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**INFLUENCE OF CLIMATIC AND EDAPHIC FACTORS ON  
RESILIENCE AND PRODUCTIVITY OF HERBACEOUS FORAGE  
SPECIES IN MACHAKOS AND THARAKA NITHI COUNTIES, KENYA**

**KARUGIA ELIJAH SAMUEL KAMAU M.Sc. (PLANT ECOLOGY)**

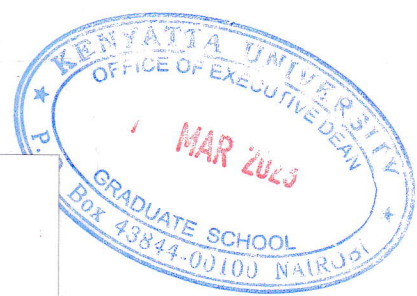
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UNIVERSITY”**

Karugia, Elijah Samuel  
*Influence of climatic and  
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Date 15/3/2023 .....

**Karugia Elijah Samuel Kamau**

Department of Plant Sciences

**SUPERVISORS**

We confirm that the work reported in this thesis was carried out by the student under our supervision.

Sign  .....

Date 15/03/2023 .....

**Dr. Francis W. Kariuki**

Department of Plant Sciences

Kenyatta University

Sign  .....

Date 15/03/2023 .....

**Dr. Joyce W. Mwaniki**

Department of Plant Sciences

Kenyatta University

## DEDICATION

I dedicate this work to my wife, Susan and children, Joy, Grace, Linus and Shirleen, for their support and encouragement during the entire duration of this research project.

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## TABLE OF CONTENTS

<b>DECLARATION</b> .....	<b>ii</b>
<b>DECLARATION BY SUPERVISORS</b> .....	<b>ii</b>
<b>DEDICATION</b> .....	<b>iii</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>iv</b>
<b>TABLE OF CONTENTS</b> .....	<b>v</b>
<b>LIST OF TABLES</b> .....	<b>ix</b>
<b>LIST OF FIGURES</b> .....	<b>xi</b>
<b>LIST OF PLATES</b> .....	<b>xii</b>
<b>LIST OF APPENDICES</b> .....	<b>xiii</b>
<b>ABBREVIATIONS AND ACRONYMS</b> .....	<b>xiv</b>
<b>DEFINITION OF IMPORTANT TERMS</b> .....	<b>xv</b>
<b>ABSTRACT</b> .....	<b>xvi</b>
<b>CHAPTER ONE</b> .....	<b>1</b>
<b>1 INTRODUCTION</b> .....	<b>1</b>
1.1 Background to the study.....	1
1.2 Statement of the problem and justification.....	3
1.3 Rationale of the Study.....	6
1.4 Research Questions.....	7
1.5 Research Hypotheses.....	7
1.6 Research objectives.....	8
1.6.1 General Objective.....	8
1.6.2 Specific Objectives.....	8
<b>CHAPTER TWO</b> .....	<b>10</b>
<b>2 LITERATURE REVIEW</b> .....	<b>10</b>
2.1 Rangeland ecology and resources.....	10
2.2 Climate and its effects on rangeland resources and productivity.....	12
2.3 Rangeland condition and trend.....	17
2.4 Rangeland herbaceous plants resilience, forage value and productivity.....	19

<b>CHAPTER THREE</b> .....	<b>25</b>
<b>3 MATERIALS AND METHODS</b> .....	<b>25</b>
3.1 Study Areas .....	25
3.2 Research design and selection of samples.....	30
3.3 Identification of key herbaceous forage plant species.....	32
3.4 Determination of forage and nutritional values of the key herbaceous forage species.....	33
3.5 Determination of resilience of key herbaceous forage species.....	37
3.6 Assessment of seasonal variation in range condition.....	37
3.6.1 Assessment of range condition dynamics using Normalized Difference Vegetation Index (NDVI).....	37
3.6.2 Determination of range condition and trend based on Land Use Land Cover change.....	39
3.6.3 Assessment of range condition trend based on seasonal variation in species diversity.....	39
3.7 Assessment of influence of climatic factors on resilience and herbaceous forage species biomass production .....	40
3.8 Determination of resilience of key herbaceous forage species.....	42
3.9 Assessment of influence of edaphic factors on key herbaceous forage species on biomass production.....	42
3.9.1 Assessment of influence of soil physical properties on herbage production.....	42
3.9.2 Assessment of influence of soil chemical properties on seasonal variation in herbage quality and quantity .....	44
3.10 Data Analysis.....	46
<b>CHAPTER FOUR</b> .....	<b>47</b>
<b>4 RESULTS</b> .....	<b>47</b>
4.1 Key Herbaceous forage species in Kivaa and Ntugi rangelands and their nutritive value .....	47

4.1.1 Forage value of key herbaceous forage species .....	47
4.1.2 Nutritional Value of the key herbaceous forage species found in Kivaa and Ntugi rangelands .....	49
4.2 Seasonal variation in range condition in Kivaa and Ntugi rangelands.....	52
4.2.1 Seasonal variation in range condition based on Normalized Difference Vegetation Index (NDVI).....	52
4.2.2 Seasonal variation in range condition based on ground cover and land use land cover change.....	56
4.2.3 Seasonal variation in range condition based on changes in species diversity .....	65
4.3 Influence of climate on resilience and biomass production of key herbaceous forage species in Kivaa and Ntugi rangelands .....	71
4.3.1 Influence of climate on resilience of key herbaceous forage species in Kivaa and Ntugi rangelands .....	71
4.3.2 Influence of climatic factors on herbaceous forage productivity .....	73
4.4 Influence of edaphic factors on forage herbage production.....	76
4.4.1 Influence of soil physical properties on forage herbage production ....	76
4.4.2 Influence of soil chemical properties on herbage quantity and quality .	80
4.4.3 Correspondence analysis .....	83
<b>CHAPTER FIVE .....</b>	<b>89</b>
<b>5 DISCUSSION.....</b>	<b>89</b>
5.1 Forage and nutritional value of key herbaceous forage species .....	89
5.2 Seasonal variation in range condition and trend in Kivaa and Ntugi rangelands .....	92
5.3 Influence of climatic factors on resilience and productivity of key herbaceous forage species .....	97
5.4 Influence of edaphic factors on herbage quantity and quality among key herbaceous forage species in Kivaa and Ntugi rangelands .....	100

<b>CHAPTER SIX</b> .....	<b>106</b>
<b>6 CONCLUSIONS AND RECOMMENDATIONS</b> .....	<b>106</b>
6.1 Conclusions .....	106
6.1.1 Forage and nutritional values of key herbaceous forage species in Kivaa and Ntugi rangelands .....	106
6.1.2 Seasonal variation in range condition and trend in Kivaa and Ntugi rangelands.....	107
6.1.3 Influence of climatic factors on resilience and production of key herbaceous forage species .....	108
6.1.4 Influence of edaphic factors on biomass production in key herbaceous forage species .....	109
6.2 Recommendations.....	111
6.2.1 Key herbaceous forage species and their forage and nutritive value ..	111
6.2.2 Seasonal variation in range condition.....	113
6.2.3 Influence of climatic factors on resilience and productivity of key herbaceous forage species .....	113
6.2.4 Influence of edaphic factors on quantity and quality of herbage from key herbaceous forage species.....	114
<b>REFERENCES</b> .....	<b>116</b>
<b>APPENDICES</b> .....	<b>125</b>

## LIST OF TABLES

Table 4.1: Key herbaceous forage species found in Kivaa rangelands and their Forage value .....	47
Table 4.2: Key Herbaceous forage species found in Ntugi rangeland and their forage value .....	48
Table 4.3a: Nutritional value of key herbaceous forage species in Kivaa – Long rainy (wet) season - 2014 .....	50
Table 4.3b: Nutritional value of key herbaceous forage species in Kivaa - Dry season (January) 2016 .....	50
Table 4.4a: Nutritional value of key herbaceous forage species in Ntugi - Wet season - June 2014.....	51
Table 4.4b: Nutritional value of key herbaceous forage species in Ntugi – Dry season – January 2016 .....	52
Table 4.5: Mean NDVI for Masinga (Kivaa) and Tharaka (Ntugi) – 2014 .....	53
Table 4.6: Herbaceous species ground cover (%) – Kivaa rangelands – 2013 and 2014 .....	57
Table 4.7: Herbaceous species ground cover (%) in Ntugi rangelands – 2013 and 2014 .....	58
Table 4.8: Woody species canopy cover (%) – Kivaa rangelands – 2013-2014....	60
Table 4.9: Woody Canopy Cover (%) – Ntugi rangelands – 2013-2014 .....	61
Table 4.10: Kivaa Ecosystem land use land cover acreages – 2013-2015 .....	62
Table 4.11: Ntugi Ecosystem land use land cover acreages – 2013-2015 .....	63
Table 4.12: Species Diversity – Kivaa – 2013-2015 .....	66
Table 4.13: Species Diversity – Ntugi – 2013-2015 .....	67
Table 4.14: Comparison of species diversity and evenness between dry and wet seasons in Kivaa and Ntugi rangelands .....	68
Table 4.15: Resilience of key herbaceous forage species in Kivaa based on frequency (presence/absence) of key herbaceous forage species .....	72

Table 4.16: Resilience of key herbaceous forage species in Ntugi based on frequency (presence/absence) of key herbaceous forage species.....	73
Table 4.17: Relationship between mean seasonal rainfall and mean seasonal forage biomass production .....	75
Table 4.18: Relationship between Soil textural classes and herbage production in Kivaa and Ntugi in year 2014 and 2016.....	76
Table 4.19: Effect of soil moisture on forage herbage species production .....	78
Table 4.20: Soil bulk density and herbage production – 2014-2016.....	79
Table 4.21: Effect of soil nutrients levels on forage herbage yields – Kivaa.....	80
Table 4.22: Effect of soil nutrient levels on forage herbage quality – Kivaa.....	81
Table 4.23: Effect of soil nutrient levels on forage herbage production – Ntugi..	82
Table 4.24: Effect of soil nutrients on herbage quality – Ntugi .....	83

## LIST OF FIGURES

Figure 3.1: Map of Kenya showing location of Kivaa and Ntugi watersheds. ....	29
Figure 3.2: Layout of belt transects and sampling plots .....	31
Figure 4.1: Graphical illustration of species diversity changes in Kivaa and Ntugi rangelands.....	69
Figure 4.2: Graphical illustration of species evenness changes in Kivaa and Ntugi rangelands.....	70
Figure 4.3: Soil and forage nutrients relationship (CCA) in Kivaa – Wet-dry season interface (June Year 2013).....	85
Figure 4.4: Soil and forage relationship in Kivaa – Dry season– January 2013...	86
Figure 4.5: Soil and forage relationship in Ntugi – Wet-dry season (June 2014).	87
Figure 4.6: Soil nutrients and forage relationship –Ntugi – Dry season (January 2016).....	88

**LIST OF PLATES**

Plate 3.1: Kivaa Hill from southern side (Source: RCMRD, 2016).....	26
Plate 3.2: Ntugi Hill from the eastern side (Source: RCMRD, 2016).....	27
Plate 4.1: NDVI Map for Kivaa rangelands (Source: RCMRD, 2014).....	54
Plate 4.2: NDVI Map for Ntugi rangelands (Source: RCMRD, 2014).....	55
Plate 4.3: Land Use Land Cover Image for Kivaa rangelands .....	64
Plate 4.4: Land Use Land Cover Images for Ntugi rangelands.....	65

**LIST OF APPENDICES**

Appendix 1: Questionnaire for collecting data on useful plant species .....	125
Appendix 2: Key herbaceous forage species.....	126
Appendix 3: Nutritional value of key herbaceous forage species .....	129
Appendix 4: Nutritional content of herbage from a combination of forage plants on.....	133
Appendix 5: Mean monthly precipitation and temperature for Masinga and Tharaka .....	135
Appendix 6: Soil nutrient content (fertility) data in Kivaa and Ntugi rangelands .....	137
Appendix 7: Results of gradient analysis (Canonical Correspondence Analysis) .....	140
Appendix 8: Herbaceous forage biomass yields on some selected sampling plots in.....	146
Appendix 9: Normalized Difference Vegetation Index (NDVI) for Kivaa and Ntugi rangelands .....	147
Appendix 10: Land Use land Cover change Images for Kivaa and Ntugi rangelands .....	149

## **ABBREVIATIONS AND ACRONYMS**

CCA – Canonical Correspondence Analysis

CIDP – County Integrated Development Plan

ICE – Institute for Culture and Ecology

KALRO – Kenya Agricultural and Livestock Research Organization

KNBS – Kenya National Bureau of Statistics

LEBHP – Local Experience-Based Herbage Preference

LULC – Land Use Land Cover

NDVI – Normalized Difference Vegetation Index

ILRI - International Livestock Research Institute

RCMRD – Regional Center for Mapping of Resources for Development

## DEFINITION OF IMPORTANT TERMS

**Biomass** – Total living matter expressed in dry or fresh weight produced by a plant or an animal.

**Forage:** Animal feed of herbage and browse type obtained from extensive grazing land.

**Herbaceous forage** – herbage from grasses and herbs (plus low growing shrubs)

**Normalized Difference Vegetation Index (NDVI)** is a composite parameter for estimating vegetation biomass at a given place and time.

$$\text{NDVI} = \frac{\text{Near Infrared-visible light}}{\text{Near Infrared} + \text{visible light}}$$

**Range condition** - the present state of health of the range in relation to what it could be within a given set of environmental and managerial factors.

**Range trend** – the direction of change in the range condition

**Resilience** – ability of an ecosystem or plants to recover after experiencing some form of disturbance.

### ABSTRACT

Rangelands are extensive tracts of land with natural vegetation used as forage by both domestic and wild ungulates. Currently rangelands cover about 80% of total landmass, host about 30% of total human population and produce about 60% of all beef consumed in Kenya. This study was informed by the scanty documented information on how seasonal variation in climatic and edaphic factors affect key herbaceous forage species' resilience and herbage quality and yields particularly in arid and semi-arid rangelands in Kenya. It was conducted for three years (2013 to early 2016) and investigated the influence of climatic and edaphic factors on resilience and herbage production among key herbaceous forage species in Kivaa and Ntugi rangelands in Eastern Kenya. Stratified random sampling was applied and belt transects of 200m by 10m established in each randomly picked block (strata). Twenty experimental plots of 5m by 5m were randomly established along each belt transect. Key herbaceous forage species were identified through purposive sampling and local experience-based herbage preference (LEBHP). Soil nutrients were analyzed using Kjeldahl, and Calorimetric among other methods. Herbage samples were analyzed for various nutrients using Atomic Absorption Spectrophotometer (AAS). Crude protein was analyzed by multiplying % Nitrogen (N) in forage samples by a factor of 6.25. The data collected were analyzed using ANOVA, regression, correlation, T-test and F-test using PAST, STATA and CANOCO softwares. It was found that *Dichanthium annulatum* (Forsk.) Stapf., *Digitaria abyssinica* (A. Rich.) Stapf and *Rhynchelytrum repens* (Willd.) C.H. Hubb was the most valuable and resilient forage species in the two rangelands. Precipitation significantly influenced herbage quality during wet and dry seasons ( $p=0.002$  and  $p=0.046$  respectively) but not yields ( $p > 0.05$ ). Precipitation also significantly influenced range condition during wet and dry seasons ( $p=0.006$ ). Soil texture influenced moisture content while the latter significantly and positively influenced herbage production during wet and dry seasons ( $p = 0.042$  and  $p=0.006$  respectively). Soil bulk density positively and significantly influenced forage species biomass production in Ntugi in 2014 ( $r = 0.513$ ,  $P = 0.019$ ) and in 2016 ( $r = 0.632$ ,  $P = 0.0059$ ) at  $P \leq 0.05$ . Soil Nitrogen (N), Potassium (K), Magnesium (Mg), Iron (Fe), Copper (Cu) and Zinc (Zn) significantly influenced forage quality while Soil Phosphorus (P), N, K, Mg, Fe and Cu positively influenced herbage yields. This study concluded that climate and soil significantly influenced resilience and herbage quality and yields among key herbaceous forage species. Species diversity, NDVI and LULC should be used to augment traditional range condition rating methods. The three key forage species should be studied further to develop ecotypes suitable for different eco-climatic zones.