

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).

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ
وهو الذي أنشأ جنات معروشات وغير معروشات والنخل والزرع مختلفا أكله والزيتون والرمان
متشابها وغير متشابهه كلوا من ثمره إذا أثمر واتوا حقه يوم حصاده ولا تسرفوا إنه لا يحب المسرفين
(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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List of contents

	Page number
Dedication	i
Acknowledgment	i i
List of contents	iv
List of tables	vi
List of figures	x
List of plates	xii
Abstract in English	xiv
Abstract in Arabic	xvi
Abbreviation	xviii
Glossary	xxii
Reference	
Appendix	

S/No.	Particular	Chapters	Page No.
Chapter One: Introduction			
1.1	Background		1
1.2	Location of the study area		3
1.3	Physical attributes		5
1.4	Soil		10
1.5	Natural resources base		10
1.6	Land use in Shomadi area		14
1.7	Economic activities		14
1.8	Statement of the problem:		16
1.9	Significant of the Research Study and its Justification		17
1.10	Aims and Objective		18
1.11	Research questions		19
1.12	Research hypothesis		20
1.13	Thesis Outline		20
Chapter Two: Literature Review & Conceptual framework			
2.1	An overview		22
2.2	Literature Review		22
2.3	The situation of the world vegetation Cover		38
2.4	Human-Environment Interaction Relations		39
2.5	The Natural Resources Exploitation Models		41
2.6	Ecosystem Stability		44
2.7	Population Dynamics and Environmental Resistance		45
2.8	Ecological Resilience		45
2.9	The Distinctive Difference between Land use and Land cover.		46
2.10	The Significance of (LU) & (LC) Information for Planners & Land use managers		51
2.11	The theory of (LU) Change		52
2.12	Scale of analysis of (LU) change		54
2.13	Land Use Type, Utilization, Classes and Classification		64
2.14	Drivers of Land Use and Land Cover Change		71
2.15	The Tools of Geo-informatics for (LU) and (LC) Change Detection		73
2.16	Contemporary Communication, Research, and Publication Technology		74
2.17	Historic Perspective to the Technological Innovation of Geo-informatics		75
2.18	GIS as an Integrating Technology		76
2.19	Remote Sensing for (LU) & (LC) Change Information		79

	Acquisition & Detection	
2.20	A Short Historic Perspective to the Rise & development of Remote sensing	87
2.21	Remote Sensing Software	88
2.22	Land (Use) & (LC) Change Detection	89
2.23	Ground Truth Verification:	103
2.24	The Purpose of Land Use Change Analysis	104
2.25	Accuracy Assessment	106
	Chapter three: Methodology & Field Observation Procedures	
3.1	Introduction	108
3.2	Field work	110
3.3	Satellite Imageries	111
	Chapter four: Results and discussion	
4.1	Pictorial analysis:	140
4.2	Satellite Remote Sensing Data	149
4.3	Results of Field Work Data Analysis	153
4.4	Database Generation	159
4.5	Questionnaires:	215
4.6	Interviews	21
		9
4.7	Observations:	22
		0
	Chapter five: Conclusion and Recommendations	
5.1	Conclusion	168
5.2	Recommendations and Future Research:	170

List of Tables

S/No	Particulars	Page No.
1	Table 1: Average Temperature ° C of Shomadi at Renk County (1972-2010).	6
2	Table 2: Rainfall in Shomadi area at-Renk County during 1972-2010	7
3	Table 3: Tree species of Shomadi area at Renk County (2010).	11
4	Table 4: Grass/weeds species of shomadi at Renk County (2010).	12
5	Table 5:Population of Shomadi area at Renk (1973-2010).	12
6	Table 6 :Animal Resource in study area at Renk County during 1973-2010)	14
7	Table 7: Satellite Data sources	112
8	Table 8: Vegetation Samples Recording Methods-Shomadi Area	137
9	Table 9: The frequency distribution of trees in Shomadi (2010)	138
10	Table 10: Frequency distribution of other plants in the study area (2010).	139

11	Table 10: Data Source of Shomadi area (Annex)	124
12	Table 11: Statistical analysis of LULC derived from Landsat 1973, 1987 and SPOT-5 2010 of Shomadi (2010).	153
12	Table 12 : LULC cover category distribution derived from landsat MSS 1973, TM 1987 SPOT-5 of Shomadi(2010)	153
13	Table 13: Land use land cover category and percentage-Shomadi (1973-2010), Derived from table 11.	153
14	Table 14: Land use land cover changes and change percentage (ha).	153
15	Table 15: Land use/land cover conversion during the period 1973- 1987	154
16	Table 16: Land use/land cover conversion during the period 1987-2010	154
17	Table 17: Error matrix accuracy totals for the classified image (2010).	168
18	Table 18: Error matrix accuracy assessment- Soil classification for the SPOT-5 classified image (2010)	170
19	Table 19: One-way ANOVA analysis of Rainfall (1973-2010) – Shomadi (2010)	173
20	Table 20: Multi-comparison analysis of Rainfall March compared with the other months - Shomadi (2010)	173
21	Table 21: Multi-comparison analysis of Rainfall -April compared with the other months - Shomadi (2010)	173
22	Table 22: Multi-comparison analysis of rainfall of May compared with the other months - Shomadi (2010).	174
23	Table 23: Multi-comparison analysis of rainfall of June compared with the other months-Shomadi (2010).	174
24	Table 24: Multi-comparison analysis of rainfall of July compared with the other months-Shomadi (2010)	174
25	Table 25 :Multi-comparison analysis of rainfall-August compared with the other months-Shomadi (2010)	175
26	Table 26 :Multi-comparison analysis of rainfall -September compared with the other months-Shomadi (2010)	175
27	Table 27 :Multi-comparison analysis of rainfall -October compared with the other months-Shomadi (2010)	175
28	Table 28 :Multi-comparison analysis of rainfall-November compared with the other months-Shomadi (2010)	176
29	Table 29: One Way ANOVA analysis of Nitrogen (N) of Shomadi (2010).	181
30	Table 30: Multiple-comparison analysis-Nitrogen from location (A) compared with soil from other locations (2010).	181
31	Table 31: Multiple-comparison analysis-Nitrogen from location (B) compared with soil from other locations (2010).	181

32	Table 32: Multiple-comparison analysis-Nitrogen from location (D) compared with soil from other locations (2010).	182
33	Table 33: Multiple-comparison analysis-Nitrogen from location (D) compared with soil from other locations (2010).	182
34	Table 34: Multiple-comparison analysis-Nitrogen from location (E) compared with soil from other locations (2010).	182
35	Table 35: Multiple-comparison analysis-Nitrogen from location (F) compared with soil from other locations (2010).	183
36	Table 36: Multiple-comparison analysis-Nitrogen from location (G) compared with soil samples from other locations (2010).	183
37	Table 37: Multiple-comparison analysis-Nitrogen from location (H) compared with soil samples from other locations (2010).	183
38	Table 38: Multiple-comparison analysis-Nitrogen from location (I) compared with soil samples from other locations (2010).	184
39	Table 39: ONE-WAY ANOVA Analysis of Nitrogen (N) (2010).	184
40	Table 40: Multi-comparison analysis of Nitrogen (N)-three levels of depth of soils by Post HocTest (2010).	184
41	Table 41: ONE-WAY ANOVA analysis of Phosphorous (P) - Shomadi (2010).	192
42	Table 42: Multiple-comparison analysis-(P) from location (A) compared with soil samples from other locations - Shomadi, 2010	192
43	Table 43: Multiple-comparison analysis of Phosphorous from location (B) compared with soil samples from other locations -Shomadi-(2010).	193
44	Table 44: Multiple-comparison analysis of Phosphorous from location (C) compared with soil samples from other locations -Shomadi (2010)	193
45	Table 45: Multiple-comparison analysis of Phosphorous from location (D) compared with soil samples from other locations -Shomadi (2010)	193
46	Table 46: Multiple-comparison analysis of Phosphorous from location (E) compared with soil samples from other locations -Shomadi (2010)	193
47	Table 47: Multiple-comparison analysis of Phosphorous from location (F) compared with soil samples from other locations - Shomadi (2010)	194
48	Table 48: Multiple-comparison analysis of Phosphorous from location (G) compared with soil samples from other locations -Shomadi (2010)	194
49	Table 49: Multiple-comparison analysis of Phosphorous from location (H) compared with soil samples from other locations -Shomadi (2010)	194

50	Table 50: Multiple-comparison analysis of Phosphorous from location (I) compared with soil samples from other locations - Shomadi (2010)	194
51	Table 51: ONE WAY-ANOVA Analysis of Phosphorous (P)– Shomadi (2010)	195
52	Table 52: Multi-comparison analysis of Phosphorous (P) at three levels of depth of soils by Post HocTest (2010).	195
53	Table 53: One way ANOVA analysis of Potassium (K) - Shomadi area (2010).	197
54	Tables 54: Multiple-comparison analysis of Potassium from location (A) compared with soil samples from other locations of Shomadi (2010).	197
55	Tables 55: Multiple-comparison analysis of (K) from location (B) compared with soil from other locations -Shomadi (2010).	197
56	Tables 56: Multiple –comparison analysis of Potassium from location (C) compared with soil samples from other locations of Shomadi area (2010)	198
57	Tables 57: Multiple –comparison analysis of Potassium from location (D) compared with soil samples from other locations of Shomadi area (2010).	198
58	Tables 58: Multiple –comp. analysis of Potassium from location (E) compared with soil samples from other locations of Shomadi (2010)..	198
59	Tables 59: Multiple –comparison analysis of Potassium from location (F) compared with soil samples from other locations of Shomadi area (2010).	199
60	Tables 60: Multiple–comparison analysis of Potassium from location (G) compared with soil samples from other locations of Shomadi (2010).	199
61	Tables 61: Multiple –comparison analysis of Potassium from location (H) compared with soil samples from other locations Shomadi area (2010)	199
62	Tables 62: Multiple-comparison analysis of Potassium from location (I) compared with soil samples from other locations of Shomadi (2010).	200
63	Table 63: ANOVA Analysis of Potassium (K) – Shomadi (2010)	200
64	Table 64: Multi-comparison analysis-Potassium in three levels of soil depth in different soil and locations-Shomadi(2010)	200
65	Table 65: Frequency distribution of tree species in Shomadi area (2010)	206
66	Table 66: Tree species density in Shomadi (2010)	206
67	Table 67: Animal resources development in Shomadi area during the period 1972-201	212
68	Table 68: Population dynamics of Shomadi area (10972-2010).	214

69	Table 69: Personal information- Shomadi area (2010).	215
70	Table 70: Anthropogenic factors influencing land use land cover change-Shomadi (2010)	217
71	Table 71: Natural factors influencing land use land cover change in Shomadi (2010)	218

List of figures

S/No	Particulars	Page No.
1	Fig. 1: Map shows the location of Upper Nile State (2010).	4
2	Fig. 2: Map shows the location of Shomadi- the study area (2010).	5
3	Fig. 3: Rainfall in early and mid August (2010)	8
4	Fig. 4: Total rainfall in late August (2010)	8
5	Fig. 5: Rainfall amount of August as a percentage of the average (2010)	9
6	Fig. 6: Image of the study area before processing	112
7	Fig. 7: Sequential flow chart of methodology of RS and GIS for geotadabase generation	113
8	Fig. 8: Layer Stacking	116
9	Fig. 9: Steps to reate Image Mosaic	117
10	Fig. 10: Steps of Creating a subset of larger ERDAS imaging File.	120
11	Fig. 11: Raster Segmentation in Homogenous Zones	124
12	Fig. 12: Change Detection	125
13	Fig. 13: Land use land cover classification of Shomadi derived from landsat MSS (1973).	150
14	Fig. 14: Land use land cover classification of Shomadi derived from landsat TM (1987).	151
15	Fig. 15: Land use land cover classification of Shomadi derived from SPOT-5 (2010).	152
16	Fig. 16: Land use land cover distribution of Shomadi in 1973	154
17	Fig. 17: Land use land cover distribution of Shomadi in 1987	155
18	Fig. 18: Land use land cover distribution of Shomadi in	155

	2010	
19	Fig. 19: Land use and Land cover of Shomadi (1973-2010), derived from landsat MSS, 1987, TM, 1987 & SPOT-5(2010).	156
20	Fig. 20: Vegetation cover in the study area (2010).	160
21	Fig. 21: Geological map of the study area (2010)	162
22	Fig. 22: Drainage map of the study area (2010)	163
23	Fig. 23: Topography of the study area (2010)	164
24	Fig. 24: Hydrology of the study area (2010)	165
25	Fig. 25: Soil of the s area (2010)	166
26	Fig. 26: ERDAS accuracy assessment view	167
27	Fig. 27:Kappa dialog	171
28	Fig. 28: Save error matrix	172
29	Fig. 29: Average monthly rainfall distribution in Shomadi area during the period (1973-2010)	178
30	Fig. 30: Average daily maximum and daily minimum temperature- Shomadi during (1973-2010)	179
31	Fig. 31: Average Nitrogen content in three depth of soil in different locations and soil types- Shomadi (2010)	192
32	Fig.32: Potassium content in different levels of soils from different locations-Shomad (2010).	201
33	Fig. 33: PH 1:5 in three levels of soil depth-Shomadi (2010)	204
34	Fig. 34: EC in three levels of soil depth-Shomadi (2010)	205
35	Fig. 35: Relationship between NPK, PH and EC ds/m in three levels of soil depth-Shomadi(2010)	205
36	Fig.36: Tree species frequency distribution in shomadi (2010)	207
37	Fig. 37: The dominant plant (weeds and grasses) species in the study area (2010)	212
38	Fig 38: Population dynamics of Shomadi (1973-2010)	214
39	Fig. 39: Age distribution in Shomadi area (2010).	216
40	Fig.40: Different human activities in Shomadi area (2010).	216
41		217
	Fig.41: Anthropogenic factors influencing land use land cover changes in the study area (2010).	
42	Fig. 42: Natural factors influencing land use land cover changes in the study area (2010)	218

List of plates		
S/No	Particulars	Page No.
1	Plate 1: Selective cutting of <i>Acacic seyal</i> (Talih) field clearnce & charcoal making-Shomadi (2010)	140
2	Plate 2: Selective cutting of <i>Acacia mellifera</i> (Kitir) field clearnce & Charcoal making -Shomadi (2010).	141
3	Plate 3: Selective cutting of <i>Balanites aegyptiaca</i> (Heglij) for charcoal making- Shomadi (2010)	141
4	Plate 4-a: Woods of different tree species ready for charcoal making- Shomadi (2010)	142
4	Plate 4 -b: Woods of different tree species ready for charcoal making- Shomadi (2010)	142
5	Plate 5: Heap of buried woods for charcoal making (kamina)-Shomadi (2010)	143
6	Plate 6: Trees trunks for sale-Shomadi -2010	143
7	Plate 7: Charcoal sacks ready for sale -Shomadi (2010)	144
8	Plate 8: Fire in forest – Shomadi (2010)	144
9	Plate 9-a: Effect of fire on weeds, shrubs and trees-Shomadi (2010)	145
9	Plate 9-b: Effect of fires on weeds, shrubs and trees-Shomadi (2010)	145
10	Plate 10-a: Opening new roads-Shomadi- 2010	146
10	Plate 10 - b: Opening new roads - Shomadi- 2010	146
11	Plate 11: Petroleum pipe lines and new roads consume big vegetation ands-Shomadi (2010)	146
12	Plate: 12: lobbing <i>A. seya</i> (Talih) - Shomadi (2010)	147
13	Plate 13: Tree Lobbing of <i>A. senegal</i> (Hashab) tree -Shomadi- (2010)	147
14	Plate 14: Vegetation cover in the extreme northern part of Shomadi (2010).	179
15	Plate 15: Short grasses and mixed shrubs-Shomadi area (2010)	180
16	Plate 16: Vegetation cover in the extreme southern part of Shomadi (2010)	180
17	Plate 17: Cracking Clay soil of Shomadi area (2010)	185
18	Plate 18: Non - cracking Clay soil of Shomadi area (2010)	185
19	Plate 19: Sandy soil of Shomadi area (2010)	186

20	Plate 20: Lowland clay soil of Shomadi area (2010)	186
21	Plate 21: Mixed (Clay and Gravel) soil of Shomadi area (2010)	187
22	Plate 22: Red soil of Shomai area (2010)	187
23	Plate 23: Vegetation in cracking Clay soil of Shomadi (2010)	188
24	Plate 24: vegetation in non-cracking clay soil of Shomadi (2010)	188
25	Plate 25: Vegetation in sandy soil of Shomadi (2010)	189
26	Plate 26: Pure stand of <i>A.senegal</i> Hashab tree species in Shomadi area (2010)	207
27	Plate 27: Pure stand of <i>Albizia sericocephala</i> (Arrad) tree in red soil-Shomadi (2010).	208
28	Plate 28: Pure stand of <i>A. mellifera</i> (Kitir) in Shomadi Area (2010).	208
29	Plate 29: Mixed forest -Shomadi (2010)	209
30	Plate 30: Pure stand of <i>A. seyal</i> (Talih)- The endangered species- Shomadi (2010)	209
31	Plate 31: Pure stand of <i>A. nubica</i> (Lawoat)- Shomadi (2010)	210
32	Plate 32: Cattle herders after grazing, come from neighboring states –Shomadi, 2010	213
33	Plate 33: Goats and Sheep grazing –Shomadi-2010	213

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 الزماني والمكاني للتغيير في استخدام الارض والغطاء النباتي في منطقة شومدي في مقاطعة الرنك بولاية أعالي النيل - السودان .

إن الإمكانات الكبيرة للغطاء النباتي الغنى في منطقة شومدي تعرضت لتدهور خطير نتيجة لتنامى النشاط البشرى غير الراشد .

كل الجهود التي بذلت لإدارة هذه الموارد بصورة مستدامة قد فشلت لعدم توفر المعلومات الكافية. لذا أصبح من الضروري إجراء دراسة بغرض الحصول على خرائط غرضية للفترة من 1973 الى 2010 والتي يمكن ان ترفع من القدرات في عمليات رصد- إدارة وتخطيط الموارد الطبيعية. ولتحقيق هذا الهدف, تم استخدام التقانات الفضائية المدعومة بالبيانات الحقلية. حيث تم استخدام صور القمر الصناعي الأمريكية لاندسات 'MSS و MT إضافة لصور القمر الصناعي الفرنسي SPOT-5 (الفترة 20 /نوفمبر/ 1973, 1978 و 2010 علي التوالي). كما تمت معالجة الصور الجوية قبل التصنيف بغرض التخلص من بعض العيوب التي قد تحدث خلال في عمليات التصنيف وتفسير المرئيات. ومن ثم أجريت عملية التصنيف باعتماد تقنيات (Object Oriented .Based Segmentation Technique (O.O . كما تم الحصول علي 7 رتب من المستوي الاول. بجانب ذلك تم أخذ عينات للتربة تم تحليلها في المعمل بغرض دراسة النيتروجين - الفسفور - الكالسيوم - الألاس الهيدروجيني والنوصيل الكهربائي. ومن ثم أجريت عملية تقييم الدقة. بلغت نسبة الدقة الكلية لتصنيف (94.09) ونسبة Kappa 91,26% .

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

البيانات الدقلية تم حليلها إحصائيا ((SPSS- نظم المعلومات الجغرافية (GIS) والحاسوب (PC).

إن نتائج تحليل ERDAS والتحليل الاحصائى بيننا انخفاضا ملحوظا في المساحات الغابية من 48 % الي 25 % , المسطحات المائية من 0.9 % الـ 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% نفس 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 بناءً على نمط توزيع الهطول المطري - نوع التربة وكثافة النشاط البشري في المنطقة. ان كثافة الاشجار تتراوح بين 28 الي 1639 شجرة في الهكتار الواحد. سجلت اشجار الكثر *Acacia mellifera* أعلى تردد (96%) في التوزيع التكراري, ثم الكرمت

Cadaba rotundifolia (59% و اللعوت *Acacia nubica* (44%), بينما

سجل العرد *Albizia sericocephala* ادني رقم 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 - الاقتصادي والبيئي.

توصي الدراسة ادخال نظم مزرعية جديدة مثل التشجير الزراعي والتي يمكن أن تعطي إنتاجاً وفيراً فضلاً عن ملاءمتها لمكونات البيئة ومشروعات التنمية المستدامة. كما توصي بتحديد مساحات في مشاريع الزراعة الآلية المطرية لزراعتها بعينات مناسبة من الأشجار.

هناك حاجة ماسة للإجراء مزيد من الدراسات فيما يتعلق بالتغيير في نظام الدورة المائية - الغطاء النباتي- الحياة البرية والانواع المهددة بالإنقراض الي جانب ال عوامل المسببة لذلك وذلك بإستخدام تقانات ذات قوة تمييزاً قراري عالي. كما توصي الدراسة بسن القوانين والأوامر التي تحكم و تنظم إستخدام الاراضي وإستغلال الغطاء النباتي في المنطقة. تشجيع المجتمعات المحلية للمشاركة في سن هذه القوانين والاورامر وتطبيقها.

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-compatible 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	Unsupervised 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	Universal Transfer 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-orbiting satellites, 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 infrared) 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

Multispectral 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.

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 acquired by satellites are recorded on CCTs, which can be read and processed by computers.

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