In the name of God, Most Gracious, Most Merciful.

It is who produceh Garden with trellises And without, and dates, and tilth, with produce of all kinds, and olives and pomegranates similar (in kind) and different (in variety) eat of their fruit in their season, but render the dues that are proper on the day that the harvest is gathered, but was not by excess: For God loveth not the wasters (An' am section 7 Ayah (141).

بسم الله الرحمن الرحيم
وهو الذي أنشأ جنات معروشات وغير معروشات والنخل والزرع مختلفا أكله والزيتون والرمان"
متشابها وغير متشابه كلوا من ثمره إذا أثمر واتوا حـ قه يوم حصاده ولا تسرفوا إنه لا يحب المسرفي
(ن- صدق الله العظيم ..." (الأنعام- الجزء السابع- الايه 141

Dedication

This humble work is dedicated to the souls of my parents, Fattoma and Haroun whose sacrifice has made their dreams reality. I very much express my deep gratitude to you. God bless you.

Dedication to the members of my family, my wives: Amal and Nailla for their patient and continuous support. My Sisters Halima, Aisha, Mariam, Nemma and brother Adam for their endless support, help and encouragement. My sons, Hesham, El Sir, Jamal, Ahmmed and young daughter Malak for being patient.

Finally, to all researchers and peace lovers around the world.

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I wish to express my deep gratitude to all teachers and friends and Renk in Shomadi area who actively participated in conducting the questionnaires and interviews in different villages.

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Abstract

The objective of this study is to investigate the spatial-temporal land use/land cover (LULC) changes of Shomadi area at Renk County in Upper Nile State - Sudan.

The huge potentiality and the rich vegetation cover of Shomadi area is seriously deteriorated due to increasing irrational anthropogenic activities.

All attempts to manage these resources in sustainable manner failed due to limitation of information. Therefore it became necessary to carry out this study with the objective to produce thematic maps for the period 1973-2010 which can facilitate capabilities of planning, monitoring and management of these resources.

To achieve this objective, field work is carried out. This includes geospatial technology (Remote sensing, GPS and GIS), where Landsat images (MSS, TM) and SPOT-5 of November 1973, November, 1987 and November 2010 respectively are used. Images pre-processing and classification are performed adopting object oriented (O.O) segmentation technique. As a result, seven classes level-1 are obtained. Along with this, soil samples are taken. They are analyzed in the laboratory to investigate the NPK, soil pH and Electrical conductivity. Then accuracy assessment is carried out. An overall accuracy (OA) of 94.09% and kappa accuracy of 91.26% are obtained.

Nevertheless, vegetation attributes are also studied by Muller method, the so called “Point Centered Quarter method (P C Q)”. Moreover, secondary data are collected; observations are listed, personal interviews and questionnaire are also conducted.

The field data are analyzed by SPSS, GIS and PC. However, the results of ERDAS imagine version and statistical analysis showed a remarkable decrease in forest lands from 48% to 25%, water bodies from 0.9 % to 0.5%, swamp area from 1.4% to 1.3% during 1973-2010. While data of the mechanized rain-fed farming reflected continuous gain from 16% in 1973 to 29% in 2010. However, similar trend of change showed by rangeland which was 33% of the total area in 1973 and it became 43.1% in 2010. The irrigated agriculture was 1% of the total area in 1973, but increased in 2010 to become 1.6% of the total area.

The settlement area was not shown in 1973 because of application of Low and Medium Resolutions (MSS and TM), but it is shown up when high resolution (SPOT-5) is applied in 2010 to represent about 0.03% of the total area.

The frequency distribution of the dominant species showed great variability depending on soil type, pattern of rainfall distribution and severity of human activity.

The tree density ranges between 28-1639 trees/ ha. where *Acacia mellifera* reflected the highest frequency distribution (96%), followed by *Cadaba rotundifolia* (59%) and *Acacia nubica* (44%), meanwhile the *Albizzia sericocephala* showed the lowest value of frequency (1%).

In conclusion, irrational land use/land cover resulted in decrease of vegetation lands, losses of wildlife and habitats, negative impact on hydrological cycle, socio-economic and environmental settings.

The study recommends the introduction of new farming system of profound produce and compatible with environmental settings and sustainable to development projects.

Afforestation of the mechanized rain-fed areas with suitable *A. species*.

Further study is needed to quantify reported water regime change, vegetation and games endangered and extinction species and the underlying factors responsible using high resolution satellite images.

Introduction of new rules and ordinances that regulate vegetation and land use utilization. Also; the local communities should be participation in formulating and implementing these rules and ordinances should be encouraged.

ملخص البحث:

إن الهدف من هذا البحث هو دراسة البعدين الزمانى والمكانى للتغيير في استخدام الارض والغطاء النباتى في منط قة شومدي في م قاطعة الرنك بو لاية أعالى النيل- السودان.

إن الإمكانيات الكبيرة للغطاء النباتي الغنى فى منط قة شومدى تعرضت لتدهور خطير نتيجة لتنامى النشاط البشرى غير الراشد.

كل المجهودات التى بذلت لإدارة هذه الموارد بصورة مستدامة قد فشلت لعدم توفر المعلومات الكافية. لذا أصبح من الضرورى إجراء دراسة بغرض الحصول على خرائط غرضية للفترة من 1973 الى 2010 والتى يمكن ان ترفع من ال قدرات فى عـ مليات رصد- إدارة وتخطيط الموارد الطبيعية. ولتحـ قيق هذا الهدف, تم إستخدام التـ قانـ ات الفضائية المدعومة بالبيانات الحـ قلية. حيث تم إستخدام صورال قمر الصناعى الأمـ ريكي لاندسات 'MSS و. MT إضافة لصور ال قمر الصناعي الفرنسي SPOT-5 (للفـ ترة 20 /نوفمبر/ 1973, 1978 و 2010 علي التوالى). كما تمت معاملة الصور ال جودية قبل التصيف بغرض التخلص من بعض العيوب التي قد تحدث خللا في عمليـ ات التصنيف وتفسير المرئيات. ومن ثم أجريت عملية التصنيف باعتماد تـ قنيات (Object Oriented .Based Segmentation Technique (O.O . لـ قد تم الحصول علي 7 رتب من المستوي الاول. بجانب ذلك تم أخذ عينات للتربة تم تـ حليلها في المعمل بغرض دراسة النيتروجين – الفسفور – الكالسيوم – ألاس الهيدروجينـ ى والنوصيل الكهربي. ومن ثم أجريت عملية تـ قييم الد قة. بلغت نسبة الد قة الكلية لـ لتصنيف) 94.09) ونسبة 91,26% Kappa .

ليس هذا فحسب, بل إن الخاصائص النباتية تمت دراستها بطريقة Muller والمعروفة "Point Centered Quarter method (P C Q)".. علاوة علي ذلك تم جمع البيانات الثانوية- تم تسجيل الملاحظات كما أجريت المقابلات الشخصية وأعدت الإستبيانات.

البيانات الحقلية تم تحليلها إحصائيا ((SPSS- نظم المعلومات الجغرافية (GIS) والحاسوب (PC).

إن نتائج تحليل ERDAS والتحليل الاحصائى بينتا انخفاضا ملحوظا في المساحات الغابية من 48 % الي 25 % , المسطحات المائية من 0.9 % الي 0.5 % – الاراضي المغمورة بالمياه 1.4 % الي 1.3 % وذلك في الفترة من 1973 الي 2010. بينما مساحات الزراعة الألية المطرية قد زادت بصورة مضطردة (16 % في 1973 الي 29 % في 2010). و المراعي من 33% الي 43% لنفس الفترة. مساحات الزراعة المروية التي كانت تمثل 1% من اجمالي المساحة الكلية في عام 1973 بلغت 1.6% في 2010.

المستوطنات التي لم تظهر مساحتها في 1973 و 1987 قد ظهرت في 2010 نتيجة لاستخدام SPOT-5 (High Resolution) والتي بلغت 0.03 % من جملة المساحة الكلية.

التوزيع التكراري بين تباينا في توزيع وسيادة بعض عينات من النباتات وذلك بناءاً علي نمط توزيع الهطول المطري – نوع التربة وكثافة النشاط البشري في المنطقة. ان كثافة الاشجار تتراوح بين 28 الي 1639 شجرة في الهيكتار الواحد. سجلت اشجار الكتر *Acacia mellifera* أعلي تردد (96%) في التوزيع التكراري, ثم الكرمت

(59% *Cadaba rotundifolia*) و اللعوت (44% *Acacia nubica*), بينما سجل العرد *Albizzia sericocephala* ادني ر قم للتردد (1%).

الخلاصة إن الإستخدام الغير راشد للأراضي والغطاء النباتي أدي الي إنخفاض في المساحات المغطاه بالنباتات, وإختفاء الحياة البرية وبيئتها الي جانب الاثر السلبي علي الدورة المائية - المكون الاجتماعي - الا قتصادي والبيئ.

توصي الدراسة ادخال نظم مزرعية جديدة مثل التشجير الزراعي والتي يمكن أن تعطي إنتاجاً وفيرا فضلاً عن ملاءمتها لمكونات البيئة ومشروعات التنمية المستدام ة. كما توصي بتحديد مساحات في مشاريع الزراعية الالية المطرية لزراعتها بعينات م ناسبة من الاشجار.

هنالک حاجة ماسة لإجراء مزيد من الدراسات فيما يتعلق بالتغيير في نظام الدورة المائية - الغطاء النباتي- الحياة البرية والانواع المهددة بالإن قراض الي جانب ال عوامل المسببة لذلک وذلک بإستخدام ت قانات ذات قوة تمييزإ قراري عالي.

كما توصي الدراسة بسن ال قوانين والأوامر التى تحكم و تنظم إستخدام الاراضي وإستغلال الغطاء النباتي في المنط قة. تشجيع المجتمعات المحلية للمشاركة في سن هذه ال قوانين والاوامر وتطبي قها.

Abbreviations

ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer

AEZ	Agro-Ecological Zone.
ANOVA	Analysis of Variance.
ANN	Artificial Neural Networks.
AOI	Area of Interest.
CCTs	Computer-compatable tapes
CVA	Change Vector Analysis
CEC	Cation Exchangeable Capacity.
CLUSTERS	Classification for Land Use Statistics: Eurostat Remote Sensing Programme.
CO_2	Carbon dioxide.
DN's	Values or digital numbers.
EC.	Electrical Conductivity.
EMR	Energy Magnetic Radiation.
ENRRI	Environmental and Natural Resources Research Institute.
EVI	Enhanced Vegetation Index.
ETM+	Enhanced Thematic Mapper Plus..
ERS-1	Earth Resource Satellite-1
FCC	False Color Composite.
FPM	Forest Pest Management Program.
NASA	Nationa Aeronautic Space Administration.
CDF	California Department of Forestry's.
FRAP	Forest Resource and Assessment Program.
ERDAS	Earth Resources Data Analysis System.
FAO	Food and Agriculture Organization of the United Nations.
GIS	Geographic Information System.
GPS	Global positioning System.
GCP's	Ground Control Points.
GS	Gramm-Schmidt.
HCD	Hybrid Change Detection.
IRS	Indian Remote Sensing Satellite.
LC	Land Cover.
LULC	Land use land cover.
LUT	Land Utilization Types.
LU/LC	Land Use Land classification.
LUCC	Land Use and Land Cover Change.
MSS	Multi- scanner sensor.
MEA	Millennium Ecosystem Assessment.
MODIS	Moderate Resolution Imaging Spectroradiometer.

NGOs	Non Governmental Organizations.
NDVI	Normalized Difference Vegetation Index.
NPK	Nitrogen, Phosphorous and potassium.
JRC	Joint Research Centre.
JPEG	Joint Photographic Experts Group.
PH	Base (10) of the activity of hydrogen ions (H^+) in solution.
PCA	Principal Component Analysis.
PC	Personal Computer.
PAT	Population, Affluence, and Technology.
PCC	Post-Classification Comparison.
PCQ	point-centered quarter method.
RS	Remote sensing.
UCD	Usupervised Change Detection.
SIC	Standard Industrial Classification system.
OE	Omission Error.
CE	Commission Error.
PA	Producer accuracy.
UA	User accuracy.
OA	Over all accuracy.
O.O	Object Oriented classification technique
KA	Kapa Accuracy.
STCA	Spectral-Temporal Combined Analysis.
PAT	Population, Affluence, and Technology.
SPOT HRV	Satellite Probatoire d'Observation de la Terre (SPOT) high resolution visible image
SPSS	Statistical Package for Social Sciences.
TCA	Thematic change analysis.
KC	Tasseled Cap.
TM	Thematic Mapper.
UTM	UinversalTranfer Marchater.
UV	Ultra Violet.
USGS	Unites States Geographic Society.
VCF	Vegetation Continuous Field.
USDA	United States Department of Agriculture.
WBE	World Bank and Environment.
WRI	World Resources Institute.

Geometric/Geodetic: The positional accuracy with which the image represents the surface (pixel coordinates vs. known ground points)

Spatial: The accuracy with which each pixel represents the image within its precise portion of the surface and no other portion

Spectral: The wavelengths of light measured in each spectral "band" of the image

Radiometric: Accuracy of the spectral data in representing the actual reflectance from the surface.

Satellite imagery: Remote sensing imagery gathered by earth-orbitingsatellites, including Landsat and Spot. Images are in specific wavebands (visible, infrared, etc.) which may be combined for purposes of interpretation. Images look like photographs but are not obtained by photographic methods, hence the term "images" or "imagery". Data from satellite imagery can be interpreted visually or analysed by computers in digitized form; they can also be entered directly into geographic information systems.

Digitization: A process of converting an image recorded on photographic film (radar, aerial photographs or thermal infera red) into an ordered array of pixels.

Image restoration: Restoration processes are designed to recognize and compensate for error and geometric distortion that occurs during the transmission, scanning, and recording processes

M**ultispectral sensor**: is characterized as a passive sensor. Passive sensors: record energy that is naturally reflected or emitted from a target. In active sensors: supply their own source of energy, directing it at the target in order to measure the returned energy.

A spectral band: is a data set collected by the sensor with information from discrete portions of the electromagnetic spectrum.a

range of electromagnetic radiation ranging from cosmic waves to radio waves.

A signature: is a set of statistics that defines the spectral characteristic of a target phenomenon or training-sites.

Spatial resolution: is the minimum size of terrain features that can be distinguished from the background in an image, or the ability to differentiate between two closely spaced features in an image. It is also defined by the area on the ground that a pixel represents in a digital image file.

Resolution: is an important term commonly used to describe remotely sensed imagery. However, there are four distinct types of resolution that must be considered. These four types of resolution are spatial, spectral, radiometric, and temporal. These resolution characteristics help to describe the functionality of both remote sensing sensors and remotely sensed data (ERDAS, Field Guide, 1999). Different types of resolution are known. These are:

Spectral resolution: it refers to the number and dimension of specific wavelength intervals in the electromagnetic spectrum to which a sensor or sensor band is sensitive or can record. Wide intervals in the electromagnetic spectrum are referred to as coarse spectral resolution, and narrow intervals are referred to as fine spectral resolution.

Radiometric resolution: it refers to the dynamic range, or number of possible data file value in each band. This is referred to by the number of bits into which the recorded energy is divided. The total intensity of the energy, from 0 to the maximum amount, the sensor measures is broken down, for example, into 256 brightness values for 8-bit data. The data file values range from 0, for no energy return, to 255, for maximum return, for each pixel.

Temporal resolution: is a measure of how often a given sensor system obtains imagery of a particular area, or how often an area can be revisited. The temporal resolution of satellites are on a fixed schedule. The fixed schedule of satellites allows for more repetitive views. This revisit capability makes it possible to use several passes, perhaps covering two or three seasons or multiple years, for interpretation. In addition, new satellite technology is incorporating pointable or directional sensors allowing for even quicker revisit capabilities. Temporal resolution is an important factor to consider in change detection studies. Landsat 5 can view the same area of the globe every 16 days (Wilkie & Finn, 1996).

Computer-Computable Tapes (CCTs): data aquired by sattelites are recorded on CCTs, which can be read and processed by computers.

Digital numbers (DN's): It is the numerical value that records the imtensity of electromagnetic energy measureed for the ground resolution cell represented by the pixel.