Monitoring Sand Encroachment on Agricultural Land in White Nile State, Sudan, During 1975–2008 Using Remote Sensing and GIS

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"Residences of agricultural systems against crises"

Introduction:

Soil degradation is on the increase worldwide, especially in the countries within the tropics. Mismanagement of arable areas by farmers and grazing areas by livestock owners is one of the major causes of soil degradation. Wind erosion is a serious problem in many parts of the world. It is worse in arid and semiarid regions. Areas most susceptible to wind erosion on agricultural land include much of North Africa and the Near East; parts of southern central, and eastern Asia and others parts of the world. Sand encroachment refers to removal or deposition of grains of sand or soil material. It is more of a problem in dry areas than humid ones, but can also be significant in areas of seasonal rainfall if vegetation is sparse or absent during the dry season.

Desertification is considered the most serious environmental problem facing Sudan, which lies within the zone where the risks of desertification are high. Therefore this study has used an integration approach to study and assessment the sand encroachment as causes and impact of degradation in the White Nile state area. In central Sudan (including White Nile State) sand encroachment poses a real threat to arable lands. Therefore, this phenomenon should be given more attention.

Objective of the study:

The main objective of this paper is to monitor and assess the encroachment of sand dunes and vegetation degradation in the study area during a period of 33 years using remotely sensed imageries and GIS techniques as well as to evaluate the efficiency of remote sensing and GIS in achieving these objectives

Photo 1: Shows the Sand encroachment threatens agricultural lands, roads, and houses in the study area which become the most serious threat to the environment

In photo 2: Notes that the sand dunes encroached and coverage most of the cultivated areas in the previous season (encroached for more than 2 meters during one growing season)

Materials and methods:

The Study Area

The study area lies within two localities of the White Nile state; El Gutayna locality eastern of the whit Nile and Ed Dueim locality western of the White Nile State. The study area is located about 50 km south of Khartoum, with coordinates: latitude from 13° 58' 37" N to15° 14' 29" N and longitude from 31° 54' 38 " E to 32° 53' 50" E. (Figure 1).The area extends from the semi-arid climatic zone in the north to the dry monsoon in the south. The White Nile is running from the south to the north in the study area and divided it into two parts, eastern bank and western bank of the White Nile. It covers an area of approximately 10214 km^2 .

Materials & Methods

For this purpose four satellite imageries (MSS 1975, TM 1986, ETM+ 2000 and 2008) were analysed in addition to field information, soil analysis and other existing information (topographical and geological maps). The study was based on visual interpretation, digital analysis, laboratory analysis and field work, whereupon geometric & radiometric correction, image enhancement, visual interpretation of color composites, unsupervised and supervised classifications as well as change detection were applied (figure 2).

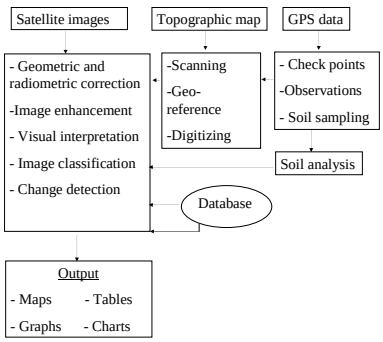

Figure2: Chart of Research Methodolgy

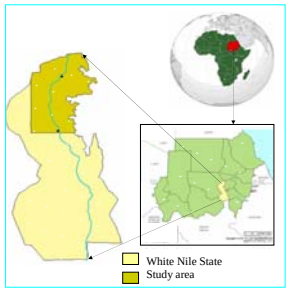

Figure 1: location map of the study area

Results:

The results of the supervised and unsupervised classification of satellite images (MSS 1975, TM 1986, ETM 2000 and ETM 2008), 11 Landuse and landcover (LULC) classes as shown in Figure 3.

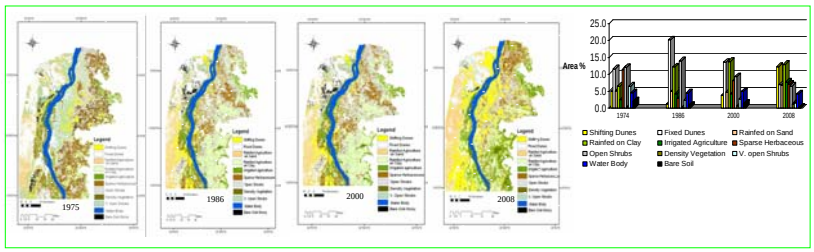

Figure 3: Landuse / Landcover distributions during 1975 – 2008

The Results of change detection analysis shows that the study area witnessed various changing during the study period, where it indicated that third period (2000-2008) contains the biggest percentage of change between the different LULC classes in the study area where it reached 59.75% followed by the first period (1974-1986) 45,24%, while the second period (1986-2000) is less percentage of change 40.10% , as is evident in figure (4).

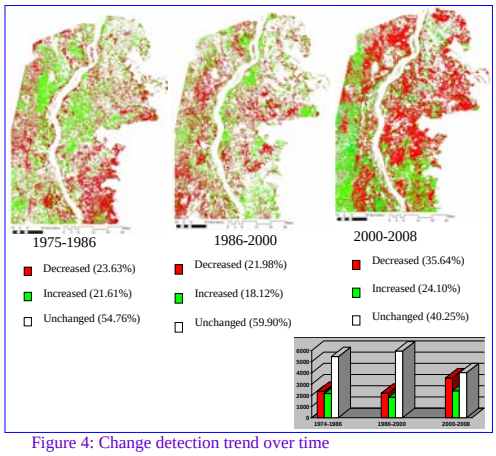

Figure 4: Change detection trend over time

The results revealed that during the study period the shifting dunes increased 11% (annual rate 0.32%/year) and the vegetation cover decreased by 20% (annual rate 0.58%/year) while the cultivated areas (rain-fed agriculture on sandy soils, rain-fed agriculture on clay soil and irrigated agriculture) increased 2%, 10% and 7% (annual rate 0.05%/year, 0.29%/year and 0.20%/year) respectively (figure 5). This trend indicates accelerated land degradation as the result of regional climatic change and human misuse of land.

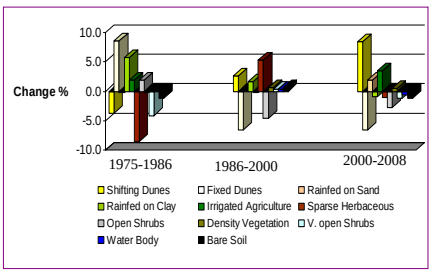

Figure 5: Landuse / Landcover Change trend (1974-2008)

Conclusion:

The study proved that sand encroachment threatens agricultural and pastoral areas in the study area, which led in some parts of the study area to disrupt agricultural operations, as well as buried some of irrigation canals which leading to exit some of agricultural projects out of production processes in the study area. The study also proves that remotely sensed image and geographic information system techniques provide detailed results which should be further exploited in similar studies.

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