

Dedicatio

n

To my lovely family

My wife

Dr. Afamia Issa Kouzi

My Daughter

Bushra Mohammad Al mahmoud

Forward

This work reported in this thesis should be seen as an exploratory one contributing to the overall studies of temporal and local variations of the rangelands in the management process in the Syrian arid rangelands. It hoped that it will aid in establishing base lines for a wide range of studies and observations.

Acknowledgements

I would like to gratefully acknowledge the enthusiastic of my main supervisor *Dr. Abdelhafiz Ali Mohammad*, for the close supervision, patience, and his professional guidance from the start of the work, and he has spent a lot of hours discussing my ideas and correcting my written work. I am gratefully acknowledge and particularly indebted to my Co-supervisor *Dr. Abdelaziz Karamalla Gaiballa*, who always had time for discussing my ideas and correcting my written work, his professional guidance from the start of the work, and his supporting. My great thanks are also extended to my Co-supervisor from *Aleppo University Dr. Mohamad Al Khatip*, for his great support for me to achieve this study. My thanks and appreciations to *Sudan University, College of Forestry and Range Science*, and my great thanks are also extended to the staff and my colleagues of the *Department of Range Science* for making their facilities available for this study and for being the surrogate family during the many years I stayed there and for their continued moral support to me. I

would like to thank the *Ministry of Higher Education and Scientific Research* in *Sudan* for offering support to this study. Also very special thanks go to *Dr. Mohammad Ahmed Alnor*, for his great support for me to achieve this study. I am grateful to *Mr. Ali Hamoud*, manger of the *Syrian Badiyah Directorate* and the directorate staff for their valuable help in field work and facilities to implement this study. Special thanks go to *FAO* officers in *Syrian Badiyah*, especially *Mr. Ahmad Taha* for their help concerning and provide me valuable information about the *Syrian Badiyah*. I am grateful to my family especially my father and mother for their patience, support and encouragement for me.

List of Contents

Contents	Page
Dedication.....	I
Forward.....	II
Acknowledgements.....	III
List of Contents.....	IV
List of Tables.....	IV
List of Maps.....	XII
List of Figurers.....	XIII
Abbreviations.....	XIV
Abstract.....	XVI
Abstract (Arabic).....	XIX

CHAPTER ONE: INTRODUCTION

1.1 General.....	1.1
1.2 Problem statement.....	1.3

1.3 Objective of the study.....	1.4
1.4 Study hypotheses.....	1.5

CHAPTER TWO: STUDY AREA

2.1 General.....	5
2.2 Study location.....	6
2.3 The area of the study.....	7
2.4 Socio-economic aspects.....	9
2.4.1 Human populations.....	10
2.4.2 Economic aspects.....	10
2.4.3 Livelihood means.....	11
2.4.4 Herds' management.....	11
2.4.5 Grazing management.....	11
2.5 Land tenure and user rights.....	14
2.6 Geography of the Syrian arid rangelands.....	15
2.6.1 Topography.....	15
2.6.2 Soil types.....	16
2.6.3 Water sources.....	17
2.6.4 Climate.....	18
2.6.5 Vegetation cover.....	18
2.7 Utilization patterns in the Syrian arid rangelands.....	20
2.7.1 Nomads or Bedouin grazing pattern.....	20
2.7.2 Semi nomads or transhumant grazing pattern.....	21
2.7.3 Sedentary or farmers grazing pattern.....	22

CHAPTER THREE: LITERATURE REVIEW

3.1 Importance of the Syrian arid rangelands.....	23
3.2 Expansion of desertification in Syrian Arab Republic.....	24
3.3 Degradation of Syrian arid rangelands.....	27

3.4 Causes of Syrian arid rangelands degradation.....	28
3.5 Management of rangelands for sustainable development.....	39
3.6 Sustainable range management and livestock production.....	41
3.7 Biodiversity and rangeland stability.....	42
3.8 Dynamics of ecological rangeland systems.....	43
3.9 Equilibrium vs. non-equilibrium.....	46
3.10 The spatial and temporal heterogeneity of rangeland.....	48
3.11 Species distribution in rangelands.....	49
3.12 Transitions, thresholds, and states of rangeland resource.....	50
3.13 Utilization of rangeland resources.....	51
3.14 Effect of grazing on range resources.....	53
3.15 Grazing ecologies not at equilibrium.....	54
3.16 Ecological and economic carrying capacity.....	54
3.17 Effect of rainfall on the arid rangelands.....	55
3.18 Seed bank in rangelands.....	55
3.18.1 General.....	55
3.18.2 Seed bank dynamics.....	56
3.19 Challenges to sustainability of the arid rangelands.....	57
3.20 Conservation philosophies of the rangelands.....	58
3.21 Pastoralism socio-economical studies.....	58

CHAPTER FOUR: MATERIALS AND METHODS

4.1 General.....	61
4.2 Study concept.....	61
4.3 Sampling procedures.....	62
4.4 Materials and tools.....	62
4.5 The rangeland cover measurements.....	63

4.5.1 Ground cover.....	63
4.5.2 Vegetation cover.....	64
4.5.3 Species composition.....	64
4.5.4 Species density.....	64
4.5.5 Species frequency.....	65
4.5.6 Species Diversity (Shannon Diversity Index H').....	65
4.5.7 Similarity indices (Sørensen and Jaccard Similarity Indices).....	65
4.6.8 Species dominance.....	66
4.5.9 Herbage mass.....	66
4.5.10 Tree density.....	66
4.6 Soil organic matter measurements.....	66
4.7 Soil seed bank assessments.....	67
4.8 Observations of soil erosion.....	68
4.9 Rangeland health assessment.....	68
4.10 Socioeconomic surveys.....	69
4.11 Data analysis.....	70

CHAPTER FIVE: RESULTS AND DISCUSSIONS

5.1 General.....	71
5.2 Rangeland cover assessments.....	72
5.2.1 Ground cover assessment.....	72
5.2.2 Soil organic matter assessments.....	84
5.2.3 Plant species composition.....	91
5.2.4 Plant species frequency.....	98
5.2.5 Plant species density.....	103
5.2.6 Plant species diversity.....	108
5.2.7 Similarity indices.....	113
5.2.8 Plant species dominance.....	115

5.2.9 Plant herbage mass.....	118
5.2.10 Tree cover assessments.....	122
5.2.11 Seed bank assessments.....	123
5.3 Socioeconomic aspects and grazing patterns of the rangelands.....	133
5.3.1 General.....	133
5.3.2 Dependence on livestock as source of income.....	134
5.3.3 Local community based organizations.....	135
5.3.4 Sources of information.....	136
5.3.5 Herds' management.....	137
5.3.6 Participation in range management.....	141
5.3.7 Range utilization patterns.....	142

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion.....	147
6.2 Recommendations.....	150
References.....	153
Appendices.....	172
Appendix (1): Rangeland measurements.....	172
Appendix (2): Seed bank analysis.....	183
Appendix (3): Soil organic matter analysis.....	184
Appendix (4): Annual precipitation recorded at Palmyra meteorological station from 1990 to 2007.....	185
Appendix (5): Socio-economic and grazing patterns Studies, Questionnaire in Syrian <i>Badiyah</i>	186

List of Tables

Table.....	Page
Table (3.1): Soil degradation types in Syria.....	26
Table (3.2): Estimated costs of land degradation in Syria in 1997.....	26
Table (4.1): Two range types and their topographical features.....	63
Table (5.1): the ground cover surveys across the range types at two seasons 2006 and 2007.....	73
Table (5.2): The ground cover surveys across the three sites within each of range type at season 2006.....	77
Table (5.3): The ground cover surveys across the three sites within each of range type at season 2007.....	77
Table (5.4): Values of plant species diversity across two range types at two seasons 2006-2007.....	110

Table (5.5): Plant species diversity values across three sites within range types at two seasons 2006-2007.....	113
Table (5.6): the values of similarity indices between two range types at two seasons 2006-2007.....	114
Table (5.7): the values of similarity indices between two seasons 2006- 2007 in two range types.....	114
Table (5.8): Values of similarity indices between three sites within range types at two seasons 2006-2007.....	115
Table (5.9): Plant species dominance across two range types and three sites within range types at two seasons 2006- 2007.....	117
Table (5.10): Number of tree <i>Pistacia atlantica</i> across three sites in 2006.....	123
Table (5.11): Soil seed bank assessment across the range types.....	131
Table (5.12): Soil seed bank assessment across the three sites within range types.....	132
Table (5.13): Percentages of dependence on livestock as source of income among the nomads and semi nomads' communities.....	135
Table (5.14): Percentages of nomads and semi nomads' communities based organizations.....	136
Table (5.15): Percentages for sources of information among the nomads and semi nomads' communities.....	136
Table (5.16): Respondent percentages according to provision of extension services.....	136
Table (5.17): Percentages of herd's structure among the nomads and semi nomads' communities.....	137
Table (5.18): Percentages of livestock ownerships among of nomads and semi nomads' communities.....	139

Table (5.19): Percentages of herds feeding patterns among the nomads and semi nomads’ communities.....140

Table (5.20): Percentages of feeding patterns sources among nomads and semi nomads’ communities.....141

Table (5. 21): Percentages of participation in range management among the nomads and semi nomads’ communities.....142

Table (5. 22): Percentages of the nomads and semi nomads’ communities according to grazing patterns.....143

Table (5. 23): Percentages of exit time from *Badiyah* areas among the nomads and semi nomads’ communities.....144

Table (5. 24): Percentages of the nomads and semi nomads’ communities according to time of exist from *Jazeera* areas.....144

Table (5.25): Percentages of the nomads and semi nomads’ communities according to time of entrance to “*Badiyah*” areas.....146

Table (5.26): Percentages of duration of stay in *Badiyah* areas among the nomads and semi nomads’ communities.....146

List of Maps

Map.....	Page
Map (2.1): Location of <i>Badiyah</i> area across the Syrian provinces.....	7
Map (2.2): The area of the study.....	9
Map (2.3): land use of Syria.....	14
Map (2.4): Topography of Syria.....	16
Map (2.5): Soil of Syria.....	17

List of Figurers

Figurer.....	Page
Fig (3.1): Growth of human population in Syria.....	30
Fig (5.1): Site (I) Higher area of mountain range.....	78
Fig (5.2): Site (II) Middle area of mountain range.....	78
Fig (5.3): Site (III) Lower area of mountain range.....	79
Fig (5.4): Site (I) Valley land of open grazing areas in steppe range.....	79
Fig (5.5): Site (II) Transitional valley land of open grazing areas in steppe range.....	80
Fig (5.6): Site (III) Flat land of open grazing areas in steppe range.....	80
Fig (5.7): Content of the soil organic matter across the range types.....	85
Fig (5.8): Content of soil organic matter across the three sites within each of range types.....	89

Fig (5.9): Percentage of plant species composition across the range types at two seasons 2006-2007.....94

Fig (5.10): Percentage of plant species composition across the three sites within range types at two seasons 2006-2007.....98

Fig (5.11): Number of plant species across the range types at two seasons 2006-2007.....105

Fig (5.12): Number of plant species across three sites within range types at two seasons 2006-2007.....108

Fig (5.13): Values of herbage mass across two range types at two seasons 2006-2007.....120

Fig (5. 14): Plant herbage mass across three sites within range types at two seasons 2006-2007.....122

Abbreviations

- WSSD: World Summit on Sustainable Development
- ACSAD: Arab Center for the Studies of Arid Zones and Dry Lands
- AOAD: Arab Organization for Agriculture Development
- FAO: Food and Agriculture Organization
- MAAR: Ministry of Agriculture and Agrarian Reform
- ICARDA: International Center for Agricultural Research in the Dry Area
- ICARRD: International Conference on Agrarian Reform and Rural Development
- GIS: Geographical Information System
- DAH Directorate of Animal Health
- BD: Badiyah Directorate
- IFAD: International Fund for Agricultural Development.

GDP: Gross Domestic Product
GNP: Gross National Product
SD: Sustainable development
SRM: Society Range Management
SNR: Syrian Natural Resources
UNDP: United Nations Development Program
UNEP: United Nations Environment Program
PAM: Plant Available Moisture
PAN: Plant Available Nutrients
GOS: Government of Syria
WFP: World Food Program
PU: Peasant Union
CBO's: Community Based Organizations
ASL: Above sea level
MD: Meteorological department
NRC: National Research Council
NRCS: Natural Resources Conservation Service
GEF: Global Environmental Facility

Abstract

The study was conducted in the central and south-east areas of the Syrian arid rangelands (*Homs province Badiyah*). The area has faced the danger of continuous degradation to such an extent that it is no longer able to fulfill its original previous functions due to the absence of sustainable management plans. This study focused on sustainable rangeland management in the Syrian arid areas, as related to temporal and local variations, and the significance of different grazing patterns on the range environment. The objective of the study was to investigate the management aspects of *Badiyah* range in Syrian arid areas as affected by local and temporal variations. The area was divided into two range types (mountain and steppe), and each type was divided into three areas (sites) based on the local variations indicated by topographical features, which may consequently lead to different soil and

vegetation characteristics. Based on Réleve method, an area that best represents the community, in each of these sites in *Badiyah* rangeland was located with a dimension of 1km x 1km. Selected types of measurements or assessment were conducted, that included ground and vegetation covers, composition, frequency, density, diversity, similarity indices, dominance and herbage mass. In addition direct count method was used to assess the tree density across the three areas. From each site within the two range types five samples of soil were randomly taken to determine the soil organic matter and seed bank. For the socioeconomic investigation 121 households of the pastoral communities were surveyed using a questionnaire. The study revealed that the Syrian arid rangelands are characterized by a high degree of spatial and temporal variations in structure and dynamic of the plant community, which were reflected by the great variations in the plant cover, composition, frequency, density, diversity, dominance and herbage mass, which have high values in mountain range than steppe range, with local variations within sites of each range type. The values of classic similarity indices (Sørensen and Jaccard) between mountain and steppe rangelands through both seasons were 0.12 and 0.21 respectively. However the similarity indices values between two seasons were 0.29 and 0.25 across mountain and steppe rangelands respectively. Furthermore the similarity indices varies among sites of each range type, the more similar sites in mountain of range were site I and site II with a similarity value of 0.55 and 0.5 respectively, on the other hand, the less similar sites were site I and site III with a similarity value of 0.23 at second season. The similarity indices among the three sites of steppe range were also greatly varied. The results showed that the density and richness of seed bank were high in mountain (165 seed/m²) range than steppe range (147 seed/m²), they were also

increased from lower to upper areas of mountain range, and from flat to valley areas of steppe range. Heavy selective grazing and overgrazing through the growing season, caused high dominance and composition of less-palatable species, such as *Artemisia herba alba*, *Peganum harmala*, *Anabasis syriaca*, *Haloxylon salicornicum*, etc, in seed bank. The results revealed that there was great loss of soil due to high rate of depletion of vegetative and litter covers resulted in high loss of soil organic matter content and increased in bare soil percentage, which lead to deterioration of physical, chemical and biological soil properties. Early, continuous and over grazing and selective grazing, and frequents drought caused unfavorable and long-term changes in the composition and productivity of range vegetation to be insufficient for livestock requirements, which in turn led to more dependence on supplementary feeds, then having far-reaching implications for pastoral social and economies in Syrian arid rangelands. The study concluded that the Syrian *Badiyah* rangelands are inherently heterogeneous where ground and vegetation cover, composition, frequency, density, diversity, similarity indices, dominance and herbage mass highly variable across multiple spatial and temporal scales. The study recommended that differential selection of range improvement measures including of seed types for reseeded in addition to management of utilization patterns to suit peculiarities of range site are required. Enrichment of herbaceous cover is necessary to control soil deterioration. Formation of CBO's to ensure involvement of the pastoral communities in the management process, in addition to make use of the existing channels of information like radio for awareness raising and community mobilization.

ملخص الدراسة

أجريت الدراسة في المناطق الوسطى و الجنوبية الشرقية من المراعي الجافة السورية (بادية محافظة حمص). تواجه هذه المنطقة خطر التدهور المستمر إلى الحد الذي تكون فيه غير قادرة على المدى الطويل تحقيق وظائفها الأساسية السابقة بسبب غياب خطط الإدارة المستدامة. ركزت هذه الدراسة على الإدارة المستدامة للمراعي في المناطق الجافة السورية فيما يتعلق بالتنوع الموضعي و الزمني للمراعي الطبيعية و أهمية أنماط الرعي المختلفة على بيئة المرعى. هدفت الدراسة لاستقصاء الموجهات الإدارية لمراعي البادية في المناطق الجافة السورية المتأثرة بالتنوع الموضعي و الزمني. قسمت مراعي المنطقة إلى نوعين من المراعي جبلي و سهلي و كل نوع قسم إلى ثلاثة مناطق (مواقع) بالاعتماد على التنوع الموضعي المستدل عليه بالمعالم الطبوغرافية و الذي يؤدي إلى اختلافات في الخصائص النباتية و الترابية. بالاعتماد على طريقة ريليف فإن المساحة الأمثل لتمثل المجتمع النباتي في كل موقع من مراعي البادية تواضعت على أبعاد 1كم × 1كم. أجريت أنواع القياسات و التقديرات المنتقاة و التي تضمنت قياس أو تقدير الغطاء النباتي و

الأرضي والتركيب و التردد و الكثافة و التنوع النباتي و دليل التشابهية و السيادة و إنتاجية الكتلة النباتية الحية. بالإضافة لاستخدام طريقة العد المباشر في تقدير الكثافة الشجرية ثلاث مناطق جبلية. تم أخذ 5 عينات عشوائية من التربة من كل موقع ضمن نوعي المرعى لتحديد محتوى المادة العضوية للتربة و المخزون البذري. تم استبيان 121 أسرة من المجتمعات الرعوية للمسح الاجتماعي الاقتصادي.

أفادت الدراسة أن المراعي الجافة السورية تتصف بدرجة عالية من التنوع الموضعي و الزمني في بنية و حركية المجتمع النباتي والتي انعكست بالتباينات الكبيرة في الغطاء النباتي و الأرضي والتركيب و التردد و الكثافة و التنوع النباتي و السيادة و إنتاجية الكتلة النباتية الحية و التي كانت أعلى في المرعى الجبلي من المرعى السهلي مع تنوع موضعي داخل المواقع لكل من نوعي المرعى. كانت قيم تصنيف دليل التشابهية (سورنيسين و جاكارد) للمراعي الجبلية و السهلية خلال الموسمين 0.12 و 0.21 على التوالي و كانت قيم تصنيف دليل التشابهية بين الموسمين 0.29 في المرعى الجبلي و 0.25 في المرعى السهلي. وكذلك كانت قيم تصنيف دليل التشابهية متنوعة فيما بين المواقع لكل من نوعي المرعى. فكان التشابه الأكبر في المواقع الجبلية خلال الموسمين بين الموقع I و الموقع II مع قيمة تشابه 0.55 و 0.50 على التوالي, و كان أقل تشابه بين الموقع I و الموقع III مع قيمة تشابه 0.23 للموسم الثاني. كان أيضا دليل التشابهية فيما بين المواقع الثلاثة من المرعى السهلي متفاوت كثيرا". أظهرت الدراسة أن غنى و كثافة المخزون البذري للتربة كان أعلى في المرعى الجبلي (165/بذرة في م²) من المرعى السهلي (147/بذرة في م²) و تزايد من المناطق العليا إلى المنخفضة في المرعى الجبلي و من المناطق المستوية إلى الوديان في المرعى السهلي. أدى الرعي الانتقائي المكثف و الجائر خلال موسم النمو إلى السيادة و التركيب العالين من الأنواع قليلة الاستساغة على سبيل المثال الشيح و الحرمل و الشنان و الرمث و غيره من المخزون البذري للتربة.

أوضحت الدراسة أن هناك فقا "كبيراً" في التربة نتيجة لمعدل الاستنزاف الهائل للغطاء النباتي و القش مما أدى إلى فقدان مهول في محتوى المادة العضوية للتربة و ازدياد نسبة الترب المعراة, مما أدى إلى تدهور خصائص التربة الفيزيائية و الكيميائية و الإحيائية. أظهرت الدراسة أن الرعي المبكر و المستمر و الجائر و الرعي الانتقائي و تردد سنوات الجفاف أدت إلى حد كبير من التغييرات الغير مناسبة في تركيب و إنتاجية الغطاء النباتي لتكون غير كافية

لتلبية الاحتياجات الغذائية للماشية والتي بدورها قادت إلى المزيد من الاعتماد على المكملات العلفية التي لديها تداعيات بالغة الأثر على الاقتصاد و المجتمع الرعوي في المراعي الجافة السورية. استنتجت الدراسة أن مراعي البادية السورية متغيرة الخواص بالأصل حيث أن الغطاء النباتي و الأراضي و التركيب و التردد والكثافة و التنوع و دليل التشابهية و السيادة و إنتاجية الكتلة النباتية الحية تكون متغيرة كثيرا " و فقا " للم قاييس المكانية و الزمنية المتعددة. أوصت الدراسة بالحاجة إلى الاختيار المختلف لمعايير تحسين المراعي المتضمن بذر لأنواع البذور بالإضافة لإدارة أنماط الاستغلال لتناسب خصوصية الموقع الرعوي و ضرورة إثراء الغطاء النباتي العشبي للتحكم في تدهور التربة. تكوين منظمات المجتمع القاعدية لتأمين ربط المجتمعات الرعوية في عملية الإدارة, بالإضافة إلى استخدام قنوات المعلومات على سبيل المثال المذيع لرفع الوعي و حشد المجتمع.