The impact of deforestation on the chemical and physical properties of the soil in the Raghdan forest in Saudi Arabia

Faykah Goman Mohamd ALGhamdy

Department of Biology, Faculty of Sciences, king Abdulaziz University, Jeddah, kingdom Saudi Arabia.
fgalghamdy@kau.edu.sa

Abstract: The removal of the natural vegetation of the forest floor leads to many environmental problems. Not only in the quality of vegetation and fluorescent installation of forest, but also to soil depletion and degradation and the effect on the chemical and physical characteristics. The study aimed to identify some of the chemical and physical properties of the forest floor soil and the impact of removing the vegetation on these properties. Six sites were selected from the forest; region (A) composed of three sites with a high density of plant and the other three sites represented region (B) with low plant cover. Methods involved determining soil texture, organic matter estimate, soil electric conductivity, soil pH, estimation of mineral elements in the soil (Na, Ca, Mg, K) and amounts of sulfates, chlorides, bicarbonates salts. Results revealed that there were high significant differences between sites in the amount of organic matter, organic matter content decreased with the decrease in coverage of plant between sites in regions A and B. There were not significant differences in soil texture between the different sites where the soil considered as silt soil in all sites. The amount of electrical conductivity between the two regions A and B were non-significant. The region A was characterized by a concentration of more than the amount of mineral elements and there was a clear reduction in the amount of metal elements in the region B with the low plant coverage. The amount of sulfates, Ca, K, Na and bicarbonates salts in the soil of the region A (of high coverage of plant) was significantly higher than other region B, while increase in amount of Mg and chlorides in the region B was noticed. Calcium recorded the highest values while potassium recorded the lowest values.

[Faykah Goman Mohamd ALGhamdy. **The impact of deforestation on the chemical and physical properties of the soil in the Raghdan forest in Saudi Arabia.** *Life Sci J* 2014;11(9s):536-540]. (ISSN:1097-8135). http://www.lifesciencesite.com. 106

Keywords: deforestation, soil properties, soil forest, degradation of forest soils.

1. Introduction

Deforestation is one of the most complex and serious problems facing ecosystems. Forests are considered the original store for plants, animals and biodiversity, as well as, natural genetic stored on the surface of the earth except for the forest preserve soil and prevent erosion (Buran and Abu-dih, 2009). Due to soil change as a result of human activities impact over the past decades was great (Grieve, 2001; Bajocco *et al*., 2012; Krasilnikov *et al*., 2013) many studies around the world pointed to the impact of the removal of vegetation on soil and it's impact on soil degradation and changing in physical and chemical properties (Gandois *et al*.,2013 ;Osman,2013;Prokop and Płoskonka,2014). The microbial biomass of the soil (Nunes *et al*.,2012), surface runoff (Fang *et al*., 2012; Kavian *et al*.,2014) and the impact of change to use land on the organic material in the soil (Sosnowska,2012; Wilson *et al*., 2014)

Thus the natural ecosystem as a whole in the forest of Raghdan which is located in the western-south part from Saudi Arabia, large parts of the forest is currently changed to wild parks where the forest is cleared completely and retain some of the large trees just to keep the overall view of the forest. The present study aimed to shed light to assess the impact of human activity in the forest of Raghdan by transferring large portions of the forest to wild parks and the elimination of the natural vegetation of the forest floor which caused the deterioration of the soil and changing in it's chemical and physical characteristics.

2.Material and methods:

Subject sample:

Raghdan forest which is located in Al-Baha region in the western-south part of the Kingdom of Saudi Arabia was selected. Six sites were selected by difference in terms of the density of plant, and was divided into two region A and B. Each region was represented in three different sites.

Region A: Represented sites with high plant density, and

Region B: Represented sites with low plant coverage.

2.1. Materials:

2.1.1. Samples:

Soil samples were collected. Three to five replicates from each sample were collected from surface till depth of 30cm.

2.2. Methods:

2.2.1. Procedure:

a- separation of stones and rocks:

Samples collected were subjected to air drying then sieved with sieve with pore diameter 2mm.

b- The form of the soil estimation:

The soil forms were estimated using different pores sieves according to system of the international association of earth sciences (Vuth, 1985).

c- PH measurement:

PH for the extract was measured using pH meter,

d-The electrical conduction (Ec) measurement:

It was measured using EC-meter.

e-Estimation of mineral elements

They were estimated in Faculty of Earth Sciences (King Abdul Aziz University)

-*Calcium and magnesium*: using the calibration method (EDTA, 0.01 N).

-*Sodium and potassium*: using Flam photometer.

-*Chlorides* dissolved in aquatic extract of the soil using titration method with silver nitrate (0.05N).

- *Sulfates* using barium chloride solution (10%).

-*Bicarbonates* in the aquatic extract of the soil using titration method with hydrochloric acid (0.1N).

-*Organic matter* was estimated in the soil as a percentage using the calibration method (Walkley and Black, 1934) by Ferrus ammonium sulphate (0.5 N) in the remainder of the calibration solution of potassium dichromate (1 N) after the interaction of the main part of it with organic materials represented in the soil sample and using di-Phenylamine as evidence for calibration and then calculating the organic material using the following equation:

Organic matter % = 10-(1-(calibration value of the soil / calibration value for the Planck) *1.34

2.2.2.Statistical analysis:

The statistical analysis of the results was done in terms of means and standard errors (± SE). In addition one way analysis of variance (*ANOVA*), using SPSS (SPSS, 2012) computer program.

Table (1) : Mean Values of Soil Fraction, EC and pH in the soil of the different sites.

Region	Sites	Soil Fraction (%)			EC (kΩ/cm)	pH
		Clay	Silt	Sand		
A	1	16 ± 0.79	57 ±0.37	27 ± 0.52	3.94 ± 0.01	7.56 ± 0.01
	2	27 ± 0.63	57 ± 0.23	16 ± 0.27	3.82 ± 0.03	7.7 ± 0.01
	3	23 ± 1.88	68 ± 1.91	9 ± 0.17	6.50 ± 0.12	7.56 ± 0.03
Mean Values		22.2 ±3.1	60.4 ±3.7	17 ± 5.1	4.75 ± 0.89	7.62 ± 0.05
B	4	22 ± 0.27	61 ±0.32	17 ± 0.03	4.72 ± 0.02	7.75 ± 0.03
	5	18 ± 0.49	60 ± 0.27	22 ± 0.44	4.34 ± 0.06	7.57 ± 0.09
	6	25 ± 0.09	53 ± 0.38	22 ±0.37	15.4 ± 0.75	7.6 ± 0.01
Mean Values		21.4 ±1.9	57.8± 2.6	20.2 ±1.7	8.15 ± 3.63	7.64 ± 0.06
Sig.		N.S	N.S	N.S	N.S	N.S
	*	significant		N.S	non significant	

3.Results :

3.1.The mechanical analysis:

Table (1) for the soil in different sites shown that silt represented the highest percentage between soil granules in the two regions A and B, Even this ratio disagreed between the two regions where the ratio ranged between (57% to 68%) in region A sites, while sites in resistance region B ratio ranged between (53% to 61%). On the contrary, sand particles percentage ranged between (9% to 27%) in region A sites, and (17% to 22%) in region B sites, and the amount of clay ranged between (16% to 27%) in region A, and between (18% to 25%) in region B. Therefore, the soil considered as silt soil in all site in both regions.

The results shown in Table (1) that the soil at the sites (1,2,3) tend to acidic where values ranged between (7.56 to 7.7), while in sites (4,5,6) ranged between (7.57 to 7.75), generally considered the soil slightly alkaline and it was near the neutral point, where ranging in all six sites between the two regions A and B between (7.6 to 7.8).

Table (1) showed that the degree of electrical conductivity in the region A in different sites (1,2,3) ranged between (3.94, 3.82, 6.5 kΩ/cm) respectively, while in the region B are ranged in different sites (4,5,6) between (4.72, 4.34, 15.4 kΩ/cm) respectively as well. The highest degree of electrical conduction was recorded in soil of region B, especially in the Site (6).

3.2.Organic material between the two regions A andB

Figure (1) showed highly significant differences in contents of organic material, while the differences in the various sites in each region were no significant. Ratio disagreed between sites under study was characterized site (1) the highest percentage of organic matter then both sites of (2), (3), respectively, while the proportion of organic matter was significantly severely drop in sites of (4,5) and reached the lowest rate in the site (6).

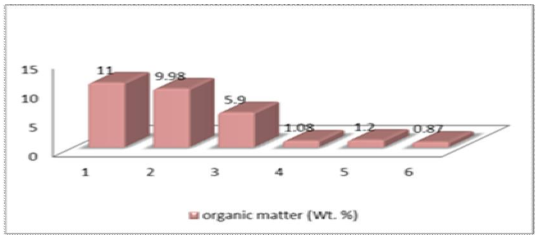

Fig.(1): Mean Values of Organic material (Wt.%) of soil for Raghdan forest on different sites

3.3.Soil mineral elements:

Figure (2) showed significant differences in contents of calcium and sulfate, also amount of chloride, while there was no significant difference between sites in contents of sodium, potassium and magnesium. The values generally are high in soil of region A compared to region B. Amount of magnesium was almost equal in both regions and recorded a slight increase in the sites of the region B where the average amount of magnesium (3.9 ml/L) and the average amount of magnesium was recorded in all region A sites (3.5 ml/L). For the average amount of potassium, has recorded a general decline in all the sites, without exception, and the average total quantity in the region A (1.1 ml/L) while the average quantity in the region B (1.01 ml/L) and therefore, there was a slight increase of the amount of potassium in region A. The results indicated a slight increase also for the amount of sodium in the area A where reached (4 ml/L) compared to the average amount of sodium in different sites of the region B which recorded (3.7 ml/L). The calcium increased the quantity of region A sites compared to sites in the region B to decrease in the average amount of calcium in a clear and recorded the amount of calcium (26.9 ml/L) in region A, while posting an average region B sites (19.5 ml/L). It was noted by the results very a sharp drop in the amount of calcium in the site (6) in the region B as least value among the various sites as a whole (7.6 ml/L).

The results of each of chlorides (Fig. 3) recorded in region A and region B, the amount of chlorides in the region B rose more than region A.The average amount of chlorides in the region B reached (13.33 ml/L), while the average amount of chlorides in the region A (8.66 ml/L).

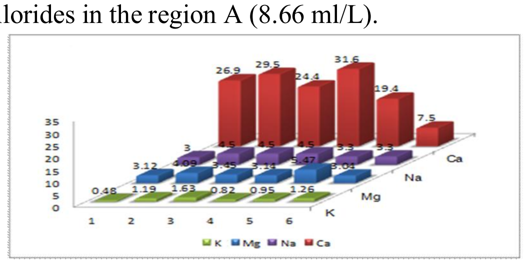

Fig.(2): Chemical analysis (K,Mg,Na,Ca ml/L) of soil for Raghdan forest on different sites

For the amount of sulfates in both regions A and B have found simple significant differences between the two regions and the amount of sulfates generally higher in region A, and the amount of sulfates in the soil of the region A was recorded (61.6 ml/L) while the average amount of sulfates in the region B (58.6 ml/L). The results indicated that there are significant differences between the high amount of bicarbonate in both regions A and B. Which reported a significant increase and large in region A from region B, and the average quantity in the region A reach (127.1 ml/L) while the average quantity in the region B (93.52 ml/L), site (2) in region A registered the highest amount among the six sites, while the lowest amount recorded at the site (6) in the region B and reached (61 ml/L).

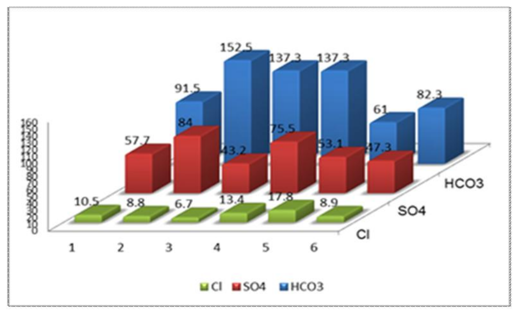

Fig.(3) : Chemical analysis (Cl,SO4,HCO3 ml/L) of soil for Raghdan forest on different sites

4. Discussion:

The removal of the natural vegetation of the forest floor leads to many problems. The most important is soil depletion and degradation. The current study addressed study of some of the chemical and physical properties of forest floor soil in Raghdan located in the western-south part of the Kingdom of Saudi Arabia, which is one of the most important and the largest forest in the Kingdom. The study examined the impact of removal of vegetation on the forest floor for some of the characteristics of this forest soil.

Many researchers dealt with the human activities impact on soil changes and the impact of the removal of vegetation to soil degradation and change its physical and chemical properties (Gandois *et al*.,2013;Osman,2013;Prokop and Płoskonka, 2014). However, the environmental studies on soil degradation and change its properties as a result of removal of vegetation in the forests of the Kingdom of Saudi Arabia especially Raghdan forest were few and rare, and here lies the importance of this study.

Results indicated the presence of high significant differences between the two regions A and B in the amount of organic matter in the soil and there was a clear significant gradation between different sites in the amount of organic matter, where there was a direct proportion in all sites between the removal of the vegetation of the forest and the decrease in the amount of organic matter. Deforestation leads to soil erosion, including the roots of the plants usually helps soil particles on the coherence and consistency in the case of soil erosion become atoms spaced and non-correlated with a significant decline in the level of organic matter (Buran and Abu-dih, 2009). Therefore, the most influential factor in the proportion of organic matter in the soil was the presence of vegetation that's where the proportion of organic matter declined to (0.87%) in the sites of low plant density (Quideau *et al*., 2000) pointed out that vegetation is a contributing factor in the amount of organic matter in the soil in their study on the direct correlation between the types of the vegetation of the forest and the amount of organic matter in the soil.

The present results indicated that there was no significant difference between sites in the soil texture, where no different textures in all sites of study and the soil considered as silt soil in all site in both regions, even there is different ratios between the quantity of each of sand, clay and silt from one site to another. It was found that the soil at the sites (1,2,3) tend to acidic, may be due to an increase in the decomposition process of natural organic materials in region with high plant coverage (region A), while decreased in the sites (4,5,6) because of the lack in organic materials decomposition as a result of removal of vegetation in these sites and thus affected the microorganisms present in these sites (Nunes *et al*., 2012). Generally, considered the soil slightly alkaline in both regions (A) and (b) and it was near the neutral point, where the soil near the neutral point was considered suitable soil for the growth of most plants (Migahid *et al*., 2009).

Region B was characterized by highly electric connection degree than region A, especially at the site (6), notes that the high electrical conductivity of the soil solution in the region B were accompanied by a rise in the amount of chlorides and thus increasing the salinity of the soil, the first biological resulting of deforestation and soil erosion process is increasing the salinity of the soil where become environmentally invalid or ineligible to attract indigenous plants (Buran and Abu-dih, 2009).

Results indicated the availability of calcium in large quantities, where it was the most elements concentrated in the soil in both regions (A,B) as an increase in granules silt in the soil leads to an increase in the soil's ability to hold water and salts and various elements such as calcium. The importance of calcium to soils to maintain soil formation exceeded colloids, as well as, in maintaining the balance of hydrogen ions in the soil(Larcher,1995) although the calcium was the most item concentrated in the soil for both regions, but there were high significant differences were between the two regions A and B, there was a reduction of the component of calcium in the soil in the region B, especially of the site (6), which increased its proportion of grains of sand, which was conjugated with the lack of clay particles because the decrease in the amount of calcium leads to disperse the soil particles and thus the proportion of clay particles decreased and increased sand granules (USDA,1959).

The present results clarified that the decrease in Magnesium accumulation in the soil of the region A comparing with region B, might be due to the plant in the region A need for Magnesium element and consumes them in photosynthesis process. Magnesium is important constituent of chlorophyll (Buran and Abu-dih, 2009), magnesium is available to the plants through ionic exchange in the organic compounds or the mud which contains high level of magnesium, the lack of this element in the soil is due to presence of high sodium, potassium and calcium concentrations (Omar, 2009), and the high calcium concentrations which caused antagonism between them (Waisle,1972) which has been confirmed by the current study. In addition, there was a significant rise the amount of calcium, sodium and potassium and a decline in the amount of magnesium in the region A, and region B in the increase.

The sulfate and bicarbonate level recorded increase in the soil of region A. Generally a high amount of mineral elements in the soil of the region A than region B was observed. This showed the importance of vegetation in the provision of plant residues and organic matter in the soil (Quideau *et al*., 2000; Sahani and Behera, 2001).

Conclusion:

From this study, it was concluded that the activity of human actress in removing vegetation to the forest floor in Raghdan forest has clear and large impact on the chemical properties of the soil and the lack of concentration of mineral nutrients, and thus the fertility of the soil and retaining natural and vital characteristics and that the removal of vegetation led to a deterioration of the soil and its lack of many of mineral nutrients. In addition, organic matter was with zero limit almost in some sites that have been the removal of vegetation. This study showed a very significant decrease in the content of organic matter in the soil of the forest with low coverage for forest plant, in all the different sites. This study confirmed that the vegetation was a contributing factor in the proportion of organic matter in the soil and remove it led to a decline in the proportion of organic matter to (0.87%) in the soil of the forest floor. This study also showed that the low coverage of plant contained high concentrations of chlorides and thus increase the salinity of the soil, giving a serious index of the soil deterioration in this forest.

This study recommends the protection and conservation of that forest, vegetation and the natural vegetation of the forest floor because of its clear significant impact on the deterioration of soil fertility, and maintaining physical and chemical characteristics that needs for very long periods until it returns to the state of stability.

References:

1. Bajocco, S., De Angelis, A., Perini, L., Ferrara, A. and Salvati, L. (2012). The Impact of Land Use/Land Cover Changes on Land Degradation Dynamics: A Mediterranean Case Study. *Environmental Management*, 49 (5): 980-989.
2. Buran, A.H. and Abu-dih, M.H. (2009). Ecology. Sunrise Library for Publishing and Distribution. Amman. Jordan.
3. Fang, N.F., Shi, Z.H., Li, L., Guo, Z.L., Liu, Q.J. and Ai, L. (2012). The effects of rainfall regimes and land use changes on runoff and soil loss in a small mountainous watershed. *Catena* 99:1–8.
4. Gandois, L., Cobb, A. R., Chieng Hei,I., Lim, L. B. L., Abu Salim, K and Harvey, C.F.(2013). Impact of deforestation on solid and dissolved organic matter characteristics of tropical peat forests: implications for carbon release. *Biogeochemistry* 114(1-3) 183-199.
5. Grieve,I.C.(2001). Human impacts on soil properties and their implications for the sensitivity of soil systems in Scotland. *Catena* 42: 361–374.
6. Kavian, A., Azmodeh, A. and Soleimani, K. (2014). Deforestation effects on soil properties, runoff and erosion in northern Iran. *Arabian Journal of Geosciences* 7(5): 1941-1950
7. Krasilnikov, P., Gutiérrez-Castorena, Ma del C., Ahrens, R J., Cruz-Gaistardo, C.O., Sedov,S and Solleiro-Rebolledo, E.(2013).Soil Degradation. *The Soils of Mexico* 127-139
8. Larcher, W. (1995). Physiological Plant Ecology: Ecophysiology and Stress physiology of functional groups. 2nd edn. Springer-Verlag. New York, Berlin, Heidenberg.
9. Migahid, A.M., Amen, A., Younis, A. and Abdulaziz, M. (2009). Plant Ecology. the Anglo-Egyptian Library. Cairo.
10. Nunes, J. S., Araujo, A. S. F., Nunes, L.A.P.L., Lima, L.M., Carniero, R.F.V,. Salviano, A. A. C and Tsai, S.M.(2012) Impact of Land Degradation on Soil Microbial Biomass and Activity in Northeast Brazil, *Pedosphere* 22(1): 88–95.
11. Omar, M.I. (2009). Chemistry of the Environment. Library of scientific publication and distribution. Cairo.
12. O (2013). Forest Soils. *Soils* 229-251.
13. P, P. and Płoskonka, D.(2014).Natural and human impact on the land use and soil properties of the Sikkim Himalayas piedmont in India. *Journal of Environmental Management* 138: 15–23
14. Quideau, S. A., Anderson, M. A., Graham, R. C., Chadwick, O. A. and Trumbore, S. E. (2000). Soil organic matter processes: characterization by 13C NMR and 14C measurements. *For. Ecol. Manage*. 138: 19-27.
15. Sahani,U. and Behera,N.(2001).Impact of deforestation on soil physicochemical characteristics, microbial biomass and microbial activity of tropical soil. *Land Degradation & Development* 12(2) : 93–105.
16. Sosnowska, A.(2012). Land use change impact on soil organic matter. Loess landscape case study. *Miscellanea Geographica* 16 (2): 11–15.
17. SPSS. (2012). Statistical preprogram for social science.
18. USDA, (1959). Chemical Amendments for improving sodium soils. *Agr. Ing. Bull*., 159.
19. Vuth, H. (1985). The basics of soil science. Library of John Wly, England.
20. Waisle, Y. (1972). Biology of Halophytes. Academic Press, New York. 12-58.
21. Walkley, A, and Black I. A. (1934) : "An Examination of Degtajaroff method for Determining Soil Organic Acid Filtration Method". *Soil Sci*. 37:29-38.
22. Wilson,T.S., Sleeter,B.M., Sleeter,R.R and Soulard, C.E. (2014). Land-Use Threats and Protected Areas: A Scenario-Based, Landscape Level Approach. *Land* 3 (2): 362-389.

8/28/2014