoum, Sudan.

[2] Dallmeier, F., 1998. Measuring and monitoring forest biodiversity: the SI/MAB model. In: Bachmann, P., Ko¨ hl, M., Pa¨ivinen, R. (Eds.), Proceedings of the Conference on Assessment of Biodiversity for Improved Forest Planning, Monte Verita`, Switzerland, October 7–11, 1996. Kluwer Academic Publishers, Dordrecht, pp. 15–29.

[3] Elsiddig, E. A., 2007. Jebel Marra The Potentials for Resources and Rural Development in Darfur. University of Khartoum, Faculty of forestry. National library Sudan 333.7.

[4] FAO 1968: Land and water resources survey in the Sudan. Final report (FAO/SF: 48: SUD17).- Khartoum.

[5] Hunting Technical Services LTD.1958: Jebel Marra investigation report on phase 1 studies. Ministry of irrigation & hydro-electric power and Ministry of Agriculture, Khartoum- Sudan.

[6] Hunting Technical Services LTD. 1977: agriculture development in Jebel Marra area ,Annex 5 Agriculture.

[7] Lebon, J. H.G., 1965 Land use in Sudan. Bude. Cornwall. World land use survey monog.4.

[8] Mahmoud, Z. N., 2009. Introduction to biodiversity. University of Khartoum, Faculty of Sciences. National library Sudan 576.86.

[9] MIEHE, S.1988: Vegetation ecology of the Jebel Marra Massif in the semiarid Sudan .Dissertations botanicae. Band113.Gebruder borntraeger,D-1000Berlin. D- 7000 Stuttgart.

[10] UNSO, 1997. Aridity Zone and Dry land Population; An Assessment of Population levels in the World's Dry land with reference to African. Discussion paper by UNSudano-Sahelian Office (UNSO) New york.

[11] WICKENS, G. E. 1976: The flora of Jebel Marra (Sudan Republic) and its geographical affinities.- Kew Bull. Add. Ser.5.-Londo.