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Interaction Between Land Use and Land Degradation Processes in Arid Regions (The Case of Kuwait)

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Abstract: During the last 20 years, significant changes in land-use were observed in Kuwait. Some of these changes have positive environmental and ecological impacts, while others have destructive effects. Establishment of the buffer zone (15 km width and more than 200 km length) between Iraq and Kuwait in 1993-1994 resulted in the restoration of biodiversity, enhancement of ecological functioning and stabilization of fragile soils. Constructing long bund walls and digging of a border trench have negative impact on soil, surface hydrologic conditions and natural vegetation. The purpose of this study is to assess the immediate and long term impacts of specific land use types (the border trench and bund wall) and to identify their interaction to land degradation processes. To realize the objective of the study, intensive field program was designed and implemented. Field investigations were accompanied by remote sensing analyses and interpretation.

Keywords: Bund walls, Environmental impact and border trench.

1. Introduction

Kuwait covers about 118,000 km^2. From west and north, it is bordered by Iraq and from south by Saudi Arabia. The Arabian Gulf skirts Kuwait from east. The border of Kuwait with Iraq is marked by a ground trench (about 3-5 m wide and 2-3 m deep). This trench was established by Kuwait in 1993-1994. On the other hand, the border between Kuwait and Saudi Arabia is marked by a bund wall (2-3 m high and 3-5 m wide). This bund wall was established by Saudi Arabia in 1991. Both the trench and bund wall caused significant change in the local environmental and hydrological conditions.

As stated by Al-Awadhi *et al.* (2005), Misak *et al*. (1999, 2000, 2003, 2009 and 2010) land degradation processes prevail in the majority of the terrestrial environment of Kuwait, which constitutes about 80% of the country. Land degradation processes include: loss of top soils (through both wind and water erosion), soil crusting, sealing and compaction, loss of soil productivity, soil salinization, hydrological disruption, vegetation degradation and as results loss of biodiversity. The magnitude, mechanism and extent of land degradation exhibit remarkable variations in the different land use categories (Misak *et al.*, 2003).

In the open desert areas (close to 75% of Kuwait), where livestock grazing is the major land use type, indicators of soil, vegetation and hydrological degradation as well as loss of biodiversity are prevailing. In the agricultural areas (about 2.7% of Kuwait), depletion of soil productivity, water logging and soil salinization are recorded.

2. Materials and Methods

To assess the impact of the border trench and bund wall on land degradation, the following activities were conducted:

- Digitization of major and secondary drainage basins (wadis) using ArcGIS 9.3. A new map for drainage basins was produced.
- Identification of zones of hydrologic disruption where drainage basins are dissected by human induced barriers, such as bund walls (2-3 m high and 3-4 m wide), trenches (3-5 m wide and 2-3 m depth) and highways .
- Ground truth of remote sensing data through eight field trips.

3. Results and Discussion

3.1. Land Degradation Processes

3.1.1. Soil Mining, Vegetation Degradation and Loss of Biodiversity

It is estimated that about 12,720,000 m^3 and 375,000 m^3 of soil were excavated to establish the border trench and the bund wall. At the same time at least 2,544,000 m^2 and 1,500,000 m^2 were disturbed by heavy machinery during digging the trench and establishing the bund wall (**Table 1**). At these disturbed areas, all plant species including Haloxylon salicornicum were removed.

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Table 1. Approximate amount of excavated soils and disturbed areas along Kuwait-Iraq border.

Land use type (introduced form)	Amount of excavated soils (m^3/km length)	Total amount of excavated soils (m^3)	Disturbed area (m^2 /km length)	Total disturbed area (m^2)	Remarks
Border trench	6,000	12,720,000	12,000	2,544,000	Total length 212 km
Bund wall	2,500	375,000	10,000	1,500,000	Total length 150 km
Total	--	13,095,000	-----	4,044,000	

Table 2. Causes, indicators and potential impact of surface hydrological disruption.

Zone of disruption	Area (km^2)	Main causes of disruption	Indicators of disruption	Potential impact
Kuwait-Saudi Arabia border	1961.7	Border bund wall	Blocking of runoff water & out washed sediments at the upstream portions of wadis.	Development of new sources of dust and sands.
Wadi Al Batin	552.2	Border trenches and bund walls.	Trapping of surface run off in border trench.	Hydrologic drought.
		Road segments (Salmi and Abraq)	Blocking of runoff water & out washed sediments at the upstream portions of wadis.	Development of new sources of dust and sands.
Al Ritqa-Abdaly	748.1	Road	Blocking of runoff water & out washed sediments at the upstream portions of wadis.	
Raudtain-Um El Eish	714.2	Abdaly Road	Blocking of runoff water & out washed sediments along segments of Abdaly Road, Ritqa cut and north-south & east-west bund walls	Disturbance of recharge conditions of fresh groundwater aquifers of Raudtain-Um El Eish.
		North-south bund walls		
		East-West bund walls		Development of new sources of dust and sands.

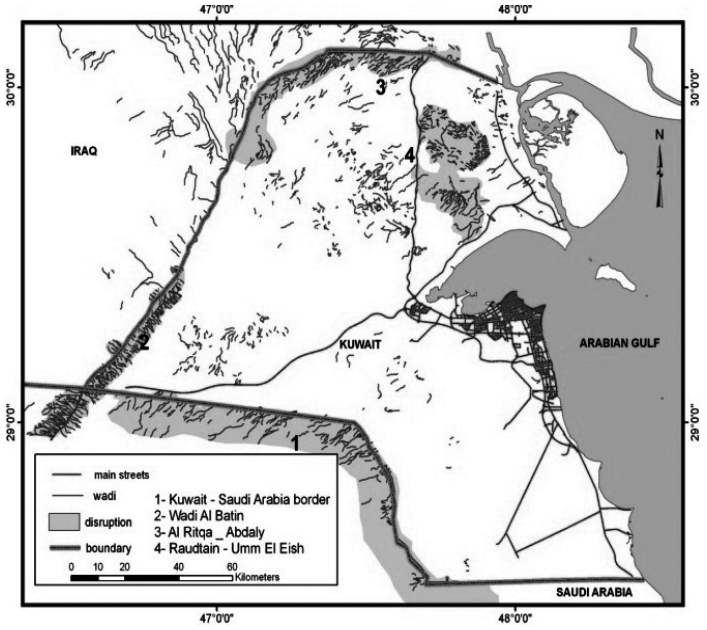

Fig. 1. Zones of surface hydrologic disruption.

3.1.2. Surface Hydrologic Disruption

Based on the results of the present study, four zones of surface hydrological disruption are described and mapped (**Fig. 1 and Table 2**). These are:

- Kuwait-Saudi Arabia border (1961.7 km^2)
- Wadi Al Batin (552.2 km^2)
- Al Ritqa-Abdaly (748.1 km^2)
- Raudtain-Um El Eish (714.2 km^2)

4. Recommendation

To restore the border zone between Kuwait and Iraq, it is recommended to design and implement a watershed management for the eastern tributaries of Wadi Al Batin. Cost effective water harvesting techniques including earth dykes (1-2 m high) are strongly recommended. This approach was successively tested in Kuwait (Al Dousari *et al*., 2007). The harvested water could be used for irrigation of drought resistance trees and shrubs as well as for other purposes.

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