Desertification Monitoring And Assessment In Al-Butana Area, Sudan, Using Remote Sensing And GIS Techniques

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Abstract: - Desertification is one of the main problems threatening the agricultural production in the Sudan. The major environmental hazard in this area is sand encroachment from the north direction towards the south directions. The study aimed at monitoring and assessing desertification in Al-Butana area, in addition to investigating the potential use of remote sensing and the geographical information system (GIS) in assessing and monitoring sand encroachment and vegetation degradation as desertification indicators in the semi-arid environment. Satellite imageries of the years 1987, 2000 and 2005 were used to measure the extent of sand encroachment and the vegetation deterioration during the above addressed periods. The study showed that there were four mainland cover classes in the study area namely: water, vegetation, sand and clay. In addition, there was change in areas covered by the four main land cover classes during the addressed periods. With reference to the year 1987, sand cover was decreased in year 2000 and then increased in 2005. It is worth to mention that, sand was encroached from northerly direction to the south part of the study area. Vegetation cover was deteriorated during the addressed periods. The study concluded that most of the study area watched a remarkable change due to sand movement and sand encroachment.

Keywords: - Change detection, Desertification, GIS, Remote sensing,

1 INTRODUCTION

Dry lands cover about 5.2 billion hectares, a third of the land area of the globe (UNEP, 1992). Roughly one fifth of the world population lives in these areas. Most of African countries affected by desertification are poor countries with low living standard. Desertification is global problem but it is one of the most urgent ecological problems in Sudan. In this research attempts to give some background about definition causes, consequences of desertification and how remote sensing and GIS technology can be used to monitor this phenomena. Sand encroachment is one of the main problems threatening the agricultural production in at some parts of the Sudan and in particular the northern State (Elhaget al., 2007). Sand creeping biggest threats that draws the general environment. The sand can be creep over long distances and lead to deterioration and desertification of areas that have crept forth, The Butana area affected by this phenomenon (sand creep) crawled to it sand from the northern side and covered on many of their areas that were contributing to the production zones pastoral.

2 STUDY AREA

The study area is located between, Blue Nile and River Atbara with the Khartoum, El Gadaref and Kassala railways as the southern boundary. It covers approximately 120,000 km^2, lying between latitude 13o 50' and 17o 50' N and longitude 32o 40' and 36o 00' E. It excludes the narrow strip of land along the eastern bank of the Blue Nile and western bank of River Atbara which are irrigated areas, Figure 1 (Abu Sin, 1970; Elhassan, 1981). The Butana lies in the belt of regular oscillation of the inter-tropical convergence zone (ITCZ) with a tropical continental climate. Geology of the study are (Butana) consists of the following main features as distinguished by Andrew (1948) and Delany (1955): Basement complex in the middle and to the south east; Nubian formation in the west and north, the central region is a basement complex with flat surface; with only a few rocky hills breaking the monotony of the plains. The central part is clay plain with numerous water resources. Most of these water courses form their own deltas and do not drain into nearby rivers. At the deltas of these water courses or 'khors' the people normally cultivate sorghum crops (Elhassan, 1981). The variation in the rainfall, together with variations in relief, drainage and parent materials produce clear local differences in the Butana soil. The top soil is mid-brown grey friable clay with round quartz pebbles and stone fragments. The cracks are not wide but medium in size and are more abundant in the soil under grass. The soil is a medium to fine textured clay, sandy clay or silty clay which contains more than 40% expanding clay (Hunting Technical Services, 1966; Khalil, 1986). The occurrence and distribution of vegetation in the study area is generally determined byamount and distribution of the rainfall,as well as topography and soil texture also play an important role in a detailed description of the distribution within areas receiving the similar amounts of the rainfall (Abu Sin, 1970). There are three main types of the natural vegetation in the Butana. The Acacia trees that form the major perennial type, including Acacia tertilus, AcaciaSeyal and Acacia mellifera. The shrubs are the second perennial type of vegetation in the study area, including bushy grasses scattered all over the region. The third type includes the annual grasses and herbs. Grasses include Schoenefeldiagracilis (Gabash), Sorghum PurpureoSericeum (Adar) and Sehimaischaemoids, while herbs includeIpemeacardiosepala (Hantut), IpomeaCordofana (Taber) and Blepharisedulis (Siha).

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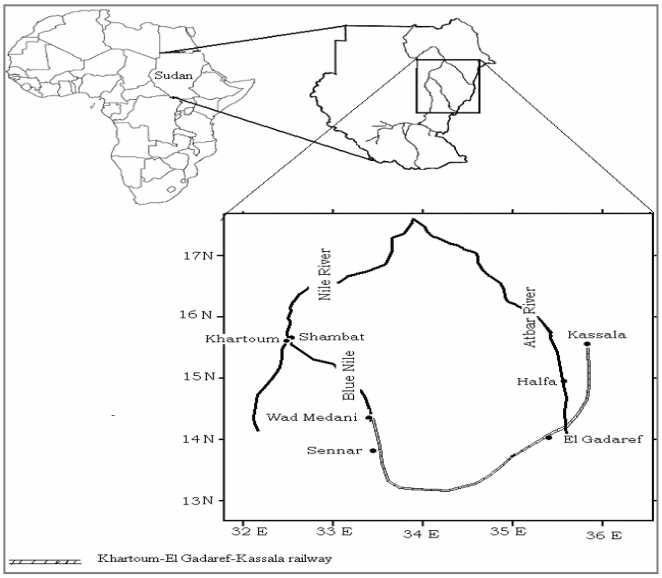

Fig. 1. Location map of the study area

3 METHODOLOGY

Four false colour composite (FCC) subsets images from Landsat TM and ETM covering the study area. It covers approximately 120,000 sq. km were used in this research. Image 1987, 2000 was Enhance Thematic mapper (ETM+) while the other image was thematic mapper (TM 2005). Landsat (ETM+) 2005 was used to assess the change detection and to combine between these Images. Radiometric and image to ground points geometric correction was conducted. In addition Global and Linear Enhancement was also performed. Supervised, unsupervised classifications analyses were used based on visual interpretation and the field work. Areas and percentage of the areas affected by sand in each year were determined, and then post classification change detection approach based on map calculation was applied to determine the dynamic of change in sand encroachment and to other classes.

4 RESULTS AND DISCUSSIONS

From the satellites images interpretation it was possible to state that sand moved from northern to the southern parts of the study area. Table (1) and figure (2) showed that sand was creeping from north to south of the area and covered about 4304976 feddan which constituted 36.12% of the total area. The vegetation cover was scatter in southern part of the area and round Atbara river, most portion of this vegetation was a part of Halfa scheme in east of the study area, the vegetation covered about 979394.40 feddan which constituted 8.22% of the total area. The water covered about 1878.98 feddan, constituted about 0.02% from the total area. Atbara River was the main component of this class. The clay land covered about 3238728feddan (27.17%).

TABLE 1
DIFFERENT LU/LC IN 2000

Class name	Area (feddan)	%
unclassified	4655496	36.56
Water	5337.58	0.04
Vegetation	114432.24	0.9
Sand	2410608	18.93
Clay	5548368	43.57

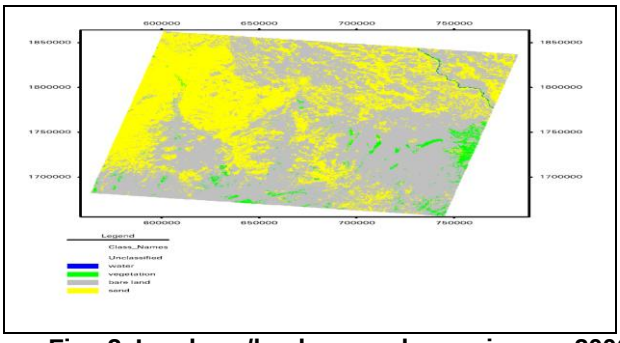

Fig. 2. Land use/land cover classes in year 2000

As showing in table (2) and figure (3), the sand covered about 2410608 feddan which constituted 18.93% of the total area. The vegetation covered about 114432.24 feddan which constituted 0.9% of the total area. The water covered 5337.58 feddan which constituted 0.04% of the total area. The clay land covered about 5548368 feddan which constituted 43.57% of the total area. It was observed that, clay was increased in that year 2000.

Table 2
DIFFERENT LULC IN 1987

Class name	Area (feddan)	%
unclassified	3393504	28.47
Water	1878.98	0.02
Vegetation	979394.4	8.22
Sand	4304976	36.12
Clay	3238728	27.17

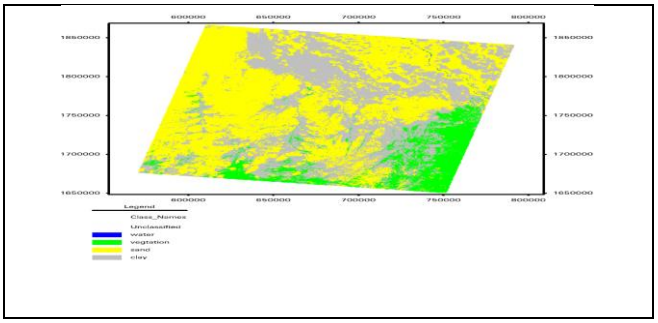

Fig. 3. Land use/land cover classes in year 1987

Table (3) and figure (4) showed that, the water was covered about 36747.12 feddan which constitute 0.30% of the total area, most of them at Atbara River. The vegetation cover was covered about 114432.24 feddan which constituted 19.8% of the total area, scattered in all of area (wades, round of Atbara River and part of Hlafa agricultural scheme), sand was covered about 5234616 feddan which constituted 42.47%. The clay land was covered about 826147.2 feddan which constituted 6.7% from the total area.

Table 3
DIFFERENT LU/LC IN 2005

Class name	Area	%
unclassified	3787128	30.73
Water	36747.12	0.3
Vegetation	2440296	19.8
Sand	5234616	42.47
Clay	826147.2	6.7

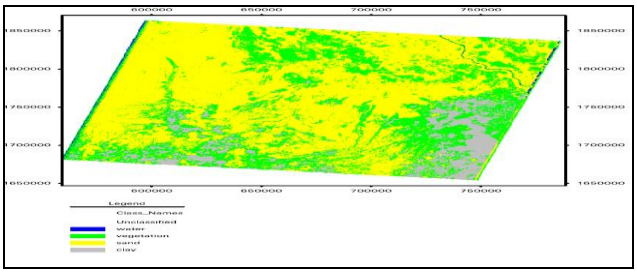

Fig. 4. Land use/land cover classes in year 2005

Changes in Land/cover and Land/use (LU/LC) classes between 1987 and 2000 to assess the desertification in area during the addressed period 1987 to 2000, a comparative study was carried out. Table4showed that, difference in areas of different LU/LC classes covering the area in year 1987 and 2000. From the table 4 the following statement could be drawn: The area of sand has decreased from 1987 to 2000; there was reduction in area counted to 1894368 feddan. This is attributed to the increased amount of water during year 1987 and 2000 from 1878.98 to 5337.58 feddan, respectively. This might be due to increase in rainfall, which of course led to sand fixation. Area covered by water was increased from 1878.98 feddan in 1987 to 5337.58 feddan in year 2000. Vegetation cover was decreased from 979394.40 feddan in 1987 to 114432.24 feddan in year 2000. This was unexpected but might be due to decrease in cultivated area in WadiHalfa scheme in that year. However this was an indicator to degradation of vegetation cover (one of desertification process). The area of clay land have increased from 3238728 feddan in 1987 to 5548368 feddan in 2000, there was increased count to be 2309640 feddan.

Table 4
CHANGES IN LULC CLASSES DURING THE PERIOD 1987-2000

Class	Area		Different
	2000	1987	2005
Water	5337.58	1878.98	3458.59
vegetation	114432.24	979394.4	-864962.16
Sand	2410608	4304976	-1894368
Clay	5548368	3238728	2309640

The unit by feddan *+ Means increased * - Means decreased

Changes in LU/LC classes between year 2000 and year 2005similar to previous period, a comparative study was carried out to assess change in LU/LC classes during the period 2000-2005. Table5 showed that, the difference in areas of different LU/LC classes covering the area in year 2000 and 2005. Table (5) showed that the area of sand have increased from 2000 to 2005 in the rate of 2410608 to 5234616 feddan, respectively, the increased increment amount was 2824008 feddan, this might be due to human activity such as removal of vegetation cover by over grazing or fuel wood production. This was an indicator for sand creeping which would ledd to desertification. This finding was agreed with study of Sami (2005).

Table 5
CHANGES IN LULC CLASSES DURING THE PERIOD 2000-2005

Class	Area (feddan)		Different
	2000	2005	
Water	5337.58	36747.12	31409.54
vegetation	114432.24	2440296	2323463.8
sand	2410608	5234616	2824008
Clay	5548368	826147.2	-47222.8

The unit by feddan *+ Means increased * - Means decreased

The area covered by water was increased from 5337.58 in 2000 to 36747.12 feddan in 2005 (31409.54 feddan).

The vegetation cover was increased from 114432.24 feddan in 2000 to 2440296 feddan in 2005.

The area of clay was decreased from 2000 to 2005, 5548368 feddan in year 2000 to 826147.2 feddan in year 2005, there is a decrease of 47222.80 feddan.

5 CONCLUSIONS AND RECOMMENDATION

The study revealed different signs of desertification and land degradation in the study area as judged by change in patterns of land use and land cover types, this changes indicated: increase of farming land, vegetation cover, sandy soil and sand dunes around and inside the study area,. These signs could be revised with the use of agricultural indicators. Based on these finding the following recommendation can be stated:

1. New policies and practices of agricultural extension should be adapted to alert farmers to the threat posted by land degradation.

2. Periodic monitoring of severity and extent of land degradation is needed.

3. Some measures are needed to retard land degradation in the study area.

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