SOIL SALINITY, SAND ENCROACHMENT AND EROSION AS INDICATORS OF LAND DEGRADATION IN HARAD GOVERNORATE, SAUDI ARABIA

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ABSTRACT

This study presents the main results of a thorough evaluation of land degradation in Saudi Arabia (Harad Centre). The study was carried out in 2006-2007 as part of a project aimed to study features and causes of land degradation in Saudi Arabia. The study area occupies the eastern part of Al-Hassa Province 330 km south-west of Al-Damam city. An integrated approach for evaluating Soil Degradation was adopted in this study, through the combined analysis of satellite imagery and supported by field work. The obtained results are useful as the basis for designing soil – conservation and restoration programs, as a base line for evaluating the performance of conservation programs and for assessing the impact of other soil – related activities (e.g. agriculture, livestock raising, etc.).

INTRODUCTION

Land degradation is a great threat to the world, not merely as an environmental issue, but also a social and economic problem. Land degradation can be defined as a decrease in either or both the biological productivity and usefulness of a particular place, due to human interference (Oldman et al., 1991). Soil salinity, sand encroachment and erosion land degradation is a major environmental constraint with severe negative impacts on agricultural productivity and sustainability, particularly in arid and semi-arid regions of the world (Jorenush and Sepaskhah, 2003). Salt-affected soils exist in more than 100 countries, extending to 76 million hectare (Jamshid and Abbas, 2002).

In several large-scale irrigation schemes, salinity-induced soil degradation has increased steadily over the last few decades with concurrent reductions in agricultural productivity and sustainability.

In studying areas expected to face desertification in Saudi Arabia, (Zoght and Akabawi, 1986)) concluded that 97% of Saudi Arabia is extremely arid while the remaining 3% which is located in the elevated areas of the southwest corner of the country, is subject to desertification. Desertification indicators that can be used in monitoring desertification are: changes in both groundwater and surface water as resources and the consequence changes in natural vegetation density and extend of agricultural areas.

Classification, evaluation, and mapping of degraded land are a major issue throughout the world. Some methods to evaluate degraded land have been proposed (Shanzhong, and Yumin, (2007). Remote sensing and GIS techniques have been widely applied to identify and characterize degraded land and monitor the trends of degraded land and desertification. However, due to the lack of perception and information about the environmental state, different physical and

social background, no satisfactory evaluation system of degraded land has been adapted to the specific characteristics of each ecosystem .This research attempts to provide a synthesis and analysis of the state of land degradation in Harad Governorate, Saudi Arabia

MATERIALS AND METHODS

STUDY AREA

Harad Governorate, is considered as one of the most agricultural important areas in the Kingdom of Saudi Arabia, that offers valuable ground water potential.The study area occupies the eastern part of Al-Hassa Province 330 km south-west of Al-Damam city and 273 km from Riyadh the Saudi Capital, lies between 20o 23' to 20o24'N and 48o40' to 49o25'E Longitudes covering an area of about 78112 Sq. Km. The study area has an aridic climate, characterized by hot summer with and cold winter. The maximum summer temperature ranges between 36^{o}C and 4.1^{o}C and a maximum winter temperature ranges from $18.19.^{o}$C to $24.9.^{o}$C with a minimum of 5.3 to 10.9^{o}C . Mean annual rainfall is 110mm, major portion of which is received during the months of January and March.

METHODS

An integrated approach for evaluating Soil salinity, sand encroachment and erosion land degradation in Harad Governorate was adopted in this study, through the combined analysis of satellite imagery and supported by field work and previous work in the region. This approach can be summarized in the following steps:

First step: Use of relevant research conducted previously in the region mainly Oldman et al., 1990).

Second step:Identification of the change in the cultivated area by comparing the dates of the successive landsate images. Through the analysis of density of vegetation index (NDVI) (Normalize density Vegetation Index) and vector generation

Third step: To identify surface features associated with the land degradation (salinization, Erosion, sand creep etc.) different techniques for image processing have been applied. These techniques include; principal component analysis (PCA) and unsupervised classification.

Forth step (field investigations): The ground truth was done through several field trips to the study area which identified a number of sites experienced a decline in productivity. The total number of these sites, amounted to 49 locations (representing all surface features related to land degradation), Nine sites were chosen to represent salinity induced land degradation. In these sites profiles were diged, samples of soil, water, were collected for further investigations

3-RESULTS

3.1-Previous research

The land suitability map (Based on the degrees of land limitation salinity, texture, etc.) showed these areas **as marginally suitable or not-suitable** for agriculture. Nonetheless, in recent years most of these soils which were classified as unsuitable were largely introduced for crop production. Generous subsides from the government plus the use of modern technology for water drilling and sophisticated irrigation system enabled the farmers to turn these soils to productive soils. Soil degradation map of Saudi Arabia based on Global

Assessment of Soil degradation (GLASOD) map (Oldman et al., 1990) showed that the area under study is **severely degraded**.

3.2-Monitoring changes in the cultivated area and its relationship to land degradation using remote sensing

The decrease in the cultivated area from the year 1993 through 1997 and 2001 up to the year 2004 was used as an indication of land degradation and linked to normalized difference vegetation index (NDVI) as determined from remote sensing data for the period 1993 through 2004. The percentage of green vegetation (both agricultural and natural) (VC%) was determined using the model which relates the vegetative cover to NDVI as follows:

(NDVI) = Near infrared (NIR) - infrared ray (IR) / Near infrared (NIR) + X-red (IR)

Visual interpretation of Landsat-TM imagery data (Band, 1,2,3,4,7) obtained at fixed dates and different years was adopted in this study. The obtained data was matched with data of years 1993, 1997 and 2001. The data showed that cultivated area in 1993 was 54.1 km 2 and gradually decreased in 1997 and 1998. However it increased again in 2001 up to 98.90 km 2 in 2001. Simple identification and mapping of degradation features was performed by digital processing and analysis using a computer. Principal component (PC) and unsupervised classifications were used to identify the ground features which could be related to land degradation.Verification by field trips (ground truth) indicated that there are three basic units and several sub-units in the area studied. The basic units are sand sheets and the sand dunes which covered most of the studied area and amounted to about 78.2% of the total area (611107.6 km2). The second unit Gypsrou pediplain with sand cover extended in about 20% of the total area (1588.7 km2). The cultivated area covered only 1.5% of the total area (114.7 km2). Morphological studies showed a wide variability of surface characteristics between the different types of land degradation i.e. white salt crust in salt affected soils, sand sheets, with varying thickness covering the surface of areas affected by sand creep. On the other hand, areas affected by wind erosion are characterized by the presence of gravel, stones and rock outcrops. Results of soil chemical and physical analysis plus field observations were used to identify the different types of land degradation in the studied area. Four major types were dominant and these includes; Stalinization (Cs), desert creep, Erosion (Et) and in rare cases fertility decline. The obtained results showed that Salinization, water quality and quantity, sand creep, and wind erosion represent the major types of land degradation in the studied area.

These results are useful as the basis for designing soil – conservation and restoration programs, as a base line for evaluating the performance of conservation programs and for assessing the impact of other soil – related activities (e.g. agriculture, livestock raising, etc.).

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