Ecological studies On EL-Jufra Desert Depression

Yacoub Mohamed El-Barasi
University of Benghazi

Manam W. B. Saaed
The Higher Institute of Agricultural Techniques, Al-Marj, Libya

Ecological studies On EL-Jufra Desert Depression

Y. M. EL-Barasi , B. M. Bader , M. W. Barrani , N. M. EL-Hashani and A. O. Alamrouni

Botany Department, Faculty of Science, Garyounis University, Benghazi, Libya.
Environmental Science Department, Academy of Post Graduate Studies, Benghazi, Libya.
Botany Department, Faculty Of science, Attahadi University, Sirt, Libya.

Abstract

This investigation was carried out on EL-Jufra (Oasis) depression located at the heart of Libyan desert (Sahara desert), at coordinates 29 – 29:30 N and 15:30 – 16:30 E. This saharean zone is characterized by low rainfall (2.5 – 45 mm / year) and high temperature range (0 – 50 C^{O}) with great quantity of shallow underground water, feeding Oases such as Waddan, Hun and Sawknah.

From ancient time a stable agriculture mainly in form of planting dense forests of Palm trees (*Phoenix dictalifera* - 2,700,000 tree) is practiced along with other types of cultivars such as vegetables and fruits suitable for desert climate, the other important activity is pastoralism, the area contains 130,800 head (125,000 sheep, 5000 camels, and 800 cattles).

The natural vegetation (xerophytic) is very poor, scattered and concentrated mainly in Vallies (wdiis), the flora consisted of 37 species belonging to 20 families, the soil showed poor fertility, $CaCO_3$ % ranged between (3.8 – 23.6 %) the pH mainly neutral to slightly alkaline (7.2 – 8.6) with wide salinity range (4.1 – 82.15 mS/cm) which increases in agricultural areas (6.72 – 93.60 mS/cm) meanwhile it's range is (13.37 – 90.20 mS/cm) in Salt marshes places (Sabkha), the sand fraction in most soil samples exceeds (90 %).

Soil seed bank at depth (0 – 10 cm) ranged between (190 – 5917 seed/m^2) and at depth (10 – 30 cm) ranged between (77 – 2813 seed/m^2) in Salt marshes areas it takes an inverse situation, where at depth (0 – 10 cm) ranged between (250 – 686 seed/m^2) and at depth (10 – 30 cm) ranged between (404 – 3176 seed/m^2).

Seed density is higher in winter than in summer, but in soils of Sawknah oasis consisted the greatest density (2227 – 5917 seed/m^2) on the other hand natural places at Hun area has the least seed bank density (77 – 416 seed/m^2).

In addition to the effect of climate in this fragile ecosystem the accumulation and increased frequency of human activities over long period of time have a great harmful impact on plant ecology on this region, changing soil characteristics, decreasing vegetation coverage and introducing variation in soil seed bank density.

Key words : EL-Jufra depression, Soil properties, Natural vegetation, Soil seed bank, Human activities.

Introduction

EL-Jufra depression lies within Libyan desert (Sahara) , this region has a historic and geographic importance as it consists of three zones (Sawknah , Hun and Waddan). The prosperity of the region rise because it was the shortest path for caravans linking the Mediterranean coastal area with African interior. The abundance of ground water near the surface also played significant role in the settlement of this region, facilitated irrigation of large area of vegetables and Palm trees that typically grow in such climate.

EL-Jufra now is consist of five main Oasis (Zalla, Waddan, Hun, Sawknah and EL-Fugha) which witnesses a vast agricultural expansion in growing Palm and Olive trees, Woods, Vegetables and Forages as well as Palm plots naturally developing where the ground water runs by.

Lemaire (1703) made the first study of the vegetation of the area followed by Oudeny *et al* (1826), Rohlfs (1881), Pampanini (1931) published II prodromo della Flora Libica, EL-Kadi and EL-Jafri (1976 - 1989) Flora of Libya and Ueld EL-Bashir (2003) The Checklist of the Flora of El-Jufra area.

The dry desert climate also has a role in imposing fragile ecosystem due to increase of temperature and lack of rainfall. Further more, the human activities have a negative impact on the region, represented in form of cultivation that results in eradication of natural flora, depletion of underground water and increase of soil salinity, continuous overgrazing that consumes the natural vegetation. These activities also deteriorated the soil properties by increased salinity, disturbance and deterioration of the vegetation and unstable soil seed bank.

The current study aims to examine some plant ecological factors of the region represented by the location, climate, landscape, soil, vegetation and soil seed bank within this region which is the first seed bank study in this zone .

Location

EL-Jufra oval depression located approximately 260 km away south the Mediterranean sea coast, coordinates are 29:00 – 29:30 N and 15:30 – 16:30 E with altitude 240 – 330 m., north EL-Sawda mountains, around 45 km long and 24 km wide with total land area of 1080 km^2.

The depression comprises Waddan, Hun and Sawknah as most important among several other Oases. It divided into two parts by fairly high plateau with plain rocky surface runs north-south.

Sawknah oasis lies near the center of the EL-Jufra depression, Hun is situated around 15 km north east it and contains the best agriculture land, while Waddan lies on the north side of the depression, around 19 km east of Hun and on its north-east side are Waddan and EL-Shurafa mountains.

The region mainly consist of sedimentary rocks from Upper cretaceous period to Tertiary period as igneous rocks cover the southern parts of the area. There are also various Quaternary rocks deposited in continental environment (Shakoor and Shagroni, 1984).

In general, the landscape is almost flat with some grooves and dry channels. Abundant stones are dispersed on most areas especially south of Sawknah next to EL-Sawda mountains, and east of Waddan near the Waddan and EL-Shurafa mountains. In other parts, however, there are plentiful Gypsum and Calcium carbonate decrease as we turn north as well as some Salt marshes.

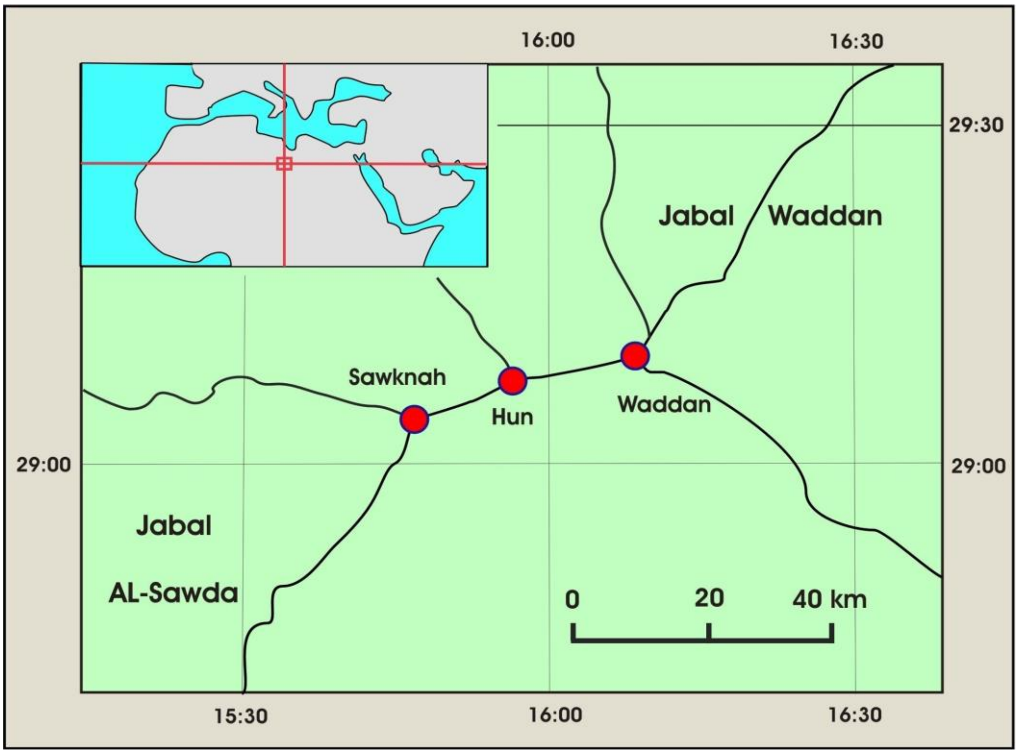


Fig. 1. The study area

Climate

Geographically, the region located at the center of Libyan desert a big part of Great Sahara, therefore it is a subject to the desert extreme changes such as lack of rain fall about 2.5 – 45 mm/year and it reaches its peak in January then decrease as Summer approaches, and wide range of temperature between 0 C^{O} in winter at night to 50 C^{O} in summer at noon, the maximum and minimum temperatures occurs during June, July and August, it ranged between 38 C^{O} and 21.8 C^{O} respectively, January and February with maximum and minimum temperatures which ranged between 21.8 C^{O} and 4.7 C^{O} respectively, the relative humidity is low within 48 % (EL-Jufra meteorological station , 1993 – 2005).

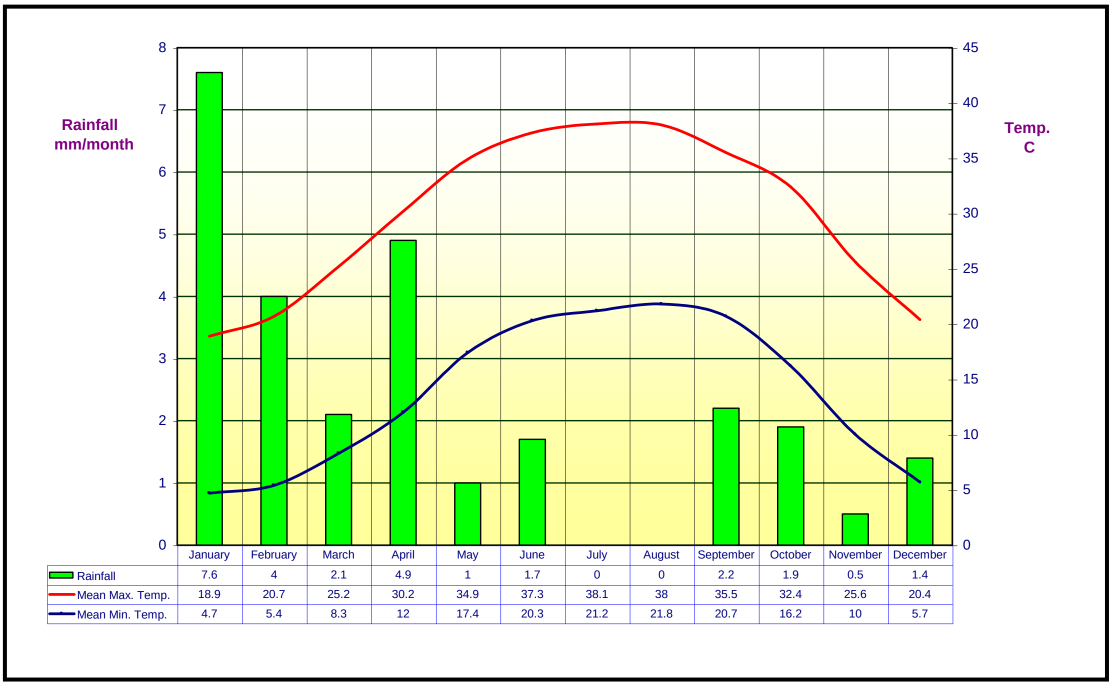


Fig. 2. Rainfall and Temperature of the study zone

Materials and Methods

Three main zones (Waddan, Sawknah and Hun) were selected as study area, the samples were collected and tested as follows :

1. Mechanical and chemical analysis :

The samples were taken from two different depths (0 – 10 cm and 10 – 30 cm) packed in plastic bags with labels of the weight and number then transferred to the Laboratory where air dried. The tests included soil texture, $CaCO3$ %, pH and concentration of dissolved salts (T.D.S.). All tests were performed after Black *et al* (1965) .

2. Count and separation of seeds :

The samples were collected in Summer and Winter of a single year to determine the seed bank. They were taken out from two different depths (0 – 10 cm and 10 – 30 cm) packed, weighed, numbered and transferred to the Laboratory where air dried then separated and counted according to Major and Pyott (1966) and Johonston *et al* (1978).

3. Floral study :

All the three zones were surveyed and plants were sampled. All samples were pressed, dried and poisoned then fixed on Herbarium sheet. Plant samples were identified using Englar method and deposited in botany department's Cyrene Herbarium of Garyounis University (C.H.G.U.).

4. Statistic analysis :

The obtained data was tabulated and statistically analyzed using statistical package (SPSS) were the following tests were performed : Descriptive analysis, T-test, Chi-square, Anova test, Multiple comparison test (LSD) and Correlation test.

Results and Discussion

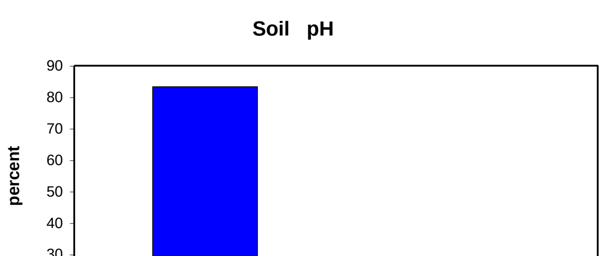
The mechanical analysis of soil revealed insignificant differences in soil texture among the studied areas (p = 0.140). The soil texture in general is distinguished by high proportion of sand which exceeded 90 % in some samples, the outstanding feature of desert coarse sand due to erosion factors. This soil consist of 44.4 % Loamy sand, 41.7 % Sandy loam, 11.1 % Sand, and 2.8 % Sany clay loam (Fig. 6).

The chemical analysis showed highly significant differences among the area in terms of $CaCO_3$ content (p = 0.000) which ranged between 3.8 – 23.6 % as a result of the original rock parent material of the region and the fact that most of the prevailing soil of both arid and semi-arid zones is calcareous as reported by Ryan *et al* (2003) and Aela *et al* (2005) that their results revealed that the soil of study area was containing a high percentage of carbonates. The concentrations of $CaCO_3$ content ranged between 9 – 23.9 % , 3.8 – 20.1 % and 6.1 – 11.1 % in Sawknah, Waddan and Hun respectively (Fig. 5).

The results also revealed significant differences among the areas concerning the degree of soil pH (p = 0.043) and it ranged between 7.58 – 8.62, 7.39 – 8.47 and 7.20 – 8.12 at Waddan, Hun and Sawknah respectively. This is attributed to the nature of chemical structure of the soil as well as the drought which is consistent with what Ben Mahmoud (1995) stated that the interaction of the dry land soil in general is often neutral, sub-alkaline or alkaline as the availability of water affects the pH of soil. SWECO (1986) also reported a relationship between soil pH and the annual rainfall in a semi-arid region in east Libya (Fig. 3).

In respect of the ratio of soil salts, there are no significant differences among the study areas (p = 0.919) although the ratio was very high 4.10 – 82.15 mS/cm in areas devoid of vegetation, 6.72 – 93.60 mS/cm in cultivated lands and 13.37 – 90.20 mS/cm in salt marshes. High soil salinity in agricultural land is attributed to salt accumulation due constant cultivation (Fig. 4).

In spite of the irrigation in this arid environment and persistent evaporation of water caused salt accumulation, this coincides with the results of EL-Batanouny *et al* (1977) that mentioned the cultivating and irrigating lands with unusable water result in soil with highest-contents of salt, thus halophytes communities which have a high tolerance to salt stress occupied the area. Species like *Suaeda vera*, *Anabasis articulata*, *Chenopodium ambrosoides* and *Chenopodium murale* grow in this area. Further more, ground water close to soil surface in this area causes continuous evaporation that largely augments salt accumulation, this has also been reported by EL-Batanouny (1973) that harsh environmental conditions such high temperature and evaporation rate give increment of soil salinity in arid zone.



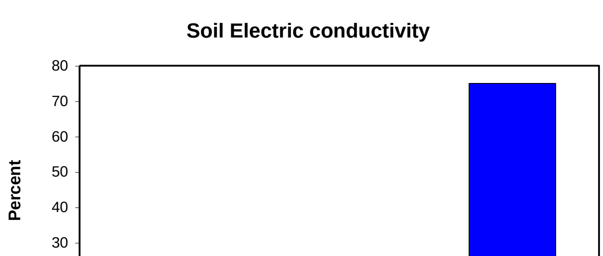
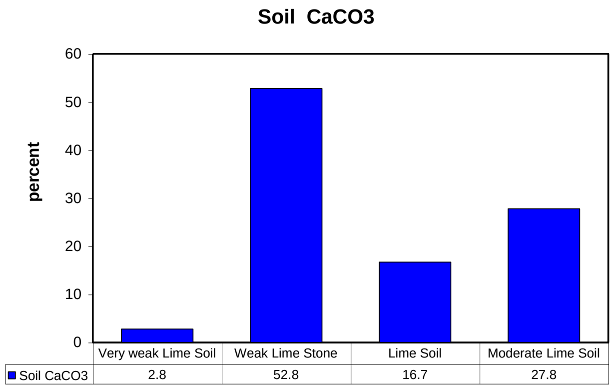
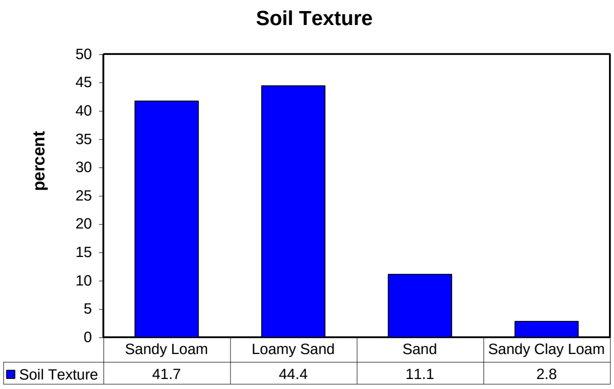


Fig. 3 . percentage of Soil pH

Fig. 4 . percentage of Soil E.C.





However the vegetation of El –Jufra depression, is in majority is of the restricted type being mainly confined to the water-collected channels of wadiis within the desert area, with ground water relatively close to the surface. Deeply rooted trees like *Acacia tortilis*, *Retama raetam* are forming the permanent poor framework of the plant cover in these wadiis.

In Places species like *Zilla spinosa*, *Hussonia pinnata*, *Zygophyllum simplex* grow forming the accidental vegetation type, which are linked to immediate water availability. The life cycle of these plants depends entirely on the amount of water stored in the ground. Establishment of the plant cover depends on the permanent seed bank present in the soil or on seeds transported by wind, but this is sometimes restricted to microdepressions and small catchment areas. According to Kassas (1952) distinguishes this type of vegetation from the ephemeral annual vegetation and perennial or permanent vegetation that are met within deserts with a more regular rainfall.

While other wadiis species are confined to, *Ifloga spicata, Cotula cinerea*, *Picris asplenoides, Chamomilla pubescencs, Launea capitata, Carduncellus eriocephalus, Traganum nudatum, Anabasis articulata, Hussonia pinnata, Sclerocephalus arabicus.*

Tamarix passerinoides occupies saltmarshes areas with deep sand deposits, where in certain instances underground water is exposed especially at Sokhna oasis. This species is considered one of climax types of salt marshes (Abu-Ziada, 1980).

However, the formation of these saline is due to uncontrolled spilling of water and flooding of the plains from El-Souda mountains surrounding EL-Jufra depression, or the water table, which is near the ground. Under these severe conditions of the oases and lack of the drainage system, flooding of soil with slightly saline artesian water rapidly increases its salinity.

Due to the intensive agricultural activities in these oasis a considerable weed vegetation is formed and species like, *Erodium glaucophylum*, *Heliotropium bacciferum*, *Helianthemum kahiricum, Malva parviflora, Cyperus laevigatus, Zygophyllum album, Zygophyllum simplex, Melilatus indicus,Oudenya Africana,Bassia muricata,Chenopodium murale,Chenopodium ambrossiodes, Perralderia garamantum,* are distributed in and around farms and agricultural projects in the whole area.

The seed bank density ranged between 77 – 5917 seed/m^2 and that so close with what was reported by Young and Evan (1975) that seed bank in some desert regions was about 2450 – 8431 seed/m^2 and EL-Barrani (2008) who suggested a range of 600 – 6000 seed/m^2 in northern eastern semi-arid part of Libya.

By comparing the three study areas, there were significant differences among them (p = 0.006) where it was 250 – 5917 seed/m^2 in Sawknah, 214 – 2484 seed/m^2 in Waddan and 77 – 557 seed/m^2 in Hun. The differences in the seed bank density is explained by the difference in the above-ground vegetation that agree somewhat with those of Norbert and Annette (2001). There were no significant differences in seasonal seed bank (p = 0.0573) which also noted by Chew (1977) and EL-Getlawi (2004) reported that climate controls the vegetation which in turn controls soil seed bank.

The seed bank density increase in winter which was about 5917 seed/m^2, 416 seed/m^2 and 2484 seed/m^2 in Sawknah, Hun and Waddan respectively. It decreased however in summer to 250 seed/m^2, 77 seed/m^2 and 214 seed/m^2 in the same previous order.

This increment in the soil seed bank in winter is mainly due to production of seeds after the rainfall in late fall and early winter, this consistent with Marone *et al* (2004) and Li Ning *et al* (2007).

The seed bank density under the canopy was high. The seed bank of *Retama raetam* and *Acacia tortilis* trees was about 5596 – 14989 seed/m^2 (Table 1 and Fig. 8) this come in line with finding of Marone *et al* (2004) and Pugnaire and Lazaro (2000) stated that the seed bank density under canopy of *Retama raetam* in arid and semi-arid regions has a relationship with above-ground vegetation, this is because of accumulation of soil organic matter, this finding was consistent with EL-Bana *et al* (2003) as *Retama raetam* capable of gathering soil as hummock around the plant as well as improving deteriorated land.

We show consistent differences in soil seed bank composition at the microhabitat. Grass seed as a whole were particularly abundant in natural depressions, whereas forb seeds were scare in all exposed microhabitats but reached high densities beneath the canopies of trees where, in turn, grass seeds were relatively scare, this finding was consistent with finding of Marone *et al* (2004).

The seed bank of open land has the lowest ranges which lie between 77 – 661 seed/m^2 due to wind erosion and poor vegetation (Table 1 and Fig. 9). Similar to other deserts, some seeds appeared to largely transient in the exposed microhabitats, and at least part of their loss could be due to seed predation, this finding come in line with the finding of Reichman (1984); Price and Joyner (1997) and Marone *et al* (1998).

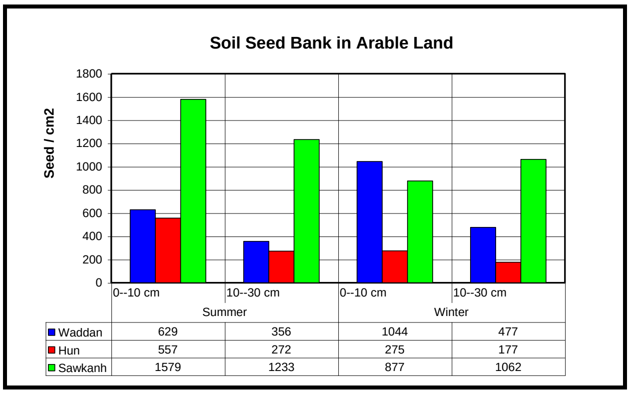
Seed bank loss may be adjudicated directly to the rapid transportation by the wind until they are trapped by the litter in the vicinity of the established plants or in natural depressions of the soil, these results are in agreement with finding in most deserts.

There was also insignificant differences in seed bank according to the soil depth ($p = 0.0503$) it was higher at depth 0 – 10 cm (190 – 5917 seed/m^2) than the depth 10 – 30 cm (77 – 2817 seed/m^2) but in salt marshes (Sabkha) it was less at depth 0 – 10 cm (250 – 686 seed/m^2) than the depth 10 – 30 cm (404 – 3176 seed/m^2). This may be attributed to accumulation of seed in deeper layer avoiding saline medium inadequate for germination except for halophytes such as *Suaeda vera*, *Anabasis articulata* and *Salsola tetrandra* (Table 1 and Fig. 10).

Existing vegetation of out study areas is closely represented in the seed bank samples, 77.8 % of them belong to the canopy cover whereas the rest 22.2 % of seeds not included.

Table 1 . Soil Seed Bank Density

Region	Season	Depth	Arable Land	Areas occupied by (*Retama raetam*)	Flat natural Land	Salt marshes Land (Sabkha)
Waddan	Summer	0 - 10	629	2295	214	338
		10 - 30	365	545	453	404
	Winter	0 - 10	1044	2484	661	686
		10 - 30	477	272	599	822
Hun	Summer	0 - 10	557	-	190	-
		10 - 30	272	-	77	-
	Winter	0 - 10	275	-	416	-
		10 - 30	177	-	271	-
Sawknah	Summer	0 - 10	1579	-	4032	250
		10 - 30	1233	-	2227	2282
	Winter	0 - 10	877	-	5917	288
		10 - 30	1062	-	2813	3176



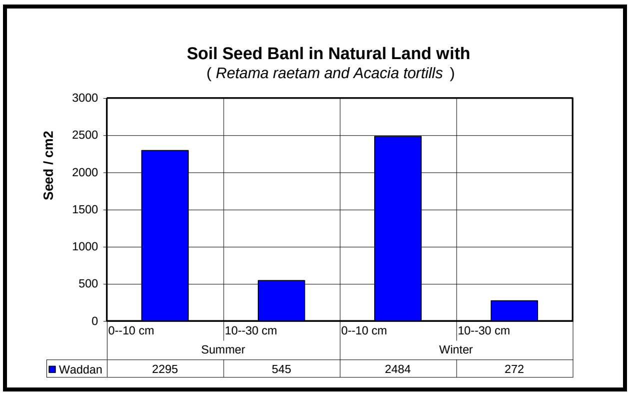
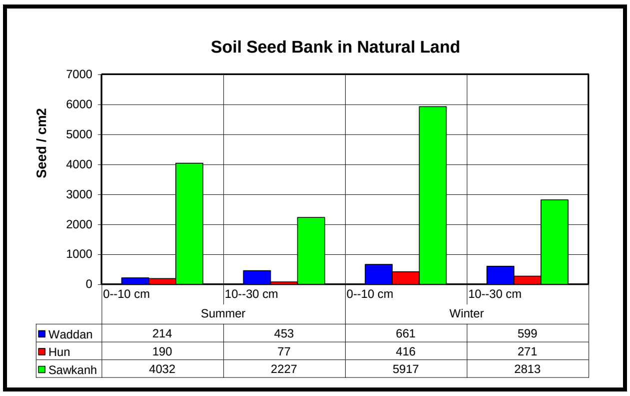


Fig. 7 . Arable land

Fig. 8 . *R. raetam* and *A. tortilis* soils



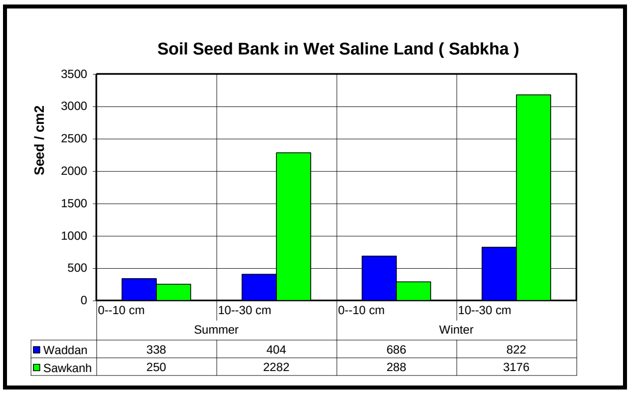


Fig. 9 . Bare areas

Fig. 10 . Salt marshes (Sabkah)

It is very clear that the study area is an arid zone where rainfall diminishes, temperature raises, has poor soil fertility and poor vegetation as well. The plant community often exists on depressions as they work as catchments while other areas remain arid with no vegetation. The identified species were 37 genera belong to 20 family, Asteraceae 18.9 %, Chenopodiaceae 18.9 %, Brassicaceae 8.1 %, Fabaceae 8.1 % and Zygophyllaceae 5.4 %, the remaining species formed 40.6 % of individual species.

The residents of study area practice Palm cultivation as a main product along with fodders and vegetables. The number of productive Palm trees in Waddan, Hun and Sawknah is 1,250,000 ; 800,000 and 650,000 tree respectively with total of 2,700,000 Palm tree (EL-Gwadi , 2006).

Under ground water reservoir utility in irrigation of different kinds of cultivation excessive cultivation in the study area increase soil deterioration and degradation with salt accumulation, besides that the agricultural land at the expenses of natural vegetation.

The residents also practice grazing, there was more than 130,800 grazing animals divided into 125,000 sheep, 5000 camels and 800 cows (EL-Jufra municipality of agriculture and livestock , 2007). However grazing is encouraged by the availability of cultivated area with fodders, grazing causing a lot of trampling and deterioration of the natural vegetation.

There is a remarkable cutting and collecting of branches of *Acacia tortilis* and *Retama raetam* which utilized as fuel and wood work, EL-Johary (2002) reported that the excessive use of the plants that represent the climatic climax of this region will affect the environmental equilibrium if such activities lasted for long.

Table 2 . Seed species

No.	Family	Species
1.	Areaceae	*Phoenix dactylifera*
2.	Zygophyllaceae	*Zygophyllum album*
3.		*Zygophyllum simplex*
4.	Fabaceae	*Retama raetam*
5.		*Melilotus indicus*
6.		*Nelilotus infestagus*
7.	Mimosaceae	*Acacia tortilis*
8.	Tamaricaceae	*Tamarix passerinoides*
9.	Malvaceae	*Malva parviflora*
10.	Brassicaceae	*Oudneya Africana*
11.		*Zilla spinosa*
12.	Polygonaceae	*Emex spinosus*
13.	Cucurbitaceae	*Citrullus colocynthis*
14.	Caryophyllaceae	*Vaccaria hispanica*
15.	Poaceae	*Hordeum murinum*
16.		*Lolium temulentuml*
17.	Asteraceae	*Picris aspienoides*
18.	Dispsaceceae	*Cephalaria syriace*

Table 3. plant species

No.	Family	Species
1.	Areaceae	*Phoenix dactylifera*
2.	Asteraceae	*Ifloga spicata*
3.		*Cotula cinerea*
4.		*Picris asplenoides*
5.		*Perraldera garamatum*
6.		*Chemomilla pubescens*
7.		*Launaea capitata*
8.		*Carduncellus eriocephalus*

9.	Chenopodiaceae	*Traganum nudatum*
10.		*Suaeda vera*
11.		*Anabasis articulate*
12.		*Chenopodium ambrosioides*
13.		*Salsola tetrandra*
14.		*Chenopodium murale*
15.		*Bassia muricata*
16.	Brassicaceae	*Zilla spinosa*
17.		*Hussonia pinnata*
18.		*Oudneya Africana*
19.	Fabaceae	*Melilotus indicus*
20.		*Retama raetam*
21.		*Alhagi graecorum*
22.	Zygophyllaceae	*Zygophyllum album*
23.		*Zygophyllum simplex*
24.	Polygonaceae	*Emex spinosus*
25.	Cucurbitaceae	*Citrullus colocynthis*
26.	Poaceae	*Hordeum murinum*
27.	Mimosaceae	*Acacia tortilis*
28.	Geraniaceae	*Erodium glaucophyllum*
29.	Asclepiadaceae	*Pergularia tomentosa*
30.	Neuradaceae	*Neurada procumbens*
31.	Cyperaceae	*Cyperus laevigatus*
32.	Illecebraceae	*Sclerocephalus arabicus*
33.	Tamaricaceae	*Tamarex passerinoides*
34.	Boraginaceae	*Heliotropium bacciferum*
35.	Cistaceae	*Helianthemum kahiricum*
36.	Plantaginaceae	*Plantago ciliata*
37.	Malvaceae	*Malva parviflora*

Conclusion

- The study area is an arid zone with average rainfall 26.4 mm/year, temperature ranging between 50 C^{o} in summer and 0 C^{o} in winter, this reflected in it's environmental condition in respect of lack biodiversity and poor vegetation with the exception of Valleis and depressions.

- Soil is subjected to severe erosion, lack of fertility, increase of percentage of sand, high content of calcium carbonate and high degree of pH as well as accumulate of salt because of the high evaporation rates. The sand fraction exceeds 90% in most samples.

- The irrigation results in highly rise of salts in the agricultural soils.

- Most of the vegetation is of the restricted type especially in wadii depressions. *Acacia tortilis, Retama raetam* form the permanent frame work of the vegetation.

- Accidental type of the vegetation grow where water is available.

- *Tamarix passerinoides , Suaeda vera, Salsola tetrandra,* dominates most salt marshes.

- Due to enhanced agricultural activities, weed vegetation is widely distributed, in and around farms and agricultural projects.

- Seed bank density is widely varied among the zones, seasons and soil depth due to the variation of rainfall, existence of vegetation and properties of the soil profile. The density of seeds ranged between 77-5917 seed/m^2 with seasonal fluctuation, while the canopy seed bank especially of *Retama raetam – Acacia tortilis* ranged between 5596-14989 seed/m^2.

- In general in EL-Jufra depression, salt marshes and saline areas are widely distributed in the areas more over, the shallow underground water, uncontrolled spilling of water and faulty irrigation systems, flooding of plains from the surrounding mountains, and the lack of drainage system, will certainly increase salinity, which will be a serious problem in the coming future.

References

1. **Aela, A. O.** ***et al*** (2005) : Soil detailed study on Aloud valley at Waddan, Institute of soil and water, Tripoli, Libya, (in Arabic).

2. **Abu-Ziada, M. E.** (1980) : Ecological studies on the Flora of Kharga and Dakhla Oases of the Western Desert of Egypt. Ph.D. Thesis Fac. Sci. Mansoura Univ. , pp. 342.

3. **Ben-Mahmoud, K. R.** (1995) : Libyan Soil – constitution, classification, properties and cultivation prospects, first edition, Tripoli, Libya.

4. **Black , C. A.** ***et al*** (1965) : Methods of Soil analysis – Chemical and Microbiological properties, Agronomy No. 9, part 1 & 2, American Society of agronomy, Washington D.C.

5. **Chew, R. M.** (1977) : Consumers as regulators of ecosystems : An alternative to energetics, Ohio journal science, 74 : 359 – 370.

6. **EL-Bana, M. *et al*** (2003) : The importance of phytogenic Mounds (Nebkhas) for restoration of arid degraded rangeland in north Sinai.

7. **EL-Barrani , Manam Wafi** (2008) : Study of the plant deterioration factors in Daphna zone (northern eastern of Libyan costal – Tobruk) M.Sc. thesis, department of environmental science and engineering, Academy of post graduate studies, Benghazi, Libya.

8. **EL-Batanouny, K. H.** (1973) : Soil properties as affected by topography in desert Wadiis, Acta Botanica Academiae Scientiarum Hungariacae Tomus, 19 (1 – 4), pp. 13 – 21.

9. **EL-Batanouny, K. H. and Abo-SItta, Y. M.** (1977) : Ecophysiological studies on Halophytes in arid and semi-arid zones, Academiae Scientiarum, Bio. Acta Hungariacae Tomus, 23 (1 – 2), pp. 13 – 31.

10. **EL-Johary, A. A.** (2002) : Ecological and floristic study on Zaza valley, Msc. Thesis, Botany department, Faculty of science, Garuonis university, Benghazi, Libya.

11. **EL-Gadi, A. and EL-Jafri, S. M. H.** (1976 – 1989) : Flora of Libya, Vols. 1 – 152, Botany department, AL-Faateh University, Tripoli.

12. **EL-Getlawi, A. D.** (2004) **:** Study of the vegetation and seed bank of Musus pasture zone desert, M. Sc. Thesis, Botany department, Faculty of science, Garyounis University, Benghazi, Libya (in Arabic).

13. **EL-Gwadi, A. G.** (2006) : unpublished report about the numbers of Palm trees on EL-Jufra (in Arabic), Waddan, Libya.

14. **EL-Jufra meteorological station** (1993 – 2005) : Unpublished data, Tripoli, Libya.

15. **EL-Jufra municipality of agriculture and livestock** (2007) : The numbers of animals at EL-Jufra, unpublished report.

16. **Johnston, S. K. ; Crawley R. H. and Murry D. S.** (1978) : Separating seed species with $CaCl_2$ Solution, Weed science, 26 : 213 - 215.

17. **Kassas, M.** (1952) : Habitat and plant communities in the Egyptian Desert, Journal of Ecology, 40 : 342-351

18. **Lemaire** (1703) : Le antiquites de la Cyrenaiqne ouil est aussi question du seltione que M. Bonnet areconnu etra Le phlomis flaccoga , France.

19. **Li Ning, Feng Gu and Tian Chang Yan** (2007) : Characteristics and dynamics of soil seed bank at the north edge of Taklimakan desert, Journal of science in china series D: Earth science, pp. 122 – 127 .

20. **Major , and Pyott W. T.** (1966) : Buried viable seeds in two California bunchgrass sites and their bearing on the definition of flora vegetation, 13 : 253 - 282 .

21. **Marone, L. *et al*** (2004) : Soil seed bank composition over microhabitats, patterns and plausible mechanisms, Canadian journal of botany, 82 : 1809 - 1816

22. **Norbert, H. and Annette, O.** (2001) : The impact of flooding regime on soil seed bank of flood-meadows, journal of vegetation science, Vol. 12, No. 2, pp. 209 – 218.

23. **Oudney, W. ; Denham, D. and Clapperton, H.** (1826) : Narrative of travels and discoveries in northern and central Africa in the years 1822, 1823 and 1824, by Major Denham, Captain clapperton and the late doctor Oudney, Botanical Appendix 22 : 208 -246.

24. **Pampanini, R.** (1931) : II Prodromo della flora Libica, Minstero Della Colonie, Forli.

25. **Pugnaire, F. I. and R. Lazaro** (2000) **:** Seed Bank understory species composition in a semi-arid environment, the effect of Shrub age and rainfall.

26. **Rayan, J. ; Astafan, G. and Abd-Elrasheed** (2003) : Analysis of soil and plant, ICARDIA publications, Syria.

27. **Reichman, O. J.** (1984) : Spatial and temporal variation of seed distributions in Sonoran desert soil, J. Biogeogy, 11 : (1 – 11).

28. **Rohlfs, G.** (1881) : Kufra Reise von Tripolis nach der Kufra, nebst Beitragen von P. Ascherson, T. Hann, F. Karsch, W. Peters, A. Stecker. Leipzig.

29. **Shakoor, A. and Shagroni, Y.** (1984) : Geological map of Libya **+** Explanatory booklet, Hun sheet (NH 33-11), Idustrial research center, Tripoli, Libya.

30. **SWECO** (1986) : Land survey, Mapping and Pasture survey for 550,000 hectares of south Jabal AL-Akhdar area, final report, Stockholm.

31. **Ueld EL-Basheer, S. H.** (2003) : The checklist of the flora of EL-Jufra area, Faculty of art and science, AL-Tahadi university, Hun, Libya.

32. **Yang, J. A. and Evan, R. A.** (1975) : Germinability of seed reserves in a big sage-brush community, weed science, 23 : 358 – 364 .