International Journal of Latest Research in Humanities and Social Science (IJLRHSS)
Volume 02 - Issue 09, 2019
www.ijlrhss.com || PP. 58-68

Assessment of Spatio-Temporal Vegetation Greenings using NDVI in North Kordofan State, Sudan

Ibrahim M. Eltom, Mohammed Ahmed. H.A.Alzubair
** Department of Remote sensing and GIS, Faculty of Geographical and Environmental Sciences, University of Khartoum*

Abstract: Land degradation has been a serious environmental problem in Sudan Sahel Zone and information about vegetation greenness cover distributions is more essential for several vegetation resource changes and the management of sustainable growth of vegetation cover. The study combines various approaches which include statististical trend analysis of satellite derived Normalized Difference Vegetation Index(NDVI) residuals to identifying the thematic mapping crating for spatial greenness seasons. The objective of this study is to assess the spatial heterogeneity and the dynamics of the vegetation greenness and land cover change using different multi-spectral images derived from AVHRR instrument. The NDVI is used as one of the geosciences adapted methods that depends on the satellite images to calculate the vegetation greenness applying mathematical function. For this project seven landsat TM-images have been selected which were taken from 1972 to 2005.The results show that there is a remarkable correlation between vegetation cover greenness and the rainfall among the studied seasons. The greenness of positive high values showed there were 5 seasons that depicted high NDVI values, while 2 of the seasons showed less NDVI values (1984 and1990).This suggests that more in-depth study of this kind of projects has to be taken by integrating the spatial data with climatological and mathematical functions.

1- Introduction:

Environmental problems that relate to the natural resources are affected by earths' resources that increasingly emerged. All problems are typically distributed in Spatio-temporal manner. Concern of attribute value such as environmental degradation, is of high interest for its spatial and time measurement in problems analysis.

Vegetation is the backbone of rural economy, contributed by all herders and nomads as well as sedentary rural people. So, for a primary economic country like Sudan, timely information on the types of grass grown and their intensity is required. Vegetation cover greenness and grass growth conditions are essential for strengthening rural areas income and distribution system. Remote sensing techniques have been used to map the land cover consumption including vegetation greenness within different ecosystems.

Reliance on meteorological and agricultural data alone is not sufficient to assess change in vegetation cover that needs help with more accuracy techniques. So, the recent satellite images data used effectively with weather data to depict the change of vegetation conditions spatially. Satellite data at global scales and resolutions that are adequate for monitoring changes related to rainfall have now become widely available (Eensham *et al*; 1999; Volcani *et al* ; 2005).

The application of Remote Sensing (RS) and Geographical Information System (GIS) in fields of natural resources management and environmental degradation assessment has highly increased and upgraded successfully. NDVI was used to assess and calculate changes in vegetation cover in relation to rainfall characteristics. The development of remote sensing techniques in the late 1970s resulted from the need for methodological methods to evaluate the vegetational conditions in their local and global extent. Priority was given to applicability and accountability of vegetation using NDVI that explains its intensity and carrying capacity and assessing in such ways water moisture content for agricultural studies.

Changing trends in ecosystem productivity can be quantified using satellite observations of Normalized Difference Vegetation Index (NDVI), the estimation of trends from NDVI time series differs substantially depending on analyzed satellite dataset (Matthias *et al*; 2013 and Lucht, 2006).

NDVI technique is used in many studies as a parameter for assessing drought occurrence due to less rainfall and less vegetation cover greenings. There is a correlation between NDVI and climatological variables mainly rainfall and temperature. The accurate assessment of rangeland vegetation cover, in terms of their productivity, their vulnerability to drought and their magnitude of degradation, requires information about the dominant vegetation types including their spatial variations in coverage (LeHouerou ,1996).

NDVI is used for different purposes to monitor agricultural production, assist in predicting hazards and to monitor agricultural drought. Drought and rainfall variability during the last three decades are the major physical challenges to vegetation in North Kordofan. Change was assessed depending on the overall NDVI values (negative or positive) for the entire study area between the selected images during 1972, 1984, 1987, 1990, 1992, 2000, and 2005. The current images of the vegetation greenness compared with selected seasons give also a good indication of rainfall change. A variety of procedures for change assessment, based on comparison of multi-temproal remote sensing data, have been developed (Ashbindu, 1989).

NDVI is more powerful as it is used for assessing the vegetation greenness and healthiness. The frequency of new assessments takes short periods and recently researchers work on biweekly NDVI were its composite image is updated every week. A new biweekly image is produced each week; by dropping the oldest weeks data and adding the newest weeks data (Burdan *et al*; 1993). NDVI has also considerable importance as developed by some authors. Francesco *et al* (2014) stated that NDVI importance comes from the fact that it gives information about a primary production (vegetation) over time.

2- Statement of the Problem:

Significant changes in the vegetation cover and seasonal plants productivity manifest rapid environmental degradation . As in rural areas, trees at the vicinity of settlements are effected by the human interferences such as overcutting and over grazing. Although the cutting rates are spatially not equal or the same, the overall cutting rate gives a danger level of environmental degradation over both provinces, Shiekan and Bara of the study area.

Tree clearance has become a serious top environmental problem, especially in arid and semi-arid ecosystems. Since 1980s, the total land forest was continuously degrading, and the loss was estimated to be over hundredth million hectares. Based on this fact, this research idea had been in reality to assess the problem of vegetation cover.

The severe drop in production observed in 1984 (one of the worst droughts in Sudan) during the 20^{th} century had its own impacts that were highly associated with the less vegetation cover for herders. About (5.800.000) persons displaced, thousands of animals died and approximately (50.695) km^2 (12.650.410 feddans) of land were degraded as reported by the Agricultural Statistic Office (ElObeid ,1990).

3- Objectives:

The main aim of this research is to use Remote sensing data and techniques to assess the vegetation cover conditions using Spatio-temporal time series approach. Minor objectives are:

1. Interpret the relationship between NDVI and rainfall.
2. Show the efficiency of the NDVI in assessing vegetation conditions.

4- Significance of this paper:

Vegetation change is one of the most indicative signs of environmental degradation that the semi-permanent green areas in the proximity of forest, water depressions and Khors, which are environmental sensitive areas, should be protected. Hence the environmental diagnosis is a need to assess the degraded areas using vegetation indices such as NDVI.

5- Conceptual Framework:

5- 1 Methodology

Materials and procedures for this research include many aspects of concerns:

5-1-1 Site of the study area:

Sudan depends almost exclusively on the natural land for rural livelihoods, animals and agriculture. Rainfall variability and exploitation of land without strategy or socio-economic planning created huge change recently over the land cover of the rural natural ecosystem. The area selected for the study was an approximately 637.000 km^2 in west Sudan which consists of two localities (Shiekan and Bara). The study area is located between 13^0 N to 16^0 N latitudes, and 29^0 E to 31^0 longitudes(Fig 1). North Kordofan is part of the dry region of the western Sudan. The annual average rainfall rarely exceeds 380 mm/y. Its dry climate encourages the expansion of shifting cultivation at the expense of forest lands that decreases the healthiness of vegetation cover. Crop cultivation during the rainy season enhances the greenness cover and depends on the amount, intensity and distribution of the rainfall.

Generally,it is characterized by arid and semi-arid ecosystems and share in a large extent same ecological characteristics. Features distributed naturally are uneven terrain, dunes and sand creeping, khors surface water courses, shallow water bodies and vegetation cover with distinct variations. The study area ,as part of North Kordofan State, is ecologically classified as a drought vulnerable area.

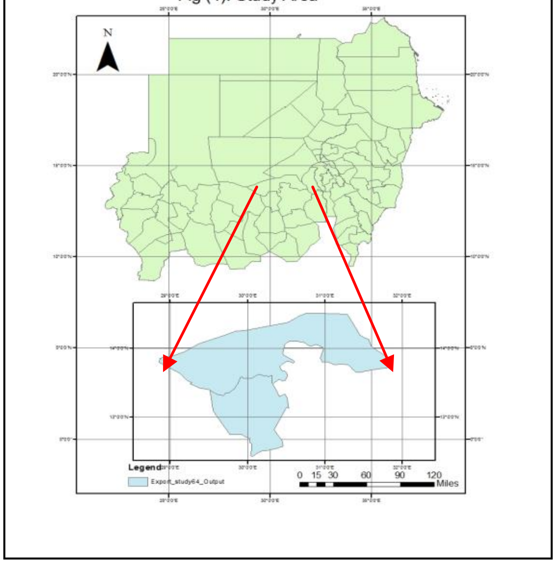

Fig (1): Study Area

5-1-2 Data capturing:

Generally speaking, scientific research is most heavily limited by the quality of the data, and remote sensing of satellite imagery is no exception. Spatial resolution problem still constitute the big obstacles for doing a very high quality research using remote sensing satellite data such as a very high resolution for distinguishing vegetation by its types (grass, herbs – trees and shrubs).

Different states of the land surface can be measured by satellite-derived biophysical parameters (Coppin, 2004).

The remote sensing community has used AVHRR data to develop a NDVI (Goword, 1990) that is sensitive to the quantity of actively photosynthesing biomass. NDVI values for vegetated areas theoretically range from 0 to 1 (Robert, 1996).

Different ecosystem changes can be analyzed from NDVI time series. For example, annual mean or peak NDVI provides an integrated view on photosynthetic activity (Myneni, 1995), the seasonal NDVI amplitude is related to the composition of evergreen and deciduous vegetation (Tucker, 2001).

Different Satellite images Landsat were used for this study, MSS Landsat2 (14Jun), spectral four Bands for the year 1972; TM landsat 4, spectral seven bands for the year 1987 (20 Jun); and ETM+, Landsat 7, spectral nine bands for years 2000,2005. The general resolutions of these instruments are 79m*79m, 30m*30m and 30m*30m for MSS, TM, and ETM+, respectively. Table (1) presents the specifications of the satellite imageries used for this study. .

Data concerning tree species density were collected from different sources including documents, field works and unstructured interviews. The time scale of the weather data was based on annually rainfall records during 1970-2005, which were obtained from Meteorological Department. For this study changes were assessed depending on the vegetation cover greenness. As in most environments, vegetation growth is limited by water availability, so the relative density of vegetation is a good indicator to assess vegetation healthiness. Annual rainfall data from ElObeid and Bara meteorological stations were obtained for the period 1970-2010 representing the study area.

Table (1): Main specifications of the imagery used

	Satellites	***Row***	***Path***	***G.resolution***
1972	MSS	For all years		60×60
1987	TM	174	50	30m×30
1990	ETM +	174	51	30×30
1992	ETM	175	50	30×30
2000	ETM	175	51	30×30
2005	ETM+	173	51	30×30

5-1-3 Methods of data analysis:

Change in biomass was measured by remote sensing of the NDVI. The difference between reflected near-infrared and visible wavebands divided by the sum of these two wavebands (Bai *et al*; 2006). Many studies have shown strong correlation between NDVI and vegetation cover, such as Purevdoj *et al*. (1998), Potter *et al*. (1993), Field *et al*. (1995), Prince and Goward (1995),and Nemani *et al*. (2003). Remote sensing involved a sequence of analyses to assess greening changes.

Erdas Imagine 9.2 had been used for analyzing the remote sensing data acquired from golvis.usgs.gov free download. After layer staking, all of the required scenes had been mosaicked to create single images for NDVI processing. Arc Map 10.2 was also used for additional processing such as NDVI reclassified maps and layout functions.

5-2 Concepts Used in Clarifications:

5-2-1 NDVI method processing:

In recent years a procedure has been developed which added many advantages in the area of vegetation analysis and evaluation. The NDVI technique uses the satellite images with varying resolution and calculates the greenness values using red and infrared radiation with mathematical equations.

Normalized Difference Vegetation Index(NDVI) processing can be defined as the manifestation of digital data by the aid of computer in order to produce more assessing image. Image processing included many software steps. The estimated values are from data acquired by the Advanced Very High Resolution Radiometer (AVHRR) sensor onboard the National Oceanic and Atmospheric Administration (NOAA) satellite series, are particularly adapted to assess these changes (Yves, 2011). The Normalized Difference Vegetation Index (NDVI) is a remotely-sensed measure of vegetation greenness and is related to structural properties of plants—like leaf area index (Turner *et al*;1999) and green biomass (Gamon *et al*;1995). Remote sensing techniques have widely been used to map the land cover composition including vegetation abundance and impervious surfaces (Braun, 2003).

NDVI is one of the remote sensing techniques that provide several improvements in areas of biogeography and environmental studies. Geographers have used NDVI data to develop a map that portrays vegetation patterns (Loveland *et al*;1991).

The NDVI is the difference of near-infrared and visible red reflectance values normalized over total reflectance. The near-Infrared(NIR) and red(R) bands differ from one Landsat to another. In Landsat 4, we use band 2 and band 1 for NIR and R, respectively while in Landsat 7, we use band 4 and band 3 for the NIR and R, respectively. In Landsat 8 the case differs, as we use bands 5 and 4 for NIR and R, respectively. NDVI is usually calculated using mathematical equation (Deening, et al 1975).

$$\mathbf{NDVI = (NIR - R) / (NIR+R)}$$

For analysis interpretation negative NDVI values indicate devegetated surfaced, while the positive ranges from 0 to +1 indicate vegetated areas. As elaborated by many, the higher the NDVI value, the more “green” the cover type (Deering *et al*;1975). That is to say, where there is a dense vegetation cover, the quantity of the NDVI values increased.

Red and NIR stand for the spectral refection measurements acquired in the visible (Red) and near infrared regions, respectively. The advantages of NDVI over a simple infrared/red ratio are therefore generally limited to any possible linearity of its functional relationship with vegetation properties (e.g. biomass).

5-2-2 Image Preprocessing workflow:

By Image Preprocessing we mean the technical procedures that governed the flow work of this study step by step: First raw data were extracted, stacked and finally mosaicked. Then the study area was clipped from the mosaicked image created study area image for (Bara and Shiekan localities). For clearing expected noise, enhancement had been done for the final image used for NDVI. Images one by one were processed using ERDAS imagine software (9.2).

5-3 Previous related studies:

During the last three decades (30 years ago), many remote sensing vegetation indices have been quantitatively developed based on the spectral band combination to monitor vegetation and assess environmental degradation. During 2000s, the studies concerning vegetation cover change have motivated by many advanced indices. NDVI and EVI have often been used to monitor vegetation conditions.

Several writings are available from literature that have shown the significance of using remote sensing data and techniques for detecting the changes in vegetation of landcover in general. Three categories can be identified; those who wrote about the NDVI as an indicator for drought occurrences; studies that assessed the surface biophysical parameters exposed to change such as vegetation indices and studies that focused upon land surface dynamics and soil moisture and Evapotranspiration.

From chronological point of view, NDVI studies return back to the era of remote sensing data exploitation since 1972. After that, the application of NDVI accelerated in vegetation and agricultural fields and it focused on the assessment of soil moisture and crop maturity as main biophysical parameters that affected the positive/negative NDVI value computation.

Anne *et al*. (2013) studied the assessment of vegetation variability and trends in north eastern Brazil using AVHRR and MODIS NDVI time series. They analyzed 25 years monthly time series (1992-2008) using NDVI data to characterize vegetation dynamics. In their results, they showed the spatial and temporal variability of the NDVI and they presented an overview on the vegetation variability. Genesis et al (2014) used of the NDVI to assess land degradation at multiple scales; a review of the current status, future trends, and practical considerations. They discussed the potential for assessment of land degradation by remote sensing and viewed applications of NDVI for land degradation assessment. Also they represented main global NDVI datasets and databases. Gezahagn *et al*. (2016), fulfilled a master thesis about spatial assessment of NDVI as an indicator of desertification in Ethiopia using Remote Sensing and GIS. The thesis studied the NDVI and rainfall at station level with respect to times. The result stated that small changes in NDVI over the study area detected, as about 41.75% of the total area of Ethiopia, had a very small positive trend. Igor et al (2016), studied the trends in NDVI associated with urban development in north west Siberia. In their findings, they reviewed details of the NDVImax analysis for 1981-1999. They finalized that disturbances of the vegetation cover around 28 cities considerably modified the observed complex pattern of the background NDVImax trends.

6- Results presentation and Discussion:

The images used in this analysis were chosen in a seasonal manner. Images were collected during the dry periods (March, April, and May) to meet the objective of discovering seasonal variations. The long term period is 33 years from 1972 to 2005.

A comparison of NDVI trends and rainfall data indicated that the trends of NDVI values were highly assessed in relation to the rainfall behavior in the study area. The maps of NDVI images in years 1972, 1984, 1987, 1990, 1992, 2000, and 2005 indicated the signs of such relationship between vegetation greenings and rainfall with association to the dryness seasons. NDVI Spatio-temporal maps for assessing greenness change depend on the NDVI outputs values.

6-1 NDVI Results presentation:

6-1-1 NDVI Maps interpretation:

(1972) NDVI Map 1: Good rainy season in 1972 (327.7) mm accounted for much of increased greenings observed in the study area. Very high NDVI values over the study area were observed in the southern parts, while the very light greenings as the NDVI interpreted were found in the north parts of the area where the severity of deforestation is high. Another important observation realized from the field (ground truth) that the occurrence of the land cover good greenings also zoned along the khors and water depressions Fig (2/a).

(1984) NDVI Map 2: Considering the historical background of this year about the severe drought over the western Sudan, we can depict that 60% of the NDVI values indicated sparse vegetation and about 30% are very light. This was the most severe drought year over the Sudan that affected severely the growth of the vegetation as the rainfall received for this season was about 127 mm (Fig 2/b).

(1987) NDVI Map 3: During this year satellite image from which NDVI was calculated, showed NDVI values ranged between moderate to light with small areas accounted a very light greenings. The difference between 1972 and 1987 outputs, showed the same vegetation greenness conditions as the rainfall recorded in both years were (327.7) mm and (271.8) mm, respectively Fig (2/c).

(1990) NDVI Map 4: So far the NDVI values calculated for this season indicated the typical conditions in 1984 as both were drought years with rainfall (150) mm in 1990 and (127) mm in 1984. The less better rainfall in this season decreased the scale of very light greenness to sparse greenness(Fig 2/d).

(**1992**) **NDVI Map 5**: During this season there were increasing positive greenness indictors stretching from south to north of the study area as depicted from NDVI positive values. The increased NDVI values trends across the north part of the study area depicted that the rain precipitated during this season was over the normal annual rainfall and more deviated from the history of the rainfall in the area (514.7) mm, which reflected significantly upon the vegetation cover intensity all over the area (Fig 2/c).

(2000) NDVI Map 6: During this season, NDVI calculated showed negative values indicated bare land as the red color marked some dispersal areas further northeast of the study area. This map noticed multi scales of NDVI ranges with good greenings, moderate and light. The positive NDVI values accounted (75%) of the total calculations (Fig 2/f).

(2005) NDVI Map 7: The rainfall amount during this year recorded (237.8) mm associated with the positive NDVI values over the study area, with the exception of some areas that showed very light to light greenness with minimum rate (5%) as compared to the total NDVI values calculated (Fig 2/h).

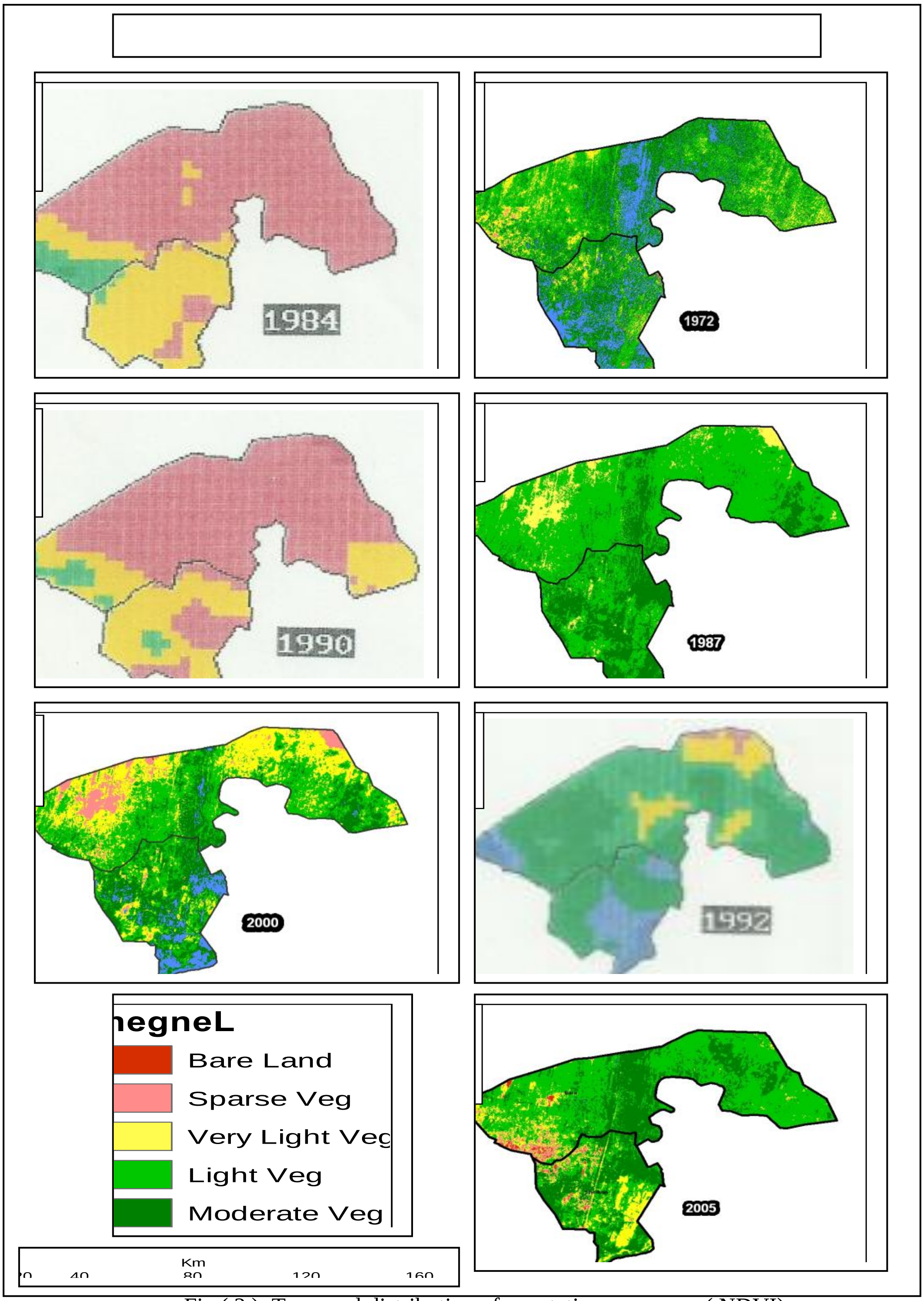

Fig (2): Temporal distribution of vegetation greenness (NDVI)

6-1-2 Overall NDVI Results interpretation:

The general range of NDVI values over the periods (1972—2015)were scaled in 6 indicators; bare land, sparse, Very light, light, moderate and dense vegetation. The appropriate maximum NDVI value was found for dense vegetated areas spatially found in green belts or batches of the Khors and water logged depressions.

The overall NDVI differences between 1972 and 2005 within the study area were classified according to the rainfall season. In fact the values of 1984 and 1990 were a much drier than 1972 1992 and 2005

Colour palette used contains darker green that indicates mostly dense or high greenness status (luxuriant vegetation). Yellow and light green indicate moderate conditions of vegetation, while red colour indicates sparse vegetation (areas of less or dispersal vegetation). As a normal conclusion, averaged values of NDVI "greenings" consistently lower under the sparse and bare lands conditions, because high NDVI values were confined to the dense vegetation areas.

6-1-3 Negative NDVI interpretation:

Minimum NDVI is the lowest value that occurs in any one year (annual). Variation in minimum NDVI may serve as a base line for other parameters (Bai, 2006). From (Fig 2/b-d) the real Minimum NDVI values were depicted during the seasons 1984 and 1990 which indicated less rainy season with less plants growth. The less greening trend occurred in areas vulnerable to drought and highly exposed to severe soil degradation. This gives negative NDVI trends (Reddish) which was associated with sandy, over cultivated and overgrazed areas.

The negative values over the study area may be caused by deforestation and heavy traditional shifting cultivation. Negative values on the other hand were attributed to the fact that majority of the study area became deforested and it's greenings would only react more instantly to seasonal rains.

6-1-4 Positive NDVI clarifications:

Maximum NDVI represents the maximum green biomass; the large spatial variations reflect the diverse landscapes and climate (Bai, 2006). So from the figures the maximum NDVI values calculated during the seasons of 1972, 2000, 2005 indicated good rainy season that yielded intense vegetation cover. The positive values in the study area indicated a good rainy season in 1995 which was an above average rainy season that witnessed torrential rainfall with high vegetation cover intensity and intense seasonal vegetation cover.

6-2 Rainfall and NDVI relationship:

The main annual precipitation showed maximum amplitude during 1960s and 2000s. During 1980s and earlier 1990s rainfall values were lesser than the mean values shown mainly in 1984 (the destructive drought). Positive trends were recognized in 1960s and 1970s and late 1980s and 1990s; meanwhile precipitation tends to denote from the mean during drought years.

Basic statistics of annual rainfall for three main stations in the study area (table 2) showed that Bara had less rainy average located in a very dry zone continuously exposed to drought. In 1984, all meteorological stations surrounding the study area received less than the normal rainfall average.

In the study area, there was a strong relationship between less vegetation cover greenings and drought years (low rainfall) (table 3). Rainfall decreased in drought seasons with an annual amount less than the normal average (e.g. in 1984). This reduces the intensity of the plants and handicapped the photosynthesis operation .

Mean rainfall patterns during 1980s showed that droughts were usually confined to the Northern and Western parts and were very much severe than those that occurred during 1970s and 1990s.

Table (2): Study area Rainfall Statistical Variability1972-2010

Station	Mean	S.D	Max.Value		Min.Value	
ElObeid	**322.8**	**68.7**	**422.8**	**1979**	**161.4**	**1984**
Bara	**21804**	**83.1**	**383.0**	**1972**	**75.0**	**1985**
UmRuaba	**364.7**	**64.5**	**338.0**	**1993**	**176.0**	**1984**

The overall trend of the rainfall in Fig (3) showed that the deviation of the rainfall annual records from the mean over 40 years (1968 to 1998) which showed a historical background about the drought occurrence and vegetational cover problems. The area did not have much clear pattern of rainfall variability. There were 9 years that were negatively accounted around the normal rainfall average, 1968, 1969,1984,1985,1990, and 1991. Among them 1984/85 and 1990/91 were the worst droughts affected areas in vegetation cover condition, as well as agricultural and hydrological related functions.

Table (3): NDVI and Rainfall Assessment

Years	NDVI Assessment	Rainfall (mm) ElObeid	Rainfall (mm) Bara
1972	**Very high**	**327.7**	383
1984	**Very low**	**127**	115
1987	**High**	**271.8**	137
1990	**Very low**	**199.5**	150
1992	**Very high**	**514.7**	411
2000	**Moderate**	**314.5**	-
2005	High	237.8	-

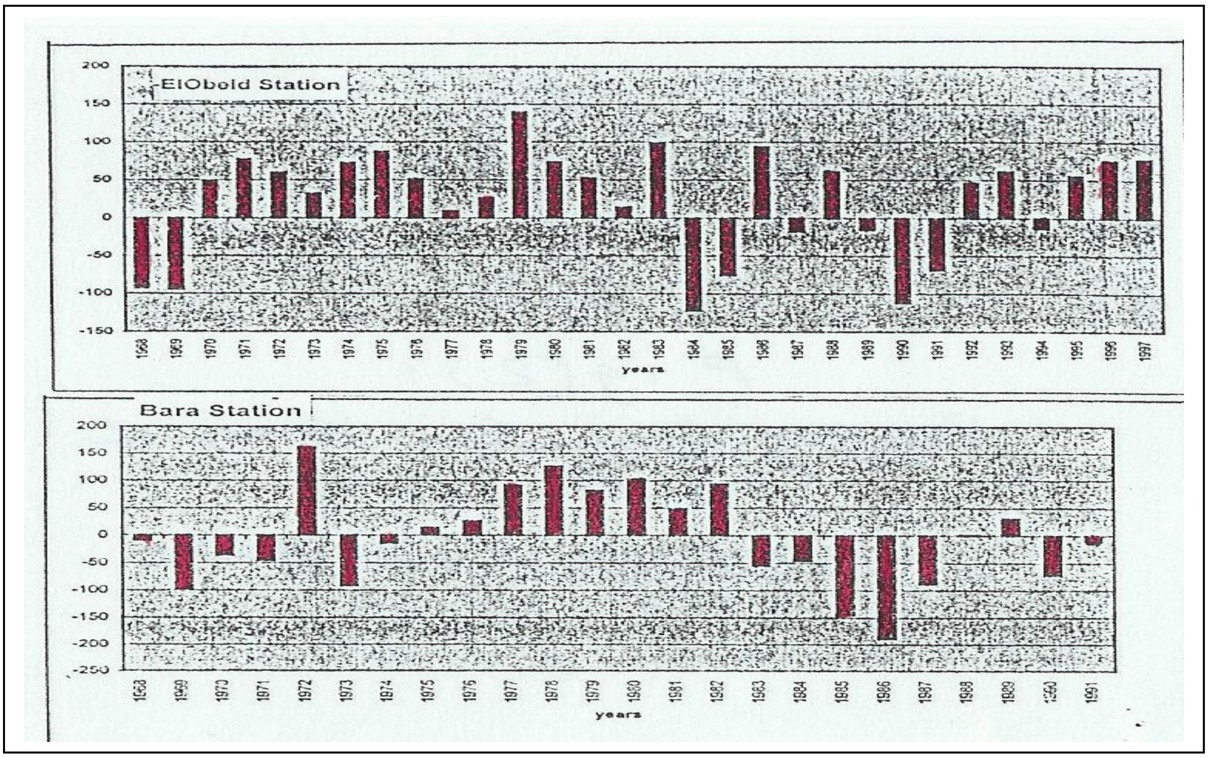

Fig (3): Rainfall values deviated from the Mean (1968-1997)

6-3 Vegetation cover degradation from (1970-2005):

Previous studies of north Kordofan (Abo sin, 1970; Suaad, 1979; Khogali, 1984; Andrew, 1984) showed significant decrease in tree density and species diversity in the last 30years of 20^{th} century. All changes were directly related to land degradation (caused by climate variability and human activities).

Table (4) represents the tree species and their natural occurrences as measured from the field. From the table, the Hashab species were still dominant and well distributed due to the Hashab reforestation programs. Marikh (*Leptadenia arborea*) also appeared in high density and occupying Quz areas, and used by the indigenous people as firewood as well as building materials. Some of the tree species had disappeared over the study area such as Talh (*Acacia seyal var fistula*)and Sarah (*Maerua crassifulia).* The important indication for the environment is that the Usher *(Calotrpic procera)* had declined over the area which gave away for Hashab (*Acacia seyal var seyal*) to recover naturally under adaptive conditions (soil properties).

Table (4) Tree Species Coverage identification in the study area

Latin name	*Local name*	*Relative density %*	*Frequency%*
A.sayal vor sayal	**hashab**	**17,3**	**36,3**
A.sayal vor fistula	**talih**	**0**	**0**
A.tortilles	**samor**	**.,5**	**6,2**
A.nilotica	**sunot**	**1,2**	**3,7**
A.mellifera	**kitter**	**.,8**	**9,2**
A.dansonia digitata	**tabaldi**	**1,4**	**8,2**
Grewia tenax	**godeem**	**17,3**	**36,3**
Maerrua crassifulia	**sarh**	**0**	**0**
Calotropis procera	**osher**	**.,5**	**6,2**
Balanites aegyptica	**higlig**	**1,2**	**3,7**
Guiera sengalensis	**gobeash**	**.,8**	**9,2**
Z.spina- christi	**sedir**	**1,4**	**8,2**
Ieptadenia arborea	**marakh**	**17,3**	**36,3**
Prosopis chilensis	**misskeet**	**0**	**0**
Terminalia brownii	**sobag**	**.,5**	**6,2**
A.albida	**haraz**	**1,2**	**3,7**
Capparis decidua	**tondob**	**.,8**	**9,2**

Sourse: Field survey,2017

Table (5) gives a general assessment about the tree species density as the researchers used the scale of three parameters (Few/dominant, Disappeared and decreased). Among the administrative councils and Bara locality, there were great variations. Except Kazgiel and Abu Haraz councils, all the rest of the study area suffered from practising tree cutting in significant rates. Bara and Abu Haraz were the two neighboring areas that witnessed high degree of tree cutting that coincided with the drought periods. The history of this area was a forestry habitat of diverse plants and animals species.

Table (5) Tree species coverage Assessment in the study area

Latin name	Local name	Few /dominant				Disappeared				Decreased			
		1	2	3	4	1	2	3	4	1	2	3	4
A.sayal vor sayal	hashab												
A.sayal vor fistula	talih												
A.tortilles	samor												
A.nilotica	sunot												
A.mellifera	kitter												
A.densona digitata	tabaldi												
Gerwia tanar	godeem												
Maerrua crassifulia	sarh												
Calo tropis procera	osher												
Balanites aegyptica	higlig												
Guiera sengalensis	gobeas h												

Z.spania christi	sedir												
Ieptadenia arbora	marakh												
Prosopis chilensis	misskee t												
Trminalia browni	sobag												
A.albida	haraz												
Capparis decadua	tondob												

Source: Field survey, 2017 1=Kazgail, 2=Abu Haraz, 3=Bara, 4=Um Usheara

7- Conclusion:

Selected image incidents for 7 years were used for calculating NDVI in the temporal compared maps. The resultant temporal maps indicated the major vegetation greenness incidents in the study area. During the span of 33 years of land sat remote sensing satellite data and rainfall data in North Kordofan State, Sudan to study the vegetation greening changes using the most familiar and potential vegetational indices (NDVI). Indicatively, the deforestation and tree clearance that occurred over the study area gave some negative NDVI values over the study area. Among the span of years, 1984 and 1990 seasons showed more negative values than positive ones, while 1987, 1992,200 and 2005 NDVI values indicated good vegetated conditions.

Relationships between the seasonal variations in the NDVI and rainfall variable were assessed. The rate of the greenness incidents for the selected images decreased and increased with the effect of rainfall intensity during the season. The NDVI incidence maps clearly visualized the differences and indicated where positive NDVI were for good seasons. That gives the NDVI its efficiency and maturity as one of the potential vegetational indices.

The researchers recommend that these research finding has let to suggest that more in-depth study of this kind of research has to be taken by integrating the spatial data, climate data and mathematical functions with very high spatial resolutions.

References

[1]. **Agriculture Statistic Office (1990):** Report on crop production statistics, North Kordofan State, Sudan, El-Obeid Town.

[2]. **Anne Schucknecht, Stefan Erasmi, Irmgard Niemeyer & Jörg Matschullat (2013):** Assessing vegetation variability and trends in north-eastern Brazil using AVHRR and MODIS NDVI time series. European Journal of Remote Sensing ISSN: (Print) 2279-7254 (Online) Journal homepage: http://www.tandfonline.com/loi/tejr20

[3]. **Ashbindu Singh (1989):** Digital Change detection techniques using remotely sensed data, International Journal of remote Sensing, Vol.10, Issue 6, pp 989-1003.

[4]. **Bai.Z.G and D.L. Dent (2006**): Global Assessment of land degradation and Improvement: Piolt study in Kenya, Report 2006/07, World Soil Information (ISRIC), FAo.

[5]. **Braun Matthiasa & Herold Martin (2003**):Mapping imperviousness using NDVI and linear spectral unmixing of ASTER data in the Cologne-Bonn Region (Germany). Proceedings of the SPIE 10th International Symposium on Remote Sensing, 8-12 September 2003, Barcelona, Spain

[6]. **Coppin, P.; Jonckheere, I.; Nackaerts, K.; Muys, B.; Lambin, E.** (2004): Digital change detection methods in ecosystem monitoring: A review. *Int. J. Remote Sens.* **2004**, *25*, 1565–1596.

[7]. **Field C b, JT Randerson and C M maelstrom (1995):** Global Net primary production: combining ecology and remote sensing, remote sensing of Environment 51,74-88.

[8]. **Gamon, J.A.; Field, C.B.; Goulden, M.L.; Griffin, K.L.; Hartley, E.; Joel, G.; Peñuelas, J.; Valentini, R. (1995):** Relationships between NDVI, canopy structure, and photosynthesis in three Californian vegetation types. *Ecol. Appl.* **1995**, *5*, 28–41.

[9]. **Geerken R, B. Zaitchik and J. P. Evans (2005):** Classifying rangeland vegetation type and coverage from NDVI time series using Fourier Filtered Cycle Similarity, International Journal of Remote Sensing , Vol. 26, No. 24, 20 December 2005, 5535–5554

[10]. **Genesis T. Yengoh, David Dent, Lennart Olsson, Anna E. Tengberg, Compton J. Tucker (2014**): The use of the Normalized Difference Vegetation Index (NDVI) to assess land degradation at multiple scales: a review of the current status, future trends, and practical considerations. Lund University Centre for Sustainability Studies –LUCSUS.

[11]. **Gezahagn Negash Seboka (2016)**: Spatial Assessment of NDVI as an Indicator of Desertification in Ethiopia using Remote Sensing and GIS. Master Thesis in Geographical Information Science nr 51. Physical Geography and Ecosystem Science Centre for Geographical Information Systems Lund University.

[12]. **Igor Esau, Victoria V. Miles, Richard Davy, Martin W. Miles, and Anna Kurchatova (2016):** Trends in normalized difference vegetation index (NDVI) associated with urban development in northern West Siberia. Atmos. Chem. Phys., 16, 9563–9577, 2016. www.atmos-chem-phys.net/16/9563/2016/. doi:10.5194/acp-16-9563-2016

[13]. **LeHouerou, H.N., (1996):** Climate change, drought and desertification. Journal of Arid Environments, 34, pp. 133–185.

[14]. **Matthias Forkel, Nuno Carvalgais, Jan Vebesselt, Miguel D. Mahecha, Christopher S.R. Neigh and Markus Reichstein (2013):** trends change detection in NDVI Time series: effects of Inter-Annual Variability and Methodology, remote Sens., 5,2113-2144; doi:10.3390/rs 5052113, open access.

[15]. **Myneni, R.B.; Hall, F.G.; Sellers, P.J.; Marshak, A.L.** (1995): The interpretation of spectral vegetation indexes. *IEEE Trans. Geosci. Remote Sens.* **1995**, *33*, 481–486

[16]. **Lucht, W.; Schaphoff, S.; Erbrecht, T.; Heyder, U.; Cramer, W. (2006):** Terrestrial vegetation redistribution and carbon balance under climate change. *Carbon Balance Manage.* **2006**, *1*, 6.

[17]. **Potter C.S, JT Randerson, C B Field and others (1993):** Terrestrial ecosystem production: a process model based on global satellite and surface data, Global Biogeographical Cycles 7,4,811-841.

[18]. **Robert E. Burgen (1996):** use of Remotely Sensed Data for Fire Danger estimation. EarSel Advances in Remote Sensing, Vol.4.No.4.X1,1996.

[19]. **Suaad.M.T.(1979)**land degradation in north kordfan Desertification Control Bulletin.NO.75-130-vol 1.

[20]. **Tucker, C.J.(1979):** Red and photographic infrared linear combinations for monitoring vegetation. *Remote Sens. Environ.* **1979**, *150*, 127–150.

[21]. **Turner, D.P.; Cohen, W.B.; Kennedy, R.E.; Fassnacht, K.S.; Briggs, J.M. (1999):** Relationships between leaf area index and Landsat TM spectral vegetation indices across three temperate zone sites. *Remote Sens. Environ.* **1999**, *70*, 52–68.

[22]. **Tucker, C.J.; Slayback, D.A.; Pinzon, J.E.; Los, S.O.; Myneni, R.B.; Taylor, M.G.** (2001): Higher northern latitude normalized difference vegetation index and growing season trends from 1982 to 1999. *Int. J. Biometeorol.* 2001, *45*, 184–190.

[23]. **Yves Julien, Jose A. Sobrino, Cristianc Mattar others (2011):** Temporal analysis of normalized difference vegetation index (NDVI) and land surface temperature (LST) parameters to detect changes in the Iberian land cover between 1981 and 2001. International Journal of Remote Sensing Vol. 32, No. 7, 10 April 2011, 2057–2068.