Shishay Kiros Weldegebriel

The Dynamics of Land Use and Ecosystem Service Values in Mekelle Urban Centre and its Hinterland

Cuvillier Verlag Göttingen
Internationaler wissenschaftlicher Fachverlag

The Dynamics of Land Use and Ecosystem Service Values
in Mekelle Urban Centre and its Hinterland

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Ethiopian Civil Service University

School of Graduate Studies

College of Urban Development and Engineering

The Dynamics of Land Use and Ecosystem Service Values in Mekelle Urban Centre and its Hinterland

By

Shishay Kiros Weldegebriel
I.D ECSU2000005

A Dissertation Submitted in the Partial Fulfillment of the Requirements for the Doctor of Philosophy in Environmental Sustainability and Climate change Resilience from the Ethiopian Civil Service University

June, 2021

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Bibliographical information held by the German National Library
The German National Library has listed this book in the Deutsche Nationalbibliografie (German national bibliography); detailed bibliographic information is available online at http://dnb.d-nb.de.
1st edition - Göttingen: Cuvillier, 2021

© CUVILLIER VERLAG, Göttingen, Germany 2021
Nonnenstieg 8, 37075 Göttingen, Germany
Telephone: +49 (0)551-54724-0
Telefax: +49 (0)551-54724-21
www.cuvillier.de

All rights reserved. This publication may not be reproduced by photomechanical means (photocopying, microfiche), in whole or in part, without the prior express permission of the publisher.
1st edition, 2021

eISBN 978-3-7369-6466-2

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Declaration

I hereby declare that this dissertation is my original work and it has been written by me in its entirety. I have accordingly acknowledged all the sources of information that have been used in the dissertation.

This dissertation has also not been submitted for any degree in any university before.

(Name)	(Signature)	(Date)
Shishay Kiros Weldegebriel		15/06/2021

Approval

The undersigned certify that they have read and hereby recommend to the Ethiopian Civil Service University to accept the Thesis/dissertation submitted by Shishay Kiros Weldegebriel, and entitled **"The Dynamics of Land Use and Ecosystem Service Values in Mekelle Urban Centre and its Hinterland, Ethiopia"**, In partial fulfilment of the requirements for the award of Doctor of Philosophy in Environmental Sustainability and Climate change Resilience.

Name of Supervisor/Promoter Ramavtar Bahadur Singh (PhD)

Supervisor's/promoter's Signature ..... Date 15/06/2021

Name of second supervisor/co-promoter Kumelachew Yeshitela (PhD)

Second Supervisor's/co-promoter's signature ..... Date 15/06/2021

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Ethiopian Civil Service University
School of Graduate Studies
Doctoral Dissertation Approval (SGS Ph.D. Form: 009)
College of Urban Development and Engineering

Student Information

Student Name: Shishay Kiros Weldegebriel
Student ID No.: ID ECSU2000005
Specialization: Environmental Sustainability and Climate change Resilience
Degree: Doctor of Philosophy in Environmental Sustainability and Climate change Resilience

Student agreement

I certify that I have presented my Doctoral Dissertation Examination Board with the final copy of my doctoral dissertation for examination and approval.

Name and signature of student Shishay Kiros Weldegebriel

Doctoral Dissertation Examination Board agreement

I certify that I have examined the final copy of the above student's dissertation and have found that it is complete and satisfies me in all respect, and that any and all revision required by the final Examination Board has been made

Internal examiner' Name: Prof. Samson Kossieh

Internal examiner's signature _____ Date 16/6/21

External examiner' Name: Prof. Fathi Bashir

External examiner's signature _____ Date June 15, 2021

External examiner's Name: Prof. Hailu Worku

External examiner's signature _____ Date 15/06/21

Department head's Name Markos Sintayehu (PhD)

Department head's Signature _____ Date June 15, 2021

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Dedication

This work is dedicated to my beloved father late kiros weldegebriel who sacrificed a lot to grew his children and my mother Letebrehan Medhin similar my dad she suffered a lot to make her babies great and 13 of my lovely brothers and sisters who had endured my continuous long periods of absence from home during these past hard years of study, and my babies Alula and Wudasey Maryma frequently laying their frustrations on my restless wife Askale Araya with the usual questions of when shishay our dad will come home again? Thanks, my family, for being patient and bearing the discomfort at a time when you needed me most.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Table of Content

Title Page

DEDICATION IV

TABLE OF CONTENT VI

LIST OF TABLES XII

LIST OF FIGURES XIV

LIST OF APPENDICES XVI

ACKNOWLEDGEMENTS XVIII

ABSTRACT XIX

CHAPTER 1: INTRODUCTION 1

1.1 Introduction 1
1.2 Background of the study 1
1.3 Problem Statement 5
1.4 Objective of the study 6
1.4.1 General objective 6
1.4.2 specific objectives 7
1.5 Research questions 7
1.6 Implications of the study and contribution to knowledge 7
1.7 Limitation and scope of the study 9
1.7.1 Limitations 9
1.7.2 Scope of the Study 10
1.8 Selection of Mekelle urban centre and its hinterland 10
1.9 Overview of the Study area 16
1.9.1 Location and topography 16
1.9.2 Climate 17
1.9.3 Drainage, soils and mineral resources 18
1.9.4 Green spaces, floral and faunal resources 19
1.9.5 Socioeconomic development and governance 19
1.10 Organization of the dissertation 20

CHAPTER 2: LITERATURE REVIEW 21

2.1 Introduction 21
2.2 Basic concepts and definitions 21
2.2.1 Ecosystem 21
2.2.2 Ecosystem services 21
2.2.3 Ecosystem services valuation 23
2.2.4 Importance of Ecosystem services valuation 24
2.2.5 Land use dynamics 25
2.2.6 The concept of urban centre and hinterland 26
2.2.7 Historical and philosophical development of ecosystem services valuation 27
2.3 Integrating ecological and economic dimensions in ecosystem service valuation 28
2.4 Theoretical Framework 29
2.4.1 Socio-ecological system theory 29

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

2.4.2 Complex Adaptive Systems Theory *31*
2.4.3 Economic valuation Theory *32*
2.4.4 Modelling land-use dynamics and ecosystem services in socio-ecological systems *35*
2.5 Empirical Literature Review 37
2.5.1 Global experiences on ecosystem services valuation *37*
2.5.2 Land use/land cover changes and ecosystem service valuations experiences in Ethiopia *40*
2.6 Conceptual framework of the study 44
2.7 Literature Gap 47
CHAPTER-3: RESEARCH METHODOLOGY **49**
3.1 Introduction 49
3.2 Research approach 49
3.2.1 Mixed research Method *49*
3.2.2 Research Design *49*
3.2.3 Pragmatism Philosophical world view *50*
3.3 Description of variables used in the study 52
3.3.1 Hypothesis *55*
3.4 The frameworks for the collection and analysis of data 56
3.5 Research Type 56
3.6 Sample Design 56
3.6.1 Study Population and target population *56*
3.6.2 Sample Frame *57*
3.6.3 Unit of analysis *57*
3.6.4 Sampling Techniques *57*
3.6.5 Sample Size *58*
3.7 Data collection techniques 61
3.7.1 Primary Source of Data *61*
3.7.2 Secondary Source of Data *63*
3.8 Method of Data Collection Instruments 64
3.8.1 Questionnaire *64*
3.8.2 Interview *66*
3.8.3 Expert focus group discussion *67*
3.8.4 Field Observation *68*
3.9 Methodology and criterion used for selection of ecosystem services indicators 68
3.10 Method of Data Analysis 71
3.10.1 Land use/land cover dynamics *72*
3.10.2 Analysis for driving forces of land-use dynamics *76*
3.10.3 For Spatio-temporal land-use dynamics and its effects on Ecosystem Service Values *78*
3.10.4 Analysis of scenario simulation *78*
3.10.5 Econometric models used for WTP analysis *84*
3.11 Data Presentation Tools 87
3.12 Human Resources, Facility available and Budget sources 87
3.13 Criterion's of quality of the study (Reliability and Validity) 87
3.14 Ethical Considerations 88

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

CHAPTER-4: ANALYSIS OF LAND USE DYNAMICS 91

4.1 Accuracy assessment and validation of remote sensed data 91
4.2 Land Use/Land cover changes matrix 95
4.3 Land use dynamics degree analysis 99
4.4 Spatial autocorrelation of the temporal and spatial trend of LUCC 108
4.5 Local elderly person views on the historical LULC changes 109
4.6 Discussion and interpretation 112

CHAPTER-5: DRIVING FORCES OF LAND USE/LAND COVER CHANGES 117

5.1 Scale of drivers 117
5.2 Overall gain and loss in Ecosystem 117
5.3 Drivers of LULC in Mekelle urban centre and its hinterland 118
5.3.1 Climate variability *118*
5.3.2 Demographic Drivers *121*
5.3.3 Qualitative data obtained key informants and local document review to identifying LULC drivers *124*
5.3.4 Policies, institutions and Legal Frameworks *127*
5.3.5 Selected literature review for LULC changes driving forces identification *130*
5.4 Discussion and interpretation 131

CHAPTER-6: QUANTIFYING THE SPATIO-TEMPO VARIATIONS OF ECOSYSTEM SERVICE VALUES 137

6.1 Analysis of ecosystem service values variation between 1972-2019 137
6.2 Net changes in ecosystem service values 140
6.3 Estimated services of individual ecosystem functions and their changes 143
6.4: Spatial and temporal distribution of ecosystem service values 147
6.5 Qualitative data analysis for ecosystem services valuation 151
6.6 Sensitivity analysis 152
6.7 Estimating ecosystem services values using the social-ecological approach in the urban centre and its hinterland 153
6.8 Discussion 154

CHAPTER-7: WILLINGNESS TO PAY OF MEKELLE CITY RESIDENTS FOR WATERSHED ECOSYSTEM SERVICES IMPROVEMENT 157

7.1 Introduction 157
7.2.1 General Socio-economic background of survey respondents *160*
7.2.2 Current watershed ecosystem services awareness and concern *162*
7.2.3 Perception of ecosystem services and their importance *162*
7.3 Households willingness to pay for improved watershed ecosystem Services 165
7.4 Econometric Model Analysis 168
7.4.1 Willingness to support a policy that improves watersheds ecosystem services *169*
7.4.2 Bivariate-Probit model *173*
7.4.3 Tobit model Analysis (censored regression model) *175*
7.5 The demand curve for the improved watershed ecosystem service 177
7.6 Assessment of operational mode of WTP 179
7.7 Watershed management impacts and possible solutions 179
7.8 Qualitative data analysis 180

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

7.9 Land use and land cover changes and its sustainable management via willingness to pay 182
7.10 Incorporation of watershed ecosystem services in spatial planning: Urban planners' views using FGD 182
7.11 Watershed governance: Policies, Planning and Management 185
7.12 Watershed Ecosystem services Demand and supply analyses and its applications for regional spatial planning 188
7.13 Understanding Mekelle urban centre and its hinterland as Socio-ecological system: Complex adaptive systems as a theoretical tool in urban planning 189
7.14 Discussion 189

CHAPTER-8: MODELLING THE POTENTIAL FUTURE LULC CHANGE SCENARIOS AND THEIR EFFECTS ON ECOSYSTEM SERVICE VALUES 195

8.1 Predicted effects of land use dynamics on ecosystem services values under Different Scenarios 195
8.2 Markov prediction to 2030 based on land use and land cover maps of 2019 198
8.3 Estimation of future Ecosystem Service Values for the year 2030 199
8.4 Estimated services of individual ecosystem functions and their predicted changes 201
8.5 Multinomial logistic regression results 202
8.6 Calibration and validation of the model 204
8.7 Discussion 206
8.8 The nexus between the dynamics of land use and ecosystem services valuation with Sustainability pillars 207

CHAPTER 9: SUMMARY, CONCLUSION, AND RECOMMENDATION 209

9.1 Introduction 209
9.2 Summary of findings 209
9.2.1 LULC dynamics in the last 47 years in Mekelle urban centre and its hinterland 209
9.2.2 Driving forces of LULC changes 210
9.2.3 Spatio-temporal variations of ESVs 211
9.2.4 Willingness to pay for improved watershed management 211
9.2.5 Modelling the potential future LULC change scenarios and their effects on ecosystem service values 213
9.3 Conclusions 214
9.3.1 LULC dynamics in the last 47 years 215
9.3.2 Driving forces of LULC changes 216
9.3.3 Spatiotemporal variation of ESVs 216
9.3.4 Willingness to pay for improved watersheds 217
9.3.5 Modelling the potential future LULC change scenarios and their effects on ecosystem service values 218
9.4 Implications for Social Change 218
9.4.1 Recommendations 219
9.4.2 Limitation of the study and direction for further studies 228

REFERENCES 231

APPENDICES 247

Appendix A.1: Household Willingness to pay Survey 247

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Appendix A.2: A Semi-structured Interview Questions for local elderly persons . 256
Appendix A.3: A Semi-structured Interview questions for directors 258
Appendix A.4: Expert Focus Group Discussion..... 262
Appendix A.5 Questionnaires that guide observations..... 266
Appendix A.6 Accuracy Assessment Checklists 267
Appendix A.7: X and Y coordinates of accuracy assessment of LULC Changes 268

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

List of Tables

TABLE 1.1: LOCATION AND AREA OF MEKELLE CITY NEIGHBORING KEBELES 13
TABLE 1.2: LISTS THE MAJOR WATERSHEDS IN THE STUDY AREA (IN HECTARES) 14
TABLE 3.1: PROPORTIONAL DISTRIBUTION OF SAMPLE HOUSEHOLDS BY SUB-CITY 60
TABLE 3.2: SPECIFICATIONS OF SATELLITE IMAGES THAT WERE USED IN THIS STUDY 62
TABLE 3.3: DESCRIPTIONS OF IDENTIFIED LULC CLASSES OF THE STUDY AREA 72
TABLE 3.4 LANDSAT BAND COMBINATIONS FOR SUPERVISED LULC CLASSIFICATION METHOD USED IN THIS STUDY 75
TABLE 4.1 COMPARISON OF ACCURACY ASSESSMENT 91
TABLE 4.2 ACCURACY ASSESSMENT: ERROR MATRIX 93
TABLE 4.3 COMPARING USER'S AND PRODUCER'S ACCURACIES 94
TABLE 4.4: KAPPA STATISTICS 95
TABLE 4.5: LULC CHANGE MATRIX THROUGHOUT THE STUDY PERIODS 95
TABLE 4.6: AREA AND AMOUNT OF CHANGE OF LAND USE AND LAND COVER FEATURES IN THE STUDY AREA DURING 1972–2019 107
TABLE 4.7 KNOWLEDGE OF HISTORICAL LAND USE/LAND COVER DYNAMICS BY LOCAL ELDERLY PERSONS 110
TABLE 5.1: CHANGES IN LULC GROUPS IN EACH STUDY PERIOD 118
TABLE 5.2: MANN-KENDALL TREND TEST 119
TABLE 5.3: SEASONAL MANN-KENDALL TEST 120
TABLE 5.4: THE POPULATION OF MEKELLE URBAN CENTRE AND ITS HINTERLAND (1972-2019 115
TABLE 5.5: SIMILARITIES OF THE VARIABLE EXTRACTED BY FACTOR ANALYSIS 123
TABLE 5.6 SEM REGRESSION RESULTS 123
TABLE 5.7 ANTHROPOGONIC DRIVING FORCES OF LULC CHANGE 125
TABLE 5.8: CLIMATE VARIABILITY DRIVERS OF LULC CHANGE IN THE STUDY AREA 126
TABLE 6.1: LULC TYPES WITH THEIR AREA IN HECTARES AND THE CORRESPONDING VALUE COEFFICIENTS 138
TABLE 6.2: THE ECOSYSTEM SERVICE VALUES PER HECTARE OF DIFFERENT LAND-USE TYPES IN MEKELLE URBAN CENTRE AND ITS HINTERLAND 133
TABLE 6.3: NET CHANGES IN ESVS IN EACH STUDY PERIODS 140
TABLE 6.4: TOTAL ESVS LOSS DURING 1972-2019(IN US$ MILLION) 143
TABLE 6.5:ANNUAL VALUE COEFFICIENTS FOR ECOSYSTEM SERVICE FUNCTIONS OF EACH LULC TYPE-BASED (KINDU ET AL., 2015) 144
TABLE 6.6: ANNUAL ESTIMATED VALUE OF ECOSYSTEM FUNCTION 145
TABLE 6.7 THE AUGMENTED DICKEY-FULLER TEST STATISTIC 148
TABLE 6.8 THE JOHANSEN'S CO-INTEGRATION TEST STASTICS 149
TABLE 6.9: PAIRWISE GRANGER CAUSALITY TESTS 151
TABLE 7.1: CURRENT WATERSHED AND FUTURE IMPROVED WATERSHED CONDITIONS 158
TABLE 7.2 GENERAL SOCIO-ECONOMIC BACKGROUND OF SURVEY RESPONDENTS 160
TABLE 7.3: SIGNIFICANT ECOSYSTEM SERVICE FOR MEKELLE CITY RESIDENTS 163
TABLE 7.4: SUMMARY STATISTICS OF WTP VARIABLES 164

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

TABLE 7.5: MEAN WILLINGNESS TO PAY PER MONTH OF OVERALL RESPONSES 166
TABLE 7.6: CORRELATION MATRIX OF INDEPENDENT VARIABLES 168
TABLE 7.7: VIF RESULTS 169
TABLE 7.8: LOGISTIC REGRESSION RESULTS 170
TABLE 7.9: PROBIT REGRESSION MODEL 171
TABLE 7.10: BIVARIATE PROBIT REGRESSION 174
TABLE 7.11: PROBIT AND BI-VARIATE PROBIT MODEL ESTIMATES 175
TABLE 7.12: MAXIMUM LIKELIHOOD ESTIMATES OF THE TOBIT MODEL 175
TABLE 7.13: AGGREGATE WTP AND POSSIBLE REVENUE FROM IMPROVED WATERSHED ECOSYSTEM SERVICES 177
TABLE 8.1 LAND-USE /LAND COVER CHANGES, FROM BASELINE YEAR 2019 TO 2030, UNDER THE BAU, PES, AND SPATIAL PLANNING SCENARIOS 198
TABLE 8.2: THE ECOSYSTEM SERVICE VALUES PER HECTARE OF DIFFERENT LAND USE TYPES FOR THE YEAR 2030 193
TABLE 8.3 ESTIMATED VALUE OF ECOSYSTEM FUNCTIONS (ESV_F IN US$ MILLION US$ $YEAR^{-1}$) UNDER EACH SERVICE CATEGORY FOR THE YEAR 2019 AND 2030 201
TABLE 8.4 CORRELATION COEFFICIENT OF INDEPENDENT DRIVING FORCES VARIABLES 202
TABLE 8.5 MULTINOMINAL LOGISTIC REGRESSION RESULTS BETWEEN LUCC AND DRIVING FORCE 203
TABLE 8.6 AREA UNDER THE CURVE (AUC) 205

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

List of Figures

FIGURE 1.1: PROPOSED HALTING ENVIRONMENT DEGRADATION MODEL 9
FIGURE 1.2 MAP OF THE MAJOR WATERSHEDS IN MEKELLE URBAN CENTRE AND ITS HINTERLAND 11
FIGURE 1.3: MAP OF KEBELE'S SURROUNDING MEKELLE CITY 12
FIGURE 1.4: DRAINAGE MAP WITH STREAM ORDERS OF THE STUDY AREA 14
FIGURE 1.5: MAP OF MEKELLE URBAN CENTRE AND ITS HINTERLAND 17
FIGURE 1.6 CLIMATIC DIAGRAMS OF MEKELLE URBAN CENTRE AND ITS HINTERLAND 18
FIGURE 2.1: CONCEPTUAL FRAMEWORK OF THE STUDY 46
FIGURE 3.1 THE RESEARCH ONION 51
FIGURE 3.2: SATELLITE IMAGERIES OF LANDS SERIES USED 63
FIGURE 3.3: FLOWS OF ECOSYSTEM SERVICES BETWEEN MEKELLE URBAN CENTRE AND ITS HINTERLAND 71
FIGURE 3.4: METHODS USED TO IDENTIFY LAND USE/ LAND COVER DRIVING FORCES 76
FIGURE 3.5 SEM FRAMEWORK FOR ANALYZING DRIVING FORCES FOR LULC CHANGES 77
FIGURE 3.6 ITERATION PROCEDURE APPLIED FOR SCENARIO GENERATION 80
FIGURE 3.7 MAP OF DRIVERS OF FUTURE LAND USE DYNAMICS 83
FIGURE 4.1: MAP OF USER-DEFINED POINTS ((REFERENCE DATA COLLECTED) 92
FIGURE 4.2 LAND USE DYNAMICS (1971-2019) 100
FIGURE 4.3: LAND USE LAND COVER MAP OF 1972 101
FIGURE 4.4: LAND USE LAND COVER MAP OF 1984 102
FIGURE 4.5: LAND USE LAND COVER MAP OF 1992 103
FIGURE 4.6: LAND USE LAND COVER MAP OF 2001 104
FIGURE 4.7: LAND USE LAND COVER MAP OF 2012 104
FIGURE 4.8: LAND USE LAND COVER MAP OF 2019 105
FIGURE 4.9: SPATIAL AUTOCORRELATION REPORT 108
FIGURE 5.1: CONCEPTUAL MODEL OF HUMAN-ENVIRONMENT INTERACTIONS IN LULC 117
FIGURE 5.2 AVERAGE MONTHLY MAXIMUM TEMPERATURE (1972-2018) 119
FIGURE 5.3: MONTHLY TOTAL RAINFALL (1972 -2018) 120
FIGURE 5.4: ANNUAL R.F/YEAR 121
FIGURE 5.5: POPULATION DENSITY OF MEKELLE URBAN CENTRE AND ITS HINTERLAND 122
FIGURE 6.1: TOTAL ESVS LOSS DURING 1972-2019(IN US$ MILLION) 142
FIGURE 6.2: TRENDS OF ECOSYSTEM SERVICE VALUE DECLINE IN MEKELLE URBAN CENTRE AND ITS HINTERLAND FROM 1972 TO 2019 146
FIGURE 6.3: SPATIAL LOCATION OF ESVS IN MILLIONS USD 147
FIGURE 7.1 WATERSHED DELINEATION OF THE STUDY AREA 157
FIGURE 7.2: PROPOSED PES SCHEMES IN MEKELLE URBAN CENTRE AND ITS HINTERLAND 159
FIGURE 7.3: MAP OF SAMPLED RESPONDENTS BY SUB-CITY 161
FIGURE 7.4: SUMMARY OF THE RESPONSES TO THE DOUBLE-BOUNDED DICHOTOMOUS CHOICE QUESTIONS 167
FIGURE 7.5 PREDICTORS OF WILLINGNESS TO PAY FOR WATERSHED IMPROVEMENTS 171
FIGURE 7.6 THE DEMAND CURVE FOR THE IMPROVED WATERSHED ECOSYSTEM SERVICES 178
FIGURE 7.7: CURRENT AND PROPOSED LAND USE PLAN OF MEKELLE CITY 184
FIGURE 8.1 LAND-USE MAPS OF THE SCENARIO UNDER THE BAU 195

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

FIGURE 8.2 LAND-USE MAPS OF THE SCENARIO UNDER PES 196
FIGURE 8.3 LAND-USE MAPS OF THE SCENARIO UNDER SPATIAL PLANNING SCENARIO 197
FIGURE 8.4: ROC CURVE 204

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

List of Appendices

APPENDIX A.1: HOUSEHOLD WILLINGNESS TO PAY SURVEY 247
APPENDIX A.2: A SEMI-STRUCTURED INTERVIEW QUESTIONS FOR LOCAL ELDERLY PERSONS 256
APPENDIX A.3: A SEMI-STRUCTURED INTERVIEW QUESTIONS FOR DIRECTORS 258
APPENDIX A.4: EXPERT FOCUS GROUP DISCUSSION 262
APPENDIX A.5 QUESTIONNAIRES THAT GUIDE OBSERVATIONS..... 266
APPENDIX A.6 ACCURACY ASSESSMENT CHECKLISTS..... 267
APPENDIX A.7: X AND Y COORDINATES OF ACCURACY ASSESSMENT OF LULC CHANGES 268

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

List of Acronyms

CAS	Complex Adaptive Systems
CV	Contingent Valuation
DBDC	Double Bounded Dichotomous Choice
DEM	Digital Elevation Model
ERDAS	Earth Resource Development Assessment System
ES	Ecosystem Service
ESF	Ecosystem Function
ESVs	Ecosystem Service Values
ETM+	Enhanced Thematic Mapper Plus
GIS	Geographic Information System
GPS	Global Positioning System
GTP	Ground Truthing Points
Landsat	Land Satellite (US Satellite Series)
LULC	Land Use/Land Cover
MCA	Mekelle City Administration
MCWSA	Mekelle City Water Supply and Sewerage Office
MEA	Millennium Ecosystem Assessment
MK	Mann-Kendall Test
MSS	Multispectral Scanner
MWSDP	Mekelle Water Supply Development Project
NASA	National Aeronautics and Space Administration
NILUPP	National Integrated Land Use Plan and Policy
NOAA	The US National Oceanic and Atmospheric Administration
OECD	Organization for Economic Cooperation and Development
OLI	Operational Land Imager
PES	Payment for Ecosystem Services
PWES	Payment for Watershed Ecosystem Services
REDD	Reducing Emissions from Deforestation and Forest Degradation
RS	Remote Sensing
SDGs	Sustainable Development Goals
SEIs	Social-Ecological Interactions
SES	Socio-Ecological System
SRS	Satellite Remote Sensing
SRTM	Shuttle Radar Topography Mission
SWIR	Shortwave Infrared
TEEB	The Economics of Ecosystem and Biodiversity
TIRS	Thermal Infrared Sensor
TM	Thematic Mapper
USGS	United States Geological Survey
WGS	World Geodetic System
WTA	Willingness to Accept
WTP	Willingness to Pay

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Acknowledgements

Above all, thanks to the ultimate and eternal **God** for His blessings which have seen me through to my academic achievements.

To my advisers Professor B.S.N Raju, Dr. Kumelachew Yeshitela, and Dr. Ranavijai Bhadur Singh I wish to express my heartfelt gratitude for their dedicated advisory support, tireless guidance, and productive comments. I was also fortuned to count on the advice and support of my colleagues and staff members at various stages of the program Professor Samson Kassahun, Dr. Daniele Lirebo Dean of CUDE, Dr. Frew Mengistu and Dr. Bisrat Kifle. Furthermore, appreciation goes towards Dr. Degu Bekelle former head department of environment and climate change, Dr. Markos Sentayehu and all department council members, Dr. Pawas Sren Ph.D. program coordinator for Environment and climate change resilience for their follow-up and success of the dissertation works.

My thanks also go to Tigrai Bureau of Trade, Industry and Urban Development, Tigrai Bureau of civil service, and Ethiopian civil service university for allowing me to pursue studies at the Ph.D. level and for the financial support, without which this achievement would not have been possible. I would like to thank all institutions and individuals at the national, regional, district and city levels who provided me with information for this study. I am thankful to my adorable father, mum, sisters, brothers and my wife, who gave me moral and material support throughout the period. I would like to extend my heartfelt gratitude to my friends Ashenafi Embaye and Hailay Aregawi for their assistance during the fieldwork. Numerous people have encouraged and supported me in various ways in this exceptionally long endeavor. My heartfelt gratitude goes to all of them.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Abstract

Scientific study on the link between land use dynamics and ecosystem service values is the key for environmental sustainability. In Ethiopian cities there is lack of empirical research on ecosystem service valuation. In the study area the relationship between land use dynamics and ecosystem services values remains unknown. The overarching goal of the study was to understand the dynamics of land use and ecosystem service values in the Mekelle urban centre and its hinterland, Ethiopia. This study, investigated the past, current, and future changes of ecosystem service values. To undertake the study preliminary works of identifying the knowledge gaps, define and frame research problem, objective and research questions respectively have been made. This was followed by the selection of the study area. After the site selection, partial reconnaissance visits were made to gather more information about the current situation of the ecosystem. The specific objectives of this study were to: assess land use/land cover dynamics over 47 years and analyze its driving forces, quantify the spatial and temporal variations of ecosystem service values, estimate the willingness to pay of surveyed respondents, and model the land use dynamics scenarios and their effects on ecosystem service values. Pertained literature to the study was reviewed. The review placed the research into context and helped the formulation of an appropriate study framework to follow. The study was conducted using both quantitative and qualitative research approaches with a sequential explanatory mixed research design. Both primary and secondary sources of data were used to investigate the problem posed. The remote sensed data was obtained from the USGS Landsat series, household survey, ground truth points, focus group discussions, key informant interview, structured observation and document review was made through employing probability and non-probability sampling techniques. The spatial data were analyzed using ERDAS imagine for LULC classifications, Arc GIS for change detection and map preparation, spatial autocorrelation for land use/land cover changes, Structural equation model for identifying the driving forces, econometrics analysis using STATA for 384 surveyed households, predicting the future land use/land cover changes were performed using the cellular automata models in CLUMondo which is a future land use simulation model by coupling human and the natural effects and document review and narrative analysis were made for qualitative data. For time series data analysis Eviews and XLSTAT softwares were used. The results were corroborated by accuracy assessment, interviews with local elderly and official interviews, policy reviews, and observations were made. The multi-temporal results show, the extent and distribution of various land use/land cover types are decreased from time to time, and a large number of landscapes are being disturbed. Dramatic land-use dynamics occurred in response to population growth, climate variability and institutional changes. The driving forces resulted in the widespread conversion of various types of ecosystems. The land-use dynamics seriously affected ecosystem service values. The results from the household survey revealed that the majority of respondents showed their willingness to pay additional fees for watershed management to sustain ecosystem services provision. However, several factors affected the household's willingness to pay. In a business-as-usual scenario, it was observed that ecosystem services value will decline by 2030 from the base year of 2019 by 4.02 million USD (12.18%), whereas under the spatial planning scenario, the ecosystem service value will increase by USD 4.17 million (13.03%) from the baseline year 2019. Finally, the land-use dynamics in the study area had multiple environmental consequences. The study recommends understanding the current and future dynamics of land use and ecosystem service values is a base to devise proper policies of payment for ecosystem services, design optimum land use planning and city region planning geared towards a sustainable environment.

Key terms*: Driving forces, Ecosystem service, land-use/cover change; valuation; scenario; Urban centre and hinterland*

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Chapter 1: Introduction

1.1 Introduction

Ecosystem services are closely related to land use/land cover changes(Fu & Forsius, 2015). The number of researches that have been done on ecosystem services has increased in recent years(Logsdon & Chaubey, 2013). However, adequate methods to quantify ecosystem services and plan for their continued provisioning remain scarce(Andrew, Wulder, Nelson, & Coops, 2015). This situation demands additional more rigorous research method of measuring, modelling and mapping ecosystem services. Identifying the specific problems and providing solutions calls for exhaustive understanding through undertaken empirical study.

This study applied dynamic and connected approaches; undertake modelling at urban centre and hinterland by employing an interdisciplinary research approach which is a combination of Ecology, Economics, and Urban Planning. The combination of the approaches provided a consolidative methodological framework for studying the problem identified. Though there is literature on ecosystem service valuation, researches that investigate the land-use dynamics from orthodox and heterodox Economics perspectives on urban centre and hinterland based on empirical analyses is very limited. This study quantified the dynamics of land use and ecosystem service values in Mekelle urban centre and its hinterland from 1972 up to 2030 through empirical evidence that provides valuable facts explaining the presence of the problem.

This study demonstrates the historical contribution of scientists from different fields towards a social-ecological system approach. Social-ecological systems allow measuring the ecosystem services. This study seeks to enhance the current knowledge base for policymakers and urban planners on ecosystem services. In this study, the historical land use pattern and its driving forces, ecosystem service valuations, and scenario have been investigated. The chapter covered the background of the study, problem statement, the objective of the study, limitations and scope, the concept of Mekelle urban centre and its hinterland, overview of the study area. It also presented the implications of the study and contribution to knowledge.

1.2 Background of the study

The idea that ecosystems play an important role to support social needs traces back to ancient time starting from Plato's philosophical influence, who understood that the deforestation of Attica led to soil erosion and the drying of springs(Mascarenhas, 2017). The concept of ecosystem services has become an important model for linking ecosystems to mankind benefits. Ecosystem services research has become an important area of inquiry over the past decades(B. C. Fisher, Robert; Turner, R. Kerry; Morling Paul, 2007). The concept had been growing in the academic literature for several years and it is as old as human beings. The concept of ecosystem services first appeared in a 1977 study by Walter Westman. Afterwards, it was more systematically studied by Ehrlich and Mooney in 1983 (Robert Costanza & Steve Farber f, 2017).

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

The interest in the ecosystem services studies have increased since the publication of the Millennium Ecosystem Assessment in 2005 a monumental work involved 1300 scientists, and come with the report of the global decline of 15 of the 25 ecosystem services, which antedates negative impact on future human welfare. Since then, one of the demands from the MEA was to increase research on measuring, modelling, and mapping ecosystem services, resulting in a positive response to increasing the energies to identify, quantify, and ESVs (Millennium Ecosystem Assessment synthesis report, 2005).

Ecosystem services benefit human beings in different ways. The contributions of nature to the basic needs, in terms of food production, water provisioning, provision of fuel and fibre and regulation of climate, water, and nutrient cycling and supporting services which produce the conditions for all other provisioning, regulating, and cultural service(Carabine, 2015).To meet the growing human needs ecosystems have been changed into different land-use types. However, the changes that have taken place in the last 50 years have been powerful as society is becoming increasingly urbanized, while ecosystems become worsened(Martínez, 2009).

Land-use change has a significant impact on the planet's ecosystems. Changes in ecosystems have huge impacts on ecosystem services supply(Stephen Polasky & Johnson, 2011). Land use alteration is a major driver of ecosystem degradation, biodiversity loss, and ecosystem service depletion. Land use/cover change and unsustainable land management impact biodiversity, ecosystem services and might even influence local climate if it happens at larger scales (Gebremicael, 2017).

Land use dynamics negatively affect the supply of ecosystem services that threaten human well-being(Quintas-Soriano, Castro, Castro, & García-Llorente, 2016).LULC dynamics change ecosystem services values (Kindu, Schneider, Teketay, & Knoke, 2016). Ecosystem service valuation is now widely recognized for its contribution to economic, environmental, social well-being and ultimately supporting in achieving sustainable development(Pandeya et al., 2016). Evaluating the influence of LULC changes on ESV is a vibrant tool to support decision-making (Sharma et al., 2019). The monetary assessment of ESVs provides an integrated, universal measure for evaluating and communicating land-use dynamics effects to prioritize investment in conservation (Gómez-Baggethun & Barton, 2013).

"No city can attain sustainability on its own"(Mukherjee, 2017, p. 10).

Cities do not function separately but within a domain of dependence on neighbouring areas and their ecosystems. Degradation of these ecosystems results in the ecosystem services loss that supports both urban and peri-urban populations. This indicates Conserving ecosystem services is a pivotal task in urban centre and their hinterlands. The urbanization pattern of large cities has important implications for environmental sustainability. This led to urban sprawl, or suburban sprawl, as such urban development will lead to land-use changes. Urban growth also impacts the environment in terms of altering the landscape, intercepting existing structure of hydrology, and reducing biodiversity (Mukherjee, 2017). The ecological principles of land use promote examining the impacts of local decisions in a regional context (Dale et al., 2000). Mekelle city is dependent on ecosystem services beyond the city boundaries.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Urbanization is a multifaceted spatiotemporal process taking place across lands even in areas far beyond urban cores; therefore, directly and indirectly affecting the functions, processes, and services of ecosystems. Urbanization is a difficult process to monitor, quantify and plan. Land located outside of urban cores is heavily affected by urbanization, yet they provide essential ecosystem services. Many cities depend on continuous flows of ecosystem services coming from adjacent non-urban ecosystems to sustain the urban functions(Barrera, 2019).

Human population growth together with competitive land use causes land scarceness. The anthropogenic aspect has a significant impact on LULC changes(Kanianska, 2016). Land use/land-cover changes on the planet reflect the interaction of anthropogonic activities and the natural environment. Each person in a population makes some demand on the environment for various ecosystem services. On a global scale, population growth has been positively associated with the expansion of agricultural and urban land, land intensification, and deforestation**.** The rapid increase in population over the past century has created the conversion of the earth's surface(Addae & Oppelt, 2019). The rapid increase of population and economic development of Ethiopia worsens the pressure on natural resources(Commission, 2008). Biophysical driving forces are moderately stable and have aggregate effects. Anthropogonic driving forces are comparatively active and are the main driving forces of LULC changes in the short term(Shao, Wei, & Xie, 2006).

Catchments have been extensively transformed through large-scale LULC change, including industrialization, urbanization, and intensive agriculture. This has benefitted economic growth but has also led to unintended consequences, such as reduced water quality and ecosystem functioning and reduced resilience against other pressures such as climate change. The ecosystem services might be endangered when the upstream catchment areas, within the water body, is located, is poorly and improperly managed (Stosch, Quilliam, Bunnefeld, & Oliver, 2017). The increasing population in both rural and urban areas generates pressure on natural resources by over-utilizing the endowment and change the ecology to different developmental activities(A. A. Getahun, 2017).

Watersheds provide numerous ecosystem services to downstream beneficiaries often with no cost to them. Non-optimal use of the ecosystem leads to watershed degradation. One method that could address this problem is payments for ecosystem services (Margaret Mejorada Calderon, 2012). PES can be established around specific ecosystem services in a specific watershed or for more general environmental conservation (Max Nielsen-Pincus, 2017). Wunder definition of PES has become commonly accepted, who defined PES as a voluntary transaction where a well-defined ecosystem service or a land-use is likely to secure that ecosystem service is being bought by a minimum one ES buyer from a minimum one ES provider if and only if the ES provider secures ES provision(Danyang Feng, 2018). This study was aimed at PES for general environmental conservation in watershed ecosystem service using WTP.

Catchments provide a variety of ecosystem goods and services. City people can reach catchment areas to relax, exercise and enjoy the fresh air. Such places are usually within easy travelling distance of the conurbations that they serve, and in some places, they are within walking distance(Grant, 2012). Increasing tree coverage in upstream areas helps to maintain water quality and quantity for urban areas located downstream. Watershed

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

ecosystems provide a wide range of ecosystem services to downstream city residents(UNDP, 2011).

The spatial extent of urban areas has grown almost four times stronger than their population(Tobias, 2013) and this influenced the demand for ES. Findings by (Ayele Almaw Fenta, Sewale Belay, & Mekonnen, 2017) indicate there is high consumption of ecosystem goods and services in Mekelle city. Henceforth, what is needed is careful planning of the complex urban centre and its hinterland systems. Urban policymakers and planners need to incorporate sustainable watershed management as part of urban development and land-use planning, to build resilience against ecosystem services-related hazards and the effects of climate change(UNDP, 2011).

Ethiopia's urbanization will happen, and this probable brings challenges. Without effective management, Ethiopia's urbanization will be reactive. Urbanization of this type, if unchecked, can result in an urban structure that is damaged in design with the result being inefficient, unsustainable, and unequal(GGGI, 2015). The environmental degradation related to LULC change costs Ethiopia about $ 4.3 billion per year(Ango, 2016). Measuring the changes in ecosystem service values is an important tool to increase awareness of different stakeholders (Liu et al., 2010), contribute to developing knowledge on the management of natural capital (Costanza et al., 1997; Frélichová et al., 2014), improve decision making in the allocation of scarce resources among contending demands (Guo et al., 2001; Barral and Oscar, 2012), formulate policies (Schägner et al., 2013) and provide an incentive to conserve the ecosystems that offer the most valuable services (Konarska et al., 2002; Bateman et al., 2013) as cited by (Kindu et al., 2016).

Mekelle city is rapidly expanding spatially; the surrounding peri-urban areas are overwhelmed to become part of the built area that has the potential to affect the value of ecosystem services. The peri-urban ecosystems are at risk of degradation and natural resources are losing. The ecosystem services are becoming progressively scarce. Currently, Mekelle urban centre and its hinterland is experiencing rapid population growth, urban sprawling, and rapid expansion of industries. Most of the water consumed by the Mekelle city comes from the hinterlands which are outside the city administrative boundary. The current land use dynamics manifesting in the urban centre and its hinterland are detrimental to the environmental quality at a time when the city is already facing an environmental crisis occasioned by the loss of several ecosystems.

The internal urban watersheds like Endarufael, Mayduba, and Illalla are highly degraded due to urbanization and human settlement(MU, 2015). The rapid conversion of land-use/cover types is having a significant negative impact on ecosystem services they can provide various services. Specifically, the conversion from one land use/cover to another is largely contributing to the loss of water ecosystem services. Urban expansion has a particularly strong impact on provisioning services of food production in Mekelle city in the last 25. Expansion of the town, resulting from rapid urban population growth, is also likely to put growing pressure on the peri-urban ecosystem(Ashebir, Pasquini, & Bihon, 2007). The ESVs is a promising method to tackle the decline of ecosystems(Shuang Liu, 2010).

The ecosystem service approach (ESA) is advocated for use in both environmental management and academic issues. However, despite the extensive conceptual

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

development, there are still few exemplary attempts for effective use of the ESA in ecosystem management(Beaumont, Mongruel, & Hooper, 2017). This study adopted a transdisciplinary perspective to address ecosystem services degradation. Analysing, modelling, quantifying, and ecosystem services management requires a transdisciplinary approach(Robert Costanza & Steve Farber f, 2017).

Several studies demonstrate the need of applying a social-ecological system approach in ecosystem services study. However, there is still a lack of empirical evidences that applies the concept of social-ecological system in ecosystem services valuation. The empirical results about the scientific basis for integrating ecosystem services into land-use decisions are still lacking. Some key variables regarding the problem have been overlooked. Several efforts have been made to improve the measurement of ecosystem services and to understand ecosystems' contribution to human well-being. From the reviewed works of literature, there are still deficiencies and methodological inconsistencies. Alternative approaches to better understand the problem is useful. Economic incentives for conservation, including the PES scheme in developing ecosystem services market can encourage conservation to apply a new management approach to protect and improve ecosystem service provision. Therefore, studying the dynamics of land use and ecosystem service values through a social-ecological systems outlook under different spatial and temporal scales can support decision-making to understand the past, current, and future changes in land use and ESVs.

1.3 Problem Statement

The need to deliver ecosystem services coupled with poor land management has meaningfully contributed to ecosystem degradation in Ethiopia (Gebremicael, 2017). The ecosystem services consumed in Mekelle city are provided from the adjacent hinterlands. The current market does not capture the ecosystem service values. Besides, the relationships between land-use dynamics and ecosystem services value remain unknown. Spatially clear values of ecosystem service values across landscapes inform land-use decisions (Tammi, Mustajärvi, & Rasinmäki, 2017) and these are lacking and the ecosystem services are poorly understood and scarcely monitored in the study area. Failure to know the complication of interactions across ecosystem service provision can endanger sustainable ecosystem services provision(Nassl & Löffler, 2015). The study area has a semi-arid climate and it is environmentally vulnerable.

Degradation of ecosystems results in the loss of ecosystem services that support both the urban and peri-urban populations. Accelerated urban expansion not only influences socioeconomic change, but also influences the ecosystem, and threatens sustainable urban development(Rimal, 2018). Integrated watershed management is practiced in the upper catchment of Mekelle urban centre and its hinterland that benefits Mekelle city residents. The local farmers have played a leading role in watershed improvement, but the Mekelle city residents who are beneficiaries, have also to play their role in conservation, are often discounted.

Upstream watersheds can affect the household's demand for ecosystem services if sustainable funding is not raised(Abebe, Dagnew, Zeleke, Eshetu, & Cirella, 2019). The upstream local communities' participation in watershed improvements is not adequate to

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

sustain the provision of ecosystem services to city residents. Sustainable watershed management planning in the study area can be hampered due to financial capacities limited to undertake watershed conservation. Hence alternative sources of conservation funds are vital. It is also important to realize the major factors that affect households' willingness to participate and to identify effective policy instruments.

The current situation indicates there is a lack of information, understanding, and planning about LULC changes and their driving forces which affect essential and beneficial ecosystem services provision and societal wellbeing. Studies about LULC at a small scale in Mekelle city only exist(Fenta et al., 2017; Tahir, Imam, & Hussain, 2013). Some studies were done in other parts of Ethiopia (Tolessa, Senbeta, & Kidane, 2017) studied the impact of LULC change on ecosystem services in Ethiopia's central highlands. Different international works of literature show there is a methodological gap in ecosystem services and from the reviewed literature there are still deficiencies and knowledge gaps. To sustain the ecosystem services provision with other technological options, a detailed understanding of the status of LULC changes in the urban centre and its hinterland is crucial.

The last few decades have observed changes in policies related to land use in Ethiopia(Teka, Van Rompaey, & Poesen, 2013). Nevertheless, a detailed study on the effects of these changes on ecosystem services value from the urban centre and its hinterlands remains scanty. Mekelle city has been not studied as a complete network with consideration of all ecosystem services, in consideration of nearby watersheds by previous investigators. The LULC dynamics and ecosystem service values in the urban centre and its hinterland are not well understood. No study has been undertaken in a city and with its hinterland level. In the study area, quantitative and empirical information about land use dynamics and ecosystem service values is absent. Furthermore, beyond analysing LULC dynamics only, a thorough understanding of the consequences of these changes on ecosystem service values through quantitative knowledge is limited.

In theory application of ecosystem service valuation is advocated in developing countries. But in practice; there is a lack of empirical research on ESV in Ethiopian cities and the absence of legislative standards for ESV. To fill the gap, this study was intended to examine the problem through analysis of land use dynamics and its drivers, ecosystem services valuation and modelling under a set of scenarios to improve decision-makers understanding of the sustainable provision of ecosystem services. Therefore, this research is novel and proposed to fill the mentioning gaps.

1.4 Objective of the study

1.4.1 General objective

The objective of this study was to assess and model the temporal and spatial land-use dynamics and ecosystem service values in Mekelle urban centre and its hinterland, Tigrai (Ethiopia).

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

1.4.2 specific objectives

1.To assess land use/land cover dynamics over a period of 47 years
2.To analyze the driving forces of land use/land cover dynamics.
3.To quantify the spatial and temporal variations of ecosystem service values
4.To estimate the willingness to pay of Mekelle city residents for watershed ecosystem services improvements
5. To model the potential future LULC change and their effects on ecosystem service values

1.5 Research questions

The above objectives were answered from the following research study questions

1. What is the pattern of land use/land cover dynamics in the past 47 years?
2. Why are land use and land cover changing in Mekelle urban centre and its hinterland?
3. Are the values of ecosystem services affected by land-use patterns?
4. How much economic value do the Mekelle city residents willing to pay for watershed ecosystem services improvement in Mekelle urban centre and its hinterland watersheds?
4.1 What are the determinant factors that affect households' willingness to pay for watersheds ecosystem services?
5. How the future changes of LULC expected to affect ecosystem service value?

1.6 Implications of the study and contribution to knowledge

Researching the dynamics of land use and ecosystem service values is important in Ethiopia. This research studied ecosystem services valuation from the urban centre and its hinterland perspective. This research contributes knowledge towards understanding ecosystem services valuation, practical gaps, and their implications, strategies to sustain ecosystem services provision in Mekelle urban centre and its hinterland in particular and in the cities of rapidly urbanizing cities in general. Furthermore, this study contributed to the building of scientific knowledge on ecosystem service valuation. The findings and recommendations can also contribute to increased academic discourse.

The study findings revealed that appropriate policy for sustaining ecosystem services provide useful bases for balancing ecosystem services supply and demand, which can have a key role in policy-making decisions. Specifically, the findings provide immense information to assist in adopting regional strategic spatial planning. Information on the current status of ecosystem services values has great importance in preparing plans. Understanding the dynamics of land use is a requirement for planning. Spatial planning could benefit from implementing innovative tools being developed by this research to improve the valuation of ecosystem services. Spatial planning has a strong impact on ecosystem services, particularly, because it is the policy domain to direct development (Tobias, 2013). Despite this fact, the current planning in Mekelle urban centre and its hinterland is not geared to conserve ecosystem services. Mekelle city administration can adopt appropriate strategies and procedures for sustainable urban development to put land into its well-planned use and to be utilized in an environmentally responsible manner.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.

Furthermore, estimating the WTP for improved watershed is very important. It will help produce empirical evidence that could inform decisions about ecosystem services provided by the watersheds that supply to the city. Creating shared ecosystem conservation benefits and externalities with stakeholders outside of a watershed like city residents of Mekelle is very important. Watersheds provide abundant ecosystem services to downstream communities of Mekelle city often with no cost to them. Although the ecosystem services are valuable to the city residents, they do not have monetary values, which results in watershed degradation. One method that could address this problem is PES schemes.

The findings of the study could provide important information to guide the future for enhanced management and conservation of watersheds in urban centre and its hinterland. In addition to this, the findings could be useful for the development of PES schemes as guiding policy at the federal level and elsewhere in Ethiopian cities. PES initiatives, however, are not without debate. Some scholars suggest that the development of a land ethic should be based on moral, rather than financial, responsibility for stewardship. Another debate also recommends ecosystem services beneficiaries, have an ethical responsibility to contribute to the stewardship of the environment. Despite, these debates, this study can bring pragmatic solutions to the academic discourse.

To summarize, this study made in-depth study of an environmental issues. Theoretical, this academic investigation extended the applicability and predictive power of socio-ecological system theory and complex adaptive system theory to ecosystem services valuation. In additions to this, it contributed to the current theoretical understanding of the studied phenomena to comprehend environmental degradation using a multi-lens approach to sustain the environment. These findings come up with improved city region concept to refer the relationships between urban centre and hinterland. Empirically, this study answered the global call to study ecosystem services due to increasing scarcity which would have negative impact on the current and future human welfare. Methodologically, diverse sources of data and modelling significantly increases result comparability and consistency. This helped to methodological advancement to study the research problem through improved research tool and improved environmental degradation halting model through adopting combination of Economics, Urban Planning and Ecology disciplines. Practically, the findings have policy real-world implications for crafting regional strategic spatial planning, design optimum land use planning, Payment for ecosystem services policies. Finally, it has an implication for positive social change in order to improve the well being of society.

Dieses Werk ist copyrightgeschützt und darf in keiner Form vervielfältigt werden noch an Dritte weitergegeben werden.
Es gilt nur für den persönlichen Gebrauch.