The Importance of Afforestation in Rehabilitation Degraded Lands in the State of Kuwait

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ABSTRACT

Land degradation processes prevail in the terrestrial ecosystem of Kuwait, which dotted by a high number of land degradation hotspots. Therefore, the detection and identify of hot spots related to land degradation and thus vegetation cover are required. The information provided by satellites on land desertification and plant degradation is the most important pillar of demonstration, which relied upon in combating this dangerous environmental phenomenon. In this present study, based on the available information, the determination of land and vegetation cover deterioration were done. After that, the phenomenon resisted by replacing new plants and treating soil deterioration by following the recommendations and proposals through integrated environmental management and the cultivation of plants exists in the desert environmental lands in the State of Kuwait. The spatial distribution of land desertification in State of Kuwait was determined as well as we observed the disappearance of vegetation cover and an increase in land degradation due to overgrazing and human stress.

Keywords: Land Degradation, Land Use; Vegetation, afforestation.

INTRODUCTION

Desertification is a form of land degradation in drylands. It is increasing droughts, less rainfall, higher temperatures, in addition to the permanent increase in climate change due to the reduced ability of the soil to conserve carbon. The policy of the State of Kuwait is supporting for combating desertification can be provided through several funding programmers from different policy areas, such as Rural development, Environment, Cohesion or Research was assessing the implementation and the monitoring of the State of Kuwait desertification related strategies.

Many administrative, environmental and scientific programs had developed that depending on artificial intelligence to evaluate and besiege the phenomenon, including the afforestation program to rehabilitate lands in the State of Kuwait (Report by the Federal Republic of Germany, 2000). The most important of these conventions are those related to climate change, the Kyoto Protocol, the biodiversity conventions, and the Convention to Combat Desertification in Countries. Experiencing Serious Droughts and/or Desertification, especially in The State of Kuwait (Khalaf, 2008).

Within the framework of Agenda 21 issued by the Earth Summit in Rio de Janeiro in 1992 concluded that the world is currently going through difficult stages that threatens with the collapse of the existing ecological balance and the increase in poverty, hunger, deadly diseases and epidemics throughout (Khalaf et al., 2013).

The phenomenon of desertification has witnessed a wide spread in the State of Kuwait in particular due to the over-exploitation of natural resources and the fragility of the ecosystems (Al Saleh et al., 2019; Zaman, 2019). There are efforts were done to limit the spread of the phenomenon of desertification and address its effects because of the prevalence of dry climate and the scarcity of water. The information as confirmed by the Convention to Combat Desertification itself remains one of the most important weapons that can used in combating desertification (Brown & Porembski, 2000; Brown & Porembski, 2019).

The State of Kuwait was the first to ratify the United Nations Convention to Combat Desertification in 1996 and immediately began implementing its provisions by organizing institutions and committees at all local and sub-regional levels to follow up, plan and implement programs and projects with the aim of combating desertification (Brown, 2003; Misak, 2003 and Misak et al., 2009).

The State of Kuwait has completed the preparation of its national plans to combat desertification. The information, as confirmed by the Convention to Combat Desertification itself, remains one of the most important weapons that can used in combating desertification (Tahoun, 2010).

The lack of geographical reference data and quantitative information on land degradation are significant challenges facing developing the action plan. So, the geographic information system (GIS) can used to draw maps and know the characteristics of land degradation in Kuwait.

Al Saleh et al. (2019) reported that the detection of land degradation hot spots is a significant prerequisite for land degradation control. Land degradation

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processes prevail in about 50.6 % of the terrestrial ecosystem of Kuwait, which dotted by a high number of land degradation hotspots. The results of the study showed 58 hotspots with a total area of about 50.6 % of the terrestrial environment. They found a significant variation in the areas, land use and indicators of land degradation of the hotspots.

Hu et al. (2020) determined the spatial distribution of land desertification in Kazakhstan and further analyzed the possible driving factors of desertification. The desertification mapping technical framework established in this paper can used in other parts of the world. The conclusions about the driving factors have reference value for the government authorities of the states of Kazakhstan. Targeted agricultural and industrial regulatory actions should take to prevent and control land desertification.

MATERIAL AND METHODS

Remote Sensing and Geographic Information System GIS Section, Kuwait *Institute for Scientific Research* (KISR) was the place that all database, data processing, analysis and maps had done. The layer of hotspots on vegetation depicted in Fig.1. The data average within the State of Kuwait obtained from 15 weather stations in the State of Kuwait collected in Table 1.

(Table 1) The ecosystem in the State of Kuwait covers approximately 15,000 square kilometers (85% of Kuwait) and the temperature sometimes reaches 50 degrees Celsius. Land degradation processes in Kuwait constitute about 50.6% of the terrestrial ecosystem in Kuwait. The rainfall in the winter season is irregular and always varies in quantity from year to year. The State of Kuwait is located in the desert geographical region, it has a continental climate where the short winters, the temperature sometimes reaches 18 degrees Celsius or even zero degrees Celsius, and the summers are hot and dry for a long time. Autumn and spring are characterized by their short periods, during the summer months, dust storms increase, and about 58 land degradation hotspots have identified with a total area of about 7590.3 km².

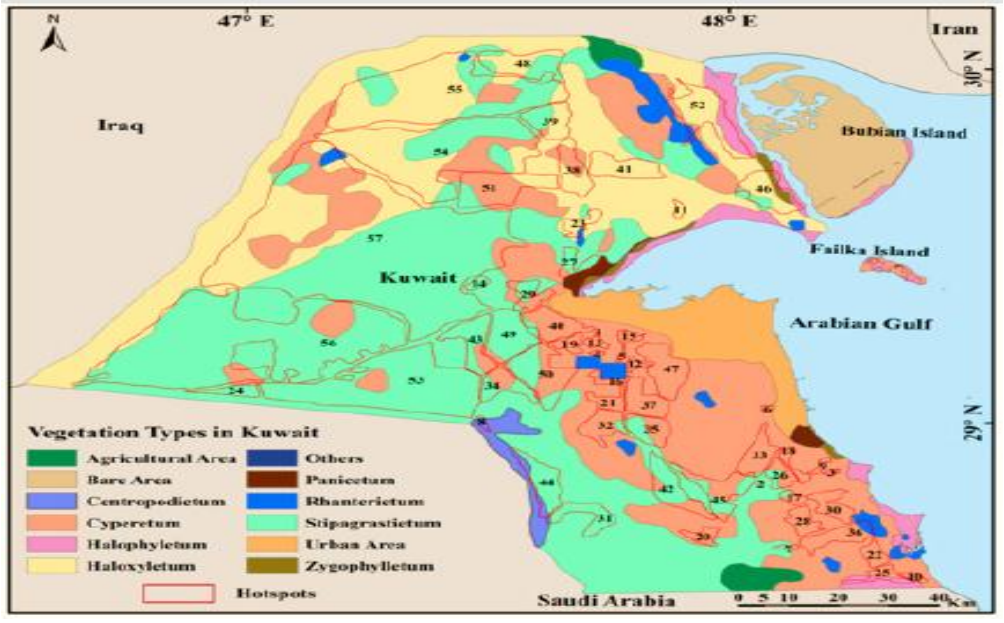

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Fig. 1. Hotspots on Vegetation Cover Layer

Table 1. Climate data

Month	Temp. ^{0}C	Rainfall (mm)	Wind speed Km/day	R. H. %	Sunshine (Hours)	Radiation	ET, (mm)	
January	42	59	32	62	5.8	2.9	4.66	2. 36
February	42	59	30	60	6.3	5.4	3.08	2.64
March	43	51	33	63	8.2	6.7	5.89	4.95
April	44	51	34	64	10.2	10.5	6.25	5.99
Mayo	45	14	35	65	10.5	10.8	6.85	6.05
June	45	32	50	70	11	10.2	6.77	6.69
July	48	31	50	70	11	10.2	7.28	5.10
August	47	37	55	69	9.6	10.9	7.78	7.68
September	47	37	56	69	10	9.5	5.62	5.20
October	42	36	40	63	10.5	9.5	4.30	4.45
Nov	43	63	40	63	7.8	9.7	4.15	4.55
Dec	42	43	32	62	6.9	9.2	4.56	4.20
Annual Average	44	55	62	60	9.2	9.2	6.81	6.93

RESULTS AND DISCUSSION

Vegetation Degradation:

The results of the current study indicate that the area of vegetation degradation is **187.560.488** acres 7590.3 Km^2 (48.7% of the total vegetation cover) (Figure 1) and (Table 2).

The highest vulnerable vegetation type to the deterioration was Stipagrastietum (911.33 acres. 3.688 Km^2, 58%), then Cyperetum (543.142 acres.198 Km^2, 50.4%) and the lowest types were Rhanterietum (8895 acres, 836 Km^2, 11%), Centropodietum (5485.74 acres, 22.2 Km^2, 14.1%), and Panicetum (2965.27 acres, 12 Km^2, 14.1%) Table (2). Degradation of vegetation cover and soil affects 50% of the terrestrial environment in Kuwait, which covers 15,130 square kilometers (85% of Kuwait) as shown in Table2.

Vegetation cover and biodiversity loss constitutes 100% degradation .Observable dry plant remains (stems and roots). c) Severe erosion by wind (scrape) when drought occurs where the grains appear in the form of ripples (Table 3).

Adoption of no sustainable measures such as earth berms bund walls (Off-road vehicles, which cause soil compaction) Gullies and rills that indicate soil loss by runoff water these hotspots with a total area of 7590.3 Km^2. There is a large variation in hotspots (Hot Spot 57) about 2,000 km² (Hot Spot 1) 1.2 km² with an average of 132.9 km². Based on their areas, the hot spots categorized into five classes (Table 4).

Table 2. Degraded vegetation types

Vegetation Type	Area Covered by Plant (km^2), (Omar et al., 2001a)	Area Covered% (Omar, 2001)	Degraded Vegetation (km^2), (Al Saleh, 2019)	Degraded Vegetation % (Al Saleh, 2019)
Haloxyletum	3,765	22.70%	1,485.3	39.4%
Rhanterietum	327	2.10%	36	11.0%
Cyperetum	4,394	26.90%	2,198.2	50.4%
Stipagrastietum	6,360	39.30%	3,688	58.0%
Zygophylletum	58	0.30%	25.2	43.4%
Centropodietum	158	1%	22.2	14.1%
Panicetum	85	0.70%	12	14.1%
Halophyletum	450	1.90%	110	24.4%
Total	15,597	94.90%	7,576.9	48.6%

Table 3. land degradation indicators in the State of Kuwait

Land Degradation Indicator	Field Evidence	Remarks
Vegetation degradation & loss of biodiversity	No visible vegetation (bare land) in comparison to the vegetation map (Omar et al., 2001b) and available control sites - Terrain dissection by intensive trials created by off-road vehicles (density at last 83%)	Image of trails created by off-road vehicles of 2020 was examined
Soil losses (by wind)	Deflated land features, e.g. granule ripples	----
Soil losses (by water)	Rills and gullies - Exposed bedrocks in water channels	------
Soil crusting, sealing, and compaction	Continuous driving (4x4 jeeps and trucks) on the fragile desert surface - Soil crusts of clayey soils	-----
Soil mining	Exploiting the soil for the establishment of berms and bund walls of 1.5- 2m high to protect facilities - Piles of excavated soils	-----

Table 4. List of observation points for soils and ground Truth

NO	Coordinates		Elevation	Land Features
	N	E	(m)	
1	29.1705	46.71458	267	Wadi Al Rimth (Tributary of Wadi Al-Batin)
2	29.74282	47.09312	126	Sand dune_Al-Huwaimliyah (sumood)
3	29.30533	47.49463	143	Al-Atraf area, southwest Ali Al Salem Air Base
4	29.38142	47.44798	169	Al-Atraf area, northwest, Ali Al Salem Air Base
5	29.38177	47.43047	178	Al-Atraf area, nort Salmi Road
6	29.36977	47.41682	171	Al-Atraf area, northwest Ali Al Salem Air Base
7	29.35932	47.44507	158	Al-Atraf area, west Ali Al Salem Air Base
8	29.41057	47.47035	159	Al-Atraf area, north Ali Al Salem Air Base
9	29.31467	47.54877	126	Al-Atraf area, south of Salmi Road
10	29.29647	47.55707	117	Sand sheet, Al Maghasil Area, Sabiyah –Umm Nega Road
11	29.6497	48.10832	3	Sand sheet, Al Maghasil Area, Sabiyah –Umm Nega Road
12	29.88498	47.9481	13	Degraded sand sheet, the intersection between a cut to a military camp and Sabiya-Umm Neqa Road main road
13	29.93972	47.93493	15	Sand accumulation, the intersection between Abdali farms and Sabiya-Umm Neqa Roads
14	29.94838	47.88202	19	Umm Neqa dune
15	29.71235	48.0436	21	Excavation for civil projec
16	29.16028	47.05643	253	Sand sheet, Shaqiah site, south-east
17	29.16141	46.97946	262	Sand sheet, Shaqiah site, southwest
18	29.21212	46.98034	239	Sand sheet, Shaqiah site, northwest
19	29.22915	47.05784	233	Sand sheet, Shaqiah site, northeast
20	29.15535	47.72223	74	Sandy plain, southeast Kabd Station (KISR
21	29.15618	47.69472	94	Sandy plain, south Kabd Station (KISR)
22	29.06112	47.7268	100	Sandy plain, Kabd animal production (Jawakheir)
23	29.04352	47.72678	110	Sandy plain, Abdaliyah, eastern side
24	29.03778	47.70333	118	Sandy plain, Abdaliyah, near the main gate
25	29.03768	47.64077	154	Sandy plain, Abdaliyah, south-west

Figure 2 shows sustainable land management, drought risk management, and biodiversity awareness of desertification, balancing pastoral land use and crops, and land control**.** Since the desertification process has already started, present pressures on the ecosystem (climate change, overgrazing, and large-scale irrigation) may lead to further desertification. Some interventions can help to restore the dry land ecosystems.

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Fig. 2. Landsat image and land degradation hotspots. The arrow indicates the northwesterly winds

CONCLUSION

The introduction of selected species, as well as erosion control and the cultivation of soil-stabilizing plants.

The use of plant and animal species that have the ability to adapt to changing climate and conditions

Combating desertification helps mitigate climate change and biodiversity loss. Adopting an environmental management approach to combat desertification and preserve biodiversity. To play on the effects of climate change.

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RECOMMENDATIONS AND SUGGESTIONS

1. Strongly recommended develop Technology of combating desertification.
2. Strongly recommended develop Desertification areas mapping.

3. Using plant and animal species adapted to climate change, while stopping overgrazing of livestock.
4. If desertification is treated, the problem of climate change is sequentially treated and biological diversity restored.
5. Adoption of no sustainable measures such as earth berms bund walls. e) Off-road vehicles which cause soil compaction.

REFERENCES

Al Saleh, A.H., F.R. Misak, A.S. Tamimi, A.H. Baker and J.M. Malek. 2019. Characterization and Mapping Land Degradation Hotspots in the Terrestrial Ecosystem of Kuwait, ISSN: 2574 -1241, DOI: 10.26717.BJSTR.2019.14.002487, Kuwait Institute for Scientific Research Kuwait.

Tahoun, S. A. 2010. Desertification and Land Uses in Heliopolis, Academic Library, Egypt, B.T., p. 412.

Brown, G. 2003. Factors maintaining plant diversity in degraded areas of northern Kuwait. J. of Arid Environ. 54(1): 183-194.

Brown, G., S. Porembski. 2000. Phytogenic hillocks and blowouts as 'safe sites' for plants in an oil-contaminated area of northern Kuwait. Environmental Conservation. 27(3): 242-249.

Brown, G., S.Porembski. 2019. Flora and vegetation aspects of miniature dunes in a sand-depleted Haloxylon salicornicum community in the Kuwait desert. Flora. 193(2): 133-140.

Khalaf, F.I. 2008. Desertification and Aeolian processes in the Kuwait desert. J. of Arid Environment. 16(2): 125-145. 6.

Khalaf, F.I., R.F. Misak, J. Al Awadi. 2013. Land use Planning for Controlling Land degradation in Kuwait Developments in Soil Classification. Land use planning and Policy Implications, Springer. 609-689.

Misak, R., J. Al Awadhi, M. Al Sudairawi. 2009. Assessment and controlling land degradation in Kuwaiti desert ecosystem. In: Proc. Conf. on the Impact of Environmental Pollution on the Development in the Gulf Region, Kuwait. 15-17.

Misak, R.F. 2003. Classes of land degradation in the Terrestrial Environment of Kuwait. In Application of New Technology for Improvement of Desert Environment, Kuwait-Japan Symposium, State of Kuwait.

Hu, Y., Y.Han, Y.Zhang. 2020. Land desertification and its influencing factors in Kazakhstan, J. of Arid Environments. 180(9): 2020- 104203.

Omar, S. 2001. Dynamics of range plants following 10 years of protection in arid rangelands of Kuwait. J. of Arid Environments. 21(1): 99- 111.

Omar, S., R. Misak, P. King, S. Shabbir, H.Abo Rizq. 2001b. Mapping the vegetation of Kuwait through reconnaissance soil survey. J. of Arid Environment. 48(3): 341-355.

Omar, S., R.Misak, H.Minkarah, P.King, A. Kwarting. 2001a. Landuse mapping for the State of Kuwait using the Geographical Information System (GIS). Arab Gulf J. of Scientific Research. 19(2): 59-65. 3.

Report by the Federal Republic of Germany. 2000. On Measures taken to assist the implementation of the UN convention to combat desertification special focus on Asia.

Zaman, S. 2019. Effects of rainfall and grazing on vegetation yield and cover of two arid rangelands in Kuwait. Environmental Conservation. 24(4): 344-350.

الملخص العربي

أهمية التشجير فى اعادة تاهيل الاراضى المتدهورة بدولة الكويت

سعد عبد الصمد السيد عبد الرازق ، خالد عبد الله الناقة

تسود عمليات تدهور الأراضي في النظام البيئي الأرضي في الكويت، والذي يتخلله عدد كبير من النقاط الساخنة لتدهور الأراضي. لذلك، يلزم اكتشاف وتحديد النقاط الساخنة المتعلقة بتدهور الأراضي وبالتالي الغطاء النباتي. يعتبر استخدام المعلومات التي توفرها الأقمار الصناعية حول تصحر الأراضي وتدهور النباتات من أهم ركائز المعرفة التي يتم الاعتماد عليها في مكافحة هذه الظاهرة البيئية الخطيرة حيث تم تحديد التوزيع المكاني لتصحر الأراضي في دولة الكويت كما لوحظ اختفاء الغطاء النباتي وزيادة تدهور الأراضي بسبب الرعي الجائر والإجهاد البشري. في دراستنا الحالية وبناءً على المعلومات المتاحة تتم متابعة الدراسة بإحلال نباتات جديدة ومعالجة تدهور التربة باتباع التوصيات والمقترحات من خلال الإدارة البيئية المتكاملة وزراعة النباتات الموجودة في أراضي البيئة الصحراوية في دولة الكويت.

الكلمات المفتاحية: تدهور الأراضي؛ استخدامات الأراضي؛ الغطاء النباتي والتشجير.