

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

**Valuing Alternative Resource Management Practices to Improve
Eco-System Services in the Midland and Lowland Communities in
Bale Eco-Region: Application of Choice Modeling**

By: Teshome kefale

Valuing Alternative Resource Management Practices to Improve Eco-System Services in the Midland and Lowland Communities in Bale Eco-Region: Application of Choice Modeling

By: Teshome Kefale

*A Thesis Submitted to the Department of Economics
Presented in Partial Fulfillment of the Requirement for the Degree of Masters of Science in Economics (Natural Resource and Environmental Economics)*

Addis Ababa University

Addis Ababa, Ethiopia

October, 2016

Addis Ababa University
School of Graduate Studies

This is to certify that the thesis prepared by Teshome Kefale, entitled: Valuing Alternative Resource Management to Improve Eco-system services in Upstream and Downstream communities in Bale Eco-region, Ethiopia: Application of Choice Experiment Valuation and submitted in the partial fulfillment of the requirement for the degree of Master of Science in Economics (Natural resources and Environmental Economics) complies with the regulations of the university and meets the accepted standards with respect to the originality and quality.

Signed by the examining committee:

Examiner _____ Signature _____ Date _____

Examiner _____ Signature _____ Date _____

Advisor _____ Signature _____ Date _____

ABSTRACT

Over 12 million population both in the Bale Eco-Region (BER) within Ethiopia and beyond, Somalia and Kenya, are estimated to directly or indirectly depend on several ecosystem services of the BER. However, BER is degraded and eco-system functions in the eco-region are extremely disturbed. To reverse these problems interventions such as reforestation/afforestation, SWC, exclosure, etc are needed. Valuing alternative resource management practices in the BER can be important to maintain eco-system health and functions in the BER. Overall, analyzing preferences of community who uses ecosystem services of BER can greatly inform efforts to bring unsustainable resource use under control in BER. This study analyzed the preferences of community in the BER for improved ecosystem benefits of the eco-region and estimates their Willingness to Pay (WTP) for selected attributes using a choice modeling approach. Mixed logit models were estimated as analytical tools. The study is based on household level data collected in 2016 from 200 randomly drawn households living in midland (Kumbi kebele) and lowland (Melka Arba) of Harena Buluk woreda, Bale zone. Results from reforestation and exclosure attributes revealed both midland and lowland community are WTP considerable amount of money for eco-system service improvement. Midland respondents Marginal Willingness To Pay (MWTP) for improvement on soil erosion, CO₂ storage and non-timber forest product were 34.45, 32.62 and 31.59 ETB per year respectively, whereas lowland respondents MWTP to reduce soil erosion, to improve biodiversity enrichment, livestock feed availability and exclosure with watering points were 24.20, 16.60, 280 and 129 ETB per year respectively. The compensating surplus, which reflect the overall WTP of respondents for changes from the status quo to alternative improved scenarios show that midland communities' average WTP for reforestation characteristics were 3053(\$145.38), 2516(\$119.83) and 1827(\$87) ETB/year for higher, medium and low impact improvement scenario and lowland respondents mean WTP for exclosure characteristics were 882(\$42), 1558(\$74.19), and 2383(\$113) ETB annually for low, medium and high impact improvement scenarios respectively. Since we were not confident with the value of MWTP and compensating surplus estimated from insignificant payment level, we didn't report their value in this study. Management strategies that fully involve local communities at all stages of implementation, starting from preferred attributes selection, may help development planners and practitioners to address the problems associated to ecosystems.

Key words: BER, willingness to pay, eco-system services, choice experiment

Acknowledgements

First of all I would like to express my limitless gratitude to Almighty God who helped me in all circumstances and give everything to finish this research study. Next my special utmost appreciation goes to my thesis supervisor Dr Fitsum Hagos (IWMI) for his indispensable advice, comments and encouragement which guided me in all phases of the research. I am so lucky being advised and guided by him. Thank you Dr Fitsum.

Moreover I would also like to extend my foremost gratitude to IWMI, SHARE project for financial support to engage this study. Finally I would like to thank Daniel van Rooijen and Matthew McCartney of the International Water Management Institute (IWMI), all the data enumerators, different staff of Harena buluk woreda and others who directly or indirectly contributed for the completion of this research. My Special thanks also go to my wife Toleshi Wakjira, my brother Abera Kefale (who stay with me in all courses of data collection at Harena buluk, Bale zone) and other individual who contributed a lot morally and ideally to the success of this paper.

Table of contents	Page No.
Acknowledgement.....	1
Table of Contents	2
CHAPTER ONE: INTRODUCTION	
1.1 Background of the study.....	7
1.2 Statement of the Problem.....	9
1.3 Research questions.....	11
1.4 Objective of the study.....	11
1.5 Significances of the study.....	11
1.6 Scope and limitations of the study.....	12
1.6 Organization of the paper.....	12
CHAPTER TWO: LITRETURE REVIEW	
2.1 Theoretical literature review	13
2.1.1 Concepts of eco-system services	13
2.1.2 Threats to eco-system services.....	14
2.1.3 Reasons for valuing eco-system services.....	14
2.1.4 Techniques used for valuing eco-system services.....	15
2.1.5 Choice modeling methods.....	15
2.1.6 Designing a choice experiment methods.....	16
2.2 Empirical Literature review	20
CHAPTER THREE: METHODOLOGY	
3.1 Description of the study area.....	23
3.2 Type and data source	24
3.3 Target population	24
3.4 Sample size	25
3.5 Choice modeling methods	26
3.6 Questioner design.....	27
3.6.1 Definitions of attributes and	27
3.6.2 Experimental design.....	24
3.6.3 Survey administration.....	36
3.7 Models for experimental design.....	37

3.7.1 Random parameter logit model (Mixed Logit model).....	37
CHAPTER FOUR: RESULTS AND DISCUSSIONS	
4.1 Descriptive statistics.....	40
4.1.1 Demographic and Socioeconomic Characteristic of Respondents.....	40
4.1.2 General perceptions and observations of the respondents on social and environmental problems existing in BER eco-region.....	43
4.1.3 Access to water.....	43
4.1.4 Interventions in natural resource management.....	44
4.1.5 Food security and other socio-economic problems.....	45
4.2 Econometric Model estimation.....	46
4.2.1. Estimation of marginal willingness to pay.....	50
4.2.2. Estimating compensating surplus (Welfare change).....	52
4.3.3. Results of the follow up questions.....	54
CHAPTER 5: CONCLUSION AND POLICY IMPLICATIONS.....	58
REFERENCES.....	61
Appendix.....	67

List of figures

Figure1: Ecosystem services (modified version of fig 1.1, vol1. MEA (2005)).....	14
Figure 2: Map of the BER and water basins.....	24

LIST OF TABLES

Table1: Descriptions of reforestation related attributes and levels used in choice experiment.....	29
Table2: Descriptions of SWC related attributes and levels used in choice experiment.....	31
Table3: Descriptions of exclosure related attributes and levels used in choice experiment.....	34
Table4: Sample choice set related with reforestation intervention.....	35
Table5: Sample choice set related with SWC program.....	35
Table6: Sample choice set related with exclosures program.....	36
Table7: Descriptive statistics for selected socioeconomic variables of the sample respondents.....	41

Table 8: Descriptive statistics of Households respondent demographic Data.....	42
Table 9: Sources of water for households in the eco-region.....	44
Table 10: Descriptive statistics for selected socio-economic and environmental problems in the Bale eco-region.....	45
Table 11: Reforestation program related attributes output (for midland households only).....	47
Table 12: Exclosure characteristics output (for lowland households only).....	48
Table 13: SWC program attributes output for midland households.....	49
Table 14: SWC intervention attributes output for lowland households	49
Table 15: Marginal willingness to pay in Ethiopian birr for reforestation attributes.....	51
Table 16: Marginal willingness to pay in Ethiopian birr for exclosure attributes.....	51
Table 19: Estimates of compensating surplus (CS) for attributes related with reforestation program.....	53
Table 20: Estimates of compensating surplus (CS) for attributes related with Exclosure program.....	54
Table 21: Mid land respondents concerns while choosing attributes related with reforestation program alternatives in the choice set.....	55
Table 22: Lowland respondents concerns while choosing attributes related with exclosure program alternatives in the choice sets.....	56
Table 23: Midland and lowland respondents concerns while choosing attributes related with SWC program alternatives in the choice sets.....	57

List of Acronyms

ASC	Alternative Specific Constant
BER	Bale Eco-Region
BMNP	Bale Mountains National Park
CGIAR	Consultative Group on International Agricultural Research
CM	Choice Modeling
CO ₂	Carbon Dioxide
CS	Compensating Surplus
CSA	Central Statistical Agency
CVM	Contingent Valuation Method

DCE	Discrete Choice Experiment
DDCVM	Double Dichotomous Contingent Valuation Method
EC	Error Component
ETB	Ethiopian Birr
FDG	Focus Group Discussion
FOA	Food and Agriculture organization
GDP	Gross Domestic Product
GHG	Green House Gas
IID	Independently and Identically Distributed
ITCM	Individual Travel Cost Method
IUF	Indirect Utility Function
IWMI	International Water Management Institution
LM	Lagrange Multiplier
LR	Likelihood Ratio
MA	Millennium Eco-System
MEA	Millennium Eco-System Assessment
Mg	Milligram
MNLM	Multi Nominal Logit Model
MWTP	Marginal Willingness to Pay
MXL	Mixed Logit Model
NGO	Non Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NTFP	Non-Timber Forest Product
PFM	Participatory Forest Management
REDD+	Reduction of Emission from Deforestation and Forest Degradation
RPL	Random Parameter Logit
RSW	Relationship with wildlife as dummy variable
RUM	Random Utility Model
RUP	Respondent Support
SHARE	Supporting Horn of Africa Resilience
Std.Dev	Standard Deviation

SWC	Soil and Water Conservation
UK	United Kingdom
UNDP	United Nation Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United State Dollar
WLE	Water, Land and Eco-systems
WTP	Willingness to Pay

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The Bale Eco-Region (BER) represents the largest area of Afro-alpine habitat on the African continent. It is endowed with high biodiversity resources that resulted in the naming of its central areas as national parks, called the Bale Mountains National Park (BMNP). It consists of widely varied vegetation formation and ecosystems ranging from afro-alpine grasslands, Erica forest, Afromontane high forests (both dry and moist), wetlands and tropical savanna hosts globally unique and diverse fauna and flora, including a significant number of rare and endemic species (REDD+, 2014). Despite this, there has been little effective management of natural resources in the area (Gashaw, 2015).

Due to growth pressure of both people and livestock in the BER, forests in the eco-region are experiencing high rate of deforestation. For example between 1986 and 2009 average deforestation rate across the BER (Dupuy, 2009) were 3.7% , which is almost four times the 1% country-wide average forest loss (FAO, 2010). There has been attempt since very recently to slow down this high rate of deforestation through Participatory Forest Management (PFM).

Deforestation and forest degradation in BER is occurring due to the conversion of natural habitat to farm land, lack of land use management plan, fire, overgrazing by livestock and unsustainable fuel wood and timber extraction. This, combined with impacts from current climate change, is increasing the vulnerability of communities that depend on the BER's ecosystem services (REDD+, 2014).

Deforestation to expand agricultural activities are the principal causes of increased run off and soil erosion, climate change, loss of biodiversity, and conflicts over resources in Ethiopia. Soil erosion further resulted in declining agricultural productivity, water resource degradation, habitat loss, increases sedimentation of reservoirs and continuing food insecurity (Badege, 2001). For example Erkossa et al. 2015 reported farmers at Dapo (In Amahara region, Ethiopia) annually lose about USD 220 and USD 150 ha^{-1} due to the loss of nitrogen and phosphorus, respectively, by soil erosion. The condition in BER is no exception. Loss of biodiversity, acceleration of soil erosion and flooding, shortage of fodder, decline in quality and quantity of water resources,

decline in the value of timber and non timber product and increasing emission of Green House Gases (GHG) are some of the consequences of land deforestation in the eco region (REDD+, 2014). Vial, 2010 reported that agricultural encroachment into BMNP (being one of the protected areas in Ethiopia) leads to continuous loss of habitat ,habitat fragmentation and increased human wildlife conflict, such as crop raiding by Mountain Nyalas, Bush Pigs (*Potamochoerus larvatus*) and Olive baboons (*Papio anubis*).

In response to the problem of land degradation on ecosystem benefits Ethiopians have been carrying out different interventions such as reforestation/aforestation, Soil Water Conservation (SWC), exclosure program, etc were implemented for the past decades. For example following the implementation of SWC measures in the Debre-Mawi watershed in Amahara region reductions in runoff ranged from 26 to 71%, reductions in sediment yield ranged from 45 to 81% and ground water table rise up to 0.5 m from the surface (CGIAR research on WLE, 2015). Following exclosure establishment in communal grazing lands in Tigray, Ethiopia soil C stock increases of 41 to 60% and to above ground C stock increases of 83 to 87% (Mekuria et al. 2011). From the case study in the Nile basin, Ethiopia differences in species diversity and considerable increases in above ground carbon (ranged from 0.6 to 4.2 t C ha⁻¹), CO₂ storage (varied between 2.1 and 15.3 t CO₂ ha⁻¹), woody species composition, and richness (ranged from 5 to 28) were observed, following the establishment of exclosures(Mekuria et al, 2015). Fodder production, mainly from grasses and fodder trees have also increased following the establishment of exclosures. Accordingly to reverse problems related to ecosystem benefits degradation in the BER we proposed reforestation/aforestation, SWC and exclosure program.

Selecting appropriate interventions is not only enough. For their successful implementation, preference of community for those interventions to improve ecosystem services of BER should be taken into consideration. However, there is no study conducted in the area which assessed preference of community for improving BER ecosystem services by using suitable interventions. Thus this study filled this information gap by analyzing the preferences of community for improved ecosystem benefits of BER and estimated their Willingness to Pay (WTP) for interventions to improve eco-system benefits using a choice modeling approach.

1.2 STATEMENT OF THE PROBLEM

The Millennium Ecosystem Assessment (MEA) found many negative environmental trends leading to declines in the majority of ecosystem services (MEA, 2005). A major reason for the rapid increase in the production of goods and services in the economy and deterioration in the provision of many ecosystem services is the fact that market economic systems reward production of commodities that are sold in markets and accounted for in Gross Domestic Product (GDP), but does not punish anyone directly for environmental degradation that leads to a reduction in ecosystem services.

Continually increasing use of the environmental goods and services by humans over time, resulting in depreciation and causing irreversible change to the environment at any of the spatial scales considered (Daily, 2000). This is true in the case of Ethiopia where demand for agricultural land use, wood fuel production, and overgrazing causing habitat destruction and loss of species of the natural ecosystem (UNESCO, 2004).

Ethiopia being water tower of Africa mainly because of its different geological formations, altitude and climatic conditions gifted with extensive water resources and natural ecosystems, wide variety of landforms and creating an extensive biodiversity and ecosystems throughout the country , but the economic values of these resources are still not well quantified. Currently, many natural ecosystems particularly biodiversity continue to be depleted at an alarming rate throughout country. Absence of markets for these resources to commercialize them, unregulated over-utilization, including deforestation to search for agricultural land, overgrazing, fire, and other interventions are the major causes for this distraction. Hence, their economic contribution to the development of the economy is under-valued.

Looking at BER, the eco-region is inhabited by about 3.3 million population (urban and rural combined) (Ethiopian social economic survey, May 2013). Moreover around 12 million population both in the BER and beyond within Ethiopia, Somalia and Kenya are estimated to directly or indirectly depend on several ecosystem services of the BER (REDD+, 2014). Particularly, those rural people in the BER are directly dependent on the forest vegetation and other natural resources of the area. Annual direct consumptive use value of the vegetation is

valued at US\$ 407 per household from the forests in the area (REDD+, 2014). Quantification of these benefits in monetary terms is increasingly important to ensure the conservation policy. This is achieved through non market environmental valuation technique such as Contingent Valuation Method (CVM), Travel Cost Method (TCM), Choice Experiment Method (CE) and other techniques. This is increasingly important to insure the implementation of effective conservation policy. For the purpose of this study we used CE method because CE does a better job than other technique in measuring the marginal value of changes in various characteristics of environmental programs, it is more informative than discrete choice CV studies, CE may minimize some of the response difficulties found in CVM (protest bids, strategic behavior, yeah saying, etc).

However, little research has been reported regarding non market valuation of ecosystem services in the area. Valuation study conducted in the BER includes: Valuation of environmental goods and services: The case of Bale Mountains National Park (BMNP), Ethiopia using contingent valuation technique (Haroyu et al., 2016). This study only estimated WTP for conservation of environmental services and local tourists' entrance fee of BMNP using contingent valuation technique. Other valuation study conducted in the area was direct consumptive use value and ecosystem goods and services in the Bale Mountains eco-region (C. Watson 2007). This study also estimated only use value of eco-system goods and services in the Bale Mountain eco-region. However, to our knowledge, comprehensive studies on valuation of the multi-functions and services especially non-use values of BER eco-system services have not yet been undertaken using choice modeling in the BER.

In order to fill this gap this study used choice experimental method (choice modeling) of environmental valuation attempted to elicits household's mean WTP for the improved BER eco-system benefits and contribute to reduce the paucity of literature in the area.

The monetary quantification of ecosystem services was not possible, nor considered necessary, for each and every ecosystem service (Van Zyl, 2015). So quantification of this study will focus on those services considered being most important in the BER and that were amenable to quantification. These eco-system services are biodiversity conservation (measured by medicinal

plants), decreasing soil erosion, increase soil moisture and fertility, increasing carbon stocks, improving non-timber forest products, reducing run-off, stabilize water flow, improving fodder availability and reducing sediment yield in rivers.

1.3 RESEARCH QUESTIONS

1. Does Marginal Willingness to Pay (MWTP) vary by different attributes?
2. What is the Compensating Surplus (CS) for ecosystem service improvement scenario?
3. Do households' preferences vary in ecosystem services valuation by their agro-ecology in the mid land and low land of the same watershed?

1.4 OBJECTIVES OF THE STUDY

The general objective of this study is to valuate alternative resource management practices to improve ecosystem services in the midland and lowland communities in BER.

The specific objectives are to:

- Estimate the MWTP and welfare impacts (compensating surplus) of improvements of each attributes of the ecosystem services.
- Assess household preferences for the improvement of ecosystem services by their location, mid land and low land of the same watershed in BER.
- To compare the importance of BER ecosystem service attributes in terms of their WTP for prioritization purposes.
- Suggest appropriate policy recommendations which could address problems related to ecosystems conservations in the BER.

1.5 SIGNIFICANCE OF THE STUDY

Economic valuation of environmental resources has made important progress in the past few years. A lot of research work has been done in many developed countries since the first attempt has been made by Clawson and Knetsch in 1966. Although biodiversity and ecosystems are playing an important role in economic growth in developing countries, limited attempts have been made to estimate their economic values.

This study will:

- Make a substantial contribution to the body of research published in this area.
- Provide information for policy makers and donors concerning decisions of improving conservation of the bio diversity and ecosystems in BER.
- Lay the ground for formulating the modalities for implementation of payment for ecosystem services in BER.

1.6 Scope and limitations of the study

The scope of this study is limited to assessing the preference of community to improve ecosystem services in the mid land and low land areas of the BER in South Central Ethiopia. Also due to time and financial constraint the study is based on 200 sample households randomly drawn from midland (Kumbi kebele) and lowland (Melka Arba kebele) of Harenebuluk woreda. Furthermore, we defined the levels of all attributes for each selected intervention where there is no enough biophysical data in the area. However, to define the correct levels of each attribute previous scientific investigation on eco-system services under valuation in other area (In Ethiopia as well as in other parts of the world), FGD, expert advice and key informant interview were facilitated.

1.7 Organization of the Paper

The first chapter presents back ground, statement of the problem, objective and significance of the study. Chapter two discusses theoretical background of environmental valuation and empirical literatures related to environmental valuation including contingent valuation as well as choice experimental technique. Chapter three discusses site description, sample technique and empirical approach used for the study. In chapter four descriptive and econometrics outputs were analyzed and discussed. Finally, chapter five concluded the main findings and forwarded some important policy implication that could address problems related to eco-system services in BER.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Theoretical Literature Review

This chapter is concerned with the theoretical and empirical literatures with particular emphasis on ecosystems valuation. The theoretical part will give a detailed description of ecosystem services; techniques used to measure ecosystem services and also describe the theoretical framework for environmental valuation techniques that are used in this study. The empirical part presents a review of some of the empirical works done by other researchers on the subject area and elsewhere.

2.1.1 Concept of Ecosystem services

The concept of ecosystem services was given increased public recognition through the Millennium Ecosystem Assessment (MEA).

As we can see from figure1 below ecosystem services are categorized into four parts based on the type of services they supply. These are Provisioning, regulating, supporting and cultural services. Provisioning services directly meet physical needs such as food, fresh water and fuel. Regulating services indirectly contribute to health and safety through regulation of climate and disease, air and water purification, and prevention of soil erosion. Cultural services provide nonmaterial benefits such as spiritual enrichment, cognitive development and recreation and supporting services such as the production of oxygen and soil formation are necessary for the maintenance of all other services.

Environmental conservation involves trade-offs between different groups of people or different basic needs. For example, forest clearing may provide income for upstream households through the sale of agricultural products, but also increases soil erosion, run-off, and segmentation of water reservoirs and reduces the stability of water flow for downstream households due to deterioration of water quality. It also provides a relevant framework for quantifying those costs. Rather than trying to value the full range of benefits provided in a watershed, the ecosystem services framework encourages the identification of changes in the flows of particular services as that ecosystem improves or deteriorates; and quantification of the resulting impacts on human

welfare. This is directly relevant to understanding the relative costs and benefits in terms of basic needs as ecosystems change (MEA 2005).

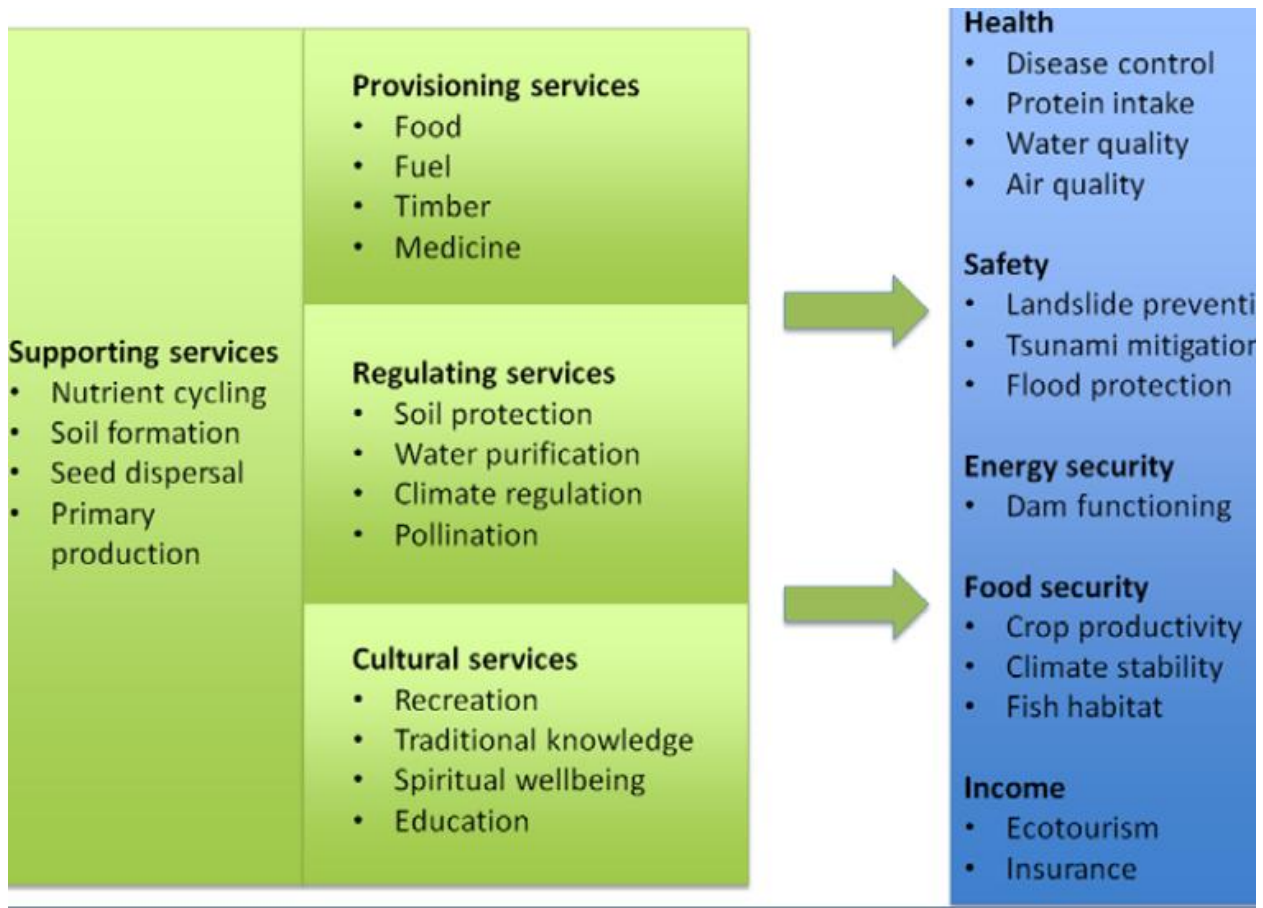


Figure 1: Ecosystem services (modified version of fig 1.1, vol1. MEA (2005))

Given the classification of ecosystem services in figure1 this study will focus on valuation of ecosystem services such as biodiversity conservation, reducing soil erosion, stabilize water flow, improving CO₂ storage, increasing fodder availability improving non timber value, reducing run off and sediment yield. The selected ecosystem services are the most important and major ES in the BER that are affected by land degradation.

2.1.2 Threats to ecosystems

Deforestation in BER involves the conversion of continuous forest landscapes to non-forest vegetation is increasing at an alarming rate. Destruction of the species-rich tropical forest and destruction of natural habitats are regarded as a major threat to global biodiversity (Carlson and Hartman, 2001).

Activities such as conversion and deforestation to expand agriculture, over grazing, fire, unsustainable harvesting of fuel wood and timber and non-timber forest products, Rapid immigration with unplanned and unrestricted settlement, lack of land use management plan and no control of resource use are the major threat to BER(Wennie Consult, 2015).

2.1.3 Reasons for valuing ecosystem services

Ecosystems provide different goods and services which are fundamental importance to human well-being, for health, livelihoods, and survival (Millennium Ecosystem (MA), 2005). Ecosystem degradation reduces the ability of ecosystems to continuously supply ecosystem services for current and next generations.

Expressing the value of ecosystem services in monetary terms is an important tool to increase awareness and convey the importance of ecosystems to policymakers. It can also helpful to determine the extent to which compensation should be paid for the loss of ecosystem services. It also provides guidance in understanding user preferences and the relative value current generations place on ecosystem services.

2.1.4. Techniques used for valuing ecosystem services

Since ecosystem services are generally not traded in markets, their values are not expressed as market prices and therefore need to be estimated by some means if they are to be compared to other values in monetary terms. Methods that were developed for the estimation of non-market values include direct market value methods, revealed-preference methods, and stated-preference methods. Below we described choice modeling in detail as this the approach we used in this thesis.

2.1.5 Choice modeling methods

Choice Modeling Methods (CM): CM finds its origins with Lancaster (1966) that proposed the idea that a ‘good’ can be treated as the combination of a group of characteristics. The first applications of CM were in the fields of marketing and transportation research. Since then, CM has been applied in several other disciplines including in environmental and health economics (Louviere and Hensher, 1982)

The two fundamental building blocks of CM are the characteristics theory of value (Lancaster 1966), and random utility theory (Thurstone, 1927). Lancaster's theory of derived utility assumes that consumers' utilities are defined over a bundle of attributes or characteristics of a purchased good or service. Consumer will derive utility from one attributes as well as disutility from other attributes, such as congestion and physical exertion. Price can be considered to be another attribute in each choice set. Welfare changes can be estimated by requesting consumer to choose best alternatives differing by levels of each attribute, including price, (Adamowicz et al., 1998).

In a CM application, respondents are presented with a series of choice sets, each of them containing usually two or more alternative options. Then, respondents are asked to choose their preferred option from each choice set. The combinations of attribute levels for each option in each choice are established using experimental design techniques. Similar to other techniques, before the choice sets are presented to respondents, there should be description of the study site, the research issues, the proposed policy changes, and the implication for the environmental attributes that are being modeled.

2.1.6. Designing a choice experiment method

Designing and implementing a Choice Experiment (CE) require a proper survey design. Baseline alternative (the status quo) should be included in each choice set, especially in order to estimate proper welfare measures. Designing a CE involves four steps:

- (1) **Definition of attributes and levels of provision:** Attributes can be quantitative or qualitative and can be generic (same levels for all alternatives) or alternative-specific

(some attributes or levels may differ across alternatives). According to Lancaster (1966), an environmental attribute is considered relevant if ignoring it would change our conclusions about the preferences of consumers. Previous scientific investigation on the environmental characteristics of the good or service under valuation, expert advice and focus groups may facilitate for the correct definition of attributes and levels of provision required for construction of the choice sets included in an experiment.

Payment vehicle and duration should be chosen in compatibility with the good under valuation and its context. Pilot tests should be used for respondents' understanding of the choice context and task, the adequacy of the attributes and levels considered, and other factors such as length of timing.

- (2) **Experimental Design:** The CE data-generation process relies on proper experimental design. Experimental design is a combination of attributes and levels used to construct the alternatives included in the choice sets. Respondents' stated alternative choices in every choice situation are used to estimate parameter/coefficient for each of the attributes. The second main step in the experimental design involves the construction of the choice combinations. Several different designs can be considered. From that full factorial design is one. It includes all possible combinations of attributes and levels. However, given that the number of combinations may become too large, fractional factorial designs are usually implemented (Hanley et al. 2007). A fractional factorial design is a sample of the full design, which allows the estimation of all the effects of interest. Fractional factorial designs can be orthogonal or so-called efficient designs
- (3) **Survey Administration:** Survey administration ranged from telephone or face-to-face to computer-administered or web-based surveys. For the purpose of this study we will use face-to-face interview. Face-to-face interviews are characterized by the interviewer and respondents sharing both time and space. Besides generating very high response rates, the advantage of this method is that the interviewer can elaborate if the respondent does not understand the task. The NOAA panel has recommended that face-to-face interviews be used in CE valuations as the benefits of this approach far exceed those of the other approaches (Arrow et al. 1993).

(4) **Models for Choice experiment Analysis:**

Final specification of the econometric model relates to the specification of the probability distribution of the error term. Choice model can be estimated using a Multinomial Logit (MNL) specification under the assumption that the error terms of the utility function are independently and identically distributed following a type I extreme value (Gumbel) distribution(Louviere et al., 2002).

The strength and limitations of the multinomial model can be explained under the following criteria (Train, 2003):

(1) MNL can represent systematic taste variations (i.e. those related to observed characteristics of the respondents) but not random taste variations (i.e. those that cannot be linked to observed characteristics of the respondents)

(2) MNL complies with the property of Independence Irrelevant Alternatives (IIA), which may not always reflect realistic situations and

(3) MNL can handle situations where only unobserved factors are independent but it cannot be used when unobserved factors are generating some correlation, for example between alternatives.

As cited by Hoyos (2010) Mixed Logit (MXL) model is able to overcome all the limitations previously mentioned. Additionally it allows coefficients to be estimated over a distribution rather than as a point estimate.

The use of MXL model involves three main specification issues:

(1) The determination of which parameters should be modeled as randomly distributed;

(2) The choice of mixing distribution for the random coefficients; and

(3) The economic interpretation of the randomly distributed coefficients.

The classical procedure to determine the random coefficients is to select among different model specifications (including/excluding random coefficients) using the likelihood ratio (LR) test. A second possibility is the use of the Lagrange Multiplier (LM) test, as proposed by McFadden and Train (2002).

2.1.6. Advantages and problems of choice modeling

2.1.6.1 Advantages

Choice modeling techniques have the following advantages over standard CV technique.

- (i) Because of its natural ability to separately identify the value of individual attributes of a good or services CE does a better job than CV in measuring the marginal value of changes in various characteristics of environmental programs which is useful focus from a management/policy perspective
- (ii) As respondents get multiple chances to express their preference for a valued good over a range of payment amounts, CE are more informative than discrete choice CV studies.
- (iii) CE may minimize some of the response difficulties found in CVM (protest bids, strategic behavior, yeah saying).

2.1.6.2. Problems

Despite choice modeling has been very widely applied in the fields of transport and marketing, its application in environmental contexts is still fairly limited. The following are some of choice modeling problems:

- (i) One of main disadvantage of CM approaches is its cognitive difficulty associated with multiple complex choices between bundles with many attributes and levels. In addition, since respondents are typically presented with large number of choice sets both learning and fatigue effects can occur that may lead to apparently irrational choices (Adamowicz, Louviere and Swait, 1998).
- iii) It is necessary to assume the value of the whole is equal to the sum of the parts to estimate the total value of an environmental programme or good from CE. In this case there may be additional attributes of the good not included in the design which generate utility (in practice, these are captured in the constant terms in the estimated model Compared to contingent valuation CE is more difficult to derive values for a sequence of elements implemented by policy or project. Hence, valuing the sequential provision of goods in multi-attribute programmes

is probably better undertaken by CV (EFTEC, A2001).

- iv) Welfare estimates from CE are sensitive to study design. For example, the choice of attributes, the levels chosen to represent them, and the way in which choices are relayed to respondents (e.g. use of picture) are not neutral and may impact on the values of estimates of consumers' surplus and marginal utilities. To reduce this problems this study used Focus Group Discussion (FGD), literature, expert opinion and key informant interview. Specifically Use of a FGD allows the researcher to obtain insight into the respondents' way of thinking and to pilot the questionnaire on an appropriate group of individuals. Issues that can be successfully dealt with FDG include General understanding of the questionnaire; degree of complexity versus cognitive burden; Chosen attributes and their levels; reactions to the cost attribute; Wording and so on.

2.2 REVIEW OF EMPIRICAL LITERATURE

This sub-section will briefly review some of the choice modeling Surveys studies done in Ethiopia as well as in other countries.

Abebe et al., (2014) applied choice experiment approach of stated preference valuation techniques to estimate the value of improvement of wet land quality of Kitto and Boye, located at the edge of Jimma town, Oromia National Regional State, Ethiopia. The study is based on household level data collected in 2011 from 120 randomly drawn respondents living around two wetlands within a radius of five kilometers in southwestern Ethiopia. Results from multinomial logit model showed that the local communities are willing to contribute significant amount of money to address the environmental problems of the wetlands. Two attributes of the wetlands were selected. These are fish stock restoration and water purification. Payment attribute is also included in the choice experiment. From these the most preferred attribute by respondents is found to be fish stock. Marginal willingness to pay for fish stock and water purification attributes is about 5.04 and 2.05 ETB respectively. The finding also showed respondents are willing to pay 39.6 ETB for the improved wetland management interventions.

Carson et al., (2012) used choice experiment method for valuing wetland attributes in Staffanstorp, southern Sweden. The study used primary data from a survey of random sample of 1200 individuals selected from the Swedish census register. Six wetland attributes and total cost per citizens were included in choice experiment. The selected wetland attributes were surrounding vegetation, fish, crayfish, Biodiversity, walking facilities and fence. They estimated conditional logit model and random logit model. Finding showed that there are heterogeneous preferences for several of the attributes; all the coefficients of the random attributes have significant standard deviations and a high probability of a reversed sign. Second, a negative mean WTP was found for the three attributes “Meadow land”, “Fenced waterline” and “Cray fish”. Following, an inclusion of these attributes will decrease social welfare. However, the WTP for “Meadow land” was insignificant in both models. Third, “Biodiversity” and “Walking facilities” have the highest marginal WTP in their study.

Fitalew (2009) applied choice experiment techniques for valuing Lake Tana fishery and watershed ecosystem services. To design choice experiment he selected three attributes, namely fishing control, lake side plantation and monetary payment. He used multinomial logit and mixed logit model choice as analytical tool. The result from mixed logit model showed all attributes were significant at one percent level of significance. The estimated MWTP for the attributes of fishing control and lake side plantation was birr 15 and birr 50 per month respectively and respondents over all willingness to pay for moderate and aggressive improvement scenario were 57 birr and 97 birr per month respectively.

Birhanu (2012) conducted a study on valuation of choke mountain range wetland ecosystem of East Gojjam Amahara region, Ethiopia using choice model. The survey was administered to a random sample of 250 respondents. He analyzed the data using Multinomial and mixed logit model by identifying three environmental attributes- Bio diversity, availability of water, availability of recreational facilities and monetary payment attribute.

The results showed that all the attributes were significant in affecting the probability of choosing an alternative scenario and had the expected sign except negative effect of biodiversity. The result for biodiversity is negative implying that improvement of these attribute reduce the utility

of respondents. The marginal willingness to pay for availability of water was the highest (birr 155 annually) which was followed by availability of recreational facilities (birr 36 per year). Moreover, the estimated compensating surplus for high impact improvement scenario, medium impact improvement scenario, and low impact improvement scenario were birr 444, birr 490 and birr 143 respectively.

Haroyu et al., 2016 investigated willingness to pay for conservation of environmental services and local tourists' entrance fee of Bale mountains National Park, Ethiopia using Contingent Valuation Method/CVM/. The survey was based on 380 respondents selected from stratified population using lottery method from Dinsho, Goba and Robe towns. Results from logistic regression model shows maximum amount of willingness to pay for the proposed conservation project scenario varied from 0 to 1000 birr (50\$), whereas mean and mode were 35 \$ and 10\$. The research finding also indicated visitors mean entrance fee WTP is over 3 times the current entrance fee.

Generally, the above empirical works showed that the existing research on the valuation of ecosystem has largely been limited to the estimation of WTP for the conservation of national park, wetland, lake, etc benefits using the CVM or to a combination of the two or the CE methods. There are limited researches in developing countries in general and in Ethiopia in particular who use choice modeling methods to estimate WTP for the improved other ecosystem benefits such as reducing soil erosion, improve non timber forest product, increasing water availability, reduce CO₂ emissions and improve fodder availability in Ethiopia in general and in BER in particular. Thus this study is expected to fill this information gap by estimating WTP of BER communities for improved ecosystem services in the area using choice modeling approach.

CHAPTER THREE

METHODOLOGY OF THE STUDY

This study used choice modeling method to estimate the economic benefits of ecosystems in BER.

3.1 STUDY AREA DESCRIPTION

This study was carried out in BER in South-Eastern Ethiopia, Oromia regional state. As we can see from Figure 2, the region is located in the head waters of the Wabe Shebelle and Genale-Dawa river basins. BER hosts globally important biodiversity including endemic and rare species. It is the largest area of Afro-alpine area in Africa and home to the half of the flagship global Ethiopian wolf population, nearly all Mountain Nyalas, and all remaining populations of the giant molerat and a range of amphibians and plants. BER is the source of more than 40 springs and five major cross-country rivers emerge, which provide year-round water to up to 12 million people in Ethiopia, Northern Kenya and the Republic of Somalia. It has large forest cover which store vast carbon and provides critical ecosystem goods and services to communities in the eco-region. The region covers an area of approximately 22,000 km², with a human population of about 3.3 million. It comprises about 16 woredas (districts) in West Arsi and Bale zones of Oromia national regional state. About 12 million population both in the BER, within Ethiopia and beyond, in Somalia and Kenya, are estimated to directly or indirectly depend on several ecosystem services of the forests of the BER (REDD+, 2014). Especially those rural people in the BER are directly dependent on the forest and other natural resources of the area. The local community depends on the natural vegetation of the BER for their livelihoods. There is significant potential to improved management of the BER to sustain and enhance conservation and the livelihoods of the local community and beyond.

Figure 2: Map of the BER



Source: IWMI, unpublished

3.2 Types and Data sources

For this specific study primary data were used. Primary data were collected by household survey method through face to face interview using questionnaires and direct observations of current natural resources use system and watershed management activities at selected BER sites, in midland and lowland communities. As such a variety of qualitative and quantitative data were obtained for descriptive and inferential analysis of household behavior.

3.3 Target population

The issue of whose values has standing in any non- market valuation is context specific and may be difficult to identify. Champ (2003) suggests that the appropriate target population consists of those who benefit from the proposed policy intervention and are willing to pay to secure provision. Accordingly beneficiaries from improved ecosystems benefits of BER are the target

population for this study. Here beneficiaries are community in the BER who sharing direct and indirect benefits from the services of the BER ecosystems.

3.4 Sample size

Determination of the appropriate sample size in any non-market valuation study is largely a case of constrained optimization. The sample size needs to be large enough in order to obtain reliable model estimates subject to the project budgetary constraints (Hoyos, 2010).

Calculation of the optimal sample size is rarely achieved in CM applications since this requires information about the value of parameter estimates a priori. This has lead to the development of a number of ad hoc rules regarding selection of sample sizes for choice models. For example, Adamowicz (2001) suggest a minimum sample size of 50 respondents per survey block. Using this guideline, the target sample size selected for this study is 200 households.

The study area is classified into three agro-ecological zones based on altitude-based clusters. Accordingly classification that categorizes areas with altitudes of <1,300 masl was indicated as lowland, but with elevations of 2,300-1,300 m.a.s.l as midland and over 2,300 m.a.s.l as highland. Woredas covering highland of BER are Adaba, Dodola, Kokosa, Dinsho, Sinana, Goba, Gasera, Goro, Gololcha, and Agarfa. Woredas covering mid altitudes are Nansabo, Harena Buluk, Dallo Mana, Madda Walabu and lowland of BER includes woredas such as Dallo Mana, Madda Walabu, Guradhamole, and Barbare. For the purpose of this study we focused on Harena buluk Woreda (Figure 3) where we find midland and lowland kebeles. We also selected one kebele from both mid land and low land purposively. The selected kebeles are located in the same watershed. These kebeles are Kumbi kebele from midland and Melka Arba from lowland. 100 households are selected from each selected kebeles by using simple random technique to gather primary data. The data were collected via face to face (in-person) interview by using structured questionnaire. Survey of this study was conducted by using local language Afan Oromo. In order to collect the data, three enumerators and one supervisor were employed and 5-6 days training on how to conduct the interview was given to them by using the local language. The survey was conducted starting from mid April, 2016 for a duration of one month.

3.5 Choice modeling methods

Choice modeling encompasses a range of stated preference technique, which takes similar approach in environmental valuation (Bateman et al., 2002). One of choice modeling techniques is Choice Experiments (CE). In a CE respondents are presented with a series of alternatives, differing in terms of attributes and levels, and asked to choose their most preferred. A baseline alternative or a status quo scenario or 'do nothing' situation, is included in each choice set. This is important to estimate proper welfare economic terms.

CE method, as explained earlier, has its theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966), and econometric basis is random utility model (Thurstone 1927). Birol et al., 2006b explained consumers derive satisfaction not only from the goods and services themselves but also the characteristics they provide. The random utility approach describes indirect utility of a choice as being comprised of a systematic (explainable) component and an error term (unexplained) component (Rolfe et al., 2000).

$$U_{ij} = V_{ij}(X_{ij}) + e_{ij} = bX_{ij} + e_{ij} \dots \dots \dots (1)$$

Where:

U_{ij} = Is indirect utility function for each respondent i given alternative j

$V_{ij}(X_{ij})$ = Is explainable component, which is typically specified as a linear index of the attributes (X) of the j different alternatives in the choice set

e_{ij} = is error term component

To illustrate the basic idea behind CE presented in this study, consider respondents choice for ecosystem services scenario and assume that utility depends on choice made from a set C, which includes all the possible ecosystem services scenario alternatives.

The respondent is assumed to have a utility function of the form:

$$U_{ij} = V(Z_j, S_i) + e_{ij} \dots \dots \dots (2)$$

The presence of error term permits to make probabilistic statements about individual's choice behavior. Choices made between alternatives in choice experiments is a function of probability

Undertaking reforestation is important to restore forest cover and improve its related eco-system services. Reforestation leads to enhance biodiversity, reduce soil erosion and sedimentation/flood load, observation of carbon stocks, stabilize the water flow, thereby increasing water availability for irrigation and domestic uses, etc. There is evidence that a reduction of forest cover amplifies flood events in developing countries (Bradshaw et al 2007) as more rainfall directly turns into run-off instead of being slowed down or buffered by forests. In Ethiopian condition, deforestation is the main cause for accelerated soil erosion and soil loss. This requires private and community initiatives. Farmers may plant trees or agro-forestry practice on farmland individually or may participate on community reforestation program on communal lands in their area. We propose this intervention for high land and midland community with the aim of conserving the existing or restoring the forest cover in BER. We selected the following four attributes related to reforestation.

1. **Biodiversity:** This attribute refers to the number of fauna and flora species improved and their habitats in the ecosystem following conservation or reforestation. For example Mekuria et al., (2015) reported that woody species composition and richness (ranged from five to 28) were observed following the establishment of exclosures. This program has three main alternatives biodiversity management scenarios. We assume that conserving the existing or restoring the forest cover increasing fauna and flora species composition and richness by 5, 10 and 15.
2. **Soil erosion:** The estimate of average annual soil losses for all types of land cover in the highlands of Ethiopia lies between 10 and 35 t/ha and average values for croplands vary between 20 and 100 t/ha (Bezuayehu et al., 2002) while estimates in (predominantly) in some parts of the Bale highlands are reported to lie between 51–100 t/ha per year (Baseline survey, 2015). Such high rate of soil erosion is attributed to extractive agricultural practices, poor vegetation cover and tillage (Baseline study, 2015). This attribute put the alternative soil erosion reduced from the direct impacts of rain and wind erosion following this program. Research conducted by Hengsdijk et al (2004) in Ethiopia's Tigray region showed a 14% decrease in soil loss for reforested watershed areas. For the purpose of our study we proposed three alternatives are envisaged; if soil erosion reduced by 5%, 10% and 20%.

3. **CO₂ storage:** Forest enhances the observation of carbon stock in both underground and above ground. Afforestation and management of fast-growing tree species, have an immediate effect on the regional rate of CO₂ sequestration by incorporating carbon dioxide (CO₂) in plant biomass (Jandl et al., 2007). This plays good ground globally for carbon trade between polluting countries and countries with good forest cover. As CO₂ storage from forest increases the benefit of BER community from carbon markets also increase as well. This attributes refers to increased CO₂ storage after we implement certain level of reforestation program. The proposed alternatives are CO₂ storage raised by 50, 65 and 70%.
4. **Non timber forest products:** This attribute refers to the level of non-timber forest product improved during/ after the implementation of reforestation program in the area. Non-timber forest values of the forest cover include use dead forest for fuel wood, medicinal plants, coffee and honey production. The proposed alternatives for this attribute are if non-timber value improved by 10, 20 and 30%.
5. **Annual payment in Birr:** Payment (in terms both labor and money) is required to conserve or restore the forest covers for better ecosystem services. The status quo option is no payment without any improvement of the ecosystem services.

Table1: Description of reforestation related attributes and levels used in choice experiment

Proposed intervention	Attributes	Status quo	Levels of attributes
Reforestation	Biodiversity(medicinal plants)	Declining biodiversity count	<u>Increased both fauna and flora species will be:</u> 5 , 10, 15
	Soil erosion	Increasing soil erosion.	<u>The reduced soil erosion/hectare will be:</u> 5% ,10% and 20%
	Non-timber forest products	Decreasing non-timber value.	<u>The proportion of improved non-timber forest product will be :</u> 10% , 20% and 30%
	CO ₂ storage	Decreasing CO ₂ storage	<u>Increased CO₂ storage will be:</u> 50% , 65% and 70%
	Willingness to pay/year	None(0)	<u>Proposed annual payment by farmers:</u> 400, 800 , and 1000 ETB

B. Soil and water conservation: This intervention includes both physical and biological SWC measures on farmlands and degraded hotspot areas like gullies or river banks. Conserving soil erosion leads increase to soil moisture and fertility (enhance crop productivity), to reduce run off and sediment yield, reduce gully erosion, improve groundwater infiltration and raising the groundwater level which improve the availability and access to water for agriculture and domestic uses in the long run. This intervention requires private and community initiative. For example farmers may practice environmentally friendly agriculture and plant grass or trees on the bounds of their plot of land to conserve soil erosion and water. Community practices on physical SWC measures such as terracing, soil and stone bunds, combined with some biological measures. The cost of this intervention is mainly payments for laborer and for seedlings. We suggest this intervention for both midland and lowland communities. We selected the following four attributes related to soil retention measures.

1. **Increase soil moisture and fertility:** Undertaking SWC program plays vital role to improve soil moisture and fertility especially in the area where soil erosion problem is serious. This program provides three alternatives of increasing soil moisture and fertility following implementation of SWC measures. This are improving soil moisture and fertility by 10 % 20% and 30%
2. **Reducing runoff:** This attributes refers to alternative runoff reduced after SWC measures is implemented in selected areas. Runoff causes soil erosion, flood, reduce water quality, etc. Implementing SWC reduces run off which in turn reduces soil erosion, decreases flood frequency and improves water quality. For example implementation of SWC measures in the Debre-Mawi watershed (in Amahara region) resulted in reductions in runoff ranged from 26 to 71 % (CGIAR briefing on WLE, 2015). Based on this we proposed alternatives to reduce run off by 20%, 35% and 70% for community lives in BER.
3. **Stabilize water flow:** This attributes refers to the improved ability of soil to absorb water and groundwater levels maintained that may so increase dry season base flow following SWC implementation. For example following implementation of SWC the availability of groundwater has increased more than 10 times since 1993 in Eastern Tigray, Ethiopia (MEJS, 2013). For the purpose of this study we proposed three

alternatives for BER community. Ensuring base flow during the rainy season only, 6 months /year and the whole year.

4. **Reducing sedimentation yield in river:** By reducing soil erosion, SWC interventions can decrease the sedimentation yield in river. This, in turn, improves the life of water management structures, water supply facilities for farmers for drinking (for both people and cattle) and irrigation purposes and flood control reservoirs for hydro dam (but they have to compensate the farmers participated in the program). Annual suspended sediment loads range between 0.11 and 15 million tones, depending on the size of the watershed area and associated run-off generated from the watershed. Local values for siltation rates in reservoirs in the water basins of BER have so far not been found. Values found in reservoirs in the Northern Tigray region are in the order of 237 -1817 t km⁻² y⁻¹ with an average of 909 t km⁻² y⁻¹, and 70% of reservoirs under study reported to have important problems associated to siltation (Haregeweyn et al., 2006). Problems associated to siltation in Ethiopian reservoirs are; loss of storage capacity resulting in shortages in water supply for irrigation and human consumption, higher dam operation costs and reductions in water quality. Undertaking SWC measures is very critical. Implementing SWC interventions in the Debre-Mawi watershed (in Amahara region) resulted in reductions in sediment yield ranging from 45 to 81%. This study gives three alternatives of sediment yield reduction in the BER. These are if sediment yield is reduced by 20 %, 30% and 40%.
5. **Annual payment in Birr:** Payment (in terms of both labor and money) is required to conserve soil erosion for better ecosystem services. The status quo option is no payment without any improvement of the ecosystem services.

Table 2: Description of SWC related attributes and levels used in choice experiment

Intervention	Attributes	Status quo	Levels of attributes
Soil and water conservation(SWC)	Increasing soil moisture and fertility	Increasing soil erosion	<u>Increased soil moisture & fertility will be:</u> 10% , 20% and 30%
	Reducing run off	Increasing run off	<u>Reduced run off will be:</u> 20% 35% and 70%
	Stabilizing water flow	Unstable water flow	<u>Ensuring water availability :</u> during rainy season only , for six months and for whole year
	Reducing sediment yield in river	Increasing sediment yield in river	<u>The proportion of reduced sedimentation will be :</u> 20% 30% and 40%
	Annual Monetary payment (cost)	None(zero)	<u>Proposed annual payment:</u> 400 , 800 , 1000 ETB/year

C. Enclosures (Enclosures): areas are closed to human and livestock interventions with the goal of promoting natural regeneration of plants and reducing degradation of former communal grazing lands. The aim of this intervention is to improve ecosystem services and reversing biodiversity losses (Mekuria et al. 2011). Enclosures increase agricultural production by reducing soil erosion, improving vegetation cover; increases cut and carry animal fodder, improve CO₂ storage (Mekuria et al. 2011). This intervention is more successful, if it is applied with SWC measures, some enrichment with fodder trees (like *Sasabania*) and grasses and watering points. Based on their importance to the community in the area we selected the following four major attributes related to enclosure.

1. **Soil erosion:** This attribute put the alternative soil erosion reduced from the direct impacts of rain and wind erosion following enclosure intervention. Mahmoudzadeh (2007) stated in his research report in Iran that improving natural vegetation by enclosure decreases soil erosion significantly. This program gives two alternatives of soil erosion reduction by 5%, 15% and 25%.
2. **Biodiversity:** This attribute refers to the number of fauna and flora species improved and their habitats in the ecosystem following enclosures. In Ethiopia, enclosures in landscapes have become increasingly important to reversing biodiversity losses. Yaynesht et al., (2009; Mekuria et al, (2015)) stated that species composition and diversity of herbaceous and woody plants were higher in the enclosures than in the

grazed areas. Woody species composition and richness (ranged from 5 to 28) were observed following the establishment of exclosures (Mekuria et al, 2015). In study we propose woody species composition and richness index will increase by 5, 15 and 25.

3. **Feed availability:** This attribute stands for livestock feed improved following successful implementation of exclosures, enrichment and other SWC measures including watering points. Mekuria et al., (2015) reported that exclosures are effective in restoring degraded lands and communities are benefiting from increased fodder production and reduced impacts of soil erosion. Yayneshet et al., (2009) also reported that the mean aboveground biomass measured inside the exclosures was more than twice that of the adjacent grazed areas and more biomass was produced from the young than the old exclosures. Yayneshet et al., (2009) indicated that a total of 61 different herbaceous and 34 woody species were recorded in the two study sites; the mean biomass measured in the exclosures was more than twice of the adjacent grazed areas. The proportion of biomass consumed by grazing animals ranged from 51 to 69% (Yayneshet et al., 2009). The alternative proposed for this attribute is livestock feed availability will be improved by 1.5, 2 and 3 times.
4. **Exclosure with watering points:** This refers to watering points to livestock through construction of trough or other gutter structures. This intervention makes exclosure more effective by applying rotational and controlled grazing. Cut-and carry system becomes also more feasible with availability water for livestock. This intervention envisages construction of 2, 3 and 5 watering points.
5. **Annual payment in Birr:** Payment (labor, money) is required to conserve ecosystem and for better ecosystem services. The status quo option is no payment with any improvement of ecosystem services.

Table 3: Description of enclosure related attributes and levels used in choice experiment

Intervention	Attributes	Status quo	Levels of attributes
Exclosures	Reducing soil erosion	Rising soil erosion	<u>Reduced soil erosion will be :</u> 5%, 15% , 20%
	Biodiversity	Declining biodiversity	<u>Increased number of fauna and flora will be :</u> 5 , 15, 25
	Livestock feed availability	Declining Live stalk feed availability	<u>The proportion of improved live stalk feed availability will be :</u> 1.5 times , 2 times and 3 times
	Exclosure with watering points	No construction of watering points	<u>Construction of :</u> 2 , 3 and 5 watering points
	Payment level	None(zero)	<u>Proposed annual payment:</u> 400 ,500 and 750ETB/year

3.6.2 Experimental design

After the relevant attributes and attribute levels were identified, the next step is construction of choice sets via experimental design. Choice sets were formed by using different levels of the attributes. The combination of different levels of attributes yields different alternative scenarios and then choice sets. In this study five attributes are selected for each selected alternative resource management practices (for reforestation, SWC and exclosure program).

The number of ecosystem management scenarios that can be generated from five attributes and all with three levels was 243 (i.e. $3^5=243$) combinations for reforestation related attributes, from five attributes and all with three levels was 243 ($3^5 = 243$) combinations for SWC related attributes and from five attributes and all with three levels was also 243($3^5 = 243$) combinations for exclosures related attributes. From the point of view of maximizing the amount of information, it would be desirable if all individuals could face possible attribute levels combinations according to their preferences.

However, as indicated earlier, full factorial design would be cognitively burdensome (Louviere et al., 2000) as well as time consuming. Thus fractional factorial design was used to ensure that all different attributes can be estimated independently (orthogonal) of each other. Finally 4

choice sets for each intervention were built and presented to the respondents to choose the best option preferred from each choice set.

Table4: sample choice set related with reforestation interventioCO2





Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status quo
Improve biodiversity count		Biodiversity count will be improved by 5	Biodiversity count will be improved by 10	Biodiversity count will be improved by 15	Declining biodiversity
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Increasing soil erosion
Increase CO ₂ storage		CO ₂ will be increased by 10%	CO ₂ will be increased by 10%	CO ₂ will be increased by 10%	Declining CO ₂ storage
Improve non-timber forest products(NTFP)		NTFP will be improved by 15%	NTFP will be improved by 15%	NTFP will be improved by 15%	Declining NTFP
Payment in terms of labor and money per year		400	800	1000	0 ETB
Please tick/mark (✓) only one					

Table5: sample choice set related with SWC program









Attributes	Picture explain the attribute	Option 1	Option2	Option 3	Status quo
Soil moisture and fertility		Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 20%	Improving soil moisture & fertility by 30%	Declining soil moisture & fertility
Reduce run-off		Reducing run-off by 20%	Reducing run-off by 20%	Reducing run-off by 20%	Rising run-off
Reduce sediment yield		Reducing sediment load by 20%	Reducing sediment load by 20%	Reducing sediment load by 20%	Rising sediment yield
Stable water flow		Water will be available only during rainy season	Water will be available only during rainy season	Water will be available only during rainy season	Further unstable water flow
Payment /year		400	800	1000	0 ETB
Please tick/mark (✓) only one					

Table 6: sample choice set related with exclosures program

Attributes	Picture used to explain attribute	Option 1	Option2	Option 3	Status gou
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 15%	Soil erosion will be reduced by 25%	Increasing soil erosion
Increases biodiversity count		Biodiversity count will be increased by 5	Biodiversity count will be increased by 5	Biodiversity count will be increased by 5	Declining biodiversity
Improve Livestock feed availability		Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 1.5 times	Declining feed availability
Establish watering points		Construction of 2 watering points	Construction of 2 watering points	Construction of 2 watering points	No construction
Payment in terms of labor and money per year		400	500	750	0 ETB
Please tick/mark (✓) only one					

In addition to CE questions, questioner prepared for this study includes: questions about socio economic status of the respondents. These typically include the respondent's age, gender, household income, marital status, occupation, number of dependents, and educational attainment. This is followed by questions on general perceptions and observations of respondents about the BER ecosystem. These questions focus on respondent's attitude and their observation with regard to the BER ecosystem.

3.6.3 Survey Administration

Survey administration ranged from telephone or face-to-face to computer-administered or web-based surveys. For the purpose of this study we will use face-to-face interview. Face-to-face interviews are characterized by the interviewer and respondents sharing both time and space. Besides generating very high response rates, the advantage of this method is that the interviewer can lead the respondent through the hypothetical scenario and elaborate if the respondent does not understand the task. The NOAA panel has suggested face-to-face interviews be used in CE valuations as the benefits of this approach far exceed those of the other approaches (Arrow et al. 1993).

3.7 Models for choice experimental analysis

Different assumption about the distribution of error term (random component) yield different component. For example, the conditional logit model assumes that the random components are Distributed Independently and Identically (IID) with a Weibul distribution and choices are consistent with the Independence of Irrelevance Alternatives (IIA) property (Train, 2003).The main draw back in Conditional Logit Model (CLM) can be overcome by employing a discrete choice model that does not require the IIA property. The Random Logit Model (RLM) or Mixed Logit Model (MXL) does not require IIA property. For the purpose of this study MXL as analytical tool is used.

3.7.1 Random parameter logit model (Mixed Logit model)

Even if MNL model is used as analytical tool to value ecosystem services by many researcher it has two main problems (Alpizar et al., 2001). First the model is based on the assumption of IIA which is not always realistic. This problem comes as a result of the IID assumptions of the model. The second problem of the MNL model specification is that it doesn't take in to considerations individuals' heterogeneity. However, the random logit model provides a simple way to generalize the MNL to permit the utilities of each alternative to be correlated (Cameron and Trivedi, 2005). The model explicitly accounts for correlations in unobserved utility over repeated choices by each respondent (Hensher and Greene 2003). McFadden and Train (2000) proofs that MXL can approximate any choice model including any multinomial probit model . The reverse cannot be said: a multinomial probit model cannot approximate any MXL, since Multinomial Probit(MNP) relies critically on normal distributions.

By relaxing the assumptions of CLM, the random utility function in the RPL model will take the following form (Birol et al., 2005):

$$U_{ij} \equiv V_{ij}(Z_j, S_i) + \epsilon_{ij}(Z_j, S_i) = V(Z_i(\beta + \eta_i), S_i) + \epsilon_{ij}(Z_j, S_i) \dots \dots \dots (4)$$

Where respondents i receives utility U choosing alternative j from a choice set C. Utility is decomposed in to a non- random component (V) and stochastic term (ϵ); and the indirect utility is assumed to be a function of the choice attributes Z with parameters β (and socio-economic characteristics, if they are included in the model) that may vary across respondents by a random

component η due to preference heterogeneity. Thus, the probability of choosing alternative i in each of the choice sets will have the following form (Birol et al., 2006b).

The probability that an individual “ n ” chooses alternative i from each choice set is then presented as:

$$P_{ij} = \frac{\exp V(z_j(\beta + \eta_i), S_i)}{\sum \exp V(z_h(\beta + \eta_i), S_i)} \dots \dots \dots (5)$$

The indirect utility function can be used to estimate the coefficient/parameters (Birot et al 2006b). The vector coefficients estimates for choice attributes can be found from the indirect utility function estimates.

Then, from the indirect utility model coefficients estimate in the choice experiments ,the MWTP value of a single choice attribute can be calculated as a ratio of the respective choice attribute coefficient and the price or monetary attribute coefficient (Hanemann, 1998)

$$MWTP = - (\beta_{any \ non \ market \ attribute \ ecosystem} / \beta_{monetary \ attribute} \dots \dots \dots (7)$$

Where, β are the estimated coefficients of the attributes in random parameter logit model.

The WTP are useful to demonstrate the tradeoff between individual attributes. A comparison of individual of the implicit prices of attributes implies some understanding of the relative importance that respondents hold for them (Bateman et al. 2002). Basically this information helps policy makers to design resource use alternatives so as to favor those attributes, which have higher (relative) implicit prices.

The welfare measure from improvements of an environmental good and service can be explained by the compensating surplus (Birol et al. 2006b). Compensating Surplus (CS) can be obtained from different choice scenarios associated with multiple changes in attributes.

$$CS = - (1/\beta_{monetary \ attribute}) (V_0 - V_i) \dots \dots \dots (8)$$

Where, V_0 is the value of the indirect utility associated with the status quo. V_i Is the indirect utility associated with different alternative improvement scenarios or plans with their specific levels of the attributes. β Is the estimated coefficient for monetary attriute.

Finally MXL is estimated using a statistical package of stata version 12. All attributes levels with percentage were coded with their respective absolute number. Attributes of biodiversity count, watering points and improve livestock feed availability levels were entered directly. The payment level attribute has been entered in cardinal-linear form. The status quo alternative scenario levels were coded as 0 for all attributes.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter focuses on the important findings and results obtained from the sample survey of choice experiment. The first section presents the descriptive statistics followed by econometric analysis.

4.1 Descriptive statistics

Three main sets of data were collected from a sample of 200 respondents via questionnaire. The first dataset includes the socioeconomic and demographic characteristics of the respondent such as income, age, sex, educational status, participation of family members in nonfarm activities or not, and about economic activities of respondents. The second dataset focused on the general perceptions and observations of the respondents on social and environmental problems existing in BER. The third dataset contains the choices of the respondents for different hypothetical improvement scenarios of BER. The data was first coded and entered into the STATA12 software for estimation and analysis.

4.1.1 Demographic and Socioeconomic Characteristic of Respondents

The descriptive statistics for selected socioeconomic variables of the sample respondents are presented in the table 7. As table 7 shows male respondents consist of 94% of the respondent. Since our respondents are household heads or someone who acts as household heads, this result is not surprising due to the fact that like in most of our country male dominated every decision making in household affairs due to socio-cultural reasons as in line with the studies of Singh et., Al (1993). The average yearly income of the respondent was about 23239.42 Ethiopian birr per year, which is equivalent to about 1106 USD¹. About 30% of sample respondents can read and write. As far as education level of the household members is concerned majority of the household members did not take education. From total sampled household members, 57.89% of them can neither read nor write (illiterate), 39.18% are of primary education (1-8 grades) level, 2.47% are of secondary education (9-12) level, 0.08% are diploma and 0.08% degree complete. The average respondents' age was 36 years and 96% of them are married with a family size of 6

¹ During our survey, the exchange rate of 1 USD ~21 ETB. (National bank of Ethiopia, 2016))

members. The average number of family size is much higher when compared with the national 5.4 per household (DHS, 2011). The mean farm land holding was 7.57 timad (1 timad \approx 0.25 hectare), which almost the same with the national figure. The result showed that only 4.5% respondent participated in non-farm activities. This shows that more than 95% of the respondents' livelihood depended on agriculture, mainly mixed farming dominated by rearing animals.

Table 7: Descriptive statistics for selected socioeconomic variables of the sample respondents

Variables	Description	Mean	Std. Dev
Age of the household head	Age of the respondent	36	9.25
Sex of the household head	= 1 if the respondent is male , and zero other wise	0.945	0.23
Family size	The number of family members	6	1.81
Whether the head could read and write	= 1 if the respondent can read and write , and zero other wise	0.3	0.46
Marital status	= 1 if respondent is married and zero other wise	0.96	0.18
Participating in non-farm sector	= 1 if the respondent participated in non-farm activities, and zero other wise	0.045	0.21
Farm size	The size of farm land respondent hold in timad	7.57	4.02
Income	Yearly respondent income in Ethiopian birr	23239.42	16464.75

Source: own survey, 2016

Looking into household composition, as table 8 shows, from total household members' male and female Comprise 45.97% and 54.03% respectively. The study also revealed that the age of household members less than 15 years of age, between 15 and 64 and greater than or equal to 65 were reported to be 55.43, 44.24 and 0.33% respectively. Even if the largest portion of household members less than 15 years are considered as dependant they have significant contributions in the economic activities in the BER by keeping cattle, fetching water, keeping crops from wild animals, collecting fire woods ,etc.

Table 8: Descriptive statistics of Households respondent demographic Data

Variables	Frequency	Percent
Sex		
Male	559	45.97
Female	657	54.03
Total	1215	100
Can households' members read and write?		
No	704	57.89
Yes	512	42.11
Total	1215	100
Marital status		
Married	410	33.72
Single	799	65.71
Divorced	7	0.85
Total	1215	100
Do household members participate in non/off-farm employment in the area or outside?		
No	1,194	98.27
Yes	21	1.73
Total	1215	100
Education level of households members (including the hh heads)		
None	707	58.19
Elementary	476	39.18
Secondary	30	2.47
Diploma	1	0.08
Degree and above	1	0.08
Total	1215	100
Age of households member		
0-14	674	55.43
15-64	538	44.24
=>65	4	0.33
Total	1215	100

Source: own survey, 2016

4.1.2 General perceptions and observations of the respondents on problems existing in BER

The respondents were also asked about the current social and environmental problems existing in the BER. These questions were needed to understand environmental and social problems in the BER and to forward possible policy recommendation to address those problems. Accordingly, 57 percent of the respondents said that deforestation rate in their area is medium, while 11% and 37.5% of respondent responded that deforestation in their area were high and low respectively. Beside this, they were also asked that what are the major causes of deforestation in the area, and then most(90%) of midland respondents claimed that agricultural expansion and timber production are the major causes of deforestation, while most (82%) of lowland respondents claimed that agricultural expansion and firewood/charcoal production are the main causes of deforestation in the area. 62 percent of the respondents agreed on the degradation of the BER and the extinction of many animal species such lion, elephant, tiger, gedemsa (by local language), yeyi (by local language), etc and many plant species like Gaguro, Oda (*Ficus sycomorus* L.), Fetto (*Lepidium sativum* L.), Hoko, Badessa (F.White), urgoo (*Endostemen tereticaulis*), etc. Regarding to vegetation status on the grazing areas in the eco-region 50.5, 36.6 and 13 percent of respondents said that vegetation status on the grazing areas in the BER is medium, low and high respectively pointing to reduction of tree cover of grazing areas.

4.1.3 Access to water

River (stream) water is the leading source of drinking water for 55% households in the study area followed by public well and ground water, which accounting 14.5% and 13.5 respectively. This implies a larger portion of the community doesn't have access to clean water. 58% of the households travelled less than 15 minutes and 43.5% travelled between 15 and 30 minutes to collect water.

Table 9: Sources of water for households in the BER

Source of water	Frequency	Percent
Tapped water	6	3%
Groundwater	27	13.7
Public well	29	14.5%
Stream water	110	55%
Stream water and tapped water	4	2%
Stream water and groundwater	6	3%
Stream water and public well	18	9%
Distance travelled to collect water		
Less than 15 minutes	58	29%
Between 15 & 30 minutes	87	43.5%
Between 30 & 45 minutes	29	14.5%
More than 45 minutes	26	13%

Source: own survey, 2016

4.1.4. Interventions in natural resource management

The survey results showed that 68 and 76 percent of respondents practice soil and water conservation measures on own land and communal land respectively. The respondents were asked about the type SWC measures they practiced. Accordingly 17.5% practiced physical (soil/stone bunds, terraces, cut-off drain, etc), 10% practices biological (tree planting, agro-forestry, grass planting, etc), while the remaining 53.5% respondents practiced both.

Lowland respondents were asked that whether area exclosures are practiced or not in the BER. From the total respondents 88% agreed that area exclosures are practiced in their area and only 47 percent of respondents confirmed area exclosures practiced with enrichment (additional plantation) such as Moringa, Nim tree (*Melia azedarach L.*), Wachu (*Acacia seyel*), Abatalmulug, Dadacha, etc. Midland respondents were also asked whether reforestation/aforestation is practiced or not in their area. 76% of respondents claimed that reforestation/aforestation is practiced in their area and from this 34% and 42% of respondents suggested reforestation takes place using single species and diverse species respectively.

Even if it is not sufficient, 93% of respondents agreed that there are on-going interventions on natural resource management (SWC, reforestation/afforestation, exclosure, etc), potable water supply, road development, and expanding electricity services. 100% of respondents agreed that there are climate variability and change in the BER. Midland respondents mentioned the main manifestations of climate variability and change in their area are low rainfall, high temperature, and sometimes high rainfall, while lowland respondents mentioned high temperature, low rainfall, frequent drought, high incidence of flooding, etc as the main manifestations of climate variability and change in their area. Interestingly, about 98% of respondents agreed for the intervention to conserve ecosystems services.

Table10: Descriptive statistics for selected socio-economic and environmental problems in the BER.

Variables	Descriptions	Mean	Std. Dev
Food consumption	=1 if household's food production and income over the past 12 months been sufficient to feed his/her family, and zero otherwise	0.23	0.241
Climate variability	=1 if there climate variability and change in the area, and zero other wise	1	0
Conserve eco-system	=1 if the respondent agreed to conserve ecosystems in his/her area, and zero otherwise	0.98	0.14

Source: own survey, 2016

4.1.5. Food security and other socio-economic problems

The survey results also indicated (see table 10) that only 23% of households reported that the past year's food production and income was sufficient to feed his/her family for over 12 months, while the remaining 77% of the households are food insecure. Most of the respondents rank the following factors as main causes of food insecurity, according to their severity. These are climate variability, soil erosion, shortage of rainfall (especially in the lowland), shortage of farm land, lack of improved seed and fertilizers, lack of modern irrigation services, low saving culture, etc. Further the respondents were asked what coping strategies to food insecurity. Many of the

respondents listed the following major coping mechanisms, according to their importance to respondents. These are:

1. Sale livestock mainly oxen to get money for purchases of grain and other households needs,
2. Borrowing from relatives or friends in the form of cash, or food grains,
3. Work as daily laborer to get income,
4. Reduce daily meal in-take both in amount and frequency,
5. Harvesting coffee seed and other grains before harvesting period,
6. Marketing on forest and forest products (firewood, charcoal, etc),

Furthermore, more than 85% of the respondents rank the main socio-economic problems in the area in the following order. These are Food shortage, lack of clean and sufficient water, shortage of animal feed, lack of infrastructures (like road, school, hospital, electricity, etc), epidemic diseases, lack of market for their product, etc. Regarding to environmental problems many of midland respondents rank it in the following order: deforestation, climate variability and change (decreasing of rainfall and increasing rainfall) and soil erosion, whereas lowland respondents order the problems as overgrazing, climate variability and change (frequent drought), soil erosion and flood as a major environmental problems in their area.

4.2 Econometric Model estimation

The choice experiments are analyzed using 6,400 (1,600, 3,200 and 1,600) observations related to reforestation (for midland only), SWC (both for midland and lowland households) and exclosure intervention (for lowland only) respectively observations elicited from 200 households. The estimates of mixed logit model for reforestation, exclosure and SWC characteristics for midland and lowland are presented in tables 11, 12, 13 and 14 respectively.

Table 11: Mixed logit results of reforestation attributes (for midland households only)

Variable	coefficient	standard error	P-value
Payment level	0.00199	0.0056	0.000
Biodiversity	-0.114	0.0348	0.001
Soil erosion	0.0688	0.025	0.005
Co ₂ storage	0.065	0.025	0.009
NTFP	0.063	0.017	0.000

Notes: NTFP represent non-timber forest product attribute

Source: own survey, 2016

As may be seen from above table (table 11), except biodiversity all other reforestation characteristics in the choice experiment are positively and significantly related to the probability of choosing an option. Even though the expected sign for biodiversity attribute was positive, it has a negative sign which is also contrary to the results of other valuation studies (e.g., Birol et al., 2005). The negative sign of biodiversity coefficient implies improvement of this attribute reduces the utility (consumption) of the respondents as improving biodiversity attribute requires excluding community from using it.

Table 12 revealed all enclosure characteristics presented in choice experiment are positively and significantly related to the probability of choosing an option, whilst payment level is negatively and significantly related as expected. This shows lowland respondents give more value to this attribute. This might be due to the fact that many midland respondents argued that biodiversity status in their area is high, whilst many lowland respondents argued that there is low status of biodiversity in their area and they gave more emphasis to this attribute. Positive and highly significant for improving livestock feeds availability and construction of watering points coefficients indicates that respondents gave attention to improve these attributes do to the fact that the lowland area is highly vulnerable to drought and livestock feed availability and water is becoming highly scarce in the area. Positive and significant soil erosion attribute coefficient also indicates that respondents have preferences to reduce soil erosion, because respondents reported

that soil erosion in the area is high, even in BER compared to highland and midland soil erosion is higher in low land eco-region. This is due to midland and highland BER is relatively covered by forest.

Table 12: Mixed logit results of enclosure characteristics (for lowland households only)

Variable	coefficient	standard error	P-value
Payment level	-0.107	-3.06	0.002
Soil erosion	2.589	3.16	0.002
Biodiversity	1.773	3.03	0.002
Livestock feed	29.966	3.16	0.002
Water points	13.795	3.17	0.002

Source: own survey, 2016

We presented the same SWC intervention characteristics choice experiment for both midland and lowland respondents of the same watersheds in the BER and compare household preferences for the improvement of ecosystem services by their location. As may be seen from tables 13 and 14 preferences do differ between the midland and lowland respondents. The results show that low land respondents gives value to all attributes presented in the choice experiments. But midland respondents give value to only soil moisture and fertility and water flow attributes from attributes presented to them in the SWC characteristics choice experiment as shown by table 13. The results revealed only soil moisture and fertility and water flow are significant and have the expected positive sign. The midland respondents do not, as we expected, care about improvements in the runoff and sediment, because runoff and sediment are not serious problems for them since the area is relatively well covered by forests

Table 13: Mixed logit results of SWC intervention attributes (for midland households)

Variable	coefficient	standard error	P-value
Payment level	0.00024	0.0005	0.686
Soil erosion	0.159	0.020	0.000
Run-off	-0.0111	0.0068	0.101
Sediment	-0.0201	0.0142	0.156
Water flow	1.129	0.176	0.000

Source: own survey, 2016

As we see from tables 13 and 14 payment level is highly insignificant which is unexpected. The findings are, in general, in line with prior empirical studies (e. g. Abebe et al. 2014). This insignificance of payment level may be because preference of community is not much different on improvements of attributes related to SWC program regardless of the payment level. This could also strengthen the fact that none of the respondents choose the current situation (status quo scenario).

Table 14: Mixed logit results of SWC intervention attributes (for lowland households)

Variable	coefficient	standard error	P-value
Payment level	-0.00056	0.00056	0.962
Soil erosion	0.042	0.018	0.022
Run off	0.0183	0.006	0.008
Sediment	0.066	0.015	0.000
Water flow	0.518	0.168	0.002

Source: own survey, 2016

4.2.1 Estimation of marginal willingness to pay

In this study marginal willingness to pay (MWTP) indicates the amount of money respondents both in midland and lowland in the BER are WTP for the improvement of eco-system attributes in the BER. Given linear income effect assumptions the MWTP for certain attribute is calculated as the ratio of the coefficient for the attribute of BER ecosystem to the estimated coefficient of the monetary attribute (marginal utility of income). Here we report only the MWTP for each reforestation and exclosure attribute presented in choice experiment. As we could see from table 13 and 14 monetary coefficients for both midland and lowland respondents are insignificant. We didn't report the MWTP for all SWC attributes presented in choice experiment for both BER respondents, because we suspected that estimated MWTP from highly insignificant monetary attribute might be incorrect and highly insignificant. The results of MWTP for both reforestation and exclosure attributes presented in choice experiment are reported in table 15 and 16, below.

May be due to expectation of decreasing current consumption from improvement of this attribute or considering it as global goods, respondents are not willing to pay for the improvement of the biodiversity attribute (Table 15). Midland (kumbi kebele's) respondents are willing to pay 34.45, 32.62 and 31.59 ETB per year for improvement on soil erosion, CO₂ storage and non-timber forest product, respectively. Respondents place higher value on reducing soil erosion attributes, expecting the improvement on soil erosion will enhance their productivity's. Improving carbon dioxide (CO₂) sequestration had a significant WTP value, implying that they might expect measures which increase forest coverage in the area would have positive impact on CO₂ storage which in turn increases gaining the benefits from the carbon markets. Bale Mountains Eco-region REDD+ project is at an advanced stage, its design and validation is completed. What is left is financing the community participated in the project. Improving non-timber forest product had also a positive and significant WTP which indicates they expect improvement of this attributes will enhance their livelihoods.

Table 15: MWTP in Ethiopian birr for reforestation attributes

Variable	MWTP	standard error	P-value
Biodiversity	-57.206	12.206	0.000
Soil erosion	34.45	8.44	0.000
Co ₂ storage	32.62	18.66	0.031
NTFP	31.59	15.43	0.041

Notes: NTFP represent non-timber forest product
Source: own survey, 2016

Table 16: MWTP in Ethiopian birr for exclosure attributes

Variable	MWTP	standard error	P-value
Soil erosion	24.20	1.385	0.000
Biodiversity	16.60	1.11	0.000
Livestock feed	280	19.38	0.000
Water points	129	1.83	0.000

Source: own survey, 2016

The above table indicates the MWTP for all four exclosure attributes included in choice experiment are highly significant at 95% significant level. Consequently, respondents are willing to pay 24.20, 16.60, 280, 129 ETB per year to reduce soil erosion, to improve biodiversity enrichment, livestock feed availability and exclosure with watering points respectively. Lowland communities place higher value on livestock feed availability attributes followed by improving exclosure with watering points attributes, expecting that improvement on both attributes will improve the productivity of their livestock which in turn improves their livelihoods' as Bale lowland communities are pastoralist. According to many respondents' currently Bale lowland area is highly vulnerable to drought and livestock feed and water is becoming highly scarce from

time to time except in the rainy season. This is why pastoralist communities travelling large distance from lowlands to highland and midland, including Bale Mountain National Park (BMNP) in search for fodder and water for their livestock during dry season. This immigration becomes the major threat to BMNP (Gashaw, 2015). This may explain why lowland communities gave more attention to improve these two attributes relative to others.

4.2.2 Estimating compensating surplus (Welfare change)

Compensating surplus measures respondents' WTP for the change from the status quo to the scenarios considered increases as we move towards improved environmental conditions (Bateman et al. 2001). Economic welfare measures or compensating surplus can be estimated by using the estimated coefficients of the attributes and the levels of the attributes in the different alternative scenarios. The compensating surplus is then estimated by calculating the difference between the value of the improved alternative options from the value of the status quo (V0) and multiplying this by the negative inverse of the coefficient for the payment attribute (Bennet and Blamey, 2001).

In order to estimate the respondents compensating surplus for improvements in eco-system services in the midland and lowland communities in BER over the status quo, nine improvement scenarios are proposed for both reforestation and exclosure program and the results are presented in the table 19 and 20. You can read the description of improvement scenarios with their attributes and levels presented in the table 17 and 18 for reforestation and exclosure attributes improvement scenarios from appendix 2. Although we were able to estimate mean annual compensating surplus values for SWC related attributes improvement scenarios, insignificant payment level coefficients in both choice models for both lowland and midland households (table 13 and 14) meant we were not confident and unable to reliably estimate compensating surplus values for all improvement scenarios. Compensating surplus values estimated from insignificant payment level may be dismissed as irrelevant. For this reason we didn't report the estimated compensating surplus values for SWC attributes improvement scenarios in this study.

Table19: Estimates of compensating surplus (CS) for attributes related with reforestation program

RRAI Scenario	RR attributes				compensating surplus (CS)	
	Biodiversity Enrichment	Reducing Soil erosion	Increasing CO2 storage	Improving NTFB value	ETB per year	Equivalent to \$ value
1.	Low level	low level	low level	low level	1827	87
2.	Low level	low level	low level	medium level	2142	102
3.	Low level	low level	medium level	medium level	2629.5	125.21
4.	Medium level	medium level	medium level	Medium level	2516.5	119.83
5.	Medium level	medium level	Medium level	high level	2831.5	134.83
6.	Medium level	medium level	high level	high level	2994	142.57
7.	High level	high level	high level	high level	3053	145.38
8.	High level	high level	medium level	low level	226	107.64
9.	High level	medium level	low level	low level	1773	84.42

Note: RRAI represents reforestation related attribute improvement

RR represents reforestation related

ETB represents Ethiopian Birr

Source: own survey, 2016

Table 19 indicates that there is welfare change due to an improvement from the status quo situation. The mid land respondent's mean willingness to pay (compensating surplus) for reforestation program increases as we improve the status of ecosystems particularly the attributes of soil erosion, CO₂ storage and NTFB value. Mean WTP for low impact improvement scenario (i. e improvement scenario 1) is 1827(\$87) ETB/year, and under the medium impact improvement scenario (i. e improvement scenario 4) as high as 2516.5(\$119.83) ETB/year. The Bale midland communities' average WTP in terms of labor and money for reforestation program increases to 3053(\$145.38) ETB/year for higher level of reforestation related attributes scenario (i. e improvement scenario 7). The findings are, in general, in line with prior empirical studies (e. g. Birhanu 2011) that local households show positive WTP for improved environmental scenarios as compared to the status quo. However, the magnitude and types of contribution varies considerably due to characteristics of the resources and respondents. Our findings showed that understanding of the Bale midland community's preferences for reforestation related attributes would contribute to improve forest coverage and forest related eco-system services in the midland of BER.

Table20: Estimates of compensating surplus (CS) for attributes related with Exclosure program

ERAI Scenario	ER attributes				compensating surplus (CS)	
	Reducing Soil erosion	Biodiversity enrichment	Improving live stock feed	construction of watering points	ETB per year	equivalent to \$ value
1.	Low level	low level	low level	low level	882	42
2.	Low level	low level	low level	medium level	1011	48.14
3.	Low level	low level	medium level	medium level	1151	54.81
4.	Medium level	medium level	medium level	medium level	1558	74.19
5.	Medium level	medium level	medium level	high level	1816	86.48
6.	Medium level	medium level	high level	high level	2096	99.81
7.	High level	high level	high level	high level	2383	113.48
8.	High level	high level	medium level	low level	1716	81.71
9.	High level	medium level	low level	low level	1410.10	67.15

Note: ERAI represents Exclosure Related Attributes Improvement
ER represents Exclosure Related

Source: own survey, 2016

It can be seen from the above compensating surplus estimates (table 20) that mean willingness to pay (in terms of money & labor) of Bale low land communities increases as we move from status quo to the scenarios considered increases, which is towards an improved exclosure related eco-system services. The lowland respondent's mean willingness to pay (compensating surplus) for exclosure program also increases as we improve the status of ecosystem services related to exclosure program. Respondents are willing to pay 882(\$42), 1558(\$74.19), and 2383(\$113.48) ETB annually for low impact (i. e improvement scenario 1), medium impact (i. e improvement scenario 4) and high impact scenarios (i. e improvement scenario 7) respectively. This finding tells that understanding of the Bale lowland community's preferences for exclosure related attributes would contribute to improve eco-system services following exclosure program implementation in the lowland of BER.

Therefore, the environmental policy makers can use this valuable information as a relevant input to do a cost benefit analysis, a tool for decision makers in different alternative improvement programmes in the BER.

4.2.3 Results of the follow up questions

To know whether which attributes have been ignored and which attributes respondents focused on in choice experiments, follow up question have been used. They have been focused on the

attributes which improves their livelihoods’ (maximize their utility) in choice experiment when making choice. A number of follow up questions for reforestation, SWC and enclosure alternative resources management practices that best describe the reason why they made their choices in answering the choice set exercises were presented to the respondents.

Table 21 indicates about 63 percent of the Bale midland (kumbi woreda) respondents replied that they gave top priority for the highest level for the attributes of soil erosion. The attributes which was least considered in the choice experiment was biodiversity enrichment which is considered by only 16% respondents. Improving non-timber forest products and increasing CO₂ storage attributes have been acquired attention during the choice experiments nearly by 48 and 56% respectively. Only 2% of respondents replied that they choose the alternative with the highest level of all attributes whatever the payment level is. All respondents never chose the status quo option in the choice experiments.

Table 21: Mid land respondents concerns while choosing attributes related with reforestation program alternatives in the choice set

Reforestation related attributes follow up questions (midland house hold only)	Percent of response (%)
I found that the conservation in biodiversity attribute is relevant and chose the alternative with highest level of this attribute.	16
I found that the attributes soil erosion as important and chose the plan with the highest level of such attribute.	63
I found that the improvement in CO ₂ storage as important and thus gave priority for choice with the highest level of this attribute	56
I focus on improvement in non-timber value and thus choose the highest level of this attribute.	48
I choose the alternative with the highest level of all attributes whatever the payment level.	2
I choose the cheapest plan whatever the levels of the attributes.	0
I choose the status quo options whatever the levels of the attributes since I haven’t the ability to pay for cost of improvement.	0

Source: own survey, 2016

As many researchers who did their research in the area of choice experiments, after the choice experiment, Bale lowland (Melka arba woreda) respondents were asked follow up questions in order to understand on which attributes they focus from attributes related to enclosure program in choice experiments. Accordingly 71, 66, 51, 23 percent of respondents focused on improving livestock feed availability, construction of watering points, decreasing soil erosion and improving bio-diversity enrichment respectively in the choice experiment. Around 3% of respondents considered the alternative with the highest level of all attributes whatever the payment level is. Table 21 also indicates that no one in the respondent's choice status quo options.

Table 22: lowland land respondents concerns while choosing attributes related with enclosure program alternatives in the choice sets

Exclosure related attributes follow up questions (for lowland respondents only)	Percent of response (%)
I found that reducing soil erosion attribute is relevant and chose the alternative with highest level of this attribute	51
I found that the enhancement in biodiversity attribute is relevant and chose the alternative with highest level of this attribute.	23
I found improvement of livestock feed is very important and choose the alternative with highest level of this attribute.	71
I found increasing construction of watering points is very important and choose the alternative with highest level of this attribute.	66
I choose the alternative with the highest level of all attributes whatever the payment level is.	3
I choose the status quo options whatever the best levels of the attributes since I cannot afford it.	0
I choose the cheapest alternative whatever best alternative it is.	0

Source: own survey, 2016

The below table (table 22) shows that about 61% of midland respondents haven considering the increasing soil fertility and moisture attributes while selecting their choices, whilst 51 percent of lowland respondents have considering it while selecting their choices. About 13 and 15% of

midland respondent have considering reducing run off and sediment loud, while greater than this about 27 and 31% of low land respondents gave attention to these attributes respectively while selecting their choices. Improving surface and groundwater attributes was considered by many respondents from both midland and lowland communities from attributes included in enclosure related attributes in choice experiments. Nearly by 63 and 68% of the midland and lowland respondents, improving surface and groundwater attributes has acquired attention respectively. Again no one in both midland and lowland respondents chose status quo options in the choice experiments. There were 3% of respondents who are willing to contribute but cannot afford it.

Table 23: Midland (Kumbi kebele) and lowland (Melka Arba kebele) respondents concerns while choosing attributes related with SWC program alternatives in the choice sets

SWC related attributes follow up questions (for lowland respondents only)	Percent of responses (%)	
	Midland hhs	Lowland hhs
I found increasing soil fertility and moisture (increasing productivity) is important and I focus on that attribute in the choice.	61	51
I found reducing run off is important and I focus on this attributes in the choice.	13	27
I found reducing sediment yield is important and I focus on this attributes in the choice.	15	31
I found improving surface and ground water is important and I focus on this attributes in the choice.	63	68
I exclusively choose the cheapest alternative	0	0
I wish I could pay/ contribute more, but I cannot afford it	3	0
I don't want to contribute (labor, money) to improve ecosystem in the eco region, because, the program cannot benefit me.	0	0

Source: own survey, 2016

CHAPTER 5: CONCLUSION AND POLICY IMPLICATIONS

Around 12 million population in the BER, both within Ethiopia and beyond, Somalia and Kenya are estimated to directly or indirectly depend on several ecosystem services of the BER. However, the continued loss and degradation of eco-system services and their functions have reached critical levels due to various factors like deforestation in search for agricultural land (especially in the highland and mid land of BER), frequent fire, overgrazing (especially in the lowland area), firewood/charcoal production, etc. To reverse these problems interventions such as reforestation/aforestation, SWC, exclosure, etc are needed.

For successful implementation of Natural Resource Management (NRM) to improve BER ecosystem benefits, preference of community who uses ecosystem services of the BER should be taken into consideration. However, there is no non-market valuation of ecosystem services improvement of the BER ecosystem by using suitable interventions. Thus this study seeks to analyses the preferences of community in the BER for improved ecosystem benefits of BER and estimates their WTP for selected attributes using a choice modeling approach.

The study is based on household level data collected in 2016 from 200 (100 from midland (kumbi kebele) and 100 from lowland (Melka Arba kebele)) randomly drawn households living in Harena Buluk woreda, Bale zone. Most (90%) of midland respondents claimed that agricultural expansion and timber production are the major causes of eco-system degradation, while most percentage of lowland respondents reported agricultural expansion and firewood/charcoal production are the main causes of ecosystem degradation in the area. We also found that about 98% of respondents agreed to be willing to conserve ecosystems in their areas. Findings show that respondents' from both lowland and midland community are willing to pay for alternative resource management practices to improve eco-system services in the BER. This can be evidenced from the compensating surplus (mean WTP) estimates. Compensating Surplus(CS) reflect overall WTP for each changes, from the status quo to alternative improvement scenarios for attributes related to reforestation and exclosure program were also calculated. The Bale midland (Kumbi kebele) communities' average WTP in terms of labor and money for reforestation program were 3053(\$145.38) ETB/year for higher level of reforestation related attributes scenario, 2516(\$119.83) ETB/year for medium impact improvement scenario

and 1827(\$87) ETB/year for low impact improvement scenario and lowland (Melka Arba kebele) respondents are WTP 882(\$42), 1558(\$74.19), and 2383(\$113.48) ETB annually for low impact, medium impact and high impact scenarios respectively.

Although we were able to estimate mean annual CS for SWC related attributes improvement scenarios, insignificant payment level coefficients in both choice models for both lowland and midland households (table 13 and 14) meant we were not confident and unable to reliably estimate CS values for all improvement scenarios. For this reason we didn't report the estimated CS values for SWC attributes improvement scenarios in this study.

The findings of the study confirm that most of the local households are aware of the adverse impact of human activities on the BER eco-system health and functions. This study also indicates that they are willing to contribute to alternative resource management practices (interventions) that improve eco-system services in the area. This tells that management strategies that fully involve local households at all levels of the implementation may help development planners and practitioners to address the problems. However, the results of the survey also showed that midland respondents are not willing to pay for the improvement of biodiversity attribute, may be considering it as global goods or the expectation of the farmers about the negative effects of the project on their current consumption of the resources in the BER. Therefore, Governmental and Non-Governmental Organizations (NGOs) need to create awareness on the direct and indirect future importance of biodiversity to the people in the BER even if it is considered as globe goods.

Further, since communities' particularly downstream and outside the BER with in Ethiopia and outside Ethiopia (e.g. Somalia and Kenya) benefited from the project, it is better to facilitate the way they compensate upstream community through a Payment for Eco-system Services (PES) strategy. For effective implementation of this strategy concerned bodies have to jointly discuss and prepare a specific PES strategy such as water-user payments/irrigation user payments particularly (e.g. for Somalia and Kenya), Hydroelectric payment for those who use river originated from the BER (e.g. Melka Wakena and other micro hydroelectric power with in

Ethiopia and outside Ethiopia), carbon payments, etc could be potential financing mechanisms for improved watershed management.

References

- Abebe T., Aseffa S., and Debela H. 2014. Benefits of wetland conservation interventions to local households in southwestern Ethiopia: empirical evidence from attributes-based valuation. *Journal of Environmental Science and Water Resources*, Vol. 3(3), pp. 060 - 068, April 2014
- Adamowicz, W.,(2001). Future directions of Stated Choice Methods for Environmental Valuation; paper prepared for the workshop on Choice Experiments, A New Approach to Environmental Valuation, London, England.
- Adamowicz, W., J. Louviere and J. Swait (1998). Introduction to Attribute-based Stated Choice Methods. NOAA-National Oceanic Atmospheric Administration, Washington, USA.
- Alpizar, F., F. Carlsson and P. Martinsson (2001). Using Choice Experiments for Non- Market Valuation; Working Paper in Economics no.52, Department of Economics, Goteborg University.
- Arrow, K., Daily, G. C., Dasgupta, P., Levin, S., Mäler, K.-G., *et al.* (1993), 'Managing Ecosystem Resources', *Environmental Science and Technology*, **34**, 1401–6.
- Badege B (2001). Deforestation and land degradation in the Ethiopian highlands: A strategy for physical *Journal of Environment and Earth Science* , ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol.4, No.9, 2014 103 recovery. *North east African Studies*. 8(1):7-26.
- Bateman, I. J., Carson, R. T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E., Pearce, D., Sugden, J., & Swanson, J. 2001, *Economic Evaluation with Stated Preference Techniques, A Manual*, 1 edn, Edward Elgar Publishing Limited, Cheltenham.
- Bateman, I.J., Jones, A.P., 2002. Contrasting conventional with multi-level modeling approaches to meta-analysis: expectation consistency in UK woodland recreation values. *Land Economics* 79, 235–258.
- Benayas et al. 2009. The impact of ecological restoration on biodiversity regeneration.
- Bennett, J., and Blamey, R. (2001). The Choice Modeling Approach to Environmental valuation: *New Horizons in Environmental Valuation*, Edward Elgar Publishing Limited, UK.

- Birhanu G. 2012. Valuation of Choke Mountain Range Wetland Ecosystem, East Gojjam, Amhara Region, Ethiopia: Application of Choice Experiment Valuation Method; Unpublished Msc. Thesis, Addis Ababa University.
- Birol E., Karousakis K., and Koundouri P. 2005. Using a Choice Experiment to Account for Preference Heterogeneity in Wetland Attributes: The Case of Cheimaditida Wetland in Greece; Environmental Economy and Policy Research Discussion Paper Series, Department of Land Economy and University of Cambridge.
- Birol E, Karousakis K and Koundouri P. (2006b). Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of *Cheimaditida* wetland in Greece. *Ecological Economics* 60: 145-156.
- Bizuayehu T., Gezahegn A., Yigezu A., Jebar M.A. & Paulos D. Nature and causes of land degradation in the Oromia Region: a review. Addis Ababa: ILRI, 2002
- Bradshaw CJA, Sodi NS, Peh KSH, Brook BW (2007) Global evidence that deforestation amplifies flood risk and severity in the developing world. *Global Change Biology*, 13, 2379–2395.
- Calder, I.R. and Aylward B. 2006. Forest and floods: moving to an evidence-based approach to watershed and integrated flood management. *Water International*, 31, 87–99.
- Cameron, A.C. and Trivedi, P.K.2005. *Micro econometrics: Methods and Applications*, Cambridge University Press.
- Carlsson, F. & Harteman, P. 2001, "Do hypothetical and actual marginal willingness to pay differ in choice experiments? Application to the valuation of the environment", *Journal of Environmental Economics and Management*, vol. 41, no. 2, pp. 179-192.
- Carlsson et al, (2012): Valuing wetland attributes: an application of choice experiments: journal of *Ecological Economics* 47 (2003) 95– 103
- CGIAR research on Water, Land and Ecosystems (WLE), 2015. Low-cost measures can reclaim gullies and reduce soil erosion in the Ethiopian highlands
- CGIAR research on Water, Land and Ecosystems (WLE). 2015. Sustaining the benefits of soil and water conservation in the highlands of Ethiopia
- CGIAR Research Program on Water, Land and Ecosystems (WLE). 2014. *Ecosystem services and resilience framework*. Colombo, Sri Lanka: International Water Management

- Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 46p. doi: 10.5337/2014.229
- Champ, P. A. & Bishop, R. C. 2003, "Donation payment mechanisms and contingent valuation: An empirical study of hypothetical bias", *Environmental & Resource Economics*, vol. 19, no. 4, pp. 383-402.
- Costanza, R., d'Arge, R., De Groot, R.S., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruel, J., Raskin, R.G., Sutton, P., Van den Belt, M., 1997. The value of the world's ecosystem service and natural capital. *Nature* 387, 253–260.
- Clawson, M. and Knetsch, J.L. (1966). *Economics of Outdoor Recreation*. Baltimore: John Hopkins University Press.
- C. Watson 2007. Direct consumptive Use Value and Eco-system goods and services in the Bale Mountains eco-region.
- Daily, G.C., Soderquist, T., Aniyar, S., Arrow, K., Dasgupta, P., Ehrlich, P.R., Folke, C., Jansson, A.M., Jansson, B.O., Kautsky, N., Levin, S., Lubchenco, J., Maler, K.G., David, S., Starrett, D., Tilman, D., Walker, B., 2000. The value of nature and the nature of value. *Science* 289, 395–396.
- De Groot, R.S., Stuij, Finlayson, C.M. and Davidson, N. 2006. Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services, Ramsar Technical Report No. 3/CBD Technical Series No. 27. Ramsar Convention Secretariat, Gland, Switzerland & Secretariat of the Convention on Biological Diversity, Montreal, Canada.
- Dupuy, J. 2009. GIS analyst. Bale Eco-Region Sustainable Management Programme. EFTEC(Economics for Environmental Consultancy)(2001) Guidance for Using Stated Preference Techniques for the Economic Valuation of Non-Market Effects, report to Department of Environment, Transport and the Regions, London, Uk
- Erkossa, Wudneh, B. Desalegn, and G. Taye : Linking soil erosion to on-site financial cost: lessons from watersheds in the Blue Nile basin, *Ethiopia, Solid Earth*, 6, 765–774, 2015
- FAO (2010). *Global Forest Assessment 2010*, Food and the Agricultural Organization of the United Nations, Rome.
- Fisher, Brendan, R. Kerry Turner, Neil D. Burgess, Ruth D. Swetnam, Jonathan Green, Rhys E. Green, George Kajembe, Kassim Kulindwa, Simon L. Lewis, and Rob Marchant. 2011.

- “Measuring, Modeling and Mapping Ecosystem Services in the Eastern Arc Mountains of Tanzania.” *Progress in Physical Geography* 35 (5): 595–611.
- Fitalew A. 2009. Valuation of Watershed and Fisheries of Lake Tana: An application of Choice Experiment; Unpublished MSc. Thesis, Addis Ababa University.
- Gashaw T. 2015. Threats of Bale Mountains National Park and solutions, Ethiopia; *Journal of Physical Science and Environmental Studies*.
- Hanemann, M, 1998. Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics* 66, 332– 341.
- Hanley, N. Mourato, S. and Wright, R. E. 2007. Choice modelling approaches: A superior alternative to environmental valuation. *Journal of Economic surveys*, 15(3): 435-462.
- Haregeweyn, N., Poesen, J., Nyssen, J., De Wit, J., Haile, M., Govers, G., Deckers, S., 2006. Reservoirs in Tigray (northern Ethiopia): characteristics and sediment deposition problems. *Land degradation and development* 17: 211-230.
- Hengsdijk H, Meijerink GW, Mosugu ME (2005) Modeling the effect of three soil and water conservation practices in Tigray, Ethiopia. *Agriculture, Ecosystems and Environment*, 105(1-2):29-40
- Hensher and Greene, 2003. The mixed logit model: the state of practice in transportation 30: 133-176.A
- Hoyos, D. 2010. The state of the art of environmental valuation with discrete choice experiments, *Ecological Economics* 26: 1595-1603.
- Jandl, R., Lindner, M., Vesterdal, L., Bauwens, B., Baritz, R., Hagedorn, F., Johnson, D.W., Minkkinen, K., Bryne, K.A., 2007. How strongly can forest management influence soil carbon sequestration? *Geoderma* 137, 253–268
- Kebede et al, 2014. Natural resource use conflict in Bale mountain national park, south eastern Ethiopia; *International journal of biodiversity and conservation*....
- Lancaster, KJ. 1966. A New Approach to Consumer Theory; *Journal of Political Economy*, Vol.74 No. 2 pp.132-157, published by the University of Chicago Press.
- Louviere, J., Hensher, D., 1982, *Stated Choice Methods, analysis and application* Cambridge University Press, U.K.
- Louviere, J.J., Hensher, D.A. and Swait, J.F. (2000) *Stated Choice Methods and Analysis*, Cambridge University Press, Cambridge.

- Louviere, J., Carson, R., Ainslie, A., Cameron, T., DeShazo, J.R., Hensher, D., Kohn, R., Marley, T., and Street, D. (2002) Dissecting the random component of utility, Workshop Report for the Asilomar Invitational Choice Symposium, California, June (to appear in *Marketing Letters*).
- Mahmoudzadeh, 2007. Vegetation Cover Plays the Most Important Role in Soil Erosion Control. *Pakistan Journal of Biological Sciences*, 10: 388-392.
- McFadden, D. 1974. Conditional Logit Analysis of Qualitative Choice Behavior in Zarembka, *Frontiers in Econometrics*, New York: Academic Press.
- McFadden, D. and K. Train (2000) Mixed MNL models for discrete response, *Journal of Applied Econometrics*, 15, 447-470.
- Mekuria et al. 2011: Restoration of Ecosystem Carbon Stocks Following Exclosure Establishment in Communal Grazing Lands in Tigray, Ethiopia.....
- Mekuria, W. B and Veldkamp., 2012. Restoration of native vegetation following exclosure establishment on communal grazing lands in Tigray, Ethiopia....
- Mekuria et al, 2015: Restoring aboveground carbon and biodiversity: a case study from the Nile basin, Ethiopia
- Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-Being: Synthesis*. Island Press.
- MEJS. 2013. Quantification of the Impact of Integrated Soil and Water Conservation Measures on Groundwater Availability in Mendae Catchment, Abraha We-Atsebaha, eastern Tigray, Ethiopia,
- Perman, R., Y. Ma, J. McGilvray and M. Common. 2003. *Natural Resource and Environmental Economics*, 3rd Edition, Pearson Education Ltd., Edinburgh.
- REDD+. 2014. Bale Mountains Eco-region Reduction of Emission from Deforestation and Forest Degradation (REDD +) Project....
- Rolfe, J., J. Bennet, and J. Louviere . 2000. Choice modeling and its potential application to tropical rainforest preservation. *Ecological Economics* 35:289-302
- Rolfe, J., Bennett, J., & Louviere, J. 2002, "Stated values and reminders of substitute goods: Testing for framing effects with choice modeling", *Australian Journal of Agricultural and Resource Economics*, vol. 46, no. 1, pp. 1-20.

- Tesfaye E. 2013. Economic valuation of conservational benefits of a natural wetland ecosystem: wonchi Crater Lake, Ethiopia; published Msc. Gonder University.
- Thurstone, L. L. 1927, "A Law of Comparative Judgment", *Psychological Review*, vol. 34, pp. 273-286.
- Train, K. (2002) a comparison of hierarchical Bayes and maximum simulated likelihood for mixed logit, Paper presented at the *Asilomar Invitational Choice Symposium*, California, June.
- Train, K., (2003) *Discrete Choice Methods with Simulation*, Cambridge University Press, Cambridge.
- UNESCO,(2004). National Water Development Report for Ethiopia (Final). World Water Assessment Program. Addis Ababa.
- Van Zyl. 2015. The economic value and potential of the federal protected Areas in Ethiopia, independent economic researchers.
- WENNI consult. 2015. Baseline study of SHARE project "Conservation of Biodiversity and Ecosystems Functions and improved well-being of Highland and Lowland Communities within Bale Eco region
- Woubshet D. 2014. Linking the economy to the ecosystems: Land use change and ecosystem services valuation at basin level; PHD dissertation, University of Twente.
- Yayneshet T, Eik LO, Moe S.R. 2009. The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *J. Arid Environ.* 73:542-549.
- Yilama Haroyu, et al., 2016. Valuation of Environmental Goods and services: The case of Bale Mountains National park; *African Journal of Environmental Economics and Management*.
- Yimer F, Ledin S, Abdelkadir A. 2007. Changes in soil organic carbon and total nitrogen contents in three adjacent land use types in the Bale Mountains, south-eastern highlands of Ethiopia. *For Ecological Management* 242(2-3):337-342.

Appendix1

SHARE Bale Eco-Region

Socioeconomic questionnaire



Brief introduction

Data collector/Enumerator: Good morning/after noon

My name is _____, we would like to collect data from household for our research on “Valuation of BER ecosystem benefits to analyses household preferences for BER ecosystem services improvement. The questionnaire has different sections and the survey is useful for research. The results of the survey will be reported in summary form and will be anonymous to the respondent. The major conclusion will provide critical inputs for policy which will improve the management of natural resources in BER.

Thank you!!!

Name of household head _____

Name of the respondent _____

Region: Oromia Zone: Bale Woreda _____ Kebele _____ Agro-ecology _____ Village/Got _____	General codes: -888= not applicable -999= don't know(not remember) 000= Zero
---	---

GPS reading of the household: _____ North _____ East _____

Altitude _____

Date of interview: Date _____ month _____ year _____ Time started _____
 Time finished _____

Section A: Households respondent demographic Data

ID #	1. what is the sex of household member 1= male 0= female	2. Age of the household member (in yrs)	3. What is the highest level of education completed by house hold member 1=none 2=primary level 3=secondary 4=certificate 5=Diploma 6= Degree and above	4. Can household member read and write? 1=Yes 0= No	5. Marital status 1=married 2=single 3=Divorced 4= others(please specify)	6. Do household Work different from farm activities? 1=yes 0=No
1						
2						
3						
4						
5						
6						
7						
8						
9						

Section B: Household production in 2015/16

1: Ownership of land and land characteristics

Plot number (start from the nearest plot!)	Type of land 1=irrigated 2=Rainfed 3=both (supplementary irrigation) 4=other, specify	Size of land (Timad) <i>*Timad=0.25ha It is a local unit of land measurement in Ethiopia</i>	Tenure pattern (use code 1)	Distance from home (one way walking distance in minutes)	Soil fertility 1=Lem (fertile) 2=lem-teuf (medium fertile) 3=teuf (less fertile)	Slope 1=meda (flat) 2=dagetama (steep) 3=gedelama (steeper)	Soil type 1=Clay 2=Sandy 3=Loamy 4=other, specify	If land was rented in for cash payment, how much did you pay? (ETB)	If land was share-cropped in, what was the division of production (1/4, 1/3, 1/2, , etc)
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
01									
02									
03									
04									

2.3 Household yearly income from off/non-farm and live stock production in 2015/16

Source of income	Measurement	Type		Unit price (birr)	Total income
Livestock	Number		Quantity		
		Cow			
		Oxen			
		Goat			
		Sheep			
		Horse			
		Donkey			
		Camel			
		Hen			
		others			
Livestock products	Kg	Butter			
		Meat			
		Milk			
		Honey			
Other off/non-farming income sources	Kg/ Birr	Off/ Non-farm employment			
		- Daily labor			
		- FFW/CFF			
		- Civil servant			
		- Others			
		Self-employment			
		- Petty trade (livestock, crop, other commodities)			
		- Selling firewood/charcoal			
		- Selling other Natural resources			
		- Others			
		Transfers			
		- Pension			
		- Compensation			
		- Remittances			
		- Food aid			
		- other			
Total					

Section C: Status of ecosystem services

1. In your perception, what is the current deforestation rate in your area?	1= High 2=Medium 3=Low 4= other (specify?)
2. What are the major causes of deforestation in the area? Rank according to their severity. The maximum rank is 4	1. Agricultural expansion 2. Fire 3. Firewood/charcoal production 4. Timber production 5. Other (specify)
3. Ecosystem in your area has been extremely degraded and many plant and animal species have disappeared. Do you _____?	1=Agree 0= Disagree
4. If your answer for question number 3 is agree, what are these species that are disappeared?	<u>Animals (fauna)</u> <u>plants (flora)</u> 1. 1. 2. 2. 3. 3. 4. 4.
5. Do you practice soil and water conservation measures on your own farm?	1= yes 0= no
6. Do you practice soil and water conservation measures on communal land?	1= yes 0= no
7. If your answer for question number 5 &6 is yes, what SWC measures do you practice?	1= Physical (Soil/stone bunds, Terraces, Cut-off drain, etc) 2= Biological (Tree planting, agro-forestry, grass planting, etc) 3= Both 4= Other (specify)-----
8. In your perception, what is vegetation status on the grazing areas in the eco-region?	1= High 2=Medium 3=Low 4= Other (specify?)
9. What is the major water source for your family?	1. Tapped water 2. Groundwater/Borehole 3. Public water supply 4. River/stream 5. Other / specify
10. How far do you travel to collect water?	1. Less than 15 minutes 2. Between 15 and 30 minutes 3. Between 30 min and 45 min 4. More than 45 min
11. Is area enclosures practiced in the eco-region?	1= yes 0= no
12. Is area enclosures with additional plantation (enrichment) practiced in the eco-region?	1= yes 0= no
13. If your answer for question number 12 is yes,	1.

what are dominant plantation species used to enrich enclosures?	2. 3.
14. Is there an aforestation\ Reforestation undertaken in the eco- region?	1= yes 0= No
15. If your answer for question number 14 is yes, aforestation\ Reforestation takes place with:	1= Single species 2= Diverse species 3= Other(specify)
16. Identify multipurpose species in the eco-region? The maximum rank is 5.	1. 2. 3. 4. 5.

Section D: Ecosystem services and food security

1. What are the main socio-economic problems in the area? Multiple answers are possible	1. Food shortage 2. Lack of clean and sufficient water 3. Lack of infrastructures like road, school, hospital, electricity, etc. 4. Epidemic diseases 5. Lack of market for your product 6. Shortage of animal feed 7. Other (specify)
2. What are the main environmental problems in the area? Multiple answers are possible	1. Deforestation 2. Overgrazing 3. Climate variability and change (frequent drought) 4. Flood 5. Erosion 6. Other (specify)
3. Has your household's food production and income over the past 12 months been sufficient to feed your family?	1=Yes 0= No
4. If your answer for question number 4 is no, what is the Causes of food insecurity?	1= 2= 3= 4=
5. What coping strategies did you use when you have no adequate food, and don't have the money to buy food? Focus on the most	1. 2. 3.

important coping strategies you use. The max rank is 6.	4. 5. 6.
6. Is there on going interventions to address problems in the eco-region?	1= yes 0= No
7. If your answer for question number 6 is yes, what are they? Multiple answers are possible	1= Natural resource management (SWC, reforestation/afforestation, exclosure, etc) 2= Water harvesting/irrigation development 3= Road and market development 4= Potable water supply 5= Expanding electricity cervices 6= Improving credit service 7= Other (specify).
8. Is there climate variability and change in your area?	1=yes 0= no
9. If your answer for question number 8 is yes, what are the main manifestations of climate variability and change?	1=Rising average temperature 2= Declining rainfall 3= increasing rainfall 4= Frequent drought 5= Increasing flooding 6= Other, specify
10. Do you suggest the interventions used to mitigate this problem?	1= Yes 0= No
11. Do you agree to conserve ecosystems in your area?	1=Yes 0=no

SECTION E. CHOICE EXPERIMENT

General scenario

To the interviewer:

Please read the scenario described below to the respondent and make sure that the respondents give attention to (and understand) your description before you proceed to the questions that follow.

Improving well-being of highland, midland and lowland communities within the Bale Eco-Region requires conserving the ecosystem and improving ecosystem services. Moreover the downstream populations within Ethiopia (also in Somalia and Kenya) are assumed to directly and indirectly benefit from this program. To improve this ecosystem services in the eco-region we propose interventions such as reforestation for highland and midland and enclosures with other physical and biological SWC measures for lowland of eco-region. To implement this program beneficiary community should pay in terms of their (labor or money) to improve and to sustainable manage their ecosystem². Thus, to maximize the benefits from ecosystem services, beneficiary households in the area have to participate to improve BER ecosystem services. National and international community will also benefit from improvement of eco-system services in the BER.

Given the description of the general scenario above we have identified the following intervention with the following attributes for midland community.

A. Reforestation: Forest degradation is severe in Ethiopia (World Bank 2015) and more recent data show a reduction in forest area (forest, woodlands, Erica forest) of about 2.3% between 2010 and 2014 (Baseline survey, 2015). Forest cover in the BER is 546,853 ha which accounts for about 15% of the BER. An additional 1,235,407 ha (33% of BER) is categorized as woodlands (Farm Africa unpublished). Thus, annually about 12000 ha forest cover is lost due to deforestation.

² The questionnaire focuses on willingness to pay (in terms of ETB) for conservation of the household is besides the annual labor contribution to community labor mobilization to participate in SWC activities. The average labor wage rate for adult labor (both female and male) is 50 ETB/day.

Undertaking reforestation is important to restore forest cover and improve its related eco-system services. Reforestation leads to enhance biodiversity, reduce soil erosion and sedimentation/flood load, observation of carbon stocks, stabilize the water flow, thereby increasing water availability for irrigation and domestic uses, etc. There is evidence that a reduction of forest cover amplifies flood events in developing countries (Bradshaw et al 2007) as more rainfall directly turns into run-off instead of being slowed down or buffered by forests. Although there are evidences contrary to that (Calder, 1999) but under Ethiopian condition, deforestation is the main cause for accelerated soil erosion and soil loss. This requires private and community initiatives. Farmers may plant trees or agro-forestry practice on farmland individually or may participate on community reforestation program on communal lands in their area. We propose this intervention for high land and midland community with the aim of conserving the existing or restoring the forest cover in BER. We selected the following four attributes related to reforestation.

- 1. Biodiversity:** This attribute refers to the number of fauna and flora species improved and their habitats in the ecosystem following conservation or reforestation. For example (Benayas et al. 2009) indicates that ecological restoration increased biodiversity (fauna and flora) by 44 %. Mekuria et al., (2015) reported that woody species composition and richness (ranged from five to 28) were observed following the establishment of exclosures. This program has three main alternatives biodiversity management scenarios. We assume that conserving the existing or restoring the forest cover increasing fauna and flora species composition and richness by 5, 15 and 30.
- 2. Soil erosion:** The estimate of average annual soil losses for all types of land cover in the highlands of Ethiopia lies between 10 and 35 t/ha and average values for croplands vary between 20 and 100 t/ha (Bezuayehu et al., 2002) while estimates in (predominantly) in some parts of the Bale highlands are reported to lie between 51–100 t/ha per year (Baseline survey, 2015). Such high rate of soil erosion is attributed to extractive agricultural practices, poor vegetation cover and tillage (Baseline study, 2015). This attribute put the alternative soil erosion reduced from the direct impacts of rain and wind erosion following this program. Research conducted by Hengsdijk et al (2005) in

Ethiopia's Tigray region showed a 14% decrease in soil loss for reforested watershed areas. For the purpose of our study we proposed three alternatives are envisaged; if soil erosion reduced by 5%, 10% and 20%.

3. **CO₂ storage:** Forest enhances the observation of carbon stock in both underground and above ground (Gorte, 2009). Afforestation and management of fast-growing tree species, have an immediate effect on the regional rate of CO₂ sequestration by incorporating carbon dioxide (CO₂) in plant biomass (Jandl et al., 2007). This plays good ground globally for carbon trade between polluting countries and countries with good forest cover. This attributes refers to increased CO₂ storage after we implement certain level of reforestation program. The proposed alternatives are CO₂ storage raised by 50, 65 and 75%.
4. **Non timber value:** This attribute refers to the level of non-timber value improved during/ after the implementation of reforestation program in the area. Non-timber values of the forest cover include use dead forest for fuel wood, medicinal plants, coffee and honey production. The proposed alternatives for this attribute are if non-timber value improved by 10, 20 and 30%.
5. **Annual payment in Birr:** Payment (in terms of labor or money) is required to conserve or restore the forest covers for better ecosystem services. The status quo option is no payment without any improvement of the ecosystem services.

B. Soil and water conservation: This intervention includes both physical and biological SWC measures on farmlands and degraded hotspot areas like gullies or river banks. Conserving soil erosion leads increase to soil moisture and fertility (hence crop productivity), to reduce run off and sediment yield, reduce gully erosion, improve groundwater infiltration and raising the groundwater level which improve the availability and access to water for agriculture and domestic uses in the long run. This intervention requires private and community initiative. For example farmers may practice environmentally friendly agriculture and plant grass or trees on the bounds of their plot of land to conserve soil erosion and water. Community practices on physical SWC measures such as terracing, soil and stone bunds, combined with some biological measures. The cost of this intervention is mainly payments for laborer and for seedlings. We suggest this intervention for midland and lowland communities. We selected the following four

attributes related to soil retention measures.

6. **Increase soil moisture and fertility:** A study carried out in Bale (Yimer et al. 2007) showed a reduction of around 30% in soil organic carbon and total nitrogen content in the top 1 meter soil layer over a period of 15 years in areas that saw land conversion from native forest to cropland. Nutrient depletion was reported as 30 kg ha⁻¹ of nitrogen and 1520 kg ha⁻¹yr⁻¹ of phosphorus (UNDP 2002) due to soil erosion. Erkossa et al. (2015) reported that (from a study in the Nile Basin) farmers annually lose about USD 220 and USD 150 ha⁻¹ due to the loss of nitrogen and phosphorus, respectively, by soil erosion. This program provides three alternatives of increasing soil moisture and fertility following implementation of SWC measures. This are improving soil moisture and fertility by 10 % 20% and 30%
7. **Reducing runoff:** This attributes refers to alternative runoff reduced after SWC measures is implemented in selected areas. Runoff causes soil erosion, flood, reduce water quality, etc. Implementing SWC reduces run off which in turn reduces soil erosion, decreases flood frequency and improves water quality. For example implementation of SWC measures in the Debre-Mawi watershed (in Amahara region) resulted in reductions in runoff ranged from 26 to 71 % (CGIAR briefing on WLE, 2015). Based on this we proposed alternatives to reduce run off by 20%, 35% and 70% for community lives in BER.
8. **Stabilize water flow:** This attributes refers to the improved ability of soil to absorb water and groundwater levels maintained that may so increase dry season base flow following SWC implementation. For example following implementation of SWC the availability of groundwater has increased more than 10 times since 1993 in Eastern Tigray, Ethiopia (MEJS, 2013). For the purpose of this study we proposed three alternatives for BER community. Ensuring base flow during the rainy season only, 6 monish /year and the whole year.
9. **Reducing sedimentation yield:** By reducing soil erosion, SWC interventions can decreases the sedimentation yield. This, in turn, improves the life of water management structures, the operational capacity of hydropower, water supply facilities and flood control reservoirs. Annual suspended sediment loads range between 0.11 and 15 million tones, depending on the size of the watershed area and associated run-off generated from

the watershed. Local values for siltation rates in reservoirs in the water basins of BER have so far not been found. Values found reservoirs in the Northern Tigray region are in the order of 237 -1817 t km⁻² y⁻¹ with an average of 909 t km⁻² y⁻¹, and 70% of reservoirs under study reported to have important problems associated to siltation (Haregeweyn et al., 2006). Problems associated to siltation in Ethiopian reservoirs are; loss of storage capacity resulting in shortages in water supply for irrigation and human consumption, higher dam operation costs and reductions in water quality (Wolancho 2012). Undertaking SWC measures is very critical. Implementing SWC interventions in the Debre-Mawi watershed (in Amahara region) resulted reductions in sediment yield ranged from 45 to 81%. This study gives three alternatives of sediment yield reduction in the eco-region. These are if sediment yield reduced by 20 %, 30% and 40%.

- 10. Annual payment in Birr:** Payment (in terms of labor or money) is required to conserve soil erosion for better ecosystem services. The status quo option is no payment without any improvement of the ecosystem services.

C. Exclosures (Enclosures): areas are closed to human and livestock interventions with the goal of promoting natural regeneration of plants and reducing degradation of former communal grazing lands. The aim of this intervention is to improve ecosystem services and reversing biodiversity losses (Mekuria et al. 2011). Exclosures increase agricultural production by reducing soil erosion, improving vegetation cover; increases cut and carry animal fodder, improve CO₂ storage (Mekuria et al. 2011). This intervention is more successful, if it is applied with SWC measures, some enrichment with fodder trees (like *Sasabania*) and grasses and watering points. Based on their importance to the community in the area we selected the following four major attributes related to exclosure.

- 11. Soil erosion:** This attribute put the alternative soil erosion reduced from the direct impacts of rain and wind erosion following exclosure intervention. Mahmoudzadeh (2007) stated in his research report in Iran that improving natural vegetation by exclosure decreases soil erosion significantly. This program gives two alternatives of soil erosion reduction by 5%, 15% and 25%.
- 12. Biodiversity:** This attribute refers to the number of fauna and flora species improved and their habitats in the ecosystem following exclosures. In Ethiopia, exclosures in landscapes



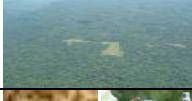
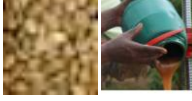
have become increasingly important to reversing biodiversity losses. Yayneshet et al., (2009; Mekuria et al, (2015)) stated that species composition and diversity of herbaceous and woody plants were higher in the exclosures than in the grazed areas. Woody species composition and richness (ranged from 5 to 28) were observed following the establishment of exclosures (Mekuria et al, 2015). In study we propose woody species composition and richness index will increase by 5, 15 and 25.

13. **Feed availability:** This attribute stands for livestock feed improved following successful implementation of exclosures, enrichment and other SWC measures including watering Points. Mekuria et al., (2015) reported that exclosures are effective in restoring degraded lands and communities are benefiting from increased fodder production and reduced impacts of soil erosion. Yayneshet et al., (2009) also reported that the mean aboveground biomass measured inside the exclosures was more than twice that of the adjacent grazed areas and more biomass was produced from the young than the old exclosures. Yayneshet et al., (2009) indicated that a total of 61 different herbaceous and 34 woody species were recorded in the two study sites; the mean biomass measured in the exclosures was more than twice of the adjacent grazed areas. The proportion of biomass consumed by grazing animals ranged from 51 to 69% (Yayneshet et al., 2009). The alternative proposed for this attribute is Livestock feed availability will be improved by 1.5, 2 and 3 times.
14. **Exclosure with watering points:** this refers to watering points to livestock through construction of trough or other gutter structures. This intervention makes exclosure more effective by applying rotational and controlled grazing. Cut-and carry system becomes also more feasible with availability water for livestock. This intervention envisages construction of 2, 3 and 5 watering points.
15. **Annual payment in Birr:** Payment (labor, money) is required to conserve ecosystem and for better ecosystem services. The status quo option is no payment with any improvement of ecosystem services.




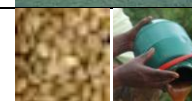
Location of the household: _____ 1= mid land, 2= low land

Choice sets for reforestation attributes (only for mid land community)





Choice set1

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Improve biodiversity count		Biodiversity count will be improved by 5	Biodiversity count will be improved by 10	Biodiversity count will be improved by 15	Declining biodiversity count
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Increasing soil erosion
Increase CO ₂ storage		CO ₂ will be increased by 10%	CO ₂ will be increased by 10%	CO ₂ will be increased by 10%	Declining CO ₂ storage
Improve non-timber forest products(NTFP)		NTFP will be improved by 15%	NTFP will be improved by 15%	NTFP will be improved by 15%	Declining NTFP
Payment in terms of labor /money per year		400	800	1000	0 ETB
Please tick/mark (✓) only one					



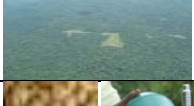

Choice se2

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Improve biodiversity count		Biodiversity count will be improved by 5	Biodiversity count will be improved by 5	Biodiversity count will be improved by 5	Declining biodiversity count
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 10%	Soil erosion will be reduced by 20%	Increasing soil erosion
Increase CO ₂ storage		CO ₂ will be increased by 50%	CO ₂ will be increased by 50%	CO ₂ will be increased by 50%	Declining CO ₂ storage
Improve non-timber forest products(NTFP)		NTFP will be improved by 15%	NTFP will be improved by 15%	NTFP will be improved by 15%	Declining NTFP
Payment in terms of labor /money per year		400	800	1000	0 ETB
Please tick/mark (✓) only one					

Choice se3

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Improve biodiversity count		Biodiversity count will be improved by 5	Biodiversity count will be improved by 5	Biodiversity count will be improved by 5	Declining biodiversity count
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Rising soil erosion
Increase CO ₂ storage		CO ₂ will be increased by 50%	CO ₂ will be increased by 65%	CO ₂ will be increased by 70 %	Declining CO ₂ storage
Improve non-timber forest products(NTFP)		NTFP will be improved by15%	NTFP will be improved by 15%	NTFP will be improved by 15%	Declining NTFP
Payment in terms of labor /money per year		400	800	1000	0 ETB
Please tick/mark (√) only one					

Choice se 4

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Improve biodiversity count		Biodiversity count will be improved by 5	Biodiversity count will be improved by 5	Biodiversity count will be improved by 5	Declining biodiversity count
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Increasing soil erosion
Increase CO ₂ storage		CO ₂ will be increased by 50%	CO ₂ will be increased by 50%	CO ₂ will be increased by 50 %	Decreasing CO ₂ storage
Improve non-timber forest products(NTFP)		NTFP will be improved by10%	NTFP will be improved by 20%	NTFP will be improved by 30%	Declining NTFP
Payment in terms of labor/ money per year		400	800	1000	0 ETB
Please tick/mark (√) only one					





Follow up question for reforestation related choice sets

Which of the following statements best describe how you reasoned while choosing between the alternatives? Mark one or more statements.





1. I found that the conservation in biodiversity attribute is relevant and chose the alternative with highest level of this attribute.
2. I choose the alternative with the highest level of all attributes whatever the payment level.
3. I found that the attributes soil erosion is important and chose the plan with the highest level of such attribute.
4. I choose the cheapest plan whatever the levels of the attributes.
5. I found that the improvement in CO₂ storage is important and thus gave priority for choice with the highest level of this attribute.
6. I focus on improvement in non-timber value and thus choose the highest level of this attribute.
7. I choose the status quo options whatever the levels of the attributes since I haven't the ability to pay for cost of improvement.

Choice sets for SWC attributes (both for mid land and lowland community)





Choice set1

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Soil moisture and fertility		Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 20%	Improving soil moisture & fertility by 30%	↓ <i>ing</i> soil moisture & fertility
Reduce run-off		Reducing run-off by 20%	Reducing run-off by 20%	Reducing run-off by 20%	↑ <i>ing</i> run-off
Reduce sediment yield		Reducing sediment loud by 20%	Reducing sediment loud by 20%	Reducing sediment loud by 20%	↑ <i>ing</i> sedim ent yield
Stable water flow		Water will be available only during rainy season	Water will be available only during rainy season	Water will be available only during rainy season	Further unstable water flow
Payment in terms of labor /money per year		400	800	1000	0 ETB
Please tick/mark (√) only one					





Choice set2

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Soil moisture and fertility		Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 10%	↓ <i>ing</i> soil moisture & fertility
Reduce run-off		Reducing run-off by 20%	Reducing run-off by 35%	Reducing run-off by 70%	↑ <i>ing</i> run-off
Reduce sediment yield		Reducing sediment loud by 20%	Reducing sediment loud by 20%	Reducing sediment loud by 20%	↑ <i>ing</i> sediment yield
Stable water flow		Water will be available only during rainy season	Water will be available only during rainy season	Water will be available only during rainy season	Further unstable water flow
Payment in terms of labor /money per year		400	800	1000	0 ETB
Please tick/mark (√) only one					

Choice set3

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status qou
Soil moisture and fertility		Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 10%	↓ <i>ing</i> soil moisture & fertility
Reduce run-off		Reducing run-off by 20%	Reducing run-off by 20%	Reducing run-off by 20%	↑ <i>ing</i> run-off
Reduce sediment yield		Reducing sediment loud by 20%	Reducing sediment loud by 30%	Reducing sediment loud by 40%	↑ <i>ing</i> sediment yield
Stable water flow		Water will be available only during rainy season	Water will be available only during rainy season	Water will be available only during rainy season	Further unstable water flow
Payment in terms of labor /money per year		400	800	1000	0 ETB
Please tick/mark (√) only one					

Choice set 4

Attributes	Picture used to explain the attribute	Option 1	Option2	Option 3	Status quo
Soil moisture and fertility		Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 10%	Improving soil moisture & fertility by 10%	↓ <i>ing</i> soil moisture & fertility
Reduce run-off		Reducing run-off by 20%	Reducing run-off by 20%	Reducing run-off by 20%	↑ <i>ing</i> run-off
Reduce sediment yield		Reducing sediment load by 20%	Reducing sediment load by 20%	Reducing sediment load by 20%	↑ <i>ing</i> sediment yield
Stable water flow		Water will be available only during rainy season	Water will be available for six months	Water will be available for full year	Further unstable water flow
Payment in terms labor/money per year		400	800	1000	0 ETB
Please tick/mark (✓) only one					

Follow up question for SWC related choice sets





Which of the following statements best describe how you reasoned while choosing between the alternatives? Mark one or more statements.

1. I found increasing soil fertility and moisture (increasing productivity) is important and I focus on that attribute in the choice.
2. I found reducing run off is important and I focus on this attributes in the choice.
3. I exclusively choose the cheapest alternative
4. I found reducing sediment yield is important and I focus on this attributes in the choice.
5. I found improving surface and ground water is important and I focus on this attributes in the choice.
6. I wish I could pay/ contribute more, but I cannot afford it.





7. I don't want to contribute (labor, money) to improve ecosystem in the eco region,
because, the program cannot benefit me.

Choice sets for enclosure attributes (only for low land community)





Choice set 1

Attributes	Picture used to explain attribute	Option 1	Option2	Option 3	Status quo
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 15%	Soil erosion will be reduced by 25%	↑ <i>ing</i> soil erosion
Increases biodiversity count		Biodiversity count will be increased by 5	Biodiversity count will be increased by 5	Biodiversity count will be increased by 5	↓ <i>ing</i> biodiversity count
Improve Livestock feed availability		Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 1.5 times	↓ <i>ing</i> feed availability
Establish watering points		Construction of 2 watering points	Construction of 2 watering points	Construction of 2 watering points	No change
Payment in terms of labor / money per year		400	500	750	0 ETB
Please tick/mark (✓) only one					





Choice 2

Attributes	Picture used to explain attribute	Option 1	Option2	Option 3	Status qou
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	↑ <i>ing</i> soil erosion
Increases biodiversity count		Biodiversity count will be increased by 5	Biodiversity count will be increased by 15	Biodiversity count will be increased by 25	↑ <i>ing</i> biodive rsity count
Improve Livestock feed availability		Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 1.5 times	↓ <i>ing</i> feed availability
Establish watering points		Construction of 2 watering points	Construction of 2 watering points	Construction of 2 watering points	No construction
Payment in terms of labor /money per year		400	500	750	0 ETB
Please tick/mark (√) only one					

Choice 3

Attributes	Picture used to explain attribute	Option 1	Option2	Option 3	Status qou
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	↑ <i>ing</i> soil erosion
Increases biodiversity count		Biodiversity count will be increased by 5	Biodiversity count will be increased by 15	Biodiversity count will be increased by 25	↓ <i>ing</i> bio diversit y count
Improve Livestock feed availability		Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 2 times	Livestock feed availability will be improved by 3 times	↓ <i>ing</i> feed availabi lity
Establish watering points		Construction of 2 watering points	Construction of 2 watering points	Construction of 2 watering points	No construc tion
Payment in terms of labor /money per year		400	500	750	0 ETB
Please tick/mark (√) only one					

Choice 4

Attributes	Picture used to explain attribute	Option 1	Option2	Option 3	Status qou
Reduce soil erosion		Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	Soil erosion will be reduced by 5%	↑ <i>ing</i> soil erosion
Increases biodiversity count		Biodiversity count will be increased by 5	Biodiversity count will be increased by 15	Biodiversity count will be increased by 25	↓ <i>ing</i> biodiversity count
Improve Livestock feed availability		Livestock feed availability will be improved by 1.5 times	Livestock feed availability will be improved by 2 times	Livestock feed availability will be improved by 3 times	↓ <i>ing</i> feed availability
Establish watering points		Construction of 2 watering points	Construction of 3 watering points	Construction of 5 watering points	No construction
Payment in terms of labor /money per year		400	500	750	0 ETB
Please tick/mark (√) only one					

Follow up question for exclosure related choice sets

Which of the following statements best describe how you reasoned while choosing between the alternatives? Mark one or more statements.

1. I found that reducing soil erosion attribute is relevant and chose the alternative with highest level of this attribute
2. I found that the enhancement in biodiversity attribute is relevant and chose the alternative with highest level of this attribute.
3. I choose the alternative with the highest level of all attributes whatever the payment level is.
4. I found improvement of livestock feed is very important and choose the alternative with highest level of this attribute.

5. I choose the status quo options whatever the best levels of the attributes since I cannot afford it.

5. I choose the cheapest alternative whatever best alternative it is.

Thank you for giving your time to complete this questionnaire!!!

Apandix2

The description of improvement scenarios with their attributes and levels are presented in the following table 17 and 18 for reforestation and exclosure attributes improvement scenarios.

Table 17: Alternative attributes improvement scenarios related to reforestation program and their attribute levels

Alternative attributes improvement scenarios related to reforestation program	Attribute levels
Status quo scenario	No improvement in biodiversity No change to soil erosion CO ₂ storage will not change Current level of non-timber value of forest product
Low impact improvement scenario	Biodiversity count will be improved by 5 units Soil erosion will be decreased by 5% CO ₂ storage will be increased 50% Non-timber value of forest product will be improved by 10%
Medium impact improvement scenario	Biodiversity count will be improved by 10 units Soil erosion will be decreased by 10% CO ₂ storage will be increased 20% Non-timber value of forest product will be improved by 65%
High impact improvement scenario	Biodiversity count will be improved by 15 units Soil erosion will be decreased by 20% CO ₂ storage will be increased 30% Non-timber value of forest product will be improved by 70%

Table 18: Alternative attributes improvement scenarios related to exclosure program and their attributes levels

Alternative attributes improvement Scenarios related to exclosure program	Attributes levels
Status quo scenario	Current level of soil erosion No improvement in biodiversity Live stalk feed availability is the same as today No construction of watering points
Low impact improvement scenario	Soil erosion will be reduced by 5% Biodiversity will be increased by 5 Live stalk feed availability will be improved by 1.5 times 2 watering points will be constructed
Medium impact improvement scenario	Soil erosion will be reduced by 15% Biodiversity will be increased by 15 Live stalk feed availability will be improved by 2 times 3 watering points will be constructed
High impact improvement scenario	Soil erosion will be reduced by 20% Biodiversity will be increased by 25 Live stalk feed availability will be improved by 3 times 5 watering points will be constructed