International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:02, Issue:06

EVALUATION OF MANGROVE TREES ENVIRONMENT AND AVAILABILITY OF ESSENTIAL NUTRIENTS IN PROTECTORATE FARASAN ISLAND ON THE COAST OF THE RED SEA

Bushra Ahmed Al-Hammad

Biology Department, College of Science and Humanities, Prince
Sattam Bin Abdulaziz University, Al-Kharj, Kingdom of Saudi Arabia

ABSTRACT

This study evaluates the availability of basic nutritional elements for the mangrove trees growing on the shores of the Red Sea in the island of Farasan in Saudi Arabia. Human behavior and its role in the protection of this environment were also evaluated. Soil samples were collected from the rhizosphere area of the mangrove trees while the botanical samples (branches and leaves) were collected from five locations in Farasan Island. Results revealed that there is some demise in concentration of phosphorus element in soil which reflected in its concentration in the different parts of the plant. Statistical analysis showed that nutritional content of mangrove plant independent on the availability of nutrients in the soil. A correlation study indicated that sodium plays a great part in the absorption of nutritional elements and in their accumulation within the fibers of the plant. The more the percentage of sodium in the soil is, the less its ability to absorb the nutritional elements necessary to the growth of the plant. Although a study of human behavior proved that more than half (65.5%) of them heard about mangrove tree, there are detrimental practices to the environment. This study highlights the need for mangrove conservation.

Keywords: Mangrove trees, Farasan Island, Soil, Mineral elements, Rhizosphere area, environment.

INTRODUCTION

Farasan islands lie in the Red Sea in the south western region of the Kingdom of Saudi Arabia (KSA). These islands have a highly political, social, and economic position in the region of Jazan. After the archipelago of Dahlek, the archipelago of the Farasan islands is regarded as the second largest group of islands in terms of size on the Red Sea. It is located between the latitudes (17 and 25 ^{o} to the north) and (15 and 16 ^{o} to the south). It also lies between the longitudes (30

ISSN: 2455-6939

Volume:02, Issue:06

and 42 º to the east) and (15 and 41º to the west). It extends to a distance of 180 kilometers towards the northwestern part of the city of Jazan. It consists of 100 islands and the total area of the archipelago amounts to around 70250 hectares (Alsharif, 2002). In addition, they are distinguished by the presence of diversified maritime and land environments which have unique primitive, botanical and zoological characteristics. On these islands there are around 140 types of permanent and immigrant birds as well as 1400 gazelles and 70 kinds of coral reefs. Meanwhile, there is a host of plants which show up heavily in various regions such as, *Avicennia, Zygophllum, Panicum, Salvadora, Haloxylon* (Ziadi and Paddy, 1985).

A sociopolitical dimension is the preservation of population growth and preventing immigration away from the islands. This requires sources maintenance of the livelihood and the professions of the inhabitants. Fishing represents the tip of the hierarchy of sources of revenue on the island. The availability of fish and the preservation of its environment depend on the abundance of the mangrove trees which are a botanical congregation of forests made up of such trees (Aloliei1995; Mandura, 1998).

Mangrove forests consist of trees or shrubs which grown in shallow waters on the coasts of seas and oceans. They are tropical plants (Tomlinson,1986). They represent a unique environmental system totally different from the rest of other similar systems (Giri et al ., 2011). The importance of these trees lies in their preservation of biological diversity in their environments which are originally so diversified. They represent a rich environmental system of high productivity as they harbor a lot of marine organisms such as fish and shrimps in addition to some Crustacea that are economically important (Ewel et al 1998a ;Ellison,1993). These trees can also remove pollution from water. In addition, they can protect coastal lands form erosion as they form natural barriers that can safeguard coastal establishments. They are used in pasturing, fuel-production, and dyeing (Lacerda et al ., 1993;Ellison and Farnsworth, 1996 ; Al-Shayaa, et al., 2007 ; AlWateed ,2010).

Mangrove trees were located in KSA on the shores of the Red Sea, on the islands existing in it, and on the shores of the Arabian Gulf. The most prevalent types of these mangrove trees are *Avicennia marina* and *Rhizophora mucronata* (Mandura1997 ; AlWateed ,2010) . Their environment is distinguished by the great biological diversity which is a real indication of the presence or a biological fortune available for investment within some ecological systems. Preservation and developing of them ultimately lead to enrichment of the environmental system and to the improvement of their productivity. Therefore, this study was performed to evaluate the validity of essential nutritional elements (nitrogen, phosphorus, sodium, potassium, calcium, and magnesium) in the different parts of the mangrove trees and their relationship with its content in

ISSN: 2455-6939

Volume:02, Issue:06

their soil. In addition, assess human knowledge, behaviors and its effect on the protection of the environment.

MATERIAL AND METHODS

Collection and analysis of soil samples

Soil samples were collected twice a month for a period of six months with a total of 60 samples. These samples were representing five locations taken from the Rhizosphere region in which mangrove trees grow. These locations were identified in table (1). Soil samples were dried aerially then grounded and sieved by passing them through a 2-ml wide sieve. Chemical parameters were analyzed in terms of pH, electrical conductivity and total dissolved solids. Also, alkali cationic elements (sodium, potassium, calcium, magnesium) were extracted with 1-muller ammonium slides at pH = 7. The percentage of extraction was 1:5. Sodium and potassium concentrations were determined using flame photometer while calcium and magnesium were determined through calibration with a standard solution (EDTA) in the presence of appropriate evidence (Sparks, 1996). Nitrogen was estimated using the Caldahl method after extracting soil samples with the help of 2M KCl. Phosphorus was estimated through colorimetric method with the use of the spectrophotometer after extracting soil samples using ammonium bicarbonate-DTPA (AB-DTPA).

Collection and analysis of plant samples

The study was conducted on 120 samples of plants representing five locations at the same period whereby the samples of plants were taken from the leaves and branches of the mangrove trees. Plant samples were digested according to USEPA 3052 method (US EPA 1996) using HNO_3, HF, and HCl acids. Nitrogen was determined using the Caldahl method after digestion of botanical samples using H_2SO_4 and H_2O_2. Phosphorus concentrations were determined by the colored method using the spectrophotometer. Na^+ and Ka^+ were estimated using flame photometer while Ca^{2+} and Mg^{2+} were estimated using calibration in the EDTA standard solution (Sparks, 1996).

ISSN: 2455-6939

Volume:02, Issue:06

Table 1: Locations of soil samples collected from Farasan islands

Number of the location	Coordinates	
	N	E
1	42º 10.963	16º 42.420
2	42º 10.439	16º 42.116
3	42º 03.940	16º 44.997
4	42º 04.110	16o 48.091
5	41º 59.997	16º 44.944

Survey of human practices toward mangrove

Humans' knowledge and behavior toward mangrove trees were assessed using a pre-designed questionnaire. A sample of 116 persons was randomly selected. A questionnaire was designed to measure their knowledge about this tree as well as their behavior regarding some wrong practices on this tree.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 11.0 computer software package (Forthofer and Lee 1995). The cut-off point for statistical significance was p value < 0.05, and all tests were two sided. Correlation was carried between essential nutritional contents in mangroves trees (branches and leaves) and their availability in soil.

RESULTS AND DISCUSSION

Table 2 shows pH and electrical conductivity values in the examined soil samples. These soils had alkaline values ranged from 8.14 to 9.17. High salinity values were observed due to their influenced by the salty sea waters. This reflects sharp values of soil electrical conductivity which ranged from 5.85 to 23.05 dS m^{-1}.

ISSN: 2455-6939

Volume:02, Issue:06

Table 2: pH values and electrical conductivity concentrations in mangrove tree soil

Location	pH				Electrical conductivity (EC, dS m^{-1})				
	Minimum Value	Maximum Value	Average	Standard Deviation	Minimum Value	Maximum Value	Average	Average	Standard Deviation
1	8.18	8.75	8.41	0.30	5.85	13.13	9.95	9.95	3.73
2	8.50	8.70	8.57	0.11	6.90	12.13	10.20	10.20	2.90
3	8.95	8.98	8.96	0.02	8.22	8.50	8.34	8.34	0.14
4	8.14	8.53	8.31	0.2	12.71	23.05	16.80	16.80	5.51
5	8.86	9.17	9.06	0.18	7.08	8.27	7.48	7.48	0.69

Tables 3 and 4 revealed concentrations of nitrogen, phosphorus, sodium, potassium, calcium and magnesium in the rhizosphere region of mangrove trees. It is observed form these tables that soil contains high concentrations of nitrogen with average ranges from 0.87 to 2.83 gm/kg among the five examined locations. The highest recorded value was in location No.4 and the least was detected in soil of location No.1. The increased value of the former location can be attributed to the increase in the concentration of total dissolved solids. The soil of that location showed the highest value in electrical conductivity with an average of 16.80 dS m^{-1}. Previous studies showed that there is a relationship between the increase in total dissolved solids concentration of soil and the increase in melt ability of organic matter (Smith et al 1994;Chen and Twilley,1998 ; Youssef and Saenger 1998 ; Goni et al., 2003). This reflects the increase in organic nitrogen concentrations of soil. In addition, Ros et al. (2009) found that the increase in total dissolved solids concentrations such as (sodium chloride or potassium chloride or calcium chloride) contribute to nitrogen extraction from soil. On the other hand, this study found that mangrove trees soils had low concentrations of phosphorus due to their pH values were more than 8. Some studies proved that high values of phosphorus reach within limits of pH from 5.5 to 7.5 (Freeman and Rowell 1981; Lindsay et al. 1989; Mackey and Hodgkinson, 1995) . It also interacts with different constituents of soil to form phosphate ingredients which varied under variable conditions of soil. Maintaining appropriate concentrations of phosphorus in soil depends on several factors. The most important of these factors is forming and decomposing of organic matter. The ability of the nonorganic part of soil to interact with dissolved phosphorus and turning it into non-dissolved ingredients is also a considerable factor (Ali and Majeed 2016)

In this study, it was observed that soil content of calcium reached to 59.29- 104.1 mmol/kg. Calcium is also able to interact with phosphorus to form non-dissolved calcium phosphate. The concentration of potassium in soil ranged from 3.87 to 15.75 mmol/kg while sodium level ranged from 74.71 to 115.4 mmol/kg. Moreover, magnesium ranged from 27.13 to 56.5 mmol/kg. Calcium and sodium showed higher concentrations in comparison with potassium and

ISSN: 2455-6939

Volume:02, Issue:06

magnesium levels in soil. It is also observed that concentrations of calcium were higher than concentrations of sodium in locations 1, 2, and 3 while in locations 4 and 5 sodium concentrations were the highest content in soil. This can be attributed to levels of sodium decreased during falling rains. As a result, there is a high probability of sodium accumulation in the deep soil layers. The high content of calcium in soil can be attributed to it contains calcium carbonates while high content of sodium is justified by the effects of salty sea waters whereby sodium has a high content.

Table 3: Phosphorus and nitrogen contents in rhizosphere region of mangrove trees

Location	Phosphorus content in plants (mg/kg)				Nitrogen content in plants (gm/kg)			
	Minimum Value	Maximum Value	Average	Standard Deviation	Minimum Value	Maximum Value	Average	Standard Deviation
1	2.00	3.35	2.78	0.70	0.52	1.05	0.87	0.27
2	0.8	4.65	3.1	2.03	0.56	1.22	0.99	0.33
3	1.75	3.50	2.68	0.88	1.12	2.13	1.55	00.52
4	0.5	3.80	1.93	1.69	2.31	3.33	2.83	0.51
5	2.60	5.65	4.6	1.73	0.89	1.09	1.14	0.28

Table 4: Availability of alkali cationic materials (sodium, potassium, calcium, magnesium) in the rhizosphere region

Location	Alkali cationic minerals (mmol/kg)			
	sodium	potassium	Calcium	Magnesium
1	2.19±85.72	2.57±4.61	6.05±104.1	2.27±40.08
2	2.26±86.59	2.23±4.24	1.56±103.03	13.71±56.50
3	1.54±74.71	1.70±3.87	8.22±102.6	6.94±51.17
4	6.34±115.4	5.71±15.75	5.22±106.5	25.58±52.92
5	1.24±74.78	2.94±5.36	15.26±59.29	15.63±27.13

Figure 1 exhibited nutritional elements content of different parts (branches and leaves) of mangrove trees. This figure showed that nitrogen concentration in their branches ranged from 0.18 to 0.51% whereas in their leaves ranged from 0.77 to 1.47%. It is clear that nitrogen content in leaves was higher than in branches. The low content of phosphorus in soil was affected its content in fibers of mangrove trees as its content was low in their parts. The concentrations of

ISSN: 2455-6939

Volume:02, Issue:06

phosphorus ranged from 0.016 to 0.076% in their branches and they were 0.03 to 0.092% in their leaves. Levels of calcium in mangrove branches ranged between 0.37 and 0.41% while from 0.45 to 0.62% in their leaves. Percentages of sodium levels in plant ranged from 0.59 to 1.01% in its branches while in its leaves it ranged from 0.64 to 1.57%. The average of potassium content in plant ranged between 0.12 and 0.16% in its branches and it ranged from 0.14 to 0.21% in its leaves. In addition, the average of magnesium content in plant ranged from 0.12 to 0.17% in its branches and between 0.16 to 0.26% in its leaves.

Tables 5 and 6 showed correlation between content of mangrove trees regarding nutritional elements and availability of them in soil. It revealed that nutritional elements content in mangrove trees independent on their availability in soil. Statistical analysis showed that sodium plays an important role in absorption of nutritional elements and their accumulation in fibers of plants. The increase in availability of sodium in soil led to its accumulation and affected in decrease of nutritional elements absorption especially nitrogen, phosphorus and potassium. In this regard, another study showed an increase in concentrations of sodium led to a decrease in botanical absorption of nutritional elements (Ball and Munns 1992 ; Mckee, 1993; Smith and Snedaker 1995a ; Turan et al, 2010). It is concluded that rhizosphere had a few content with regard to phosphorus.

The association study proved that mangrove trees suffer from a problem of essential elements balance needed for them. Therefore, mangrove trees must be protected against shortage of nutritional elements and their imbalance. There is a need for management of their growth environment including soil in which they grow and prevent any barrier of nutritional elements absorption through it. Appropriate measures should be applied to supply these trees with nutritional elements such as sprinkling their leaves with appropriate concentrations of nutritional elements.

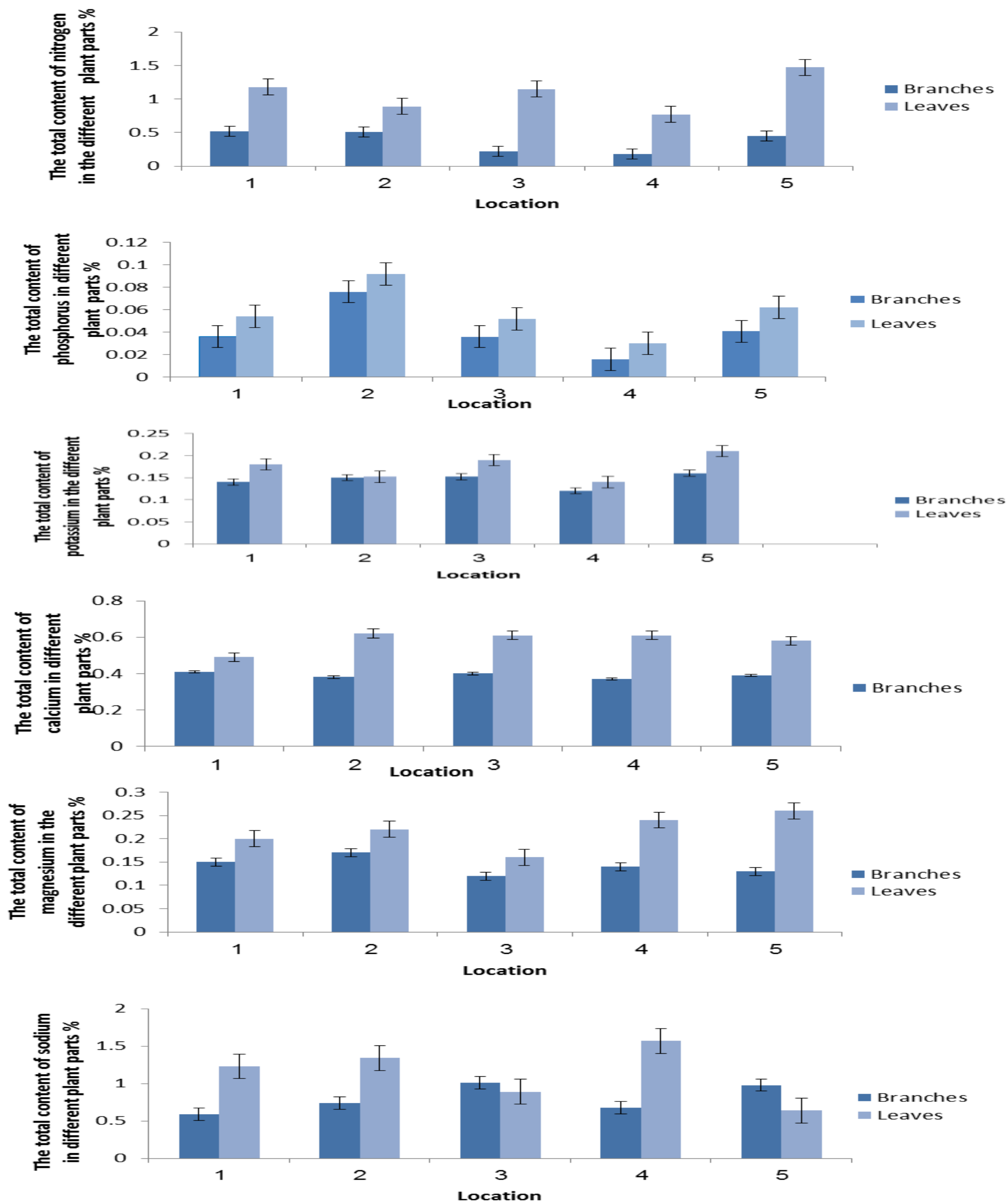

Figure 1: Essential nutritional content (nitrogen, phosphorus, potassium, calcium, magnesium) in the different parts of the mangrove trees.

ISSN: 2455-6939

Volume:02, Issue:06

Table 5: Correlation between nutritional contents in mangroves trees branches and their availability in soil

(X) x (Y)	Correlation equation	R2
Nitrogen (Plant) x Nitrogen (Soil)	Y= -0.1116x+0.5409	0.280
Phosphorus (Plant) x Phosphorus (Soil)	Y = 0.0051x+0.0249	0.092
potassium (Plant) x potassium (Soil)	Y = -0.0022 x +0.1628	0.346
Nitrogen (Plant) x sodium (Soil)	Y = -0.0036x+0.694	0.103
Phosphorus (Plant) x sodium (Soil)	Y =- 0.0005x+0.0864	0.097
potassium (Plant) x sodium (Soil)	Y = -0.001x+0.2316	0.556
Nitrogen (Plant) x sodium (Soil)	Y = -0.1305x+0.474	0.034
sodium (Plant) x Phosphorus (Plant)	Y = 0.0047x+0.037	0.002
sodium (Plant) x potassium (Plant)	Y = -0.0306x+0.1705	0.150

Table 6: Correlation between nutritional contents in mangroves trees leaves and their availability in soil

(X) x (Y)	Correlation equation	R2
Nitrogen (Plant) x Nitrogen (Soil)	Y = -0.0881x+1.2019	0.057
Phosphorus (Plant) x Phosphorus (Soil)	Y = 0.008x+0.0569	0.002
potassium (Plant) x potassium (Soil)	Y = -0.0021x+0.1912	0.109
Nitrogen (Plant) x sodium (Soil)	Y = -0.0117x+2.0938	0.353
Phosphorus (Plant) x sodium (Soil)	Y = -0.0008x+0.1267	0.171
potassium (Plant) x sodium (Soil)	Y = -0.0015x+0.3062	0.433
Nitrogen (Plant) x sodium (Plant)	Y = -0.4546x+1.4981	0.328
Phosphorus (Plant) x sodium (Plant)	Y = -0.0366x+0.0935	0.237
potassium (Plant) x sodium (Plant)	Y = -0.0419x+0.2159	0.212

Survey results about knowledge and behavior of inhabitants towards mangrove trees showed that 65.5% of them know such trees while more than third (34.5%) of them ignored these trees. A very low percentage of inhabitants had some knowledge of the proliferation and growth of these trees. There are also some wrong practices as shown in table 7. A percentage of 44.8% are engaged in fishing and 20.7% cut mangrove trees. 27.6% raise animals. Mandura and Khafagi (1992) indicated the causes of Avicennia marina trees deterioration in Farasan archipelago. They found that wide human activities are responsible for that, coupled with establishment of Farasan harbor and inauguration of roads, wharfs, and small businesses and removal of some trees and conveying them to several places which led to death of a large number of the mangrove plants. The reason also was shortage of water necessary for plant. Pollution plays a big role in the mangrove environment has stated (Sotomayer, et al., 1994;Mastaller, 1996) to explore oil and gas operations and leakage destroy the ecosystem of the mangrove forests. Has pointed out (Grant et al., 1993) that the soil in which the leak to the oil be invalid for the establishment of seedlings of mangrove and reduce its life for several years, because oil is causing the stock loss in seedlings Avicennia marina (Martin et al., 1990) and (Grant et al., 1993), and combine the oil in the mangrove environment that destroys the animals that live in the soil as well as the roots of the mangrove ground (Mackey and Hodgkinson, 1995). High levels of organic pollution leads to disease and death, and changes in mangrove forests configurations. (Tattar et al., 1994) Have been found (Mandura, 1997) that the sewer kill aerobic rooted in the kind *Avicennia marina* (Kusmana, 1990; Snedaker and Araujo. 1998).Due to the vitality of the contents of this plant, Mandura (1998) found that plant had a direct effect on the production of fish and shrimps. This explained that fishing industry in KSA is based on *Peanaeus semisulcatus* which needs the presence of mangrove trees to complete its life cycle whereas some other species need mangrove trees in their early stages of growth for nutrition and protection (Ibrahim, 1990).

Table 7: Percentages of human knowledge and behavior regarding mangrove trees

Phrase & Practice	Number	Percentage
He knows mangrove trees	76	65.5
He never heard about them.	40	34.5
He does not practice grazing.	88	75.9
He practices grazing.	28	24.1
He does not practice animal husbandry in jungles.	84	72.4
He practices animal husbandry.	32	27.6

I do not cut off the mangrove trees.	92	79.3
I cut off the mangrove trees.	24	20.7
He does not practice fishing.	64	55.2
He practices fishing.	52	44.8
Total	116	100%

CONCLUSIONS AND RECOMMENDATIONS

This study concluded that preservation of natural environment is urgent for growth of mangrove trees due to they were exposed to ecological destruction and havoc out of some irresponsible behavior by human beings. Grazing and spread of civilizational and commercial activities in the studied region are negatively affects the life style and business chances on these islands. Therefore, the importance of fish wealth and the concomitant resources, whether coastal or marine, such as mangrove trees, confirms the need for a national program for the management of the coastal areas.

REFERENCES

Ali, N. S. and N. H. Majeed. 2016 .Rhizosphere Microorganisms and Phosphorus Availabillability for Plants . The Iraqi Journal of Agricultural Sciences . 47(2): 635-645.

Aloliei, A. N. 1995. Nature reserves in Saudi Arabia. National Commission for Wildlife Conservation and Development. One Edition. Riyadh, Kingdom of Saudi Arabia.

Alsharif, A. S. 2002. Geography Saudi Arabia. Part I, Sixth Edition. Mars Publishers, Riyadh. Kingdom of Saudi Arabia

Al-Shayaa, M. S., A. Elhag, and S. Muneer. 2007. The role of people's knowledge and attitudes in conservation of wildlife in the National Reservations: a case study of Ibex reservation in Riyadh region, Saudi Arabia. Saudi J Biol Sci ., 14 (1): 123-135.

AlWateed , A.M. 2010. Cultivation of Avicennia marina "mangrove" plant in Saudi Arabia. Department of Environmental Protection. Aramco Saudi Arabia.

Ball, M.C. and R. Munns, 1992. Plant responses to salinity under elevated atmospheric concentrations of CO2. Aust. J. Bot .,40: 515 - 525.

ISSN: 2455-6939

Volume:02, Issue:06

Chen, R. and R.R.Twilley, 1998. A gap dynamic model of mangrove forest development along gradients of soil salinity and nutrients resources. J. Ecol ., 86(1): 37 - 51.

Ellison, JC. 1993.Mangrove retreat with rising sea level, Bermuda. Estuarine. Coastal and Shelf Science. 37: 75–87.

Ellison, A.M. and E.J. Farnsworth. 1996.Anthropogenic disturbance of Caribbean mangrove ecosystems: Past impacts, present trends and future predictions .Biotropic a., 28: 549–565

Ewel, K. C., S. Zherg, A. S. Pinzon, and J . A. Bourgeois. 1998a. Environmental effects of canopy gap formation in high-rainfall mangrove forests. Biotropic a., 30(4):510-518.

Forthofer, R.N. and E.S. Lee. 1995. Introduction to Biostatistics: a Guide to Design, Analysis, and Discovery. San Diego, New York, Boston, London, Syndney, Tokyo, Toronto: Academic Press Inc.

Freeman, J.S. and D.L. Rowell. (1981) The adsorption and precipitation of phosphate onto calcite. J Soil Sci ., 32:75–84.

Giri, C., E. Ochieng , L. L. Tieszen , Z. Zhu , A. Singh , T. Loveland, J. Masek, and N. Duke. 2011.Status and distribution of mangrove forests of the world using earth observation satellite data. Glob. Ecol. Biogeogr., 20: 154-159 .

Goni, M. A., M. J. Teixeira, and D. W. Perkey. 2003. Sources and distribution of organic matter in a river-dominated estuary (Winyah Bay, SC, USA), Estuarine Coastal Shelf. Sci.,57: 1023– 1048.

Grant, D.L., P.J. Clarke, and W.G. Allaway. 1993 . The response of grey mangrove avicennia marina (forssk) Vierh. Seedlings to spill of crude oil. J. Exp. Mar. Biol. Ecol., 71(2): 273 - 295.

Ibrahim, S. 1990. The effects of clear felling mangroves on sediment anaerobiosis. Journal of Tropical Forest Science. 3(1): 58 - 75.

Kusmana, C. 1990. Soil as a factor influencing the mangrove forest communities in talidendang Besar, Riau. Biotropic a., 4: 9 – 18.

Lacerda, L.D., C.E.V.Carvalho, K.F. Tanizaki , A.R.C. Ovalle, and C.E . Rezende . 1993. The biogeochemistry and trace metals distribution of mangrove Rhizopheres. Biotropic a .,25:251-256.

Lindsay, W.L., P.L. Vlek, and S. H. Chien .1989. Phosphate minerals. In: J.B. Dixon and S.B. Weed (Editors), Minerals in soil environment, 2nd edn. Soil Science Society of America, Madison, pp. 1089–1130.

Mackey, A. P. and M. Hodgkinson. 1995 . Concentrations and spatial distribution of trace metals in mangrove sediments from the Brisbane River. Australia. Environmental Pollution . 90: 181-186.

Mandura, A.S. 1997. A mangrove stand under sewage pollution stress. Red sea . Mangroves and salt Marshes .1: 255 - 262.

Mandura, A.S. 1998. Litter fall and leaf decomposition in a sewage polluted mangrove stand at the Red Sea. Journal of King A bdulaziz University Mar.sci., 9: 101-112.

Martin, F. E. , Dutriex, and A. Debry. 1990: Natural recolonization of a chronically oil polluted mangrove soil after a depollution process. Ocean and Shoreline Management . 14(3): 173 - 190.

Mastaller, M. 1996. Destruction of mangrove wet sand causes and consequences. Natural Resources and Development . 43(44):37-57.

Mckee, K.L. 1993. soil physio-chemical patterns and mangrove species distribution reciprocal effects . J. Ecol ., 81:477-487.

Mandura, A. and A. M. Khafaji. 1992. The impact of human activities on the mangroves at Khor Farasan Island on the southern Red Sea coast of Saudi Arabia. the publisher, Kluwer Academy, the Netherlands.

Ros, P. M., C. Taylor, M. Hughes, N. Kofod, and L.Whitaker. 2009. “Threshold concepts: challenging the culture of teaching and learning biology” In Threshold Concepts: from theory to practice. (J.H.F. Meyer, R. Land, and C. Baillie, Eds.). Sense Publishers.

Smith, K. G., K. A. Smith, D. P. Bannon, J. D. Olian, H. P. Sims, and J. A. Scully. 1994. ‘Top management team demography and process: The role of social integration and communication. Adm Sci Q ., 39, pp. 412–438.

Smith, S. M. and S.C. Snedaker . 1995a. Salinity responses in two populations of viviparous rhizophora mangle L. seedlings. Biotropic a.,2,7 (4): 435 - 440.

Snedaker, S.C. and R.J. Araujo. 1998. Stomatal conductance and gas exchange in four species of Caribbean mangroves exposed to ambient and increased CO2. Mar. Freshw. Res., 49: 325–327.

ISSN: 2455-6939

Volume:02, Issue:06

Sotomayer, D., J.E. Corredor, and J.M. Morell. 1994. Methane flux from mangrove sediments along the southwestern Coast of Puerto Rico. Estuaries .(1B): 140 - 147.

Sparks, D.L . 1996. Methods of soil analysis. Part 3 – Chemical methods. SSSA Book Series No. 5. SSSA and ASA, Madison, WI.

Tattar T.A., E.J. Klekowski, and A.I. Stern. 1994 . Dieback and mortality in red mangrove, Rhizophora mangle L, in Southwest Puerto Rico. Arboricultural Journal. 18: 419 – 429.

Tomlinson, P.B. (1986). The botany of mangrove. Cambridge Uuniversity. press,pp. 413 - 415 .

Turan, M.A., A. H. A. Elkarim, N. Taban, and S.Taban. 2010. Effect of salt stress on growth and ion distribution and accumulation in shoot and root of maize plant. Afr J Agric Res., 5(7): 584-588.

US Environmental Protection Agency. (1996). Soil screening guidance: technical background document. USEPA Rep. 540/R-95/128. US Gov. Print. Office, Washington, DC.

Youssef, T. and P.Saenger. 1998. Photosynthetic gas exchange and accumulation of phytotoxins in mangrove seedling in response to soil Physico - Chemical characteristics associatea with water logging. Tree physiology. 18(5): 317 – 32.

Ziadi, F.S. and K. H. Paddy. 1985. Report on forests advice on the shores of the Red Sea. the Ministry of Agriculture and Water. Riyadh, Saudi Arabia.

