VALUATION OF ECOLOGICAL RESOURCE ATTRIBUTES IN UPPER BLUE NILE BASIN: THE CASE OF TULLU DIMTU MOUNTAIN AND ANBESA FOREST, WESTERN ETHIOPIA

M.SC. THESIS

BY

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JIMMA ETHIOPIA

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M.SC. THESIS

Submitted to the School of Graduate Studies, Jimma University College of Agriculture and Veterinary Medicine, Department of Natural Resource Management in Partial Fulfilment of the Requirements for the Degree of Master of Science in Natural Resource Management (Specialization: Watershed Management)

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APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

As thesis research advisors we hereby certify that we have read and evaluated the thesis prepared, under our guidance, by Dessalegn Zeleke Wirtu entitled: Valuation of Ecological Resource Attributes in Upper Blue Nile Basin: The Case of Tullu Dimtu Mountain and Anbesa Forest, Western Ethiopia. We recommend that it be submitted as fulfilling thesis requirement.

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As member of Board of Examiners of the M.Sc. Thesis Open Defence Examination, We certify that we have read evaluated the thesis prepared by Dessanegn Zeleke entitled: Valuation of Ecological Resource Attributes in Upper Blue Nile Basin: The Case of Tullu Dimtu Mountain and Anbesa Forest, Western Ethiopia. We recommend that it be accepted as fulfilling the thesis requirement for the degree of Master of Science in Natural Resource Management (Field of Watershed Management)

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DEDICATED TO

I dedicate this manuscript to my beloved family those who had impelled me to pursue this post graduate study and gave me unrestricted encouragement to accomplish this research.

STATEMENT OF AUTHOR

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all sorts of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfilment of the requirements for the M.Sc. Degree at Jimma University, College of Agriculture and Veterinary Medicine and is deposited at the University Library to be made available as reference under rules and regulations of the Library.

Name: Dessalegn Zeleke Wirtu

Signature: ___________________

Place: Jimma University

Date: April, 2016

BIOGRAPHICAL SKETCH

Dessalegn Zeleke Wirtu was born and raised in Dibate district Benishangul Gumuz National Regional State, western Ethiopia. He attended his elementary and junior secondary school education at Berber School. Then, he joined Dibate preparatory School and completed his secondary education in 2009. The author joined to Jigjiga University in 2010 and completed three years degree program and obtained his BA degree in field of Geography and Environmental study (Applied Geography) with distinction in June, 2012 from the University. Immediately, in July, 2012 he applied for Masters Program of Integrated Watershed Management offered by Jimma University at college of Agriculture and Veterinary Medicine under the Department of Natural Resource Management and fortunately he was granted to join in the field sought.

Given the multidisciplinary nature of the program, Dessalegn has an interest in the application of economics on Natural Resource issue. His Applied Geography background supports during both his course work as well as during his field research. In his thesis, the author addressed the issue of relevant ecological resource attributes being utilizing and the value it receives from the beneficiary sample households at the selected study area in upper Blue Nile Basin. He believes that the relationships between ecological resource user and ecosystem itself should be governed by pay for ecosystem approach for long lasting of ecosystem services. The ongoing ecosystem service degradation attributed to the benefits that is being generating from the ecosystem to stakeholders, and the hypothesized approach would maintain the service through efficient use of the resource and/or limiting maximum range of extraction up on stockholders preference to pay and use.

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ACRONYMS

ABM	Averting Behaviour Methods
BGNRS	Bnishangul Gumuz National Regional State
BV	Bequest Value
CE	Choice Experiment
CL	Conditional Logit
CVM	Contingent Valuation Method
DUV	Direct Use Value
EV	Existence Value
FGD	Focus Group Discussion
HPM	Hedonic Pricing Method
IIA	Independent of Irrelevant Alternatives
IID	Independently and Identically Distributed
IP	Implicit Price
IUV	Indirect Use Value
MA	Millennium Ecosystem Assessment
MNL	Multinomial Logit
MXL	Mixed Logit
OV	Option Value
PES	Pay for Ecosystem
PFM	Production Function Methods
RUT	Random Utility Theory
SV	Stewardship Value
TCM	Travel Cost Methods
WTA	Willingness To Accept
WTP	Willingness To Pay

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ABSTRACT

Anbesa forest and Tullu Dimtu ecosystems are well productive ecosystems in providing ecological resources to the by surrounding for their livelihood making. However, it is harshly being degraded due to various socio- economic factors. These factors include but not limited to increasing population, over grazing, farmland expansion and over extraction of construction materials. Therefore, it necessitates investigating empirical scenario analysis that suit to guide line of appropriate intervention technique which contribute to insuring sustainability of the ecosystem services. Payment for ecosystem service (PES) is considered as a voluntary alternative policy instrument and has a potential to preserve ecosystem services worldwide. The voluntary nature of PES approach raises the issue of understanding ecological resource use scenario and socio-economic factor that relate to ecological resource user's choice decision behaviour to participate in such intervention. This study is conducted in 2014 with the objectives of identifying the major component of ecological resource used, the value farmers attach to it, and socio-economic factor affecting values respondents attached to it. To assign monetary values to the ecological resource attribute services offered by both Anbesa forest and Tullu Dimtu ecosystems, the study employ choice experiment valuation method. Five attributes were identified from Tullu Dimtu ecosystem including access water service, Grass for grazing, Grass for domestic use, Bamboo for domestic use and the monetary payment. Similarly, six attributes were identified from Anbesa forest ecosystem including medicinal plant for domestic use, medicinal plant for market, and Bamboo for market, Bamboo for domestic use, access to wild food and monetary payment were identified and used. A sample of 125 from Anbesa forest and 122 from Tullu Dimtu were randomly selected for the study. Random parameter logit model was fitted for both Anbesa forest and Tullu Dimtu ecosystems to analyze the data. All the attributes, except cost component variable, significantly affect the probability of choosing an alternative scenario designed to help conserve ecosystem service and are processed positive signs. For Tullu Dimtu ecosystem, the marginal willingness to pay under the fitted model for Grass for grazing, Bamboo for domestic use, Grass for domestic use, access to water service at near distance and at far distance are estimated to be 48.013, 5.699, 40.853, 4969.132 and 3702.781 ETB, respectively. Following the same procedure at Anbesa forest ecosystem, the marginal willingness to pay for Bamboo for domestic use, access to wild food, medicinal plant for domestic use, medicinal plant for market and Bamboo for market estimated to be 6.195, 2847.353, 711.837, 743.567 and 867.117 ETB respectively. These positive signs of attached WTP coefficient imply community's great concern to the ecosystem service in general and for the attributes considered in the choice scenario in particular. From this result, it can be concluded that the respondents are positive to participate if any intervention project improving these attributes and costs them is planned. Using this finding, therefore, it is better if proper attention be given to the planning of conservation practices which improves all the ecological resource attributes considered in the model to address the satisfaction (utility) of the community in the study area while keeping the ecosystem's health and services.

Key Words: Anbesa forest, Choice Experiment, Mixed logit, Tullu Dimtu, Upper Blue Nile, Willingness to pay

1. INTRODUCTION

1.1. Background

Ecosystem has different components, which are the building block of the system. Each component is a base of multi-functioning ecosystem of the world which provides numerous economic, biological, ecological, social, and cultural functions and services to human being. These functions and services of ecosystem entirely support and protect production and consumption activities; hence, have determinant effects on overall human wellbeing (MA, 2005).

Ecosystem is enabled to provide such services as a result of its components interaction or coordination. This clearly indicates that ecological resources can be viewed as goods and services which humans gain from the ecosystem and at the same time it is components of the system that involves in well functioning of the system so that ecosystem generate more goods and services as by product. These ecological components are ecological resources as they are important in supporting ecosystem function through interaction with each other and human being is using them directly or indirectly. The reasoning of saying 'ecological components are resources because they are useful' is adopted from the narrower definition of resource stated as "anything that is of use to humans" given by (Boyd and Banzhaf, 2007).

However, at larger scope, the meaning of a resource is not only tied with the benefit it provides to human being. Instead, even if its benefit to human being is not known, it is a resource since it presents in the system and contributes in ecosystem framing. Therefore, ecosystem components whose uses for human being are unknown are valuable resources having non-use values. Reasonably, it is possible to argue those components of ecosystem whose systematic interaction and relationship proved ecosystem to be potent in multi-functioning are ecological resources even if they have invisible and implicit function in the system. Ecological resources and ecosystem services are often public goods which serves all human beings without discrimination to make various livelihoods. Meanwhile, the extensive reliance of human being on ecosystem resources and services is affecting its sustainability (Barnosky *et al.*, 2012).

According to MA (2005), rapid ecological resources degradation, even some are to irreversible loss was occurred within 50 years after 1950, which has not been recorded in any time of human history due to the demands for food, fresh Water, timber and fuel. In relation to ecological resource degradation, livelihood of the community which highly depend on existence of these resources directly endangered. Because, the sustainability of livelihood depends again on the sustainability of livelihood supporting attributes which ecological resource provide for demanding community at a specific geographic location, and it farther determined by the management scheme that users follow. Management scheme in operation affects the sustainable existence and productivity of ecological resources.

Hence, its service provision is sustainable if and only if harvest rate of the community is less or is equal to the growth and/or productivity rate of the resources and their interaction, which is in turn determined by management scheme employed. Agreeable to this general principle, harvest rate exceeding ecological resource growth and/or productivity rate results in (renewable) ecological resource base degradation. As a result, immense dependence of human community's multiple livelihood need from a specific ecological resource domain (in the scope of diversity and geographic location) sprouts productivity reduction and complete loss of the resource in long run. Ecosystem and resource management literatures conceptualized ecological resource degradation as the process of over time ecological resource productivity reduction and complete loss in long run (Gete and Hurni, 2001; Hurni *et al.*, 2005; Dessie and Kleman, 2007; Hoekstra, 2009; Tadesse *et al.*, 2014).

The call for ecological resource conservation is reasonable with high and complex consequences of ecological resource degradation. In general, the challenge on human welfare rises with its intensive degradation. It is possible to mention multitudes of factors causing threat on ecological resource. Among these, a lion share of ecological resource degradation in general and in developing countries in particular can be attributed to population growth, since it poses significant pressure in utilization of the resource directly and/or indirectly. Especially, deforestation is mostly associated with primary economic activity. The alarming developing countries' population growth rate and low economic prosperity imposing high demand for livelihoods generated from primary economic activity increases forest ecosystem degradation (Tsegaye *et al.*, 2010; Biazin and Sterk, 2013).

Ethiopia also experienced similar continuous and serious ecological resource degradation since so long. FAO (2010) reported forest alarming degradation rate which is increasing year after a year. Benishangul Gumuz National Regional State (BGNRS), one of the regional states of Ethiopia, was known for its dense woodland cover and less density of population in the past (Getachew, 2009; SID, 2010). The feature may be attributed to its distance from the centre of the country and low availability of infrastructures attracting economic activities demanding land use change. This conclusion is arrived as change in the feature of low deforestation of natural vegetation and disturbance of ecological resources is reported within the last few decades (SID, 2010) following some improvement of infrastructures. In line with this, Amsalu *et al.* (2007), attributed extensive deforestation to market force which induced expansion of farmland and livestock rearing. According to the citation of (SID, 2010) from Woody Biomass inventory Map, the soil loss rate of the region ranges to 200 tons/ha/year and concluded that deforestation of natural vegetation to be main cause inducing high soil erosion. Hence, these empirical findings reported the emergence of problem of ecological resource degradation in the region.

1.2. Statement of the Problem

The study by Sebsebe *et al.* (2005), carried out in Benshangule Gumuz Reginal State, Western Ethiopia to identify diversity of ecological resources has well documented the existence of valuable ecological resources having great deal of biological and economic benefits at both local and national level. Moreover, the authors have documented not only the presence of the resources but also the prevalence of degradation imposed on the vital resource bases. Furthermore, they identified threats to the resources like population demand of farmland expansion, clearing woodlands for settlement purpose, influx of refugees from Southern Sudan and implementation of developmental activities aggravating degradation of the resources. As the outcome of the study, researchers recommended site selection for conservation work mitigating biodiversity disruption especially due to endeavour for different development activities.

Semeneh Bessie (2014), undertook another study with an objective of estimating deforestation pattern, magnitude, assessing the triggering factors of deforestation and forest conservation protection strategy prevailing in Beles sub basin (which shares the same Zone with Tullu Dimitu ecosystem). Still, the study uncovered prevalence of deforestation in the study area and the researcher attributed loss of precious biodiversity like migration of lion, elephant and Buffalo to the deforestation. Triggering factors of deforestation were identified with this study and argued to directly associated to socio-economic activities like farmland expansion, fuel wood and construction material extraction. In addition to the assessment made, the author recommended to establish conservation practice in order to improve water, land and forest of the study area. He also commented to engage local community in conservation so that the intervention is benefited from participatory approach. Without devaluating the effort recently made on delineation and establishment of user groups on Anbesa forest, it is difficult to find reliable conservation works insuring sustainability of resource and service provision of the ecosystems of the area. This shows rare and insignificant response to the former studies though worthwhile recommendations were forwarded. As a result, it is important to investigate the benefit of participatory natural resource conservation interventions in order to convince the public, policy makers, government as well as the practitioners of the subject.

The approach used in community based conservation intervention should be demand driven. Therefore, generally it requires identifying the demand of the community for the approach and respective impact of the approach on the resource and the community. Since natural resource users are assumed to be rational enough to make trade off among activities and relay on the more use full strategies, convincing empirical finding is rewarding to show the importance of conservation interventions. However, none of study was carried out so far addressing empirical estimation of conservation work benefit so that it is used in community based conservation intervention planning and monitoring in the case of this study area. Hence, this study was intended to fill this gap empirically estimating the value that respondents attached to ecosystem service and investigating social welfare impact of conservation intervention.

Due to the fact that ecosystem provides ecosystem service for all interested users without any discrimination its conservation requires participation of all beneficiaries. Tragedy of ecological resource degradation is caused due to intensive livelihood dependency of users on ecosystem as a result of lack of alternative economic activity and low understanding of beneficiaries on the result of misuse of ecological resources. Therefore, undertaking scientific and strategic studies on the preference of the community towards conservation intervention is pre requisite for ecosystem conservation planning.

Tullu Dimtu Mountain and Anbesa forest ecosystems are exemplary natural ecosystems found in Benishangul Gumuz regional states, provides different sets of livelihoods generated from different ecological resources for surrounding community. The community needs ecological resource provided livelihoods for long lasting of life. Bamboo (for house construction, sell and livestock feed during dry season), Grass (for roofing and grazing), logging of forest resources (for construction and energy sources like fire wood and charcoal), wild food and fruits (for human being), medicinal plants (for human and livestock disease treatments), and small springs and/or streams (used as a source of drinking water for animals and human) worth to mention some among all resource the local community used as a source of livelihood (own observation).

However, the productivity of ecological resources of the area is decreasing overtime. This is revealed as the resources the community needed for livelihood making is diminishing. To be specific and forward, the grazing land is not providing enough pasture even during rainy season; the area is not providing Grass for roofing; Bamboo is shrinking and only found at specific patches in some areas; dense forest resources are abandoning, wild food are decreasing, medicinal plants are extremely abandoned and most of the streams/springs do not provide water throughout the year.

The community depending on the resource is getting to serious socio-economic calamities. The problem is much more alarming particularly when absence of substitutable options at the locality is considered. As a result, rehabilitation and conservation of the ecosystem on which life depends is not an option; rather it is a question of life or death.

But, in the case of both study sites selected (i.e Anbesa foresr and Tullu Dimtu) for this research, there is scant innovated/adopted or community's preference based resource conservation practice that maintains sustainability of flow of the ecosystem goods and services. To propose adoption of research recommended conservation technologies or cultural practices from other area, analysing each concepts and synthesising respective consequences in relation to the specific study area resources' and community's condition is vital. Because, synthesising available technologies and predicting respective outcomes is needed to plan rehabilitation and conservation projects. In addition to finding promising conservation practices with reliable expected results, it is also important to know society's preference and response towards the introduction of research recommended conservation technologies. This means, in addition to options sensitization according to its fits to ecosystem under consideration and its important results in benefiting the community, understanding communities' response to different sets of regulations and ecological resource conservation work is important, which in turn demands empirical study.

In addition, it is important to know what and how much the community contributes for the sets of regulation fulfilment and conservation work if they accept any. However, the work of rehabilitation and conservation of a resource needs to mobilize the community so that the community develop sense of ownership for the rehabilitated and/or protected area. In order to mobilize the community, however, there should be a planned activity on hand. Besides absence of preference based adopted technologies, one can have difficulty to find empirical study conducted on effect of different alternative conservation technologies on resource degradation and its benefit to the community of the area. Furthermore, empirical research finding on community's response to any proposed introduction of natural resource rehabilitation and conservation technologies of the study area is almost non-existent.

Such an empirical analysis, however, provides contextual reality of socio economic set up and respondent's preference thereby helping designer to persuade beneficiary society of the area leading towards planning preferred resource use and conservation scenario (Sobrevila, 2008). In line with this truth, tools used in analysis of ecological resources and changes on their attributes have become the most significant areas of research in environmental, natural resource and ecological economics. The results of such studies have wide ranging implication on ecological resource conservation intervention (Turner *et al.*, 2003). For instance, the efforts to assess the monetary value of ecological resources play multiple roles in managing the links between human livelihoods and natural ecosystems (Howarth and Farber, 2000). However, in the case of the study areas (the zones and districts) proposed for this research in general and ecosystem resource domains or sites in particular, it is difficult to find such study to different alternatives of ecological resource conservation/rehabilitation work options. Thus, this study is proposed to bridge this empirical and practical work gap with the following objective.

1.3. General Objectives

The main objective of this study is to assess Tullu Dimtu and Anbesa forest ecological resource attributes used by farmers; socioeconomic factors contributing to the decision making of farmers' resource use modality choice and its relationship to ecological resource base degradation; and their willingness to pay for the conservation or rehabilitation of the attributes.

The specific objectives proposed for this study are

1. To identify major ecological resources that farmers used from Tullu Dimtu Mountain and Anbesa forest ecosystems; and their respective attributes
2. To analyze farmers' value attached to ecological resource attributes; and
3. To identify the socio-economic factors affecting farmers' ecological resource attributes use choice decision and their attached values

1.4. Research Questions

This study was designed with an intention to analyze ecological resource attributes and socioeconomic factors contributing in farmers' ecological resource attributes use choice decision making. Consequently, the following research questions are going to be answered by this particular study:

1. What ecological resources respondent frequently used from Tullu Dimtu and Anbesa forest ecosystem?
2. Which resource attributes more influence respondent's ecological resource use choice decision?
3. What value farmers attached to ecological resource attributes?
4. Which socio economic factors determine respondent's ecological resource use choice decision?
5. How socio economic factors determine respondent's resource use choice decision?

1.5. Significance of the Study

This research provides important practical implications to ecological resource management scheme improvement and its possible ecological and users' welfare impact. It asserted economic reasons and theoretical grounds of ecological resource degradation. Depending on empirical result, the research report stated ways of improving ecological resource management performance implying appropriate and relevant feasible measures to be taken in order to insure ecological resource sustainable existence and optimum use. The result of this research work is useful for those working on ecological resource management and biodiversity conservation. Especially, the study report provided important practical answers for those asking how ecological resource management scheme change impact ecological sustainability and users' welfare. Based on economic and theoretical reasons, the finding of this study is vital in designing efficiently and effectively benefits channelling conservation strategies to serve the interests of users and enable it to contribute to national development goal. In the long run, since the study area is in the upper steam of Blue Nile Basin, this finding will be useful as an input of conservation planning that can enhance rain water infiltration which improves water resource availability in the basin. It farther benefits the

Ethiopians grand renascence hydroelectric dam in siltation redaction practice, which is national call at this moment. The study will also be a good stepping-ground for other studies searching management schemes streaming ecological resource economic value towards local community for sustainable ecological resource management.

As a result, this study will benefit farmers who depend on Tullu Dimtu Mountain and Anbesa forest ecosystems as well as other ecosystem under similar conditions. Furthermore, Ecological resource management planners and biodiversity conservation practitioners can be benefited from the research report by referring the finding that identify relevant ecological resource attributes and preference of the respondents in the study area.

1.6. Scope and Limitation of the Study

The study on hand aimed at exploring determinant factors reasoning farmers' resource use decision-making process from Tullu Dimtu Mountain and Anbesa forest ecosystem. It pursued to deepen knowledge on factors contributing to ecological resource degradation. It empirically investigates the answer for the question "why farmers choose one resource use system among other available alternatives?" To add an insight on the knowledge about farmers' decision that influence sustainability of natural ecosystem, farmers' choice attributes valuation analysis was employed. Thus, the scope of this study can be generally coined as investigating economic grounds of farmers' decision that causes ecological resource degradation. However, it is focusing only on Tullu Dimtu Mountain and Anbesa forest ecosystems in Metekel and Asosa Zone of Benishangul Gumuz Region, respectively. This is justifiable because of time and logistic constraint. But, these ecosystems are exemplary in its high-level ecosystem service provision for the community and are exposed for serious degradation. Therefore, this finding is very important for national ecological resource management strategy development to calibrate for the same socio economic and biophysical condition, in spite of its narrowness in spatial scope.

1.7. Organization of the Thesis

This thesis consists of five major chapters. Background, problems statement, objective, significance, scope and limitations of the study is presented in the first chapter. Following chapter discusses the review of related theoretical and empirical literatures. Then chapter three describes the employed methodology. Chapter four depicts the results and discussion of the study. Finally, chapter five constitutes conclusion and recommendations.

2. LITERATURE REVIEW

2.1. Concepts and Definition

2.1.1. Ecosystem

Ecosystem is a dynamic complex interaction of animals, plants, microorganism communities and nonliving environment in which each component has a function. The term complex is to mean a process and relationship of components of the system is difficult to understand because it has multitudes of parts all interlinked in different ways and degree. Like all complex systems, ecosystem(s) is/are made up of a number of interacting parts. Ecosystem components vary in their type, structure and function within the whole system (De Groot *et al.*, 2010).

In a fully-grown ecosystem, there is/are strong interaction(s) among parts building the system. Analysis of interaction of ecosystem and human beings social system needs the concept of ecosystem functions and knowledge of human society's reliance on ecosystems services and functions (Hanley *et al*., 2001). This is particularly useful and necessary task for ecosystem conservation strategy and program development. Because, it is important to recognize that ecosystems functions deliver goods and services necessary for a decent quality of life in addition to their necessity for maintaining ecosystems integrity and resilience. Furthermore, goods and services that ecosystems provide have private, common-pool and public good features enhancing potential degradation of natural ecosystem. Ecosystem's goods and services utilization and ownership institutionalization should acknowledge this innate nature of the system (Braat and De Groot, 2012)

2.1.2. Disturbance of ecosystem and human being

In their seminal work, Virtanen *et al.* (2010) defined disturbance as "any relative discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment". Ecosystem disturbance is an upsetting external event directed to the ecosystem due to which a change on features and functions of ecosystem sprouts. It is irregularly stirring periodic event resulting in rapid change of ecosystem. It can also be articulated as a force, which changes the state of ecosystem at which it was. The change in state of ecosystem occurs to maintain itself at some steady state or equilibrium due to important factors inhibiting community structure and dynamics preventing ecosystem's self-organization to gravitate towards its starting state. This final steady state is where difference due to disturbance is observed regarding the function of the ecosystem before and after disturbance. Hence, disturbance results in a change of system's situation. Looking back to the definition provided for disturbances, an analysis on disturbance can be extend from happening on ecosystem itself to its components including community or population. It also results in change of structure of ecosystem and resources, substrate availability and/or the physical environment (Thakur *et al.*, 2014; Sottile *et al.*, 2015; Van Lierop *et al.*, 2015). Therefore, ecologists understood disturbance to have an ability of changing the structure of ecosystem through which it impairs ecosystem capability in performing its important ecological functions.

Further extending the analysis of definition given to disturbance and linking it to human activities, ecologists acknowledged human activities as the main disturbance factor of ecosystems on the earth. They justified as human exert earth's ecosystem disturbing acts through overharvesting of ecological resources, releasing pollutants, changing different ecosystems to residences and human needed ecosystem states, features or forms (like agriculture and managed landscapes), and man made goods and services. Because, disturbance includes any modifications in the environment that cause changes in how ecosystems functions and human managed ecosystems are among these changed ecosystems and how they functions. Therefore, most of world ecosystem disturbance is attributed to human induced as a result of demand for maximization of benefit or utility generated from natural ecosystem. Thus, human being and its activities is accounted as the main disturbing factor of ecosystem (MA, 2005)

2.1.3. Human activities and threats to ecosystem sustainability

The term 'Sustainability' embodied ecosystem health as a comprehensive, multi-scale, dynamic, hierarchical measure of system resilience, organization and vigour. It is used to conceptualize a way of management, which does not cause serious and irreversible ecological change. With this conceptualization, sustainability implies continuity of the system maintained in its structure and function over time (De Groot *et al.*, 2010). This characteristic of the system partly attributed to system's ability to maintain itself in the face of external stress and on the other part associated to the maximum level of external stress is below the level that damages the systems structures and functions.

Hence, sustainability of ecosystem depends on the level of upsetting forces and the characteristics of the system to maintain itself. In line with this, upsetting factors threats the sustainability of ecosystem. With exerted level of factor of disturbance above a threshold of the ecosystem to assimilate, the ecosystems characteristics abolish and the continuity of the system's function disputes. In case of forest ecosystem, large-scale disturbance results in the fragmentation of the formerly unbroken forest cover into fragmented forest patches. Fragmentation has an important impact on sustainability of ecosystem through reduction of ecosystem's size, edge effects, reduced seed dissemination and higher-order effects (Lang *et al.*, 2015; Currano *et al.*, 2011). In agreement with this all, human activity threatens the existence of majority of world's natural ecosystem.

2.2. Ecosystem Resources and Resource Attributes

Ecological resource attributes are characteristics of ecosystem components whose composition or bundle make the resource and describe what the resource is (Muller and Burkhard, 2012; Nyssen *et al.*, 2008). For instance, Bamboo is a component of Tullu Dimtu and Anbesa forest ecosystem and is the resource. This resource or good can be classified to different attributes whose level combination gives consumption preferences of the users. This can be represented as its marketability, availability, harvest level allowed, etc. For managerial and conservation work, these characteristics or attributes of the resource should be known. For example, knowing the effect of marketability of Bamboo on sustainability of the ecosystem is crucial to promote or inhibit promotion of market for Bamboo.

In line with this, choice modelling requires to present goods with their respective attributes so that the attributes are valued (Hanley, 1998). As economic theory asserts, a consumer decides whether to choose a good under consideration depending on the levels of characteristics or attributes found in the bundle of the good providing the given good at some specified state, not the good itself. Hence, ecological resource users also judge their choice depending on the composition of levels of ecological resource attributes making the bundle, which is the resource. Therefore, ecological resource attributes are factors through which users' access or utilize ecological resources.

2.3. Conservation of Ecosystem Resource

The concept of conservation is understood, in most cases, as it is negating the use of ecosystem resources (Arjunan *et al.*, 2006). However, the purpose of conservation should not be impediment of ecosystem resource utilization. Actually, it may propose strong premises of control to insure sustainable existence of the resource so as to have continuous flow of services and functions needed to grow human world's economy. Furthermore, conservation methods proposed in case of species at marginal to extinction could assert to hamper use. In both cases, the purpose is to insure the existence of the resource benefiting human society and insuring the sustainability of benefits overtime flow from the resources. Hence, conservation encourages planning wise use that adds to the effort made for sustainable development rather than proposing to prohibit use of ecosystem resources. The intention of ecosystem conservation should be understood as setting up sustainable input for economic development. Since ecological resources have economic values, investments in conservation should be judged in economic terms, requiring reliable and credible means of measuring the benefits of conserving resources (McNeely, 1993).

2.4. Value of Ecological Resources or Services

Ecological resources are serving the globe being as primary source of remedies for messes arising in biophysical pitch. The natural world encompassing sets of chemicals and ecosystem services guaranteed human to relay on it as a source of solutions of multitudes of human trouble. Consequently, it is valued highly in human being's life. However, the future worthiness and importance of ecological resources is obligated to be judged within the framework of those nuisances concerning the sustainability of human wellbeing and enterprises. High growth rate of human population resulted in over populated world. All human head needs necessary goods and services to live healthy life. Ecosystem is expected to provide these needed goods and servers. Therefore, it is required to produce as much as the demand for goods and services. To be potentially productive as much as is required, ecosystem trait needs to be modified and sharpen in demanded and productivity potential. This results in rejecting ecosystem traits with low potentials to satiate productivity requirement and human demand. As result, the base of different ecosystems traits may diminish specializing on importance of traits to specific human demand. However, it also needs to build ecosystem, which can provide high services and goods. Therefore, public needs to be convinced with the reason of national outlay for ecological resource management. It is vital to decide the importance of conserving ecological resource and explain the reason of conservation budget (Boettcher *et al.*, 2010).

Therefore, the public should have value ecological resource and decision makers should understand what values the public attached to the resources in order to decide on its maintenance. The premise of this argument is the public could have willingness to incur respective conservation cost if they have attached values to the resources. Target of conservation then should focus on improvements of the ecological resources and at the same time it has to compare conservation cost incurred with the return expected. Acknowledging the worthiness of ecosystem resources gives a priority to use economic principles and clarify the relation of economic growth and sustainable flow of ecosystem benefits and ecological resource, hence, encouraging conservation of ecosystem (Kumar, 2010).

The Convention on Biological Diversity acknowledges the importance of economic valuation of ecological resources to be a tool for well-targeted and calibrated economic benefit measures emanating from ecosystem. Because, economic valuation is the way to measure the extent of values that the public attached to the resources. Therefore, it is possible to argue that the potential of empirical results of economic valuation studies in indicating environmental protection strategy options is immense. Furthermore, as The Economics of Ecosystem & Biodiversity (Kumar, 2010) argue, the result of economic valuation empirical study is important to ground conservation claims on sound economic reason as it shades light on important factors that should be considered to decide on conservation including explicit recognition, efficient allocation, conservation of costs and fair distribution of benefits and sustainable use of ecological resources.

From natural resource economic valuation point of view, total ecosystem economic value is categorized under two distinct clusters. These are use value and non-use value. The differences of these classes of values, whose sum is total economic value of the good for economists, arise from viewing the decision-making agent's position whether it is in supply or demand side. From the demand side, the agent's willingness to pay for the good or service it demanded to have reflects use value whereas the agent's willingness to accept for cost associated to supplying the good or service in order to insure its existence is non-use value (Wattage and Mardle, 2008). Hence, algebraically it can be expressed as:

Total Economic Value = Use Value + Non Use Value

Values of ecosystem goods and services, which are directly related to the utilization (benefits) of the resources by consumer individuals or groups, are recognized as use value. This means, the use value of ecosystem services can exist only when consumers use the goods and services. Depending on utilization method and time, the use values are further divided in to three sub-categories of values, namely direct use values (DUV), indirect use values (IUV) and Option value (OV) (Perman *et al.*, 2003).

In contrast to use value, non-use value is not directly related to the consumed ecosystem goods and services. Rather, it can be estimated from those individuals willing to pay for not to utilize but to conserve attributes of the ecosystems goods. This non-use value also further classified as Existence value (EV), Bequest value (BV) and Stewardship value (SV) (Wattage and Mardle, 2008). The simple diagrammatic sketch showing each class is presented in fig.1 below.

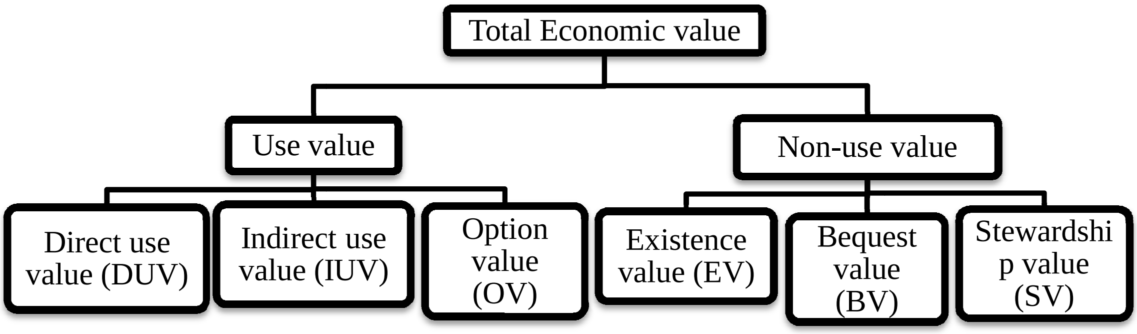


Fig. 1. Schematic presentation of types of value of ecological resource attributes.

2.5. Ecosystem Resource Valuation Methodological Review

If not all, market fails to signal scarcity of most of resources provided by natural ecosystem. Because, those resources' market prices are not easily observed or if exiting, the observed market prices are not potent of revealing their true value. As a result, economic valuation is employed in most cases to uncover undistorted economic values of ecological resources.

Economic valuation is the method used to express monetized value of what ecological good or service worth for users. Articulation of benefits of ecological resources in terms of economic measure needs to employ economic valuation. Hence, ecological resource valuation can be described as the way of stating economic values that the users put on the use of environmental goods and services.

Even if economic value is among many possible ways of measuring the work of a goods or services for users, it is not the only one. However, failure to understand the importance of other types of resource valuation techniques, economic values of economic valuations payback a lot in economic choice decision where resource allocation tradeoffs entail. Because, in economic valuation techniques, economic value are measured based on people's preference. Hence, it relies on the law of demand in measuring respective resources' economic values. In the methods of economic valuation, values of the resources is estimated from preferences for different resources or resource attributes and tradeoffs made across the resources or resources attributes that people make which is expressed through choices they made. In choice and decision theory serving being the blackguard of economic valuation, individuals are acknowledged as rational and best judges of what they want. They are assumed to make a decision analyzing the object of choice, reference state and other context of the decision (Coyles and Gokey, 2002). Hence, economic valuation proceeds from these milestones the theory and made based on individual preferences and choices.

Besides this, however, recognition of ecological resources multidimensionality, multiplicity and complexity of its valuation emanated hot debates on the way to handle the subject. Indeed, this is what enforced the theorists and practitioners of empirical model developers to touch different wings of the area while living the other side unfilled. This in turn resulted in evolution of several valuation techniques; where one cannot substitute the other. In spite of having array of valuation methodologies, all available methods can be clustered under three distinct but broad categories, each category encompassing relatively similar techniques within the cluster. These are market based, revealed preference and stated preference techniques. Each class has different methods. Each class in general and method in particular is associated with its own advantage and disadvantage. Each method also differ from the other in data it requires, assumptions under which it functions, context under which to apply and value type intended to estimate (Kallas *et al.*, 2007) Each category with its own sub-classes, respective drawbacks and premises were discussed in the subsequent sections and subsections.

2.5.1. Market based valuation methods

The methods employing market based valuation methods make use of marketable ecological resources provided goods' and services' prices established through selling and buying process. Compared to the other families of valuation methods, market based valuation techniques have great advantage since the process of buying and selling in market establishes their prices. However, market based valuation methods should not be understood as it uses only market prices although it is among used data under specific cases considered or method employed. Actually, there is a case and context where actual market price of a goods and/or services (whose determination is dependent on some attributes of the resource) is used. But, the methods employed under this family of valuation techniques also use proxy of market price including costs associated to maintaining or replacing those goods or services. These are data used to infer economic values of ecological resource attributes in methods categorized under market based valuation techniques (Salles, 2011).

Using market price and/or cost to use as a proxy of market prices in methods using these data to conduct ecological resource valuation is plain. Market prices, which are in trade and/or its proxies associated with ecological resource products, are collected by surveying markets to get data requirement of these methods. In case of non-traded resource attribute and its economic value estimation is required, other options of data generation is followed. Of these methods of data generation options, marketed goods or services substituting the attribute to be valued is identified and its price is substituted for missed market price of the non-marketed attribute as an approximated proxy variable (Kallas *et al.*, 2007; Christie *et al.*, 2012). On the other hand, another alternative of data generation to substitute the missed market price of the attribute under consideration is using an outlay required to prevent or compensate for the loss of a non-market benefit of the attribute to proxy for the value of the benefit itself (Christie *et al.*, 2006). As a result of this diversity of data potentially used, methodologies employed to use each data type is different. With recognition of such variety of data methodologies, market based valuation techniques used to value ecological resources are classified to market price approach, resource replacement and avoided cost approaches and the opportunity cost approach (Kallas *et al.*, 2007; Salles, 2011).

In spite of their potential to be employed in different frameworks of empirical studies, none of these cost based methods provide strict measures of economic value, which are based on willingness to pay for a product or service. Instead, they assume that the costs of avoiding damages or replacing aspects of a resource can be used to estimate their value. This in turn is based on the assumption that if people incur costs to avoid damages or to replace attributes of a resource, then the resource must be worth at least what individuals paid to replace the damage. However, from a strict economic theory's perspective, this assumption is tight and strict, because costs need bear no relationship to an individual's willingness to pay. In addition, costs are encored for a bundle of attributes giving the good, thus, the value of each attributes in the good is inestimable. This renders low information that could be used planning activities to improve aspects of ecological goods and services. Furthermore, using costs to measure benefits will produce a benefit-cost ratio of unity. As a result, the technique does not give benefit of measuring the efficiency of investing in natural resource management and conservation work (Kontogianni *et al.*, 2010).

2.5.2. Revealed preference (non market based) valuation methods

Differing from market based approaches using market prices or related costs, revealed preference valuation methods use the proxy of market prices (like travel costs, housing prices, etc.) whose value is determined by ecological resource aspects. The proxy of or surrogate market prices revealed in the decision of users shade alight on the values of those non-marketable aspects of ecological resources or resource attributes. Valuation methods employed under revealed preference includes hedonic pricing methods (HPM), travel cost methods (TCM), averting behaviour methods (ABM) and production function methods (PFM) with their respective assumptions and implication potentials.

The working philosophy of hedonic pricing method is derived from Lancaster's characteristics theory of value (Lancaster, 1966). The method premises on the notion that a good consists of a number of distinct attributes each combined or bundled at specific levels to provide specific good. Each attributes in the good has its own value to the consumer. A decision maker hence will convey its inclination to a particular non-marketable attribute in the good by choosing a good with higher level of the attribute which enables estimation of that non-marketable attribute economic value (Geoghegan, 2002). With this argument, the method of hedonic price asserts the possibility to establish the relationship between market price and the non-marketable attribute of the good (Gonzalez *et al.*, 2009).

Under travel cost valuation method observed behaviour and related expenditure of recreation users is used to estimate ecological resource attributes. The model developed from recreation users data (travel frequency and visit associated costs) is used to predict the relationship between user's response (which includes user's decision on changes of travel and associated cost) with changes made on resource attributes (Randall, 1994; Font, 2000). With this datum, travel cost method estimate the values of ecosystem attributes from their response the change made in the ecosystem. The value of ecological resource attributes is generated by finding how much people are willing to pay to get to the recreation site due to the improved attributes (Brander *et al.*, 2007). An implementation of ecological resource attributes valuation employing averting behaviour method is employed within the framework of household production and consumer behaviour theories. Its foundation is individuals conduct in relation to risk aversion, hence, an attempt they made to protect themselves in case of risk episode associated with loss of ecosystem attributes. Thus, the value of non-marketable ecological resource attributes are attributed to an expenditure that individuals spend which they would not if ecological resource attribute are not lost (Christie *et al.*, 2006). Linking with this argument, the final line of averting behaviour method of ecological resource valuation concludes saying, ecological resource attributes whose loss causes additional expenditure at individual level to have safe life owes the additional expenditure individuals spend as its value.

In employing production function approach valuation of ecological resource attributes, the intention of a practitioner is to estimate the contribution of ecological resource attributes to the value of traded product (Gayatri and Edwared, 2002). It analyses input-output relationship of the ecological resources attributes to marketable good or service in a production function (Celine and Caroline, 2009). It essentially measures a response of production of marketable commodity to ecological resources attributes use. The final goal of production function approach is shading light on indirect use values of ecological resource attributes natural ecosystem contributed in production process of a product.

As observed behaviour data is used in valuation methods of revealed preference, it differs from methods of stated preference that use response to hypothetical questionnaires. As a result, it is reasonable to expect relative stability of ecological resource attributes values estimated of revealed preference data when compared to values estimated from stated preference data (to be discussed below). However, the values of ecological resource attributes are inferred using market prices rendered to a good composite of different attributes, hence, it uses a proxy variable of revealed values rather than directly reflected values assigned to individual attributes. Consequently, they are limited in terms of the ecological resource attributes to which they can be applied. For instance, travel costs and hedonic price methods are largely confined to the recreation, amenity and aesthetic values of ecological resource; averting behaviour is limited to the risk reducing value of ecological resource and production functions are limited to ecological resource attributes that have a quantifiable input-output relationship with marketable goods. Hence, stated preference ecological valuation methods takes an advantage of applicability to which cost and market based approaches cannot be used for.

2.5.3. Stated preference valuation methods

Contrary to ecological resource attributes valuation methods categorized under revealed preference, valuation methods categorized under stated preference approaches does not use market prices as a proxy from which values of non-marketable ecological resources attributes are inferred. Instead, the values of ecological resource attributes are collected through direct questioning individuals. It is done by clearly stating a hypothetical situation under which the users are requested for their preferences and associated values (List and Gallet, 2001; Harrison, 2006). Principally, at the absence of direct market prices for ecological resource attributes or proxy variable to infer from, valuation methods under stated preference are handy to estimate values of ecological resource attributes. There is two direction of measuring the values of ecological resource attributes depending on the change direction of the attributes. Hence, the value users asked in case of ecological resource attributes improvement is an individual's willingness to pay (WTP). Differently, individuals are asked for their willingness to accept (WTA) in case of proposing a project or an activity which can result in undesirable change in ecological resource attributes so that a compensation for the loss of welfare due to deterioration of their environment thus to have stable welfare level as before the change happens (Gonzalez *et al.*, 2009). In stated preference based valuation techniques, in spite of asking individuals to present their value for hypothetical situation, they are assumed as they behave in a real situation. Of an array of stated preference methods existing in the arena of economic valuation, contingent valuation and choice experiment are the two mainly empirically applied methods.

Contingent valuation method is used to determine the value of ecological resources eliciting how much respondents are willing to pay for particular ecosystem attributes or services. In this method, even if the operating market and resource attributes supplied is hypothetical, individuals response is assumed to be the reflectance of their true willingness to pay (WTP) or willingness to accept (WTA) (Font, 2000; Farber, 2002; Hanley *et al.*, 2001). Hence, this assumption and the methods characteristics to operate under hypothetical market enabled researchers to apply it on valuation studies of ecological resources with non-use values (Markandya *et al.*, 2002; Kotchen and Reiling, 2000; Randall, 1994).

Although a contingent valuation technique is expensively applied on ecological resource valuation empirical studies, it has its own incapability and drawbacks. Of these incapability, the method is applied to a confounded attributes where the good considered is only defined as a single good and not able to treat different attributes in the good. Hence, it is not capable of handling a valuation of multi-attributed good. The other drawback of contingent valuation is, it is associated with a number of potential sources of bias (Birol, 2006). These include strategic bias, vehicle bias**,** information bias and hypothetical bias. Strategic bias is caused by individuals being able to secure benefits greater than the costs they have to pay by answering dishonestly. On the other hand, vehicle bias arises from the hypothetical instrument of payment defined to be used. Information bias is a bias streaming from the amount of information provided to respondents. Hypothetical emerges where respondents answer a question in such a way as to please the interviewer or state that they are willing to pay more than they truly would knowing that they will not have to spend real money (Champ and Bishop, 2001; Kotchen and Reiling, 2000; Font, 2000).

Employing choice experiment valuation method is based on Lancastrian consumer technology theory, which is stated as, the choice of consumers for a good is based on the preferences it has for attributes of the goods but not based on a comparison made between goods without considering the attributes encompassed in each of the goods in the comparison (Lancaster, 1966). Choice experiment empirical application is made possible with the random utility model (RUM) of (Thurstone, 1927) defining decision makers' choice to have deterministic and random components. Based on theory of Lancaster and model of Thurstone, econometric model was developed and applied by (McFaden, 1974; McFaden, 2001) which made the analysis of individual's preference for multi-attributes of goods (McFadden and Train 2000). Therefore, in attempting to develop measures of ecological resource attributes value, one needs to examine preferences over wide diversities of attributes and understand the relationships among these various attributes of the good (Soliva, *et al.*, 2010). Choice experiments estimate individual preferences and measure the relative importance of these various attributes in the goods. Respondents are presented with a series of optional goods having different attribute levels and asked to choose their most preferred alternative (Hensher, 2005).

Hence, choice experiment (CE) enables estimation of not only value of ecological goods and services as a whole, but also the implicit marginal values of its attributes (Boxall, 1996), a major merit which differs it from contingent valuation method (CVM). Therefore, choice experiment is important to find values that individuals assign to different attributes of ecological resources (Hensher, 2005). This is in contrast to the contingent valuation method which evaluates the values relate to a discrete changes in some or one specifically defined ecological resource attribute(s) (Hanley *et al.*, 1998). Hence, in choice experiment, the value of ecosystem resource is estimated summing up the values of individual attributes of ecological resources, which may empirically be greater than or smaller than the value stated if an individual is asked to value the whole attributes at the same time (Soliva *et al.*, 2010).

In spite of a criticism on their innate nature of working under hypothetical market than observed behaviour (Kontogianni *et al.*, 2010), stated preference methods are very helpful. In general speaking, they have the ability of shading a light on the possible consequence of changes before incidence of the changes. Hence, the possible outcome of a change on ecosystem can be drawn priori undertaking the proposed changes. It can also draw out implicit values of attributes which cannot be captured using other valuation techniques.

In addition to the criticism forwarded due to its hypothetical nature, the other possible source of criticism on the difficulty that decision makers encounter to understand complex nature of attributes and indicators of ecosystem resources. In line with this, there could be shortage of knowledge on the functions and the risks (impacts) associated with its changes (Brouwer *et al.*, 2010). However, it should be noted that, this criticism could equally applied to reveal and market based valuation methods. Because, if an individual cannot understand the impacts of changes in attributes of ecological resources and the risk associated with it, it could not reveal its preference or pay for the attributes of the resource which it gets difficult to understand (Brouwer *et al.*, 2010). The schematic sketch of classes of valuation techniques reviewed is presented below

(Fig. 2)

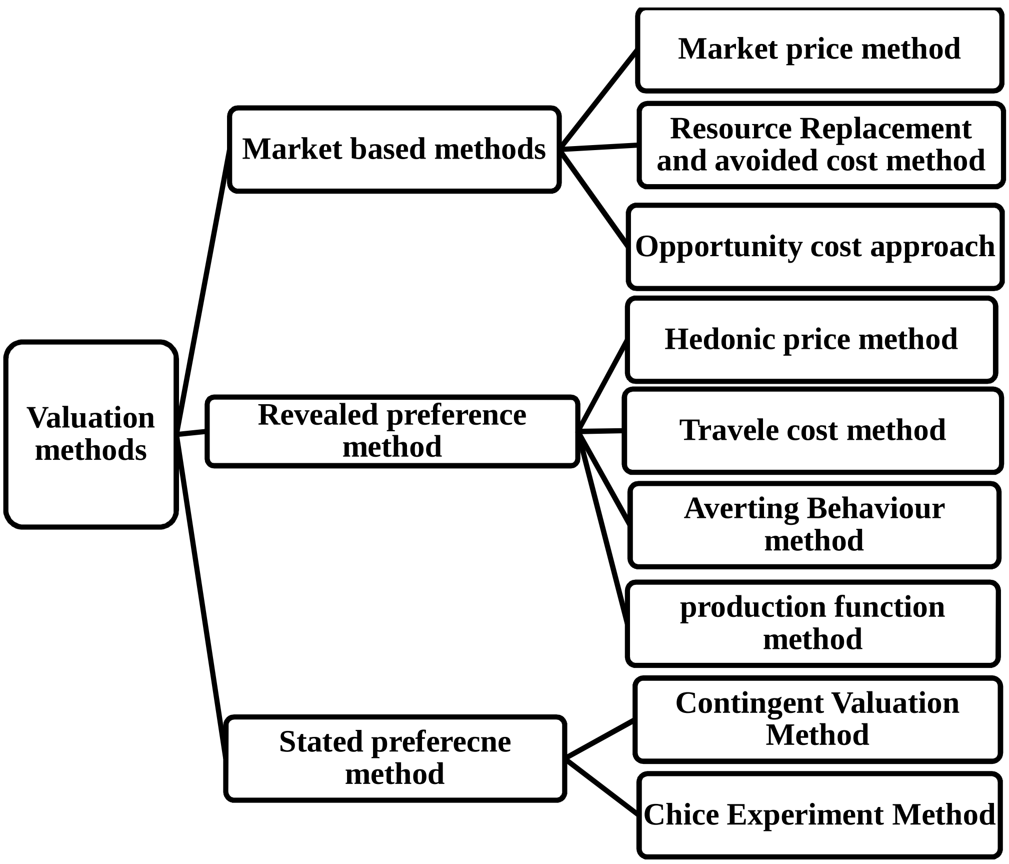


Fig. 2. Schematic presentation of classes of valuation techniques.

2.6. Review of Related Empirical Studies

In Ethiopia, natural resource economic valuation empirical study (especially with choice experiment valuation method) is not yet carried out as much as needed. As a result, the possibility of accessing an array of findings to review is not such admirable. What is important is that, besides the subject of the study is natural resource valuation, it is imperative to know as one work is done due to specific interest which is different from the purpose of the other empirical work. Furthermore, crediting context difference under which each research is conducted and methods used is also paramount. Hence, it is possible to group natural resource valuation studies under different categories based up on the purpose of the study, context of the study and methods used.

Literature review reported in previous titles and sub-titles revealed that, different possible way to measure value of natural resources attributes. As an in-depth deal with this subject uncovered, market based, revealed and stated preference approaches were the major classes under which the other specific methodologies were categorized. Besides, there is no an all fit method since all valuation methods have strength and weakness. For instance, methods used to measure natural resource values based on market prices are criticized with their characteristics of failure to reveal the economic value of non-marketable attributes (Birol *et al.*, 2008). On the other hand, methods used to estimate natural resource values depending on stated preference methods are condemned with their intrinsic hypothetical nature and the fact that they are not extracted from revealed actual behaviour (List and Gallet, 2001). Furthermore, the confoundedness of revealed preference data used for valuation draw a get for a criticism forward to revealed preference valuation methods. This method is further condemned with its characteristics such as confoundedness of data to reveal different values and a suffering it gets with co-linearity among attributes (Sinafikih, 2010). As a result practitioners and researchers of the area commented combining the methods especially, the two more applied methods (i.e. revealed and stated methods) in order to increase the statistical efficiency of results. However, given that stated preference is employed in this particular study, comparable empirical research works used in setting its foundation but having difference in essential areas and interest of study is reviewed.

To start with (Alemu, 2000; Tefera, 2006; Ayalneh, 2011; and Dambala And Koch, 2012), among all, employed stated preference, particularly CVM to value community forest (attributes) and/or forest conservation in Ethiopia. Alemu (2000), analyzed the value of community forest in rural Ethiopia with the application of CVM. In setting the situation, the work hypothesized the establishment of village woodlot. Then, it asked the willingness to pay of farm households for establishment and to keep the plantation. The elicitation format used was single bounded dichotomy followed by open ended question for maximum willingness to pay in cash, in kind and in labor. Using the collected data, sample selection corrected tobit model was fitted. Then, household size, household income, distance of households' home from proposed site of plantation lot, number of tree owned and sex of household head were found and reported as significant determinant factors explaining the willingness to pay. In addition to econometric model to identify determinant factors of willingness to pay, mean willingness to pay and aggregated value households would pay for establishment of woodlot was estimated from the data. Besides, however, significant difference among mean willingness to pay of different sites was reported. Hence, the researcher concluded the need of acknowledgement of site specificity in demand level or willingness to pay heterogeneity for woodlot establishment and the necessity of community participation in establishment and management of community forest in rural Ethiopia.

Tefera (2006), employed similar tool (CVM) to estimate the value of forest ecosystem, but differing from previously reviewed work Alemu (2000), whose subject is community or village woodlot establishment, while Tefera (2006), employed the method to estimate economic value of patch of natural forest found in wondogent. Alternative values from which respondents were asked to choose were presented. In addition to presenting alternatives, the elicitation format allows for respondents to appraise their true willingness to pay or accept. The researcher tested the relationship between WTP/WTA and education where significant relationship was reported. Furthermore, wealth factors, where land holding and livestock size was used as proxy variables, were found to be significant in explaining willingness to pay and willingness to accept of households.

Ayalneh (2007), similar to previously reviewed two empirical research works in employed methodological tool CVM to estimate the WTP of farm households in order to value forest resource. This is used to evaluate the implemented conservation (management) policy or participatory forest management strategy's potential to insure initiating community's forest conservation or management interest. The researcher applied CVM in Adaba and Dodola Forest Priority Areas where WAJIB, in *afan Oromo* (*Walda Jiratota Bosona* which can be translated as Forest Dwellers Association) is implemented as forest conservation and/or management strategy. Double bounded dichotomous response elicitation method followed by an open ended question of maximum willingness to pay was employed. Using the generated data of CV elicitation complemented with socioeconomic variables, binary probit and ordered probit models were estimated to identify factors explaining farm household willingness to pay. The researcher reported household size, education level, perception towards the need of forest conservation, members of forest dwellers association and wealthier farmers (farmers having larger land holding and livestock) to be factors significantly explaining the probability of willingness to pay.

Dambala and Koch (2012), employed CVM with double bounded dichotomous response contingent valuation elicitation method to collect valuation data to estimate rural farm households' willingness to pay for village woodlot establishment. Interval censored data models, bivariate probit models and various random effects probit models were employed to identify the determinants of willingness to pay. In addition to willingness to pay, the researchers used these models to test for preference irregularities which CVM is criticized mainly for. Income and Livestock ownership were reported to be significant determinants of willingness to pay of rural farm households. In addition to this, they identified the presence of incentive incompatibility and framing effects in CV which needs control to devise policy recommendations from its welfare analysis result.

These all employed CVM, which is a stated preference method, a feature that the research on had shares with them. Furthermore, these all empirical works were used to estimate the values of forest, which is one among many of natural resources, with no market price. Hence, this research shares this feature also.

However, these all reviewed empirical works differ from the research on hand. Of their difference is that, even if both studies employed valuation methodologies found under the family of stated preference, at the specific methodology level, they differ since this research project employed choice experiment (CE) method rather than CVM. In line with this, the study on hand estimated the implicit price of attributes of resources under the study rather than estimating the aggregated value of the resource which is the subject of CVM. Further difference is that, even if the subject of CVM studies reviewed is forest, which is the component of the study on hand, forest is not the only subject of this study as that of CVM studies reviewed. Instead, the subject of this study is ecological resource attributes where forest is considered as one entity. Thus, further review of empirical research works having some important similar feature with this study, which the pervious reviewed works lack, was made here under.

In Ethiopia, empirical research works reported using choice experiment is scant in general and on ecological resources in particular. Of these scant literatures, the work of sinafikih *et al.* (2010), on valuation of ecological attributes of crops, which could not be traded on market, is mentionable. The work was conducted on sorghum and *teff* crops in southern Ethiopia. The data was collected with choice experiment using designed choice set questionnaire. Fitting conditional logit and random parameter logit models, they argued the gain of model fit from random parameter logit. Implicit prices of crop attributes considered were estimated from both employed models to reveal the gain due to model difference. Further, with the help of the result from random parameter logit, the researchers argued the presence of heterogeneity within the demand of the community for the attributes. They also uncovered the sources of the heterogeneity discovered using conditional logit model fitted on the data where choice attributes were interacted with socioeconomic variables. As a result, they recommended the concerned parties to give due attention for those sources of heterogeneity for successful crop technology adoption and crop biodiversity conservation.

Girma *et al.* (2012), also employed choice experiment to estimate the value of Animal genetic resources in central Ethiopia. They collected choice data from Denno district and fitted conditional logit and random parameter logit in which choice attributes were interacted with socioeconomic variables of farmers. They calculated implicit prices of livestock attributes from the models fitted. Depending on their finding of random parameter logit model, they argued the heterogeneity of preferences of farmers to choice attributes. Hence, they argued to reframe animal genetic resource conservation policy in which the sources of preference heterogeneity is acknowledged.

Beside agro-ecological resource attributes, there are some researchers who employed the method on valuation of other resources in Ethiopia. For instance, Dambala and Koch (2012), similar to (Alemu, 2000), evaluated willingness to pay of community for establishment of community forest. Besides their similarity on the subject of the study, Alemu (2000) employed CVM while Dambala and Koch (2012), used choice experiment (CE). With employment of CE, Dembela amd Koch (2012), estimated community's forest use attribute specific implicit prices, an information which CVM application cannot provide. In addition to estimation of implicit prices of the attributes considered, they also evaluated preference heterogeneity for each attributes among individuals in the community with application of random parameter logit and latent class models, which is further improvement to CVM. Hence, to establish community forest or establish forest conservation interventions, they recommended considering factors governing the heterogeneity of preferences for forest use attributes.

In addition to Dembela and Koch (2012) Nega (2012), employed choice experimental approach to estimate the value of economic benefit of natural resource. Irrespective to their similarity in employing choice experiment, the later study is conducted on irrigation water attributes, Ribb Irrigation and Drainage Project in South Gonder, Ethiopia. Collecting choice experiment data the researcher fitted multinomial logit. To improve the IIA assumption of multinomial logit, random parameter logit model was employed and the researcher reported the betterment in fit of the model. Using the result of random parameter logit model, implicit values of irrigation water was estimated and reported.

So far reviewed empirical works were concerned with stated preference methods employed in natural resource valuation studies in Ethiopia in general. Particularly, the later three empirical works were those which employed choice experiment approach, which is more similar with the method used in the research on hand. However, the subject of the study of so far reviewed works are more or less has a disparity with the subject of the study of this thesis, despite all being natural resources which has no market price.

Thus, an important work which is more relevant and has to be reviewed in relation to this thesis is the work of Befikadu (2015), conducted on assessing determinants of WTP and WTA in watershed management in the Blue Nile basin, Ethiopia. In this work the interest of the researcher was to estimate the economic values of ecosystem services. Using choice experiment approach, the researcher identified WTP and WTA as values of ecosystem services. Further, the determinants of WTP and WTA for ecosystem services were uncovered. Being the ecosystem rendered benefit which is the subject of the study and methods employed for data collection in this empirical study is similar with that of subject of the study and method employed in this thesis.

However, there is some important difference within the two works. The reviewed empirical work is conducted within the frame work of payment for ecosystem services (PES) intervention. Hence, it evaluated the WTP of downstream households for improved ecosystem services due to the management made by upstream households and WTA of upstream households for the management they made on watershed that improves ecosystem services. The WTP and WTA of downstream and upstream households was estimated and inferred as the value of ecosystem services. Thus, the work did not estimated implicit values of ecosystem resource attributes explicitly.

In this thesis, however, the valuation study is made at ecosystem level without differentiating downstream and upstream households. Even, the study was conducted within the framework of community level, where the value that the community attributed to ecological resource attributes was estimated explicitly. The works further differ in the method they used to identify the attributes and attribute levels in both studies. More importantly, the reviewed empirical work makes use of nested logit model, which is different from the model used in this study, which is conditional logit and random parameter logit.

The similarity and dissimilarity of both studies has important implication. Since both are concerned with ecosystem resource valuation, the interpretation of results of both studies has similarity. However, since the study on hand is interested with the value of attributes of ecosystem resources, both studies differ with the values they reported. The methods employed for econometric analysis also introduced important interpretation difference in the results obtained. Hence, the reviewed empirical work's result was interpreted as the determinant of willingness to pay and accept for water shade management, whereas, the interpretation of this study is made as the determinant of demand for ecosystem resource attributes.

3. METHODOLOGY

3.1. Description of the Study Area

This study is conducted in two Localities (Anbesa forest and Tullu Dimtu Mountain) found within two different districts of Benishangul Gumuz National Regional State (BGNRS). Tullu Dimtu ecosystem is located in Dibate district of Metekel zone whereas and Anbesa forest is situated in Bambasi district of Asosa zone. BGNRS is located in the Western part of the country. It stretches along the Sudanese border between 09.17^0 and 12.06^0 N latitudes and between 34.10^0 and 37.04^0 E longitudes (Fig.3).

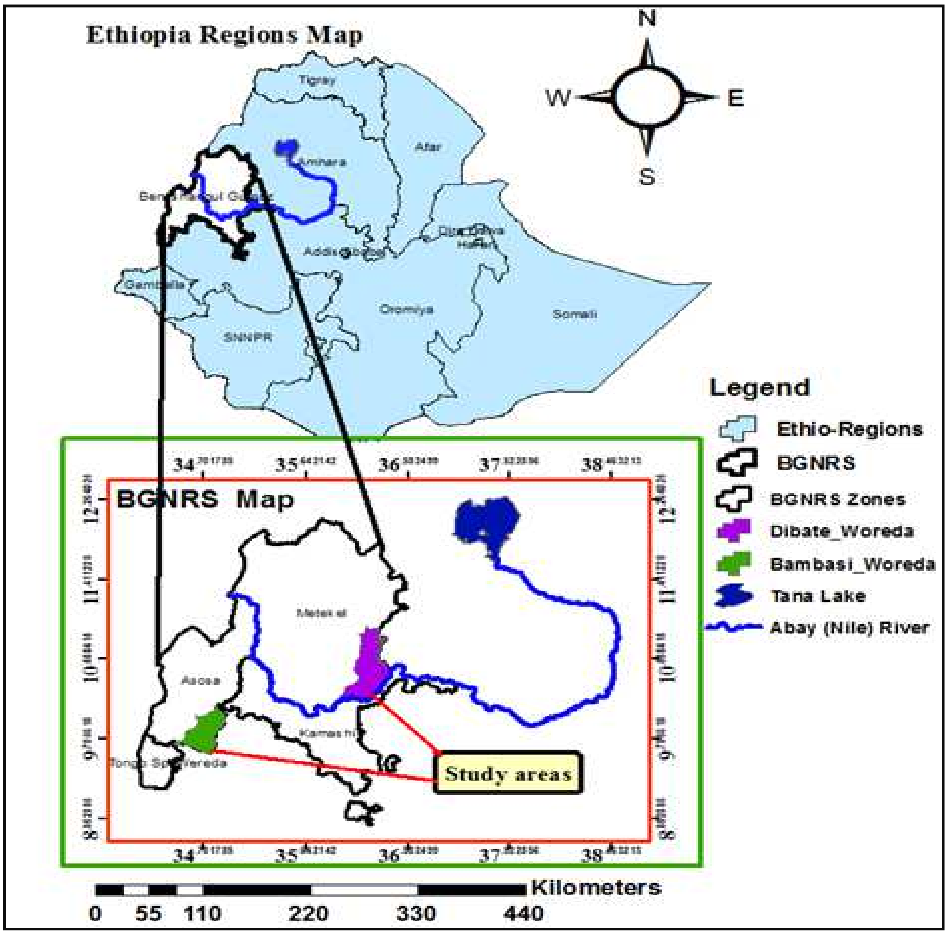


Fig. 3. Map of the study area.

The Amhara, Oromiya and Gambella National Regional States are bordering the region in the North, East and South respectively. Dibate district is located at 10.65^0 N and 36.21^0 E latitude and longitude respectively, whereas Bambasi district is located at 09.75^0 N and 34.73^0 E latitude and longitude respectively. Dibate district is found at distance of 548 km where Bambasi district is found at distance of 619km from Addis Ababa, the capital city of Ethiopia.

The Topography of Dibate district is mainly known with mountains and steep slope with an elevation of 1,438m while that of Bambasi district is known with slightly gentle slope with an elevation of 1,668m a.s.l. Larger part of Dibate district is located within Tana Beles sub watershed, whilst Bambasi district is situated within Dabus River sub watershed.

3.2. Rainfall and temperature

The study areas get single rainy summer season (May to October) and single harvest per year. Dibate district is mono modal getting its maximum rainfall in August with average monthly value of 1900.98 mm and minimum rainfall in February with average monthly value of 0.01 mm within the rainy season. The temperature of the district reaches its maximum in February with average monthly value of 38.64^0c and it gets its minimum monthly temperature in December with minimum average monthly temperature of 13.03^0c (fig.4).

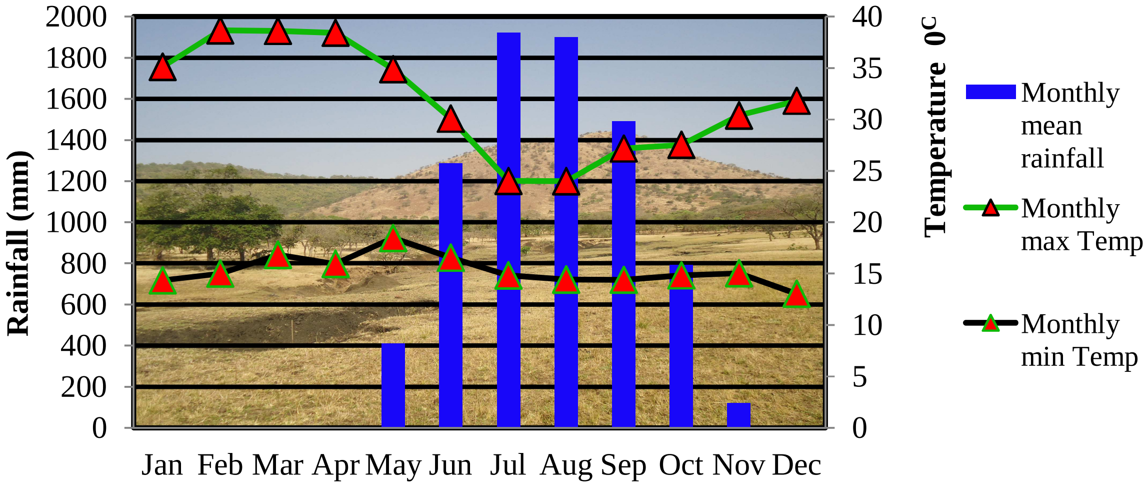


Fig. 4. Temperature and precipitation of Dibate district.

Source: Glgel Beles meteorological station, 2014

Bambasi also share similar feature of Dibate district in being monomodal. Hence, it gets its maximum rainfall in August with average monthly value of 1800.77 mm and minimum rainfall in January with average monthly value of 0.01 mm within the rainy season. The temperature of the district reaches its maximum in February with average monthly value of 33.66 ^{0}c and it gets its minimum monthly temperature in August with minimum average monthly temperature of 13.23^{0}c (fig.5).

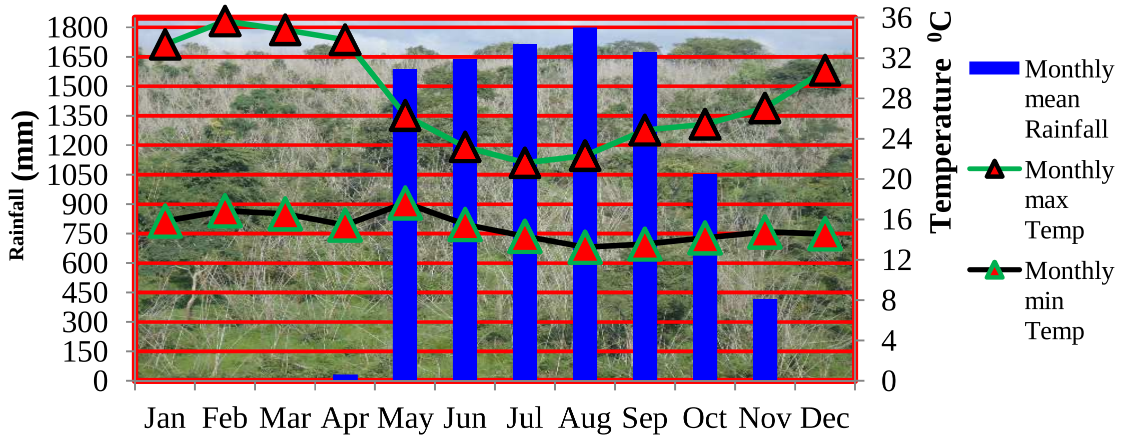


Fig. 5. Temperature and precipitation of Bambasi district.
Source: Bambasi (Amba16) Meteorological station (2014)

3.3. Soil of the Study Areas

According to Food and Agriculture Organization soil classification the soil type of Dibate district categorized in to three major classes. These are Haplic Alisols, Eutric Cambisols and Humic Nitosols. In terms of area coverage, Eutric Cambisols, Haplic Alisols and Humic Nitosols covers 58%, 39% and 1%, respectively and the remain 2% area of the district is covered by water body. Similarly, soil class of Bambasi district grouped in to four major soil types. These are Dystric Podzoluviso, Eutric Cambisols, Haplic Alisols and Humic Nitosols. Of total area of the district, Humic Nitosols Eutric Cambisols Dystric Podzoluviso Haplic Alisols covers, 63%, 25%, 11% and 1%, respectively and the rest is covered by water body (FAO, 2009).

3.3. Land Use/ Land Cover

International Network for Bamboo and Rattan cited in Semeneh, *et al.* (2014) estimates showed that, at regional level bushes and shrubs are predominant vegetation covering 77.4 percent of the region. On the other hand, forestland covers about 11.4 percent whereas, cultivated land, grazing land and marginal land covers 5.3 percent, 3.2 percent and 2.3 percent, respectively. At large scale, the vegetation in the region is classified into eight types, constituting dense forest, riverin forest, broad-leaved deciduous woodlands, acacia woodland, bush land, shrub lands, boswellia woodland and Bamboo.

However, other authors reported intensive land use conversion from natural vegetation to farmland in the region (SID, 2010; Semeneh, 2014; Tegegne, 2014). As these findings, the mainly intensively degraded and converted land use types were Grassland, Bamboo land, dry woody land and forestland. They also acclimatized to report the trade off to be within those natural vegetations and farmland and bare land (due to over grazing and farming).

3.4. Demography/Population

The census of 2007 revealed the population of the region to be counted at 784,345 people comprising of 398,655 males and 385,690 females who were found in 174,445 households. Males has 51% share of the region's population whereas females accounted for 49%. The regional average family size was reported to be 4 persons per household. The population of Metekel and Asosa zone estimated to be 321,919 and 310, 822, respectively. The share of male is 50% in Metekel zone and 51% in Asosa zone. Total households were 70,318 and 72,879 in Metekel and Asosa zones respectively. The average household numbers in Metekel zone is 5 whereas 4 in Asosa zone. Dibate district is inhabited with 66,654 people of which 50% is male. This population is found within 14,177 households whose average household size is 4.7. Similarly, the population of Bambasi district is 48,694 with 51% male and the average household size of 4.3 (CSA, 2008).

3.5. Major Economic Activities of the Study Areas

Almost all of the regions' community production system can be characterized as mixed farming system, while some part of the community intermittently engaged in extraction of non-timber forest products for economic activities. Generally, Crop, livestock and non-timber forest products are among the major mean of rural livelihood in the region. (SID, 2010; Semeneh, 2014; Tegegne, 2014).

Farmers of Dibate district rear livestock as a compulsory of their livelihood making. The diversity of livestock found in the district includes cattle, small ruminants (goat and sheep), poultry, donkey and mule. The farmers of the area rear livestock for cash income generation, selling the live animals and using them as a source of traction power. Oxen are the main resource used for faming where as mule and donkey serves as a means of transportation. The small ruminants mainly reared for sell especially when small-scale cash is required for household expenditure. Cow is owned mainly for reproduction and giving dairy products used for household consumption and sell, particularly in case of butter.

In addition to livestock rearing, farmers of Dibate district produce crop for home consumption and marketing. Of crops produced, oil crops were entirely produced for marketing. These crops include noug, sesame and groundnut. The report from district agricultural and rural development office showed that the district is suitable for those reported oil crops and farmers produce them as cash crops. In addition to oil crops, farmers of the district produce cereals for home consumption and partly for market. These crops include teff, finger millet, maize sorghum, and rice. Among fruits, mango, papaya, lemon and banana are reported to be mainly produced in the area. The production level of crops within their category (in percent) and total potential annual production report of the district is presented in table 1 below.

Similar to Dibate district, farmers of Bambasi district rear livestock and cultivate crops. They make their major livelihood from these produces. The community of the district is rearing includes large and small ruminants (i.e. cattle, sheep and goat), Donkey, mule, and poultry. As any of rural community of the nation, livestock shoulders the main livelihood making of the community. In addition to livestock rearing, the community of the district produces crop, which is dependent on livestock rearing mainly oxen, as stated above. Table 1 below presented the types of crops produced in the district. Among crops produced, cereals account for 52.94% whereas oil crops accounts for 31.3%, next to cereal crops. Of the cereals grown in the district, sorghum has the largest share with 29% followed by maize whose share is 29%. Finger millet and teff are those mainly grown cereals next maize having 6% and 2.6% respectively. Rice is a cereal whose share of area coverage is small in the district accounting for 0.1%.

Table 1. Crop production of the study area

Crop types	Dibate district		Bambasi district	
Cereals	% share	Annual harvest in (qu)	% share	Annual harvest in (qu)
Teff	21.63	3251	2.6	8961
Finger millet	21.06	32643	6	29673
Maize	22	73177	15.24	229892
Sorghum	38.16	18793	29.00	293500.7
Rice	15.40	150	0.1	16312
Oil crops				
Noug	35.45	1879	16.6	46343
Sesame	34.48	2615	13.7	25483
Ground nut	29.04	8965	0.7	293500.7
Fruits				
Mango	52.63	6540	0.4	39425
Lemon	21.63	2421	0.003	180
Banana	26.32	-	0.1	-
Papaya	-	230	0.05	3410

Note: qu = 100 kg

Source: Dibate and Bambasi district agricultural and rural development office, 2014.

3.6. Types and Sources of Data

Both secondary and primary data were collected and used for this study. Secondary data were obtained from available published articles related to the issue under consideration, maps of different geographical information reports and magazines, worked on ecological resource degradation and sustainable management strategies, which were reported by both NGOs and governmental organizations. In addition, the back ground and socio-economic sketch of the study area was collected from different sources such as district and *kebele* administration reports. In addition population characteristic of the area was collected from CSA reports. On the other hand, the main part of data required for accomplishment of proposed research objectives, the primary data was collected from district and *kebele* agricultural and natural resource professionals and extension experts and farmers.

3.7. Sampling Strategy and Sample Size for the Primary Data Collection

In this study, mixed method (MM) sampling was used for selection of study area and sample respondents from the domain. Mixed method sampling techniques involves the combination of both probability and non probability sampling techniques (Teddlie and Yu, 2007; Johnson *et al.*, 2007). This sampling technique is selected depending on advantages it provides for different types of sampling practice we made in various stages. In the first stage the study districts were purposefully selected based on the availability of endangered ecological resources providing the community with various ecosystem services. Accordingly, Dibate and Bambasi districts in which Tullu Dimtu Mountain and Anbesa forest are respectively found were purposively selected.

In the second stage, the *Kebele*s whose resident farmers use resources from Tullu Dimtu and Anbesa forest ecosystem were selected purposefully from the selected districts. Then, for the household survey, simple random sampling design was employed for selection of respondents from the domain of *Kebele's* farmers in collaboration with *Kebele*s administration. The lists of total households in the selected *Kebele*s were obtained from *Kebele* administration. Depending on the total households obtained from the *Kebele*s administrator. The sample size for this study was calculated by Cochran's sample size determination formula (Cochran's, 1977), and 125 and 122 households were respectively selected from Anbesa forest and Tullu Dimtu ecosystems (Table:2)

$$no = \frac{Z^2 * (P)(q)}{d^2} \qquad n_1 = \frac{no}{(1 + no/N)}$$

Where;

n_o = desired sample size Cochran's (1977) when population greater than 10000

n_1 = finite population correction factors (Cochran's formula, 1977) less than 10000

Z = standard normal deviation (1.96 for 95% confidence level)

P = 0.1 (proportion of population to be included in sample i.e. 10%)

q =is 1-P i.e. (0.9)

N = is total number of population

d =is degree of accuracy desired (0.05)

Table 2. Summary of sample size distribution

Study Area	*Kebele*	Household no.	%Share	Selected Sample	Total
Bambasi (Anbesa forest)	Afabuldaru	138	11	14	125
	Jmatsa	240	19	24	
	Sonika	218	17	21	
	Shobora	293	22	27	
	Mender 47	403	31	39	
Dibate (Tullu Dimtuu)	Korka	975	100	122	122

Source: District and *Kebele* administrations of the study area; 2014

3.8. Methods Employed in Collection of Primary Data

Participatory rural appraisal (PRA) tools, structured questionnaire and choice experiment cards were employed as data collection tools for this study. Detailed procedures followed and tools used for primary data collection is discussed here under.

3.8.1. Participatory rural appraisal (PRA)

Participatory rural appraisal (PRA) is an array of tools some of which were used for this study to generate information at community level (i.e. the key informant interview, focus group discussion, joint resource and social mapping, transect walk and pair wise comparison and ranking). These tools are a powerful combination of approaches and methods that enable rural people to share their knowledge of life and conditions. A main aim of using this tool was to find the chronic problem of the area that attributed to ecological resource use and degradation, which enables farther data gathering activity. To be clear and specific, employing the PRA tools has supported the investigator to identify constraints of ecological resource use of the study areas. Identification and prioritization of such problems had again invaluable contribution to identify relevant ecological resource components that the livelihoods of the community relay on, which is the first objective of the research on the hand and going to be valued. The detail of employed tools and contributions of each tool explained here under.

3.8.1.1. Key informants interview

Key informant interview is among PRA tools by which informants are purposely selected and interviewed, since they are resource persons in providing information. They are key and good sources of certain historical events and their occurrence trends. They also have a potential in reasoning, arguing and relating factors and those historical events. For this study, selection activity of this informant was conducted based on purposive criteria such as their local area historical and event knowledge. Depending on these criteria and for the benefit of logistic and time, a total of ten key informants from different social class (i.e two *kebele* officials, six elders (three from both sexes) and two experts/Das on ecological resource use systems) were purposefully chosen and interviewed at each *kebele* of under study to gain the information targeted.

Kebele officials are government units proximate to the community. They are also politically empowered units in implementing government policies, rules and regulations. Thus, the interview held with those officials provided the information regarding natural resource use, management and conservation works done at *kebele* levels and specifically the ecosystems under consideration. Hence, a discussion held with *kebele* officials had provided good base to guide the other survey process in the study area. Pre designed open ended Semi-structured interview questions related to abundance and scarce of resource, equal access of these resources, existing common and/or private resource, utilization system of these resources, problems attributed to natural resource degradation, drivers of these degradation and presence of conservation practice at the area were interviewed. The interview held with key informants has provided full picture of the area and enabled the investigator to understand the general feature of the *kebele*s and ecological resource considered.

3.8.1.2. Focus group discussion (FGD)

Focus group discussion is a prominent PRA tool by which groups of focused (purposely selected) individuals generate information guiding field observation (transect walk) and supports farther structured question development activity used in house hold survey. For this purpose, participants of focus group discussion (FGD) members to participate in the scoping study were identified through local contacts. For the benefit of time and logistic, focus groups four for Tullu Dimtu and six for Anbesa forest were formed. The group level difference depends on the ecosystem's resource users stockholders; Anbesa forest has large area coverage and many beneficiary stockholders than Tullu Dimtu. Thus, representative participants of farmers whose livelihood relayed on ecological resource of the study area and assumed likely to have related knowledge and share common interests were included from each population categories. Caution was taken during identification of members of focus group discussion to include representatives of all groups of stakeholders like youth and women. A focus group discussion was conducted with eight to ten participants facilitated by a principal investigator and held in a neutral and free environment whereby participants are encouraged to discuss the issue of the study following the recommendation of (Krueger and Casey, 2002; Heary and Hennessy, 2002). Discussion session was held with groups at villages of selected study area. Focus group discussion was employed to characterize area specific ecological resources, levels of the ecological resources use, ecological resource degradation and management conditions. Furthermore, factors related to ecosystem management, ecological resource attributes, relevant attribute and attribute levels for contextual scenario development and choice experimentation were identified by group discussion participants.

Ecological resource listing activity was made during the discussion held to get important data helping choice modelling. It was also done identify and prioritize relevant ecological resources and attributes. This is important to deal on conservation cost component identification and levelling since it was understood as the input to maintain these services (resources) and the ecosystem in general. Next to listing and comparing activity of constraints and problems associated to ecological resource, listing activities of ecological resources that ecosystem renders to the community and maintained ecosystem condition was held to be benefited from it for further works concerning ecological resource attribute identification for choice experiment identification. Accordingly, list of ecological resources that the livelihood of the community relayed on was listed by group dissection participant at all focus group discussion sites. In line with list of ecological resources, list of attributes of each resource stated also identified. It is from these listed ecological resource attributes that relevant attributes for choice experiment was selected.

In natural resource economic valuation using choice experiment approach, representing the good to be valued in terms of attributes and attribute levels is primal. But, a good has immense number of attributes and each attribute could have large number of levels. However, it is impossible to consider all attributes and attribute levels as it comes to be fuzzy for decision-making agents (particularly farmers in our case) and inflates the number of choice sets to be considered in data collection. Because, the increase in number of either attributes or attribute levels or both, increases the choice sets and choice alternatives generated by choice experimental design. As a result, choice experimentation will be complicated and confuses decision makers. Hence, choosing reasonable number of relevant attributes governing the dynamics of choice decision of farmers and the ecosystem, and deciding on the optimum attribute level is mandatory to economize the work and reduce the fatigue that farmers could encounter during choice experimentation. Hence, six and five relevant attributes from Anbesa forest and Tullu Dimtu, respectively were selected with the use of multi-criterion comparison technique. Level setting process of selected relevant attributes was done by contextually meaningful bases.

Relevancy of ecological resource attribute was compared with each other according communities concern depending on the benefit it contributes to the community's livelihood. For the purpose of selecting relevant attributes, multi-criterion attribute selection procedure was employed which is a reliable method help identification of high-ranking important attributes when the attributes were very large. In this study, farmers were asked to extensively list ecosystem attributes as goods and services they derive from the ecosystem. Following the listing exercise, relevant attributes (for livelihood making and ecosystem sustainable existence) was selected from the long list of attributes, following some pre-defined comparison technique. Using this method improves the subjectivity of relevant attribute selection process. It was also good stepping ground for the technique of comparison work employed. To conduct multi-criterion comparison of attributes, primarily, identification of relevance indictors for each attributes of ecological resource is needed. In this instance setting criteria (relevance indictor) for the attributes is the primary work needed. Following, measurement system for the defined indictor criterions (likert scale) was set with the agreement of stakeholders. Following this procedure, value of each relevance-measurement criteria for each attribute was determined. Finally, the values of each criterion for each attributes were summed up to indicate the total value of the attribute and thus, the rank of each attribute was determined based on the result of its score summation. As such, the relevant attributes were selected for further investigation.

3.8.1.3. Joint Resource and social mapping

Joint resource and social mapping is a visual communication technique in which participants of focused group discussion sketch a map of the position of different natural resources they use in the ecosystem and different social institutions including residence sites of community using the resources with marker on a poster. It is a process in which a group of farmers help each other and discuss on what resources they derive from natural resource found in their locality and specifies where it is found. Furthermore, besides indicating the place of the resources they use or drive benefits from, it is also used to present where degraded resources were found. Depending on its methodological guide line, in this study, one individual of group member holds the pen to draw a symbol for different resources and residences of user community; and the group members help the drawer to place each resource and residences on places where it could reflect the true place of the resources on the ground. The researcher and experts took encouraging function and helping in directing the groups' mapping activity, since they have no mapping experience after giving a basic introduction to the group and placing some well known spots (River, Road, etc) on the mapping sheet to keep simplicity in mapping activity. They also discuss what was drawn, and also how it had been placed (direction of placed resources respective to different references) on the map.

Joint resource and social mapping is an in-depth qualitative data generation technique that is capable of indicating the sources of specific natural resource degradation. Because, it can indicate the pressure of users on specific resource found at specific site. The mapping activity supported the investigator to identify direction and places of available, degraded and totally depleted ecological resources of the study areas. Furthermore, the technique can guide transact walk to look those resources on the ground and to discuss the past feature and current degradation status of the resources.

3.8.1.4. Transect walk and observation of the study area

Transect walk is a planned walk and a method among PRA tools, which is used in this study to observe and collect bio-geo-physical data of the study area in general and study subject (i.e. relevant and degraded resources of the ecosystem) in particular. It is informative method guiding data generation process. It entirely depends on the information provided by focus groups participants, particularly it enormously depends on resource and social mapping exercises. Furthermore, it uses the information offered by different parties with whom a discussion and interviews was held. The method helps the investigator to observe and understand the real concern and understanding of local community directed to natural resource degradation. Thus, it uncovers the real problem and its extent on the ground.

Following the discussions and joint resource mapping exercise of focus group participants, transect walk was planned to observe, collect datum of resources which the community reflected as degraded and relevant resources of the ecosystem. It was agreed with the community to represent their member to guide the investigator to the point where they map on the chart so that to track samples of existing and degraded natural resources. Moreover, it was also planned to be conducted in order to obtain information about location of the joint resources mapped, dried and available water points, depleted resources indicated and to validate previously acquired information by mapping. For instance, following the guidance of farmers' representatives, maps of degraded natural resource bases including Bamboo, grazing land and Grass for housing were tracked using GPS. The technique was highly valuable in order to acquire information which can't be obtained by the rest of PRA tools. During it was understood how far people walk to gather forest resources, which steep hills they climb and creeks they pass, how the degradation is meaning full for them reducing the benefit they earn from natural resource and how far it is degraded.

3.8.1.5. Pair-wise and multi criteria comparison

Focus group members were asked to upraise persistent natural resource use constraints and problems of their area. Ecological resource use constraints and problems listing helped to foster discussion participants towards prioritization of problems and constraints associated with ecological resource use. Furthermore, it was conducted with an objective of brainstorming for thinking on action to be taken and improve the sector. The method was employed as an entry point and sensitization of ecological resource listing, ecological resource attribute identification, and attributes relevance identification and relevant attributes levelling, which follows it in sequel. It was conducted to be used as an activity of rehearsing intensive work needed prior to experimental choice data collection questionnaire/card preparation.

The working philosophy used in this session is that, farmers iteratively compare two of natural resource use constraints and problems which they upraised and select persistent problem among the two. Following this method, the prioritization is completed by ranking the problems depending on the result of frequency and/or percentage of selection as a persistent problem in iterative comparison of pair of problems. In the method, problems listed in the appraisal session is referred and used. Then, the listed problems were listed in a matrix format. Following listing in the matrix format, each problem was compared with all the other listed problems. Finally, the frequency and/or percentage that the problem's out beat the problems with which it is compared is counted and ranked depending on the value of the counted frequency.

3.8.2. Structured questionnaire

Structured questionnaire was developed on the bases of gathered information by (PRA) tools. The questionnaire was pre-tested for response rate evaluation, simplicity of the questions for interviewees' understanding the meaning and intention of the questions, inclusiveness of all response options and adjusted accordingly.

Enumerators all fluent speakers of the local language were recruited and intensive training was given on data collection procedures, interviewing techniques and the detailed contents of the questionnaire. In addition to training on the procedures of interviewing, interviewing techniques and questionnaire content, the intention of each question was discussed (including choice experiment questionnaire). Data collected using structured questionnaire household survey includes socio-economic characteristics (i.e. age, education, and wealth characteristics), demographics, background data concerning the attitudes and perceptions about ecological resource uses (i.e. past experience, present ecological resource utilization and degradation).

3.8.3. Choice experiment card

Attribute based Choice data collection involves two strong theories concerning about opt-out option which unable to agree. On the one hand, including opt-out option in the choice would distort the attributes' coefficient that capable to show the actual trade off made between attributes that reflects preference decision. This is due to the fact that opt-out option is always stands outside of experimental design process. Since choice experiment support models would be fitted under probability framework, adding opt-out option means, it increases the numbers of options (candidates) that already designed to compute each other, thereby influencing their probability of being selected. Thus, when opt-out is appended to choice options that already designed and efficiency has been measured through experimental design process, it potentially distorts coefficients that directly linked to welfare analysis. Once coefficients are distorted, the investigator would be exposed to report untrue result (Kontoleon and Yabe, 2003). On the other hand, excluding opt-out criticised as enforced choice, but has potential to uncover the choice decision that respondents made. In this study, the opt-out option was excluded for two convincing reasons. Firstly, we decide to exclude opt-out option to escape from its coefficient distortion potential which was the principal aim of this study that show the best ecosystem management scenario option that respondents prefer. Secondly, as it is clearly discussed under attribute level setting we have the lowest level for each attributes considered in the choice showing current situation of the ecological resource level of the study area. Then, the analysis involves estimating the tradeoffs which respondents made between attribute level improvements and how much implicit price they will to give-up in order to have a marginal change of the attributes, expecting communities would prefer improvement that sustains the ecosystem services.

Thus, choice sets were constructed to collect attribute based choice preference data of ecological resource use. Specifically, to address data needed for the second and third objectives of this study, Choice experiment was conducted with structured choice sets. The design of choice experiments was developed to reflect the stimuli of ecological resource use choice decisions made. In the application of the choice experiment based data collection, individual respondents were presented using a questionnaire of hypothetical choice situation of ecological resource use that were categorized under two options for choice purpose, from which only one alternative that renders highest utility can be chosen. Every alternative in a choice set is described by several attributes, which can have several levels over different alternatives. Choice card was developed from relevant attributes and their respective levels using OPTEX procedure of SAS facility imposing necessary restriction to imitate the reality on the ground. With this facility, the choice set and alternatives with D-efficient optimal design was generated (see APPENDX B)

3.8.3.1. Framing and setting the scenario of choice experiment

As described in the background and statement of the problem, users entirely depend on Tullu Dimtu and Anbesa forest ecosystem without applying preference based recommended conservation practice. Therefore, one can propose preference based conservation policy for the long lasting of resources the ecosystem renders for the community and the benefit of ecosystem balance. There are two major classes of policy perspective under which any conservation policy can be stratified. Among these, one of conservation policy necessitates strict control and imposes penalties on users who did not follow the guideline prepared for assurance of sustainable existence of the resources. The other conservation policy is a technique, which proposes an incentive for those maintain sustainability of the ecosystem where sustainability depends on the harvesting and management level of users.

Choosing from these two prevailing conversion practices have different impacts on community's welfare. Situational analysis of the study area indicates that, users' complete abstinence and strict conservation policy implementation will leave them with no options to substitute goods and services they generate from the respective ecosystems. Therefore, it is rather important to deal with how people generate the benefit keeping the potential sustainable productivity of the system. This option's hypothesis is, farmers harvesting can be balanced with ecosystem's productivity if they understand the effect of degradation and the resource ownership is transferred to them, a case in which they manage its sustainability. The management cost would be constructed as payment for service they get from the ecosystem. In economic theory, consumers will reduce the quantity of consumption as consumption cost increases.

However, even if it can solve common resource free ride problem and ecosystem degradation, it is important to measure its impact on users' utility and welfare. For this purpose, resource use and its penalty level scenarios were developed using resources and its attributes, which users get from the ecosystem proposed for this study.

To investigate this, ussing identified relevant attibutes and their levels, attributes at different levels were systematically combined to represent different harvest levels of resources from the ecosystem with different model of conservation cost or penalities. In addition to having different harvest levels and associated costs of cosnervation or penalities imposed on users, the combination of the attributes at different levels should reveal the reality on the ground. Some times, free combination of different attributes levels may not represent the reality on the ground. Thus, a combination of the attributes to get the model of good on the ground needs to make some restrictions.

With this notation, in experimental design of this research project, restriction was imposed on free combination of some attributes levels. Forinstance, with high cost of ecosystem enrichment, it is expected that the availability of ecological resource attributes (i.e. goods and services) is improved (increased). On the other hand, with low ecosystem enrichment cost, it is expected that the availability of ecological resource attributes will decrease. Thus, in the choice experiment designing, this expectation (reality) should be refelected.

In this particular research project, it is expected that, as the community will to incure high ecosystem enrichment cost, the availability of wild-food and medicinal plant will improve. On the contrary, with low/no enrichment cost, the availability of medicinal plants and wild food will deteriorate as a result of degradation. Therefore, with the presence of high enrichment cost, it is meaningless/senseless to have low availability of medicinal plant and wild food. Similarly, achieving high availability of medicinal plants and wild food at low enrichment cost is not the reflectance of reality. In addition to this, it is possible to attain high availability of medicinal plant regardless of low availability of wild food. But, the reverse is not true, since with high availability of wild food, it is defacto to get hgih availability of medicinal plant. As a result, restriction was imposed on the design generation process not to combine low availability of medicinal plant and wild food with high enrichment cost; and high availability of medicinal plant and wild food at low enrichment cost. Similarly, the combination of low availability of medicinal plant with high availabilty of wild food was restricted. Thus, restriction macro was used in SAS to take care of the design generation for representation of the reality.

3.8.3.2. Ecological resource attribute level setting for experimental design

In addition and next to relevant attributes selection, choice experiment designing requires defined attributes levels to render choice sets and choice alternatives. Besides to its requirement for designing, attributes level setting should reflect the reality, should be interpretable and meaningful in the context of social and environmental condition of the study area. To make it meaningful in this study, an in depth discussion was made with farmers on the mode of their natural resource utilization, how they derive the attributes selected as relevant for livelihood making and ecosystem sustainability. In line with this, bases for level setting are dealt with referring information available from the locality.

In ecosystem resource valuation, attributes represent the characteristics of goods and services that users derive from the ecosystem where their levels are about dictating the degree to which users derive the attributes of the resources and/or services. For reliable resource value estimation, successful implementations of interventions and ecosystem management insuring sustainability, choice experiment approach of resource valuation analysis focuses on levels of attributes. Expressing ecosystem attribute in meaning full and realistic levels is useful in analysing attribute tradeoffs, enables estimation of marginal economic value of each attributes and has multiple policy implication, which is useful in conservation decision-making process.

As it is clearly explained in statement of the problem, for centuries, the community nearby Tullu Dimtu and Anbesa forest derives goods and services from the ecosystem. Further, as the relevance of this research was discussed so far, this is to estimate the value of Tullu Dimtu and Anbesa forest ecosystem resource attributes so that the result will benefit conservation planning to insure ecosystem sustainability. Given this central essence of this research and the nature of choice experiment, it is necessary to represent the ecosystem with those goods and services that it provides and their respective attributes whose intensive use is endangering ecological sustainability of the system. Moreover, it is important to represent the amount of those attributes of resources generated from the ecosystem with their respective levels for the benefit of choice scenario development used in choice experiment. Thus, the more valuable and extensively utilized resource attribute was identified and their level was assigned focusing on the degree of its exploitation. This enables to estimate economic value of Tullu Dimtu and

Anbesa forest ecosystem resource attributes. This is done by estimating the value of provision services of the system, of which over exploitation results in general ecosystem disturbance. The bases of level setting and identified levels of each attributes that enabled the estimation were discussed in detail here under.

Bases for level setting of relevant attributes of Tullu Dimtu ecosystem

I. Base for level setting of grazing service provision attribute of the ecosystem

Grazing service provision of the ecosystem was identified as one of priority and relevant attribute of natural resource. During level setting exercise, group discussion participants agreed to base grazing service level setting on the possible livestock number that farmers can own and graze on the grazing land of the ecosystem. Doing so, they classified the number of livestock holding classes of farmers depending on existing economic level class of the community. Livestock holding vary across these classes as it is the bases of economic level classification. These classes were determined based on livestock (particularly cattle) numbers that one has. With this procedure, thus, they classified the community in to three groups as poor, medium and rich in their local area context.

In the context of the study area, poor farmers were identified as those who have less than or equal to three cattle and medium farmers were identified as those who have cattle between 4 up to 20. The rich farmers were identified as those who have more than 20 cattle. But, the maximum number of cattle one can have in the area was found to be 40. Depending on this classification, thus, the grazing service provision of the ecosystem was decided to have three levels as:

A. Grazing provision for three cattle
B. Grazing provision for 20 cattle
C. Grazing provision for 40 cattle

II. The base of level setting for Bamboo use for domestic use

Farmers selected ecosystem provision of Bamboo for domestic use to be among relevant attributes of their ecosystem. In setting levels for this attribute, they decided to base on pieces of Bamboo sticks required to construct house. Using Bamboo sticks required for house construction as a base for different level setting needs the variability of the requirement of Bamboo sticks for different classes of houses. In line with this, they identified three classes of houses to be large, medium and small sized houses. Following this classification of house sizes, they identified three level of Bamboo sticks required as:

A. 500 sticks for large house construction;
B. 350 sticks for large house construction and
C. 250 sticks for large house construction

Therefore, they decided to use these classes of Bamboo stick requirement as levels of the attribute, Bamboo for construction.

III. Base of level setting for domestic use of Grass

Grass for house construction was identified as priority and relevant attribute among the services the ecosystem provided and identified as it is different from the grazing service. Because the quality, type and use type of the Grass used for house construction is completely different from Grass used for grazing. Therefore, it was needed and agreed up on to identify and consider it as another attributes of the ecosystem.

During its level setting, similar to the base for level setting of Bamboo for house construction, Grass for domestic use was also based on house size classes and their Grass requirement. As discussed so far, three different classes of house sizes were identified as large, medium and small sized houses. Thus, the requirement if construction Grass for these class houses were used as levels of this attribute and identified as:

A. 30 loads of Grass for large sized house construction;
B. 15 loads of Grass for large sized house construction and
C. 6 loads of Grass for large sized house construction

IV. Base of level setting of access to water service provision of the ecosystem

Water availability came to be a challenge for the community living in the Tullu Dimtu ecosystem. Most water sources particularly spring and rivers were completely dried and disappeared. Thus, water provision service of the ecosystem was identified as the main relevant attribute of the natural ecosystem of the area.

The level setting base for this attribute was identified to be the scenarios they experienced so far. For instance, they have an experience where all water bodies of the area provide water throughout the year. But now, they also experienced as they get water only at very far distance from their residence. In addition to this, they also understood that the water bodies currently they get at far distance from their residence is not reliable. Because, their volume is declining from year to year showing similar feature to those lost water bodies. Thus, they developed three levels of this attributes as:

A. A management condition under which they could get reliable water sources in every water points throughout the year (throughout the year/at near distance)
B. A management scheme under which they could get reliable water sources only at far distance from their residence in dry season but no wary in rainy season as they can get water in every water points and (at far distance)
C. A management condition under which they could not get water around their residence in dry season but no wary in rainy season as they can get water in every water points (only rainy season)

V. Base for cost component attribute level setting

The essence of natural resource conservation and management is mainly attributed to ensure the sustainable co-existence of service providing ecosystem and the optimized utility of community entirely depending on the ecosystem. In line with this connotation, farmers of the area identified degradation prone area and interested for conservation of Tullu Dimtu. The site they identified coincided with the area where they reported to be the place where almost all ecosystem services were found and the sources or tops of all water sources in particular.

However, an interest for conservation of an area itself is not enough. It needs planning, agreement on the participation of different stallholders and responsibility of each part takers. For instance, under planning for conservation work, it is essential to know the cost required as conservation work needs an outlay.

For the calculation of conservation cost required for conservation structure development of Tullu Dimtu, a cost incurred in conservation structures in the *Kebele* was used as a benchmark. There is conservation structure development effort in the *Kebele* mainly targeting farmlands. From the existing conservation effort initiatives, it was found as farmers contribute labour. One person constructs a 2 meter long structure per day. A 100 meter long structure requires 50 man days. In addition to this, 19 meters were required in between two conservation structures. From this information, it is possible to calculate labour required to cover a hectare of land to be about 250 man days.

To calculate the cost of conservation of required for area identified as susceptible and prone for degradation and determining the deterioration of other natural resource provided services, goods and attributes in the Tullu Dimtu, the area of identified site was calculated. The conservation interest site was identified with the community and shown on the map of geo-physical feature of the study area. For area calculation purpose of the identified conservation interest sit, area of conservation sit was extracted from Digital Elevation Model (DEM) image of the site using contour generation facility of GIS soft ware. The result identifies and conservation interest site of the community of the study area (Fig. 6).

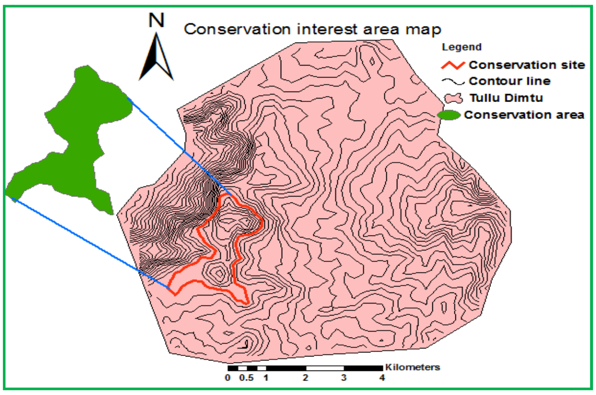


Fig. 6. Conservation interest site of Tullu Dimtu.
Source: own data, 2014

Besides extraction of the shape file of conservation interest site from DEM image, it was also approved as it coincides with the area where numerous water points determining downstream water availability were lost (Fig. 7).

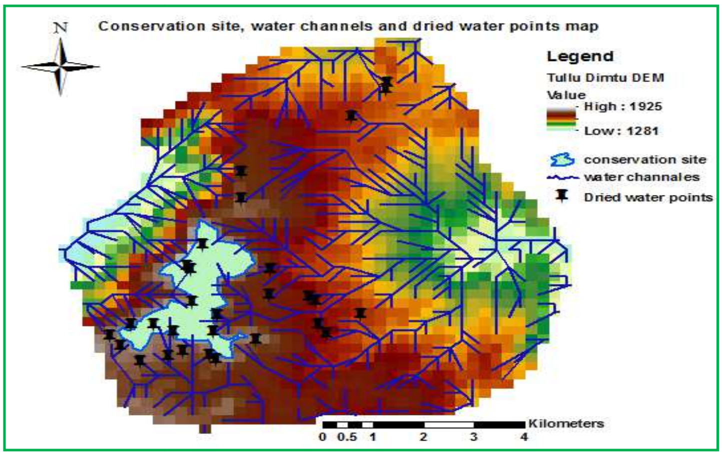


Fig. 7. Coincidence of selected conservation site and lost water sources.
Source: own data, 2014

In addition to ensuring the image to coincide with the area where water sources were lost, it also overplayed with the area of other resource degradation sites tracked with GPS tool (i.e area of deforested Bamboo, totally loss of Grass area and forests) during field observation and transect walk (Fig.8).

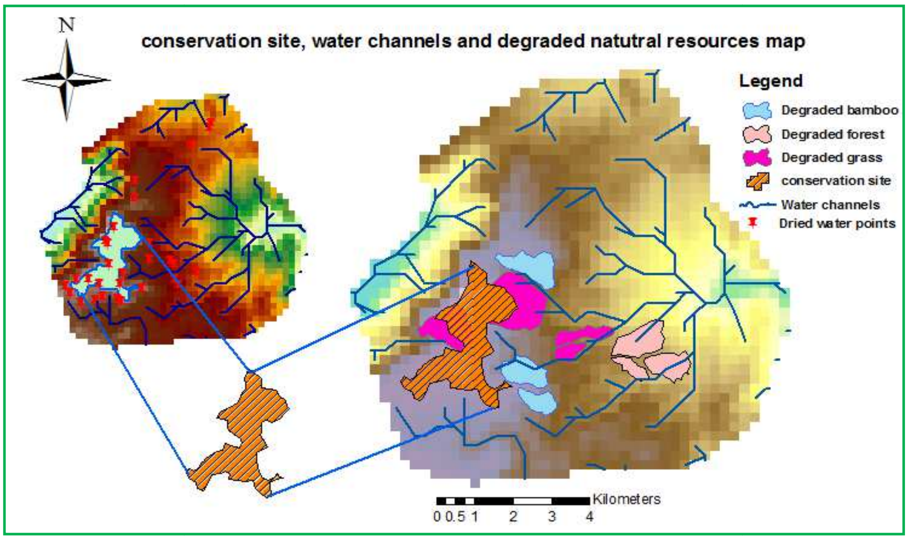


Fig. 8. Co-incidence of selected conservation site and degraded resources.
Source: own data, 2014

From the polygon area of the extracted site, the magnitude of its area was calculated to be about 344 hectare. Using the information found in the *Kebele* water shade development initiative and so far established benchmark for conservation cost calculation, labour requirement of the area was calculated to be about 86,000 man-days. In addition to the discussed benchmarks, the report also indicated as each household contributes about 24 man-days per year. The current wage of a labourer in the study area is 50 Birr/day. Using this current wage rate, the total conservation cost of the site is estimated to be about 4,300,000 Birr.

The secondary data collected from *kebele* administration indicated the number of household heads residing surrounding the ecosystem to be 975. Planning with the current scenario, i.e. with the current number of household heads of 975 and each household contributing 24 man-days labour per year, the conservation structure establishment work of the site could be finalized in about 4 years. From this scenario, it is strait forward to develop each household's contribution of conservation cost using the current wage rate resulting in 1200 Birr/yea. This implies hypostatization of completion of conservation structures development needs four years and its maintenance is required every four years.

Using this benchmark, cost component level setting was done by hypothesizing different scenarios on the time required for the completion of conservation structure works and its maintenance. The first scenario is hypothesized changing the years needed for completion of conservation structure works in two years and maintenance of the structures is required every two years, i.e. half of the year hypothesized in the benchmark scenario, it requires doubling annual conservation cost outlay of each households resulting in 2400 Birr/year. The other scenario is to double the years required to complete conservation structure development and the time lapses to maintain the structures. This implies to complete the development of conservation structures in eight years and maintaining the structures every eight year, thus reducing the conservation outlay of household by half of the benchmark cost, which results in 600 Birr/year. Further assuming an establishment of a payment scheme as fee for using ecosystem rendered services, three levels of cost component is specified as:

A. 2400 Birr/year;
B. 1200 Birr/year and
C. 600 Birr/year

Table 3. Tullu Dimtu ecosystem's relevant attributes and their respective levels

Attributes	Levels		
	1	2	3
Grazing service	3 cattle	20 cattle	40 cattle
Bamboo for dometic use	250sticks	350 sticks	500 sticks
Grass for dometic use	6 loads	15 loads	30 loads
Access to Water service	Only rainy season	At distance in dry season	Throught the year
Conservation cost	ETB 600/year	ETB 1200/year	ETB 2400/year

Source: own survey, 2014

With this all information, benchmarks and discussions made with different stakeholders (mainly focussing on the local community benefiting from the ecosystem and main responsible for its conservation), the levels of the five attributes identified to be relevant in the ecosystem was developed. The result of attribute levelling is summarized and presented in Table 3 above. The developed attributes and their respective levels were used in the choice experiment designing where the design generated choice alternatives as different use and conservation scenarios.

Base for Level setting of relevant attributes of Anbesa forest ecosystem

With the similar method done for Tullu Dimtu, after relevant attributes selection exercise identified the major prior attributes and their respective measuring proxy variable, the next pertinent assignment was identification of levels for the selected attributes. Thus, the group discussion session identified levels for six attributes. The bases used for level setting of each attributes were identified. During reasoning and argument made for identification of each level, possible care was taken to make each attribute levels meaningful and reflectance of the reality on the ground. The bases of level setting and identified levels of each attributes were discussed here under.

I. Base for level setting of access to wild food

Wild food service provision of the ecosystem was identified as one of priority and relevant attribute of natural resource. During level setting exercise, group discussion participants agreed to base wild food level on its availability. Binary setting was used to represent wild food availability. That means, level 1 is used to represent richly available and 2 is used to represent very low/not available. Level one is used to indicate the enriched ecosystem whereas level two is used to represent degraded ecosystem condition. Thus;

A. Richly available wild food in the ecosystem
B. Very low/not available wild food in the ecosystem

II. Base for level setting of medicinal plant for domestic use

Medicinal plant service provision of the ecosystem was identified as one of priority and relevant attribute of natural resource. Similar to availability of wild food, during level setting exercise, group discussion participants agreed to base medicinal plant level on its availability. Binary setting was used to represent medicinal plant availability. That means, level 1 is used to represent richly available and 2 is used to represent very low/not available. Level one is used to indicate the enriched ecosystem whereas level two is used to represent degraded ecosystem condition.

A. Richly available wild food in the ecosystem
B. Very low/not available wild food in the ecosystem

III. Medicinal plant for market

Medicinal plant marketability variable is selected to represent the power that could lead natural resource management activity. It is used as an indicator variable. Binary setting was used to represent medicinal plant marketability. That means, level 1 is used to represent marketable and 2 is used to represent not marketable condition of medicinal plants.

A. Medicinal plant is marketable
B. Medicinal plant is not marketable

IV. The base of level setting of Bamboo for domestic use

Farmers selected ecosystem provision of Bamboo for domestic use like for construction to be among relevant attributes of their ecosystem. In setting levels for this attribute, they decided to base on pieces of Bamboo sticks required to construct house. Using Bamboo sticks required for house construction as a base for different level setting needs the variability of the requirement of Bamboo sticks for different classes of houses. In line with this, they identified three classes of houses to be large, medium and small sized houses. Following this classification of house sizes, they identified three level of Bamboo sticks required as:

A. 500 sticks for large house construction;
B. 350 sticks for large house construction and
C. 250 sticks for large house construction

Therefore, they decided to use these classes of Bamboo stick requirement as levels of the attribute, Bamboo for construction.

V. Base of level setting of Bamboo for market

Similar to medicinal plant marketability variable, marketability of Bamboo is selected to represent the power that could lead natural resource management activity. It is used as an indicator variable. Binary setting was used to represent Bamboo marketability. That means, level 1 is used to represent marketable and 2 is used to represent not marketable condition of Bamboo.

A. Bamboo is marketable
B. Bamboo is not marketable

VI. Base for cost component attribute level setting

The essence of natural resource conservation and management is mainly attributed to ensure the sustainable co-existence of service providing ecosystem and the optimized utility of community entirely depending on the ecosystem. In line with this connotation, different institutions and farmers of the area identified Anbesa forest for conservation.

However, an interest for conservation of an area itself is not enough. It needs planning, agreement on the participation of different stakeholders and their responsibility. For instance, during planning for conservation work, it is essential to know the cost required.

For the calculation of conservation cost required per household per year, conservation practices undertaken before in the *Kebele*s was used as a benchmark. There is conservation effort in the *Kebele*s mainly targeting the forest land and soil and water conservation. From the existing conservation effort initiatives, it was found as farmers contribute labour. One person contributes in average 40 labours per year. This gives monetary value of Ethiopian Birr 1600 when derived from wage rate prevailing at the area (40 X 40). Forty again represents wage rate at the area.

Using this benchmark, cost component level setting was done by hypothesizing doubling and half of the cost that they used to contribute currently. The first scenario is hypothesized to half the cost component of the bench mark labour contribution converted to Birr (wage) to enrich the biodiversity of conservation interest area (Ethiopian Birr 800 per year). The other scenario is to double the cost required to implement conservation work of the area so that diversity enrichment is more addressed assuming the enrichment of biodiversity to be linearly related to cost component. Thus, it increases the conservation outlay of household per year. The monetary value of labour contribution is derived using wage rate of the locality (Ethiopian Birr 3200 per year). Further assuming an establishment of a payment scheme as fee for using ecosystem rendered services, three levels of cost component is specified as:

A. Ethiopian Birr 800year;
B. Ethiopian Birr 1600 year and
C. Ethiopian Birr 3200 year

With this all information, benchmarks and discussions made with different stakeholders (mainly focussing on the local community benefiting from the ecosystem and main responsible for its conservation), the levels of the five attributes identified to be relevant in the ecosystem was developed.

Table 4. Anbesa forest ecosystem's relevant attributes and their respective levels

Attributes	Levels		
	1	2	3
Access to wild food	Low/not available	Reachly availabel	-
Medicinal plant for domestic	Low/not available	Reachly availabel	-
Medicinal plant for market	Not markatabel	Markatbel	-
Bamboo for domestic use	250	350	500
Bamboo for market	Not markatabel	Markatbel	-
Conservation cost	ETB 800/year	ETB 1600/year	ETB 3200/year

Source: own survey, 2014

This developed attributes levels also used in the choice experiment designing where the design generated choice alternatives as different use and conservation scenarios. The result of attribute levelling is summarized in Table 4 above. However, given that this conservation fee/cost will be covered by a means labour force, the choice cared consisting cost component in termes of montly possible contribution of labour will be presented to respondent to atrract respondent's attaintion and simplify the senario for later coversion and calculation in terms of money during analysis (data entery) sesion.

3.8.3.3. Choice experiment design

All of the five attributes that were selected to describe Tullu Dimtu ecological resource use scenario (i.e. ecological resource use scenario which expected to maintain sustainability of the ecosystem and benefits derived from it) took three levels. Among these one attribute (i.e availability of water) is dummy variable and the remaining four attributes are continuous variables. The full factorial of these attributes and attribute levels calculated to be 243 (3^5) unique factor combinations which represent different options of ecological resource use profiles. Similarly among six relevant attributes identified from Anbesa forest that represent ecological resource use scenario four attributes took two levels and they are binary variables, while the remaining two attributes were took three level and they are continuous variables.

From these attributes and attribute levels, it is possible to construct up to 144 (2^4*3^2) distinct ecological resource use profiles by full factorial.

However, since application of complete (full) factorial design burdensome to both respondent and investigator, in this study, fractional factorial design was employed to focus only on the main effects. Because possible factor combinations by full factorial design generate larger number of profiles which is not manageable to work with the experiment. Thus, it motivated to reduce these combinations into manageable number so that a practical work can be undertaken in the field without compromising on the capacity of the reduced combination to capture the most important sources of variation in decision makers' preferences. As a result, efficient fractional factorial choice design yielding 36 profiles allocated to 18 different choice sets for Tullu Dimtu ecological resource use scenario, and 24 profiles allocated to 12 different choice sets for Anbesa forest ecological resource use scenario, each choice sets having two alternatives were generated using OPTEX procedure of SAS 9.2.

Table 5. Sample of choice experiment data collection card for Tullu Dimtu

Ecological resource attributes	Choice set1	
	Alternative 1	Alternative 2
Grazing service	20 Heads	3 Heads
Bamboo for domestic use	350 Sticks	500 Sticks
Grass for domestic use	30 Loads	6 Loads
Cost	600 Birr	2400 Birr
Access to water service	Only Rainy season	Throughout the year
Please make tick (√) in your preferred alternative		

Source: own data, 2014

Table 6. Sample of choice experiment data collection card for Anbesa forest

Attributes	Choice Set 1	
	Option 1	Option 2
Access to wild food	Not-available	highly available
Medicinal pant for domestic use	Not-available	Available
Medicinal pant for market	Not-marketable	Marketable
Bamboo for market	Highly marketable	Not-marketable
Bamboo domestic use	250 sticks	350 sticks
Cost	4 Labour per month	4 Labour per month
Please make tick (√) in your preferred alternative		

Source: own data, 2014

For all choice designs, generic designing method was employed since the process of dynamics of ecological resource use type is hypothesized to be determined by attribute levels dynamics and branded designing which gives due attention for alternative specific attributes is not employed. In addition to this restriction macro was used in order to control for combination of attribute levels, which logically co-occurrence is impossible which is stated under the ecological resource use scenario (i.e low enrichment cost or use fee and high availability of wild food or medicinal plant could not occur together or accepting this combination could not represent the reality on the ground). Like these combinations were restricted not to appear together on the choice card. This is made since it has no meaning in relation to the ground truth and it is difficult to apply on the resource use system preference going to be evaluated under the second objective of this study. The first choice card used for ecological resource use decision making of both study area are presented above (Table 5 and 6).

3.9. Variables Definitions and Expected Signs in the Choice Experiment Method

Dependent variable (Ecological resource use choice): is a discrete variable among which the sampled household chooses its preference. This is the dependent variable and it is assumed as farm households ecological resource use choice depends on attribute level combination of the ecological resource and socio-economic characteristics of a farmer leading preference of farmers to choose the ecosystem management and use scenario type. Farmers make decisions about ecological resource use choice variables based on their own characteristics (socio economic background) and attribute characteristics (attribute type and level) included in the choice card and presented to them (Birol *et al*., 2006).

Independent variables: these variables are ecological resource attributes which were selected with multi criteria prioritization procedure for choice experiment modelling of valuation analysis and the livelihood of the community at the study area assumed to be more depending on it. Since the selection of all ecological resource attributes based on the benefits gained from it, all are expected to correlate positively with respondent's preference or the resource use choice scenario except cost component (as price increase the demand decrease). The attributes definition and their hypothesized signs are presented in Table 7 below.

Table 7. Ecological resource attributes, regression coding, levels, and expected sings

	Ecological resource attributes of Tullu Dimtu ecosystem			
Attribute	Regression label	Level	Variable type	Expected sings
Enrichment cost contribution	Cost	1. 2400 Birr 2. 1200 Birr 3. 600 Birr	Continuous	-
Bamboo for domestic use	BamDome	1. 500 sticks 2. 350 sticks 3. 250 sticks	Continuous	+
Grazing service	CatGraz	1. 40 cattle 2. 20 cattle 3. 3 cattle	Continuous	+
Grass for domestic use	GraDome	1. 30 load 2. 15 load 3. 6 load	Continuous	+
Access to water service	WatServ	1. Access throughout the year near (WatServ##) 2. Access at far distance (WatServ#) 3. Access only in rainy season (WatServ0) this was used as base out come	Dummy	+
Ecological resource attributes of Anbesa forest ecosystem				
Enrichment cost contribution	Cost	1. 800 Birr 2. 1600 Birr 3. 3200 Birr	Continuous	-
Bamboo for domestic use	BamDome	1. 250 stick 2. 350 stick 3. 500 stick	Continuous	+
Bamboo for Market	BamMkt	1 marketable 0 not marketable	Dummy	+
Medicinal plant for domestic use	MedpDome	1 highly available 0 not available	Dummy	+
Medicinal plant for Market	MedpMkt	1 marketable 0 not marketable	Dummy	+
Access to wild food	AcctWfd	1 highly available 0 not available	Dummy	+

Socio-economic variable included in the model to address source of heterogeneity

In choice experiment method of ecological resource valuation study, a given ecosystem represented with ecological resource attributes and attribute level. Accordingly, in this study, Tullu Dimtu and Anbesa forest ecosystems represented with their respective ecological resource attributes and attribute levels and presented to responded to evaluate to which attributes the inclination of the respondents move with. Even though similar options presented to the respondent, it is natural the respondent's preference would not identical depending on their socioeconomic background (personal characteristics).

Table 8. Definition and measurement of socio-economic variables in the model

Variable	**Definition**	**Measurement**
HHeduL	Education level in year	Number
HHFLanTR	Household Head farm land transaction	1 if Male, 0 otherwise
HHR&wr	Literacy status or read and write	1 if literate, 0 otherwise
FamilyS	Family Size	Number
MMLabor	Meal Labor in the working age (14-64)	Number
HHLanho	Agricultural land holding	Number (Hectares)
DpenRet	Dependency ratio	Number
HHCashCro	Participation in Cash crops production	1 if Yes, 0 if No
Lanshort	Farm land shortage	1 if Yes, 0 if No
HHNRuExp	HH heads NR use experience	1 if leader, 0 otherwise
SoilFertPM	Soil fertility problem of the HH	1 if Yes, 0 if No
HHRhist	Residence history of the HH	1 if before 1977, 0 otherwise
NRLackM	HH said there is Lack of NR management	1 if Yes, 0 if No
HHLabMkt	HH Labor market participation	1 if Yes, 0 if No
HHWildMt	Wild Life meat using experience of the HH	1 if Yes, 0 if No

Thus, identifying such socio economic background making individuals preference to be vary is rewarding to get insight of farther information regarding use and conserve approach preference of the sampled household. Therefore, the socio economic data which assumed to be related to the ecological resource attribute utilization system of the study area was collected and interacted with ecological resource attributes. Socio economic data used for interaction is presented in Table 8 above.

The expected singe of interacted variables

Socio economic data interaction analysis supported the investigator to understand and report which personal character effects makes respondent to demand (prefer) ecological resource

Table 9. Expected singe of socioeconomic interacted variables

Variable category in terms of location	Socioeconomic variables	Ecological resource attribute variables of Tullu Dimtu and Anbesa forest							
		Common variable for both area	Unique variables for Tullu Dimtu Ecosystem			Unique variables for Anbesa forest Ecosystem			
	Interaction of row and column **(X)**	BamDome	CatGraz	GraDome	Watserv	BamMkt	MedpDome	MedpMkt	AcctWfd
Common variables for both area	HHeduL	+	-	+	+	+	+	+	+
	HHLanho	-	-	-	-	-	-	-	-
	HHR&wr	+	+	+	+	+	+	+	+
Unique variables for Tullu Dimtu	DpenRet	+/-	+	+	+				
	HHRhist	+	+	+	+				
	HHFLanTR	+/-	+	+	+				
Unique socio economic variables for Anbesa forest	FamilyS	+				+	+	+	+
	HHCashCro	+/-				+/-	+/-	+/-	+/-
	Lanshort	+				+	+	+	+
	HHNRuExp	+				+	+	+	+
	SoilFertPM	+				+	+	+	+
	MMLabor	+				-	-	-	-
	NRLackM	+				+	+	+	+
	HHLabMkt	+				-	-	-	-
	HHWildMt	+				-	+	-	+

attributes heterogeneously. So, the complementary interaction variables and their expected signs are presented in the Table 9 above. The expected singe of these all interacted variables is hypothesized based on hot debate made during focus group discussion session.

3.10. Methods of Data Analysis

This study used qualitative, descriptive and econometric data analysis methods. Primarily, qualitative data generated through different qualitative data generation techniques were analyzed using qualitative data analysis techniques including transcribed and augmenting; and further relating or linking with other data sets like GIS maps of different characteristics of the area. Next, descriptive statistics tools including percentage and mean was used and presented the result in tables to describe farm household characteristics and geo-physical data. Other suitable comparison methods (pair wise) was also used to describe and rank ecological resources according to their importance to the local community's livelihood making; which is sought to address first objective of this study.

To investigate whether there have been visible changes in the status of ecological resource use choice in selected peasant associations a combined descriptive and econometric analysis were employed. First, the characteristics of ecological resource uses, their geographic and socio-demographics were demonstrated using simple descriptive statistics. The descriptive statistics findings and hypotheses concerning households' resource use choice were tested using a discrete choice-modelling framework. Discrete choice modelling provides an analytical framework to analyse and predict how people's choice is influenced by different attributes of the choice alternatives available to them and their personal characteristics (Hanley *et al.*, 1998). Since resource use choice decision is taken at household level, it is properly addressed using disaggregated household data using choice modelling. Further, from econometric models carried out in an attempt to identify credible determinants of farmers' resource use choices decision, the value farmers attached to different resource attributes were estimated. For all statistical analysis, STATA version 13 and SPSS version 20 statistical software were employed. In addition, to statistical software, ArcGIS 10.2 and Surfer 13 (Golden software) facilities were intensively employed to process and map different geographical data sets produced during data collection.

3.10.1. Empirical Model specification of choice modelling

Benefits derived from the existence of well-managed ecosystem are numerous. However, all the benefits derived as ecosystem goods and services are not traded in existing the market, so that, non-market valuation tools are required to identify the magnitude of these benefits. Human preferences regarding attributes of resource uses differ across regions, countries, communities and production systems. In least developing country's (LDC) the most valuable Ecological resource is often those that successfully guarantee multi-functionality, flexibility and resilience in order to deal with variable environmental conditions (Scarpa, 2001; Kontogianni *et al.*, 2010). Research in the development of methods to value Ecological resource goods and services can therefore benefit greatly from knowledge that a choice experiment (CE) is indeed a reliable method to estimate preferences over valuable non-market attributes.

3.10.1.1. Econometric model specification (The basic multinomial logit model)

Unlike other stated preference methods such as contingent valuation method (CVM), choice experiment (CE) enables estimation of not only the value of ecological goods and services as a whole, but also the implicit marginal values of its attributes (Boxall, 1996). Both methods are grounded on Lancaster's theory of consumption technology (Lancaster, 1966) and random utility theory (RUT) developed dating back to Thurstone (1927). Lancaster's theory of consumption technology asserted that the subject derives utility not from the good itself but from the bundle of attributes and magnitude of the attributes, which characterizes specific good. RUT states that a utility consumer derived from a good consists of two decomposable parts: deterministic and an unobservable. Further, (McFadden, 1974) established the econometric model of random utility theory (RUT) relating these two theories, i.e. Lancastrians consumer consumption technology and RUM.

Therefore, adopting the model to this study, a composite empirical utility model of Ecological resource use is functionally specified as:

$$U_{nj} = V_{nj}(X_{nj}) + \varepsilon_{nj} \qquad (1)$$

Where U_{nj} is the total utility

V_{nj} is the deterministic component (i.e. observable for analyst) and is a function of a vector

X_{nj}(i.e. resource specific attributes) as well as individual specific characteristics and

ε_{nj} is the error component of utility derived from the choice of resource use scenario.

$V_{nj}(X_{nj})$ is an indirect utility function used as a proxy to estimate utility based choice decision of the subject. This implies, a decision maker will choose an alternative with the highest utility provided the set of alternatives. From this statement, it is forwarded to conclude that, estimation of coefficients of a specified function is possible by finding the probability of a choice decision one make given choice attributes. That means, the indirect utility coefficients show the relationship between the probabilities of selecting one resource use scenario option that is most likely to occur given the choices the respondents are facing and eventually making (Sandefur *et al.*, 1996). This statement leads to the conditional analytical argument specified as:

$$V_{ni}(X_{ni}) + \varepsilon_{ni} > V_{nj}(X_{nj}) + \varepsilon_{nj}; \forall i \neq j, \forall j \in C \qquad (2)$$

Following this argument, the probability that individual *n* will choose option *i* over option *j* resource use is specified as:

$$Prob(i = 1/_{C}) = Prob\{V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj}\}, \forall i \neq j, \forall j \in C \qquad (3)$$

Where C is complete set of resource use options. The estimation of Equation (3) can conveniently be done when assuming extreme value type I distribution. By further assuming a linear functional form for $V_{ni}(X_{ni})$ (the indirect utility function) and independent and identical distributes (iid) for the error component in Equation (3), a discrete choice model, known as multinomial logit (MNL) model can be specified following (McFadden, 1974) as:

$$\mathbf{Pr}\boldsymbol{ob}_{ni}(i/_{c}) = \frac{\exp(\mu ß' x_{ni})}{\sum_{j}\exp(\mu ß' x_{nj})} \quad (4)$$

Where x is a vector of independent variables (resource use scenario attributes) and $\boldsymbol{\beta}$ is a vector of parameters to be estimated.

$\mathbf{Pr}\boldsymbol{ob}_{ni}$, then gives the probability of choosing alternative i resource use scenario out of j alternatives (found in the finite set C) for decision maker n. The scale vector $\boldsymbol{\mu}$ is usually assumed to equal 1 (implying constant error variance) so that the model becomes deterministic and the $\boldsymbol{\beta}$'s can be identified (Hanley *et al.*, 1998). The basic multinomial logit (MNL) model is therefore reduced to give:

$$\mathbf{L}_{ni}(i = 1/_{c}) = \frac{\exp(ß' x_{ni})}{\sum_{j=1}^{J}\exp(\beta' x_{nj})} \quad (5)$$

Even though Multinomial logit serve us being a base model, it has no variable specification room for the repeated observation nature of choice experiment data generated. Instead conditional logit model; an extension of multinomial logit which works under the same assumption with its base model (MNL) but differ in fitting system and possess specification environment for repeated observation that MNL couldn't to accommodate was used to solve this short coming of MNL model.

3.10.1.2. Conditional logit model

Conditional logit model is importantly differing from basic MNL model in which it capable to fit repeated observation data (Adamowicz *et al.*, 1997; Long, 2004), which is difficult in multinomial logit model. Further, it also differ in its important potential to calculate implicit price of choice attributes known as marginal willingness to pay, from its estimates given one attribute is monetary, the function that MNL model cannot perform. But, the CL fails to use choice invariant (subject specific) factors in its primary function. In addition to this both multinomial logit and conditional logits work under independently and identically distributed (IID) and independence from irrelevant alternatives (IIA) assumptions for which the models are most often criticized. Moreover, even though conditional logit solves the repeated observation problem inherited in choice experiment data, because of its homogeneity assumption, CL model fitting was omitted for attribute preference probability estimation. Instead, In this study, since respondent preference heterogeneity is assumed as a factor of personal characteristics (socio economic factor) and CL fails to control it, its extension, mixed logit model was used to estimate farmers demand for ecological resource attributes and to identify the presence of preference heterogeneity to attributes considered in the model simultaneously. However, conditional logit model was fitted on a data set produced by interacting ecological resource attributes with demographic and socio-economic factors in order to investigate the source of heterogeneity in farmers' demand. This makes the models important to serve different purpose from both models in this thesis. Therefore, it was used to model repeated observation of the choice experiment data preserving the MNL assumptions (similar socioeconomic characteristics were assumed to be homogeneous in the interaction analysis) when conditional model was employed to investigate source of heterogeneity, and relaxing when mixed logit was used to calculate implicit prices (IPs) of choice attributes.

3.10.1.3. The mixed (random parameter) logit model

The mixed logit (MXL) model is an extension of basic MNL model qualifying important aspects and solving problems that the MNL and CL cannot cope with. One advantage of MXL over basic MNL is relaxing independently and identically distributed (IID) and independence from irrelevant alternatives (IIA) assumptions inherited in MNL and CL models (Hensher and Greene, 2003). The first assumption describes the unconditional homogeneity of farmers' preference while the second assumption refers to a consistent probability of choice irrespective of incorporation of irrelevant alternatives. The violation of these assumptions renders CL and Multinomial Logit (ML) models inappropriate.

The second and biggest benefit of applying MXL model is its potential to detect the presence of choice (ecological resource use scenario preference) heterogeneity among decision makers (Howard and Salkeld, 2009; Hoyos, 2010). Thus, this model was employed in order to analyse the ecological resource use scenario choice and the presence of preference heterogeneity among sampled households. Understanding the presence of preference heterogeneity among decision makers supports to develop contextual conservation intervention. Hence, following the specification of Equation (1), for the decision maker $\boldsymbol{n}$ facing $\boldsymbol{J}$ alternatives, the utility person $\boldsymbol{n}$ derives from alternative $\boldsymbol{i}$ is specified as:

$$\mathbf{U}_{\mathbf{ni}} = \boldsymbol{\beta}_{\mathbf{n}} \mathbf{X}_{\mathbf{ni}}'\mathbf{s} + \boldsymbol{\varepsilon}_{\mathbf{ni}} \qquad (\mathbf{6})$$

and

$$\mathbf{L}_{\mathbf{ni}}\left(\boldsymbol{i} = \mathbf{1}/_{\boldsymbol{c}}\right) = \frac{\mathbf{exp}(\boldsymbol{\beta}_{\mathbf{n}}\boldsymbol{x}_{\boldsymbol{ni}}'\boldsymbol{s})}{\sum_{\mathbf{j=1}}^{\mathbf{J}} \mathbf{exp}\left(\boldsymbol{\beta}_{\mathbf{n}}\mathbf{x}_{\mathbf{nj}}'\mathbf{s}\right)} \qquad (\mathbf{7})$$

Where $\boldsymbol{X}_{\boldsymbol{ni}}'\boldsymbol{s}$ are choice attributes and decision maker characteristics,

$\boldsymbol{\beta}_{\boldsymbol{n}}$ is a vector of coefficients of these variables for person *n* representing that person's tastes,

$\boldsymbol{\varepsilon}_{\boldsymbol{ni}}$ is a random term that is *iid* extreme value and

$\mathbf{L}_{\mathbf{ni}}$ is logit.

3.10.1.4. Estimates of Implicit Prices of Ecological Resource Attributes

The choice experiment method is consistent with utility maximization and demand theory (Hanley *et al.*, 2006). Given one attribute is monetary, for any utility change induced by a change in choice attributes, one can calculate the monetary payment that would result in the same level of overall utility as existed before the change. This implies, after parameter estimates found, welfare measures can be estimated from the mixed logit models using the formula:

$$\boldsymbol{CS} = \frac{\boldsymbol{ln}\sum \boldsymbol{exp}(\boldsymbol{v}_{\boldsymbol{i1}}) - \boldsymbol{ln}\sum \boldsymbol{exp}(\boldsymbol{v}_{\boldsymbol{i0}})}{\boldsymbol{a}} \qquad (\mathbf{8})$$

Where **CS** is the compensating surplus welfare measure, α is the marginal utility of money (generally represented by the coefficient of the monetary attribute in the choice experiment) and $\boldsymbol{v}_{\boldsymbol{i0}}$ and $\boldsymbol{v}_{\boldsymbol{i1}}$ represent indirect utility functions before and after the change under consideration. This monetary payment is equivalent to the individual farmers Willingness to pay (WTP)/ Willingness to accept (WTA). Implicit price (IP) marginal willingness to pay (MWTP) for obtaining a specific change in a single desirable choice attribute or a compensation to give up a specific change in a single desirable choice attribute, while the other attribute levels remain unchanged (ceteris paribus).

For the linear utility index, the marginal value of change in a single attribute can be represented as a ratio of coefficients attributes in question and monetary attribute. Thus, given that the MXL model assumes a linear form of the utility function, it permits the calculation of IP to be simplified to the ratio of the coefficients of the attributes in question $\beta_{atribute}$ and the coefficient of the monetary variable β_{money} (Kerstin & Drucker, 2008) reducing the equation to:

$$\mathbf{MWTP} = -\frac{\mathbf{B_{atribute}}}{\mathbf{B_{money}}} \qquad (\mathbf{9})$$

The implicit price reflects the importance respondent put on each of the non-monetary attributes indicated in terms of monetary value or respondents' willingness for possible tradeoffs between attributes of the choice. This enables calculation of farmers' attached values to different choice alternatives attributes including resource use attributes.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statics

4.1.1. Household's demographic characteristics

The mean family size or number of individuals per sampled farm household of Anbesa forest is 6.3 and that of Tullu Dimtu is 7.03. Likewise, the mean age of the interviewed sample household heads are 40 and 43 years with the standard error of 1 year for Anbesa forest and Tullu Dimtu ecosystems respectively. Similarly, the average number of an age of between 14 and 64 is 3.8 persons per household in case of Anbesa forest while it is 3.5 for Tullu Dimtu ecosystem. From this result, it is clear that the household of the study area has higher number of age between 14 and 64 family members than the other age groups. On average, each sampled household from Anbesa forest ecosystem has 1.9 male and 1.9 female within age range of 14 and 64. Similarly, the average number of age range between 14 and 64 males and females are 1.8 and 1.7 in the case of Tullu Dimtu ecosystem. On the other hand mean dependency ratio of the interviewed households estimated to be 0.8 for Anbesa forest while it is 1.2 in case of Tullu Dimtu ecosystem (Table 10).

4.1.2. Literacy and Education level composition

Of sampled household heads, 51.20% in Anbesa forest ecosystem and 47.50in Tullu Dimtu ecosystem are illiterate. Furthermore, of the sample of this study, 23.20% of the household heads from Anbesa forest ecosystem and 35.20 of the household heads from Tullu Dimtu ecosystem have only reading and writing skills which they developed without joining formal education. Of the sample household heads, only 25.60% had attended formal education in case of Anbesa Forest and it is 17.3 for Tullu Dimtu ecosystem sampled farm households. The result further indicated that the mean number of illiterate family member of the sample household is 1.6 for Anbesa Forest sampled farmers while it is 2.58 for Tullu Dimtu ecosystem farmers (Table 10).

4.1.3. Residence History

Of the interviewed households, 77% are native peoples whereas 22.4% are resettles (stranger) from other area in the Anbesa forest ecosystem. On the other hand, 70.50% are native peoples whereas 29.50% are resettles among the sampled household heads of the Tullu Dimtu ecosystem (Table 10).

Table 10. Age, education and family size characteristics of sample households

	Anbesa	forest		Tullu	Dimtu	
Variables	%	Mean	Std. error	%	Mean	Std. error
Age and family size composition						
Total family size	-	6.30	0.27	-	7.03	0.20
Household head age	-	40.06	1.06	-	43.51	0.92
Age group 14-64	-	3.76	2.05	-	3.51	0.15
Age group 14-64 (male)	-	1.85	0.11	-	1.78	0.09
Age group 14-64 (female)	-	1.92	0.12	-	1.73	0.09
Dependency ratio	-	0.82	0.06	-	1.19	0.07
Education status of the sample						
Education level (for all sample)	-	1.63	0.27	-	0.91	2.22
Illiterate household heads	51.20	1.58	1.09	47.50	2.58	0.10
Read and write skill	23.20	0.83	1.26	35.2	1.76	0.10
Attained formal education	25.60	6.18	2.66	17.3	5.84	0.38
Residence status of respondent						
Indigenous	77.60	-	-	70.50	-	-
Resettles (stranger)	22.40	-	-	29.50	-	-

Source: own survey, 2014

4.1.4. Wealth characteristics

Agriculture is serving the community of the study area being as a dominant economic activity through which households generate income and manage their way of life. Farm land and livestock units are agricultural entities that support farm households to earn food item and money for their family expense. The mean total land holding of the sampled households of Anbesa forest ecosystem is 3 hectare while that of Tullu Dimtu is 5.58. On the other hand, on average, total livestock holding (TLU) holding of sampled farm households of Anbesa forest ecosystem is estimated to be 2.68 with standard error of 0.23 while that of Tullu Dimtu is 10.48 with standard error of 0.62. The livestock diversities that household of the study areas rear includes cattle (i.e. cow, oxen, heifer, calves and bulls), small ruminants (i.e. goat and sheep), donkey, poultry and beehive. Farm household sampled and interviewed for this study revealed as the farmers of the study areas earn their income from livestock sell, livestock product sell and crop sell. Mean total annual income of the sampled households is Birr 10,199.20 for Anbesa forest ecosystem and 9345.87 for Tullu Dimtu ecosystem (Table 11).

4.1.5. Economic activities

The interview made as quantitative data generating tool revealed that the farmers of the study area engaged in various income generating activities. Among the interviewed farm households, 17.60% and 50% of Anbesa forest and Tullu Dimtu engaged in rural land transaction (rent in and rent out). Furthermore, of Anbesa forest and Tullu Dimtu sample households, 11.20% and 71.30 engaged in renting in land respectively. Similarly, the respective percentage of sampled farmers engaged in renting out their land is 8.80% and 70.50 % Anbesa forest and Tullu Dimtu ecosystems respectively.

Among those farm households selected for interview of this study, almost all those who reported as they engaged in rural labour market reported as they hire in labourer and they do not hire out their labour or their family labour. Of the farmers interviewed from Anbesa forest and Tullu Dimtu ecosystem, 21.6% and 57.40% engaged in rural labour market respectively and hire in labourer.

As discussed so far, farmers generate their income from crop sell in addition to livestock and livestock product sell. Of the sample farmers interviewed from Anbesa forest and Tullu Dimtu ecosystem, 69.60% and 50% reported as they sell staple food crops respectively. Similarly, of the Anbesa forest and Tullu Dimtu ecosystem farmers, 44.80% and 42.60% respectively reported as they produce and sell cash crop (Table 11).

Table 11. Wealth characteristics and major economic activities

	Anbesa	forest		Tullu	Dimtu	
Variables	%	Mean	Std. error	%	Mean	Std. error
wealth characteristics						
Total land holding	-	3	2.53	-	5.58	0.32
TLU	-	2.68	0.23	-	10.48	0.62
Total annual income	-	10199.20	20146.28	-	9345.86	1094.28
Economic activities						
Rural land market participation	17.60	-	-	50.00	-	-
Land renting in participation	11.20	-	-	71.30	-	-
Land renting out participation	8.80	-	-	70.50	-	-
Labour market participation	21.60	-	-	57.40	-	-
Staple crop sell participation	69.60	-	-	50.00	-	-
Cash crop sell participation	44.80	-	-	42.60	-	-

Source: own survey, 2014

4.1.6. Ecological resource use

In depth discussion was made under contextual analysis section of this thesis presenting analysis result of qualitative data generated from the study areas indicating ecological resource use of the community. In agreement with this, the result of empirical descriptive statistics analysis of the quantitative data indicated as sampled farm households used different sets of ecological resources of their environment. For instance, 45.60% and 27% of the interviewed households reported as they used Bamboo bud for food in Anbesa forest ecosystem and palm bud in Tullu Dimtu ecosystems respectively (Table 12).

On the other hand, 60% and 27% of farmers from Anbesa forest and Tullu Dimtu ecosystems reported their making use of *Kocho* (locally known as *Buri* and *Echa) (in Gmuz and afan Oromo)* for food respectively. Furthermore, 40% of Anbesa forest and 19.70% of Tullu Dimtu ecosystems famers hunt wildlife to use as meat source. On the other hand, 66.4% of the sample farmers of Anbesa forest ecosystem reported as they collect and used medicinal plants while 27.90% of Tullu Dimtu ecosystem farmers reported as they collect and used wild honey (Table 12).

Table 12. Ecological resources utilization condition

Variables	Anbesa forest	Tullu Dimtu
	%	%
Using Bamboo and/or palm bud for food	45.60	27
Using wild kocho and/or Echa for food	60	27
Using wild life meat for food	40	19.70
Using medicinal plant	66.40	-
Using wild honey	-	27.90

Source: own survey, 2014

4.1.7. Production problems and Land management practices

In relation to production problems and land management, the farmers of the study area reported as land shortage and soil fertility is a major problem. Under contextual analysis of the study area, the reason and evolution of land shortage was reported and thoroughly discussed. In line with this, for instance, 31.20% and 54.10% of the interviewed farm household heads reported land shortage problem in case of Anbesa forest and Tullu Dimtu ecosystems respectively.

In addition, 73.60% and 87.70% of Anbesa forest and Tullu Dimtu ecosystems sample farmers respectively reported as they encounter soil fertility problem. Furthermore, 40% and 100 of the sampled household heads of Anbesa forest and Tullu Dimtu ecosystems stated as they have no any technology used for soil fertility management of their land. Besides, 28% and 49.20% of Anbesa forest and Tullu Dimtu ecosystems sampled farmers tolled as they practice land expansion by practicing deforestation in order to solve their land shortage problem and/or soil fertility problem (Table 13).

Table 13. Agricultural production constraints and land management practices

Variables	Anbesa forest %	Tullu Dimtu %
Land shortage	31.20	54.10
Soil fertility problem	73.60	87.70
Farm land expansion	28	49.20
Lack of soil fertility management	40	100

Source: own survey, 2012

4.2. Qualitative Analysis of PRA tools data

4.2.1. Qualitatively comparing socio economic set up

Communities living in *Kebele*s surrounding *Anbesa chaka*, the then Anbesa forest of Bambasi district and that of Tullu Dimtu ecosystems of Dibate district have similar feature in the main economic activities and livelihood making. Both communities mainly depend on agriculture. Crop production and livestock rearing are the two main constituents of agricultural production on which they mainly depend. However, if the two ecosystems are compared, in contrast to Tullu Dimtu ecosystem users, livestock rearing is not much dependable sector for Anbesa forest ecosystem users. This is attributed to the serious prevalence of livestock disease at the area. As a result, the community of the area does not consider it as their reliable economic activity.

In both ecosystems, in addition to agricultural production (i.e. crop cultivation and livestock rearing), there are other economic activities rendering income thereby supporting livelihood of the community. Besides the difference in its contribution level for livelihood of both communities, hiving provides additional livelihood making opportunity for both ecosystem user communities. However, in addition to contribution level difference on the livelihood of participating households, the number of participating households and production per participating households in hiving differ in both ecosystems. To clearly state, Anbesa forest ecosystem users do not engage in hiving as much as that of Tullu Dimtu ecosystem users. In spite of this difference of hiving contribution in livelihood of the two communities, the problem of hiving is similar in both areas. The potential of hiving to provide good economic earning, the population of bee colony and productivity per hive deteriorated due to ecological resource deterioration. Furthermore, production system of the community at both study area completely rely on traditional hives made locally and they hang it on trees. Hence, these constraints and back ward production system enormously contributes to beehives' very low productivity.

In addition, both area share similarity in engagement of selling Grass and Bamboo for housing and the ventures are emerging economic activities in both areas. Earlier, these ventures have no market price since they are not binding in any activity of both areas. But lately, they failed to be found locally and farmers started to harvest tracking long distance. With increasing pressure of human and livestock need for these resources, the scarcity is more intensified. The end of the tragedy is different in both areas. In Tullu Dimtu ecosystem, the community entirely lost the resources. Hence, some farmers started to cultivate on their plots of farm like crops. These farmers are very few in number. In contrast, in the case of Anbesa forest ecosystem, the scene ended differently. It resulted in establishment of jointly managing cooperative. Hence, in order to harvest Bamboo for own use or sell, one should be a member of forest users' cooperative, a local institution established to manage community forest (natural resource). Even if cooperative is established to manage the resource jointly, one should track far distance to harvest the resources. The scarcity of the resource emanated market value for these resources which has no market price someday back. Hence, the scenario gives a presumption as these ventures have economic value and could be source of income in both areas.

The use of timber and poles for construction and sell at market has similarity in both areas. They are made of trees found within natural forest of the ecosystems. These provide income to the community and are very valuable at local market. Moreover, a discussion made with different parts of the community in the study area uncovered the reliance of economic activities and livelihoods of the community on the ecological resources of the area.

4.2.2. Dependency of community's livelihood on the natural resource

Secondary data obtained from both local and district level officials and focuses group discussion outcomes that had been validated by transect walk indicated the dependence of major livelihood making of the community on natural resources. The provision of naturally endowed resources to the community is indicated to attribute major share of economic earnings and even determinant in existence of life (e.g. the existence of water for drinking is associated with well functioning of the ecosystem). Thus, the obtained secondary data, key informant interview and focuses group discussion showed communities extensive utilization and its reliance on natural resources. Since the group discussion places were systematically selected to focus on the villages situating nearby or within the ecosystems on which the study focused on so that maximum possible information of benefit derived from the forest ecosystems is obtained, Particularly in case of Anbesa forest ecosystem, it was identified that Anbesa forest is located between two districts (Bambasi and Assosa). Given that the majority of the forest area lay within Bambasi district, the group discussion was held in *Kebele*s of Bambasi district.

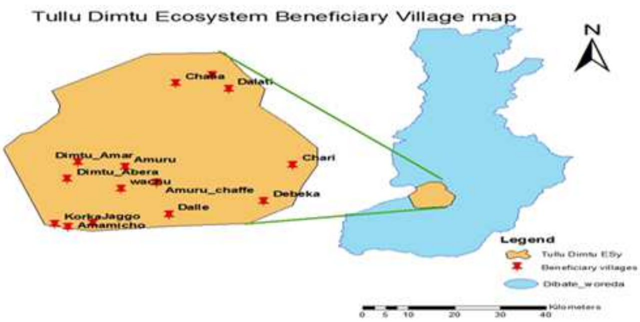
A. Mapping exercise at chaliya B. Mapping Exercise at Amuru C. Mapping Exercise at korka

Fig. 9. Joint resource and social mapping exercise of sites Tullu Dimtu ecosystem.
Source: own data, 2014

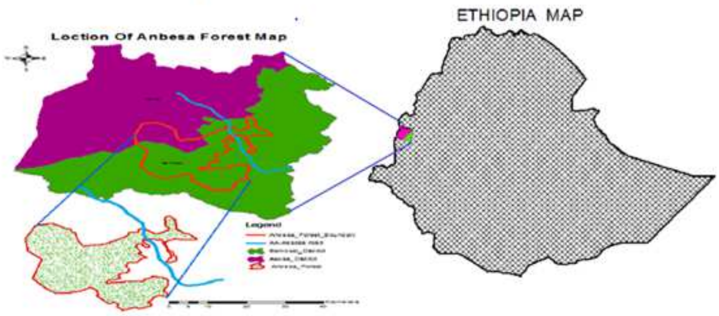
A. Focus group discusion and maping exercise at sonka B. Focus group discusion and maping exercise at Afa bulfdatu C. Focus group discusion and maping exercise at Jemasta D. Focus group discusion and maping exercise at Mender 48

Fig. 10. Joint resource and social mapping exercise of Anbesa forest ecosystem
Source: Own data.

In case of Tullu Dimtu, since the study area is located in single *kebele* the group discussion was held at villages that surrounded by Tullu Dimtu. During group discussion sessions held at each discussion places, farmers discussed the existence of intensive degradation of natural resources in their area. In addition to their discussion, they indicated different features (i.e location of depleted forest, Bamboo, Grass, and villages that frequently using these resources from the ecosystem) and mapped using joint resource mapping of PRA tool. The result of focus group discussion followed by the conformation activities including survey of GPS point data collection, transect walk and tracking important resource sites were illustrated with self explanatory maps. The natural resources, that the community raised as common issue at discussion session was mapped using GIS facility. These activities of focuses group discussions and the result of joint resource mapping activity at both study area are presented here (Fig. 9 and 10).



A. Tllu Dimtu Ecosystem Beneficiary villages



B. Location of Anbesa forest

Fig. 11. Tllu Dimtu Ecosystem Beneficiary villages and location of Anbesa forest.
Source: own data. 2014

Depending on the knowledge acquired from the focus group discussion joint resource and social mapping activity real distribution and location of beneficiary stockholders villages in ecosystem was mapped. As it can be seen from the maps, villages were distributed in the ecosystems showing the ecosystem rendering immense benefits for a considerable number of households. It also importantly indicated the value of ecosystem resources in their livelihood making (Fig. 11).

4.2.3. Economic activities and Natural resource degradation

During group discussion sessions, the community's extensive reliance on natural resources was reported to end in resource base degradation. This was reapproved with observation made during reconnaissance. The surveyed data showed the extensive dependence of the community on natural resource and degraded natural resources as a result.

Fig 12. Deforestation practice for farm land expansion.
Source: own survey, 2014

With joint resource mapping, they also mapped the location where they found different natural resource derived benefits previously and completely lost in present. In case of Tullu Dimtu ecosystem, following their mapping activity on a flip chart, tracks of degraded resources were surveyed and tracked using GPS with the guidance of farmers' representatives and following the roots of resource mapping result of the discussion group.

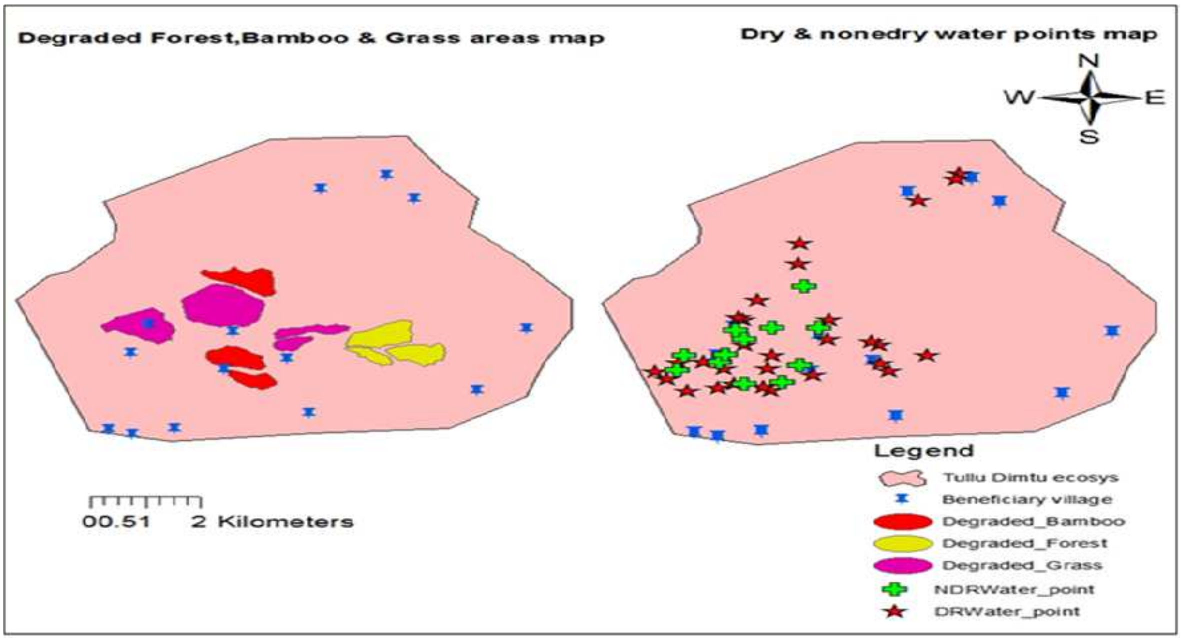
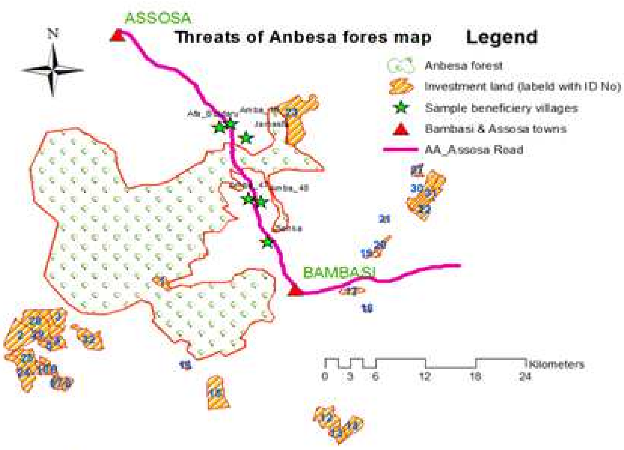


Fig. 13. Degraded natural resources in Tullu Dimtu ecosystem.

Source: own data, 2014



Natural Bamboo drought at Anbesa forest. A photograph taken in Aug, 2014

A map of private agricultural investment land surrounding Anbesa forest

Fig. 14. Map and photograph showing Anbesa forest threat.

Source: own data, 2014

In the case of Anbesa forest ecosystem on the other hand, combining the joint mapping activity of farmers on a flip chart, the site of degraded resources were inferred from the current map of Anbesa forest that already surveyed and mapped by Ethiopian institute of Biodiversity medicinal plant project. The analysis was made to investigate and realize whether degradation is real from Anbesa forest map and it whether overlaps with the places the group identified as a resource area before degradation. The survey of the area of the resources before degradation is made using the guidance of farmers' representatives and following the roots of joint resource mapping result of group discussion. Using GIS facility, the surveyed and tracked samples of the degraded natural resources that the community claimed was mapped and presented (Fig. 13 and 14).

During observation made on the ground, it was confirmed that, farmers really mapped the true sites of degraded natural resource sites. Guided with maps produced by joint resource mapping exercise and with the help of representative farmers to indicate the points presented on the maps, the reality of existence of the problem on the ground had been reaffirmed. Following the realization of the problem farmers stated in their discussion and on their mapping exercise, tracks of sample degraded natural resources had been surveyed using GPS and the map of degraded resources were developed using GIS facility. The map shows that, there is extensive degradation of considerable natural resources. This includes Grass that they rely on for animal feed and housing, Bamboo using for house construction, forest resources from where they drive different inputs for farm activities (like farm implements) and bee hive making and the loss of springs, which is the only source of water for drinking of humans and livestock. Particularly in Tullu Dimtu ecosystem, about 40 springs (water source points) were collected from the ecosystem (particularly proximate to the mountain). Of these number of water sources, only about 12 springs has water throughout the year. The community argued that, even these springs are not reliable as their number is decreasing from year to year. Furthermore, out of these springs, two to three water bodies serve for drinking of livestock during dry season as the volume decline and the use of livestock will further deteriorate the quality of the water for human drinking. From the map, one can realize as numerous springs were lost around beneficiary villages. Furthermore, the map is also descriptive to show the process of degradation of plant body (like forest, Bamboo and Grass) causing low infiltration rate and moisture holding capacity of the soil.

The cumulative effect of nature dependent agriculture resulted in deterioration of ecosystem services. According to focus groups and key informants, extensive crop farming and intensive grazing has degraded natural resource in general and Grass and Bamboo grown on sloppy areas in particular. High livestock population degraded not only sloppy areas but also plane Grasslands. Farmland expansions shrink grazing land in both ecosystems in general and even the former Anbesa chaka of Anbesa forest ecosystem in particular. This increased grazing intensity on grazing land since large livestock population used to graze on reduced grazing land having extremely undulated area.

In addition to intensive use of resources, the natural geo-physical setup of the area (Fig. 15 and 16) also contributed a lot for its degradation. Besides the natural set up of the land, unplanned use (absence of land use planning) of the area aggravated its susceptibility for physical degradation.

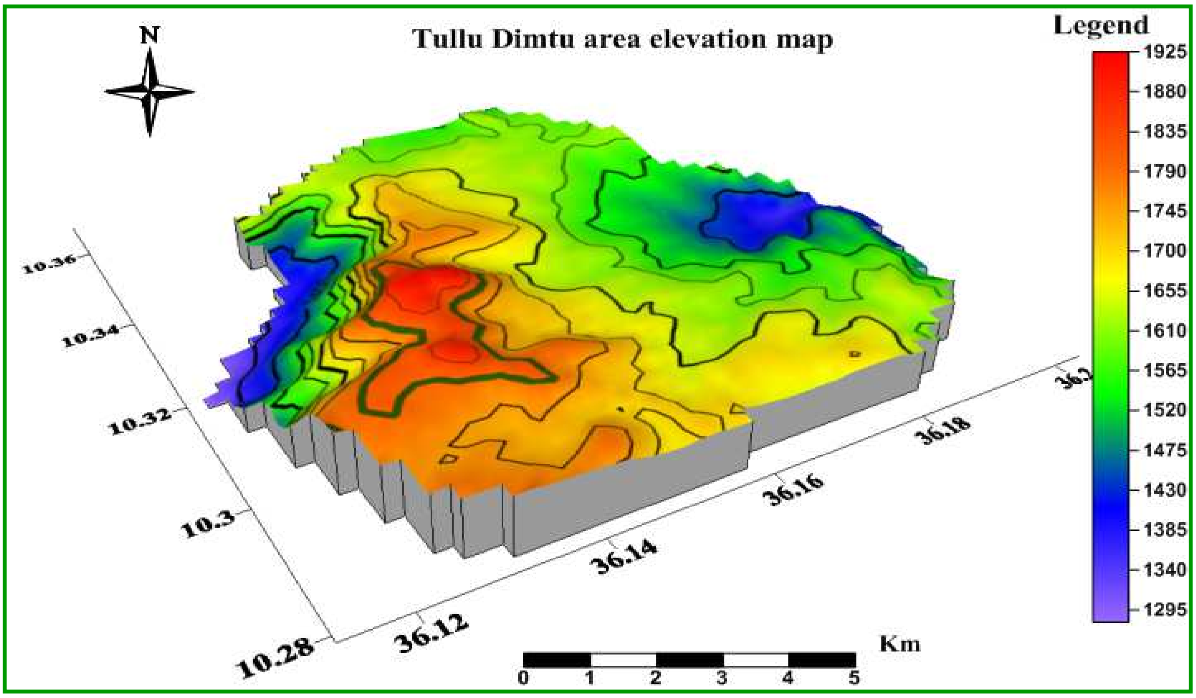


Fig. 15. 3D Geo-physical map of the study area (Tullu Dimtu).
Source: own data, 2014

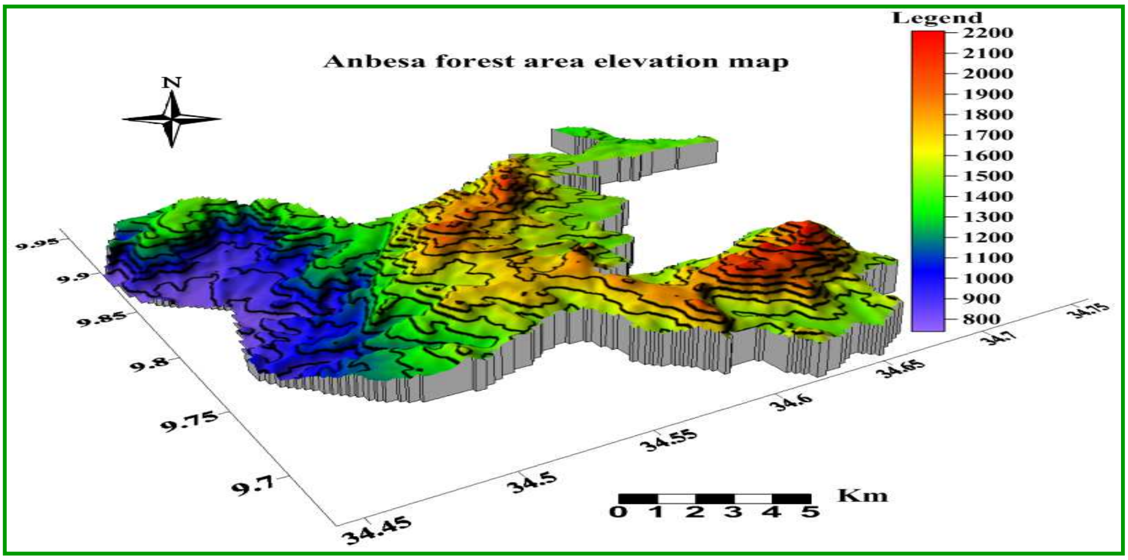


Fig. 16. 3D Geo-physical map of the study area (Anbesa forest).

Source: own data, 2014

As a result of natural resource base degradation, run-off is highly prevalent on farmlands and uncultivated mountainous sides. The run-off eroded upper part of the soil and exposed the stony part of the land crust. The moisture content of the farmland is extremely decreased and crops completely fail with small rainfall variability. Frequent late starting date of rain fall, early rain set and low moisture preservation potential of the soil is extremely affecting crop productivity, pasture productivity, Grass productivity and water availability during dry season.

The other factor mainly contributing to natural resource deterioration is shifting cultivation,. Farmers shift farmland as it gets older and decreased productivity. Earlier, fallowing practice was promising in recapping soil fertility, soil water holding capacity, reforestation, etc. But lately, the farmlands preserved for fallowing is used for grazing and it continue under degradation with intensive grazing. Hence, shifting cultivation could not ensure sustainability of natural resource availability in presence of intensive grazing.

This all-cyclic integration of anthropogenic effect resulted in low soil fertility, low pasture productivity, low crop productivity and low livestock productivity. Particularly in case of

Tullu Dimtu ecosystem, for instance, an effort made to maintain soil fertility and crop productivity by applying synthesised chemical fertilizers was not fruit full. Because, farmland under crop cultivation is mainly found on extremely sloppy areas and run-off take the applied fertilizer.

4.2.4. Identification of natural resource use constraints and problems

As the interest of this work was to study the value of ecosystem resource attributes rendering benefit to the community and maintaining the sustainability of ecosystem functions, list of livelihood problems related to ecological resources degradation is paramount in helping the purpose. Accordingly, the ecological resource use problems and constraints were listed at all discussion sits. This particular exercise was used as an entry point to the other following activities. Hence, listing of the problems had contributed a lot to undertake problem prioritization for the purpose of thinking on action to be taken and improve the sector. It also helped natural resource listing and relevant resource attribute selection exercises, a deal on management aspect and conservation, attributes levelling and use model description. It also contributed a lot being a brainstorming and rehearsing activities for the other following activities. It was also importantly benefited to deal on conservation cost component identification and levelling since it was made clear as the way out of the of the listed problems. The result of natural resource use constraints and problems listing activity of focus group discussion in different discussion sits of both ecosystems were summarized and presented (see Table 1 and 2 in the APPENDIX A).

4.2.5. Prioritization of natural resource use constraints and problems

Problem prioritization helped the investigator to indentify chronic problems of the community attribute to ecological resources of the study area. Since there is no farming system characterization study in the areas, at both ecosystems discussion sites, following their ecosystem resource use problem and constraint listing, they were asked to rank or prioritize the problems.

As the study was conducted on the whole ecosystem and not at specific discussion sites, it was also agreed up on compiling the list of all problems listed at different sits within the ecosystem, and the second discussion session is to be held with representatives of each sites coming together. They were told as representative participants of each sites are required to participate at the next discussion session. Agreeing with this, participants of group discussion of all sites nominated their representative to participate on the second discussion session which will be held with the representatives of all discussion sites coming together to set prior problems affecting their livelihood at the whole ecosystem level.

In order to reduce the generality of simple ranking inducing fuzziness of prioritization decision, well-established guideline of ranking was employed. To help this and set priority or rank of the problems, pair wise comparison was employed. Pair wise comparison method (PRA tool) is applied to prioritize the problems associated with ecological resource use constraints and problems. Its working principle is, following problem listing activities, the listed problems were presented in a matrix format. Then, each problem was compared with all the other problems. If the problem is selected as more useful than that with which it was compared, its value is registered in the interaction cell of both problems. The frequency of selection of a problem when compared with the other problems is obtained by counting its recorded value in interaction cells.

As pair wise comparison result shows, in case of Tullu Dimtu, low availability of water in dry season was as the main problem with frequency of 9. Thus, it is prioritized and ranked as the first important problem as there is no other problem having more than 9 times frequent selection in the comparison among listed problems. Following the same principles, low availability of Grass for housing, low availability of Bamboo for construction and low availability of Grass for grazing ranked the second to fourth important problems among listed and considered problems in the group discussion session. With the fashion, of Anbesa forest, Low availability of wild plants used for food was appeared as the main problem with the frequency of 10. Thus, it is prioritized and ranked as the first important problem as there is no other problem having more than 10 times frequent selection in the comparison among problems listed by the participants. Following the same principles, Low availability of medicinal plants, low marketability/market price of medicinal plants, low availability of Bamboo for construction and Low marketability/market price of Bamboo ranked the second to fifth important problems among listed and considered problems in the group discussion.

This paved way of relevant ecological resource selection for farther level setting activity of experimental choice card preparation. The pair wise comparison result of problem prioritization activity at both ecosystems of the study area is summarized and presented in table (see Table 3 and 4 in the APPENDIX A).

4.2.6 Identification of relevant natural resources and their attributes

Similar to problem listing activity, farmers listed and narrated different resource that they earn from the ecosystem and maintaining the ecosystem functions. Undertaking this exercise is important since ecological resource attribute identification is possible after having list of ecological resources. It was also important to deal on conservation cost component identification and levelling since maintaining these resources, their respective attributes and the ecosystem in general is possible with conservation cost. However, this activity was benefited a lot from listed associated problems earlier. Because, the problem listed is associated with ecological resources, which gave a clue of what resources the community get from the ecosystem and maintain the functioning of the ecosystems.

Table 14. List of ecological resources of both study areas

No.	Ecological resources	No.	Ecological resources
1	Bamboo	6	Construction materials
2	Grass	7	Fuel wood
3	Water	8	Medicinal plants
4	Wild fruit	9	Wild life
5	Wild honey	10	Wild plants used for food

Source: own survey, 2014

During the discussion sessions held at different sites, it was made clear that the discussion with those participants is not the only one and the possibility of finding another resource that they did not listed. Even though maximum possible effort was made, the lists of natural resources obtained from different sites were almost similar. This is attributed to the fact that a community reside at the same location tends to have similar natural resource utilization system. In order to address the first objective of this study, the summary of ecological resource that had been listed during the discussion held at different sites of both study area are presented (Table 14 above).

Identification of ecosystem resource attributes was conducted following listing of ecological resources and it was mostly required to level setting activity for experimental choice card design. Similar to ecological resource listing activity, they were also asked to state the attributes of resources they proclaimed. This activity was used or benefited from the result of problem listing in addition to ecological resources listing activity result, as some listed problems were associated to resource attributes not resources itself. In line with resource listing activities, this is also undertaken in different sites of discussion sessions and it was similar in the way of compiling the listed resource after all session was held. Making this clear for FGD participants, the representatives they elected after group discussion sessions held at different sites within the respective ecosystems told them as they also take part on selection of relevant prior ecological resources attributes in addition to prioritization of listed ecological resources. Because, as discussed so far, common problems should be identified for designing of choice experiment to be undertaken in the ecosystem in general, not in each discussion sites in particular. After an in depth discussion and extensive listing of ecological resource attributes the community derives from the ecosystem at each group discussion sites, all attributes that they listed were compiled. The compiled list of natural resource attributes raised at different discussion sessions of both study area are presented with tables (see Table 5 and 6 of APPENDIX A).

4.2.7. Result of multi-criterion comparison of resource attributes

For the purpose of selecting relevant attributes, multi-criterion attribute selection procedure is a reliable method helping identification of high-ranking important attributes to consider for further investigation when the attributes were very hulking. In this method, extensively listed ecosystem resource attributes at different discussion sites as goods and services that farmers derive from the ecosystem is compiled. Following the compilation, the selection of relevant attributes (for livelihood making and ecosystem sustainable existence) from the long list of attributes should follow some contextually pre-defined criterion measuring the relevance of the attributes. These criterions measuring the relevance of each attributes were also listed with the participants of PRA discussion. Next, the group defined five class likert scales for each relevance-measuring criterion. Then, the listed attributes and selected relevance measuring criterions were arranged in matrix formant. This is done by arranging attributes in the column and the criterions in the row. Following this procedure, likert values of each relevance-measuring criterion for each attributes were determined. Finally, the likert values of each criterion in each cell for the attributes were summed to indicate the total value of the attribute and thus, the rank of each attribute was determined based on the result of the sum. Finally, the relevant attributes were selected for further investigation.

The comparison of benefits of goods and services of ecosystem attributes needs well established indicator(s) that measures different aspects of the attributes. In this study, a thoroughly intensive discussion was made with the FGD discussion participants to establish the indicators, which are common for all listed attributes. In addition to listing of the indicators at each discussion sites, it was compiled and presented for the second discussion session participants and they agreed up on it to use as an indicators. Dealing on this, the indictor variables were selected and the selected indicators (multi criterions) are;

1. Community need consistency of the attributes across the seasons
2. Attribute availability across the seasons
3. Community's attribute collection/use frequency
4. Community's attribute usage for consumption
5. Community's attribute usage for sell
6. Attributes deterioration effect on ecosystem services provision consistency

Furthermore, since identification of indicators were not enough and strait forward to use in relevant attribute selection, measurement scale (likert scale), the meaning of the scale to the respondent and ranking direction (i.e according to community's concern) of the measurement was also clearly developed in collaboration and with FGD participants and employed in multi-criteria attribute comparison activity. The identified relevancy indicator for ecological resource attributes, their measurement scale and meaning are presented in table (see Table 7 of APPENDIX A).

Finally, with the use of identified criterions and respective likart scales, group discussion participants gave criterion values for each considered attributes. Relevant attributes were identified by summing the likert values of criterions given for each attributes and the sum result of the attributes was compared to rank each attributes considered in the exercise. The result of the exercise for both study area are reported in the Tables 15 and 16 blow.

Table 15. Relevant attribute selection using multi-criterions for Tullu Dimtu ecosystem

No.	Attributes	Criterion						Total	Rank
		1	2	3	4	5	6		
1	Bamboo for domestic use	4	5	4	5	1	4	23	3
2	Bamboo for fodder	2	5	3	5	1	3	19	5
3	Grass for grazing	5	5	5	5	1	4	25	2
4	Grass for domestic use	5	5	3	5	3	5	26	1
5	Access to water service	5	5	5	5	1	5	26	1
6	Wild fruit	1	5	1	5	1	3	16	6
7	Honey production	5	5	6	3	4	1	19	5
8	Construction material (poles, timber,)	3	1	1	5	1	4	15	7
9	Fuel wood	5	1	5	5	1	5	22	4
10	Medicinal plants	1	5	1	5	1	3	16	6
11	Hunting wild life	5	2	5	5	1	1	19	5

Source: own survey, 2014

From the result of multi criterion analysis output, Access to water service, and Grass for domestic use got first rank. The other two attributes, Grass for domestic use and Bamboo for domestic use ranked second and third respectively. As choice experimentation is possible with limited attributes, following relevant attributes selection exercise, the first four attributes were selected for further attributes level setting of the selected attributes with second discussion session participants of Tullu Dimtu ecosystem.

The result of multi criterion analysis indicated medicinal plant for domestic use and Access to wild food to be ranked first and second respectively. Bamboo for domestic use and medicinal plant for market were ranked second and third. Furthermore, Bamboo for market ranked fifth. As choice experimentation is possible with limited attributes (variables), following relevant attributes selection exercise, the first five attributes were selected for further level setting of the selected variables with second PRA session participants of Anbesa Forest ecosystem participants.

Table 16. Relevant attribute selection using multi criterions for Anbesa forest ecosystem

No.	Attributes	Criterion						Total	Rank
		1	2	3	4	5	6		
1	Access to Wild food	5	4	5	5	5	4	28	2
2	Bamboo for domestic use	5	5	4	3	5	5	27	3
3	Availability of Bamboo for fodder	2	3	3	4	1	3	16	12
4	Bamboo for market	5	4	3	3	5	5	25	5
5	Availability of Grass for construction	2	5	2	3	5	5	22	8
6	Availability of Grass for Grazing	5	3	3	4	1	5	21	9
7	Marketability of Grass	5	3	2	2	3	5	20	10
8	Availability of Water	5	1	5	5	1	5	23	7
9	Availability of Wild honey	3	5	2	2	5	3	15	13
10	Availability of Bee colony for hiving	4	5	2	2	5	1	19	11
11	Availability of wild life	5	3	5	5	1	2	21	9
12	Availability of Construction material	3	1	1	5	1	4	15	13
13	Availability of fuel wood	5	3	5	5	1	5	24	6
14	Medicinal plant for domestic use	5	5	5	5	5	4	29	1
15	Medicinal plant for market	5	5	5	4	3	4	26	4

Source: own survey, 2014

4.3. Econometric Model Results

4.3.1. Ecological resource attribute preference analysis of Tullu Dimtu ecosystem

In order to estimate farmers demand and detect presence of preference heterogeneity for ecological resource attributes of Tullu Dimtu ecosystem, mixed logit model was fitted on choice experimental data collected at household level. Choice decision of farmers was used as dependent variable and ecological resource attributes were used as independent or determinant variables. Highly statistically significant (at less than 1% statistical significance level) coefficients of all attributes considered in the choice experiment were found from the result of mixed logit model. This result indicated to as all attributes considered in the choice experiment determine farmers' ecological resource use and management scenario choice decision. These variables are ecosystem enrichment cost, grazing service, Bamboo for domestic use, Grass for domestic use and access of water service.

The sign of coefficients of all ecological resource attributes are in line with prior expectation. This means, except ecosystem enrichment cost attribute, coefficients of all considered ecological resource attributes have positive sign. This implies that an intervention that leads to improvement of the ecological resource attributes considered in the model will leads to higher probability of farmers' choice decision of ecosystem management and use scenario. The negative sign of the cost attribute exhibits left to right downward sloping demand curve. This reveals that the demand or preference of farmers for attributes improvement decreases with increases in expenditure or cost requested to get the improvement of attributes. This result agrees with demand theory which states that, as a price of a good increases, the demand of a consumer (or the number of a good that the consumer will purchase) will decrease. On the other hand, the positive sign of coefficients of the other ecological resource attributes indicates that farmers on average have positive demand for the attributes. Hence, they will pay to have the improvement of the attributes considered. This study was in agreement with the finding of Getnet (2012), who undertook choice experiment application of valuation study on choke mountain wetland ecosystem, East Gojjam Zone, Ethiopia and report that the positive preference of the sample households for water resource and recreational facilities site improvement. Similarly, the study by Nega Assefa (2012), carried out on Ribb Irrigation and Drainage Project in South Gonder, Ethiopia to estimate the value that the beneficiary stockholder attached to the Irrigation attribute reported that, the respondent's positive preference for fish, irrigation water availability and productivity.

Keeping ecosystem enrichment cost as a normalizing factor, access of water service has higher coefficient. This indicates that, it is more determinant factor in governing farmers' ecosystem management and use scenario choice decision. This shows that, the effect of its improvement on the likelihood of choice decision of farmers is higher than the effect of improvement of other attributes in the model to affect the choice decision likelihood of farmers. The effect of this variable on the likelihood of choice decision of farmers is followed by the effect of improvement of grazing service and Grass for domestic use in order of importance. Bamboo for domestic use improvement impact on likelihood of farmers' choice decision level was lower than all other considered attributes.

To state the results independently and specifically, an ecosystem management and use scenario requesting farmers' expenditure having a power of improving availability of water at near distance in the ecosystem increases the likelihood of farmers' ecosystem management choice decision scenario by 3.554. Similarly, improvement of grazing service of the ecosystem increases the likelihood of farmers' choice decision for ecosystem management scenario improving the ecosystem by 0.034. On the other hand, even if it requests them an expenditure, an intervention which can improve harvesting level of Grass and Bamboo for domestic use increases the likelihood of farmers choice decision of an intervention by 0.029 and 0.004 respectively (Table 17).

Table 17. Indirect utility function: mixed logit model result

Attributes	**Coef. (Std. Err.)**		**SD (Std. Err.)**		
Cost	$-7.151 \times 10^{-4} (7.37 \times 10^{-5})$***				
BamDome	$0.004 (4.654 \times 10^{-4})$***				
CatGraz	0.034 (0.003)***				
GraDome	0.029 (0.006)***		0.040 (0.007)***		
WatServ##	3.554 (0.200)***		-0.708 (0.173)***		
WatServ#	2.648 (0.173)***		1.101 (0.139)***		
Number of obs	4392	LR chi2(6)	84.85	Log likelihood	-823.189

 # and ## indicate availability of water throughout the year at far and near distance respectively.
, ** and * represent 0.10, 0.05 and 0.01 levels of statistical significance*
Source: own survey, 2014

This study was agreed with the study of Nega Assefa (2012), reported that the sampled households attached positive value to the attribute considered in his study. The community of his study area will to pay 748 and 822 Birr annually to have improved fish access and Irrigation water, respectively.

The farmers of the study area complained for extreme deterioration of availability of water for domestic utilization like for drinking of human and cattle's. Consequently, the largest access to water service coefficient revealed highest relative importance the attribute than the other considered in the model. This result justified the sampled household heads have sensitive need for it since they have no alternative substituting it for human and livestock drinking purpose. Furthermore, grazing service of the ecosystem is extremely endangered. Nevertheless, they are looking it as a security and insurance of their life since livestock is all what they have. Even indirectly, crop production is dependent on it since ploughing function of oxen depends on presence of grazing service of the ecosystem. Hence, the result from this model coincides with their need, which they thoroughly discussed during group discussion sessions.

On the other hand, Grass for domestic use got higher weight of importance than Bamboo for domestic use and is more limiting factor of likelihood of farmers' choice decision. This result is very interesting. Because, for what they presently used Bamboo, they can substitute with wood products and farmers have no constraints of the availability and harvest wood for domestic use since the area has dens woody cover. Furthermore, the use they can make of this ecological resource is only personal or household consumption, which is very substitutable. However, even if the importance of Grass is household use, its use is difficulty substitutable. Therefore, they have more weight of positive demand for Grass for domestic use than Bamboo for domestic use. Hence, the preference farmers' have for an intervention of Grass for domestic use attribute improvement is greater than their preference for the intervention oriented to improve the Bamboo for domestic use even if they derive positive utility and have preference for both interventions.

4.3.2. Farmers' ecological resource attributes demand heterogeneity

Fitting Mixed logit model has simultaneous benefit in estimation of ecological resource attribute scenario choice which can is reflected through attributes' coefficient and preference heterogeneity test detected through standard deviations of the same coefficients. Thus, the Mixed logit model result uncovered the exhibition of heterogeneous farmers' preference for three ecological resource attributes. That means, farmers have different preference for those attributes whose utility that they render to farmers distributed heterogeneously. The presence of heterogeneity of farmer' demand for the attributes is discovered by looking at the statistically significant values of standard deviations of the coefficients of the attributes in the indirect utility function.

All ecological resource attributes exhibiting heterogeneous utility for the farmers have statistically significant standard deviations. However, Grass for domestic use is the only attribute having higher standard deviation than its respective coefficient (mean value) of the attribute in the indirect utility function. This indicates that, there are farmers who derive negative utility from a request for expenditure in order to implement intervention which improves the attribute having higher and statistically significant standard deviation. This can be found by subtracting the value of standard deviation from its respective mean value in the indirect utility function.

For instance, there are farmers who derive negative utility if they are enforced to participate in an intervention, which improves the availability of Grass for domestic use, and that their participation costs them. This is revealed by subtracting the standard deviation of the coefficient of availability of Grass for domestic use in the indirect utility function (i.e. 0.04) from the coefficient (mean) of the attribute itself. Hence, (0.029-0.04) is negative, thus, it indicates the presence of farmers deriving negative utility from an expenditure they have to make in order to participate in the intervention pursuing improvement of the attribute.

However, even if the demand of farmers for access to water service availability is heterogonous (having statistically significant standard deviation), all farmers derive positive utility from its improvement. This argument is as a result of the higher values of coefficients of the attributes as compared to their respective standard deviation values. The significance of this result is that there is a variation in the farmers' willingness to pay level for the improvement of water availability improvement. Nevertheless, all have positive willingness to pay for it (Table 17).

4.3.3. Farmers' ecological resource attributes valuation of Tullu Dimtu ecosystem

The mean or average willingness to pay (WTP) or willingness to accept (WTA) of farmers for the attributes was calculated from the mixed logit model result fitted previously. In order to calculate the monetized farmers' values attached to ecological resource attributes, ecosystem enrichment cost attributes (the cost component coefficient) was used as normalizing attribute.

All estimated result of monetized farmers' value attached to ecological resource attributes (part worth) is positive. The positive sign of the implicit price coefficients of the attributes indicates farmers willingness to pay (WTP) for the improvement of the attributes. Hence, the result indicated that farmers will to make an expenditure of 48.01 Birr per head of cattle for an intervention which makes better access to have higher grazing service of the ecosystem keeping the other factors constant. Similarly, farmers will to pay 5.70 Birr per stick of Bamboo for domestic use for an intervention which improves availability of Bamboo. Interpreting the other implicit prices of the other attributes in the same way, farmers will to pay for an intervention improving availability Grass for domestic use and access to water service. Their respective willingness to pay for an intervention improving Grass for domestic use availability is 40.85 per load.

Table 18. Mean WTP/IP of ecological resource attributes

Attributes	WTP	95% CI
CatGraz	48.013	(38.429, 57.598)
BamDemo	5.699	(4.2664,7.132)
GraDemo	40.853	(23.135, 58.571)
Watserv##	4969.132	(4137.696, 5800.568)
Watserv#	3702.781	(3013.225, 4392.338)

 # and ## indicate availability of water throughout the year at far and near distance respectively.

Source: own survey, 2014

On the other hand the willingness of farmers to pay is 4969.13 Birr per year for an intervention which improves water availability in the nearest streams while it is 3702.78 Birr per year for an intervention improving the same variable at the far streams (Table 18). This result was in agreement with Stegaw et al. (2014), who carried out a valuation study on wetland ecosystem attributes around Jimma, South west of Ethiopia and reported respondent's MWTP to be 5.04 and 2.05 ETB one-off payment for attributes improvement included in the choice experiment scenario (i.e. fish stock and water purification).

4.3.4. Sources of farmers' ecological resource attributes' preference heterogeneity

The investigation conducted so far revealed presence of farm households' demand heterogeneity for two of the ecological resource attributes among the considered attributes in the study. As a result, investigation of the sources of heterogeneity in farm household's demand for resource attributes is important to make any decision in relation to ecosystem or natural resource management planning. In order to investigate the source of heterogeneity in farmers' demand, conditional logit model was fitted on a data set produced by interacting ecological resource attributes with demographic and socio-economic factors.

Table 19. Summary of variables in the model

Continuous Variables	Mean	Std. Err.
Education level	0.910	2.219
Total land holding	5.850	3.482
Dependency ratio	1.186	0.779
Family members having reading and writing skill	0.541	0.946
Categorical/Dummy Variables	**Frequency (%)**	
Native people	70.49	
Farmers practicing land renting in	28.69	
Farmers practicing land renting out	29.51	
Farmers participating in rural land transaction	50	

Source: own survey, 2014

The model fitted on the data set derived by interacting demographic and socio-economic factors with ecological resource attributes providing heterogeneous utility for farmers resulted in significant determinants. The significance of the interactions in the model indicates the potential of the interacted demographic and socio-economic variables to explain sources of farmers' ecological resource attributes demand heterogeneity.

Model result of farmer's ecological resource attributes heterogeneous demand analysis revealed positive demand of native people for Grass for domestic use. This is important indicator of the interaction of endogenous community with its ecosystems service. Furthermore, more of settlers (new arrival) are not permanent dwellers in the area where their long lasting in the area is mainly attributed with the comparative productive potential of the area with other areas. Similarly, those farmers having larger land holding derive positive utility from improvement of the Grass provision service of the ecosystem for domestic use. Due to degradation of the ecosystem's Grass provision potential, farmers having larger land size started to grow the Grass on their farm. Hence, it started to compete with crop production. Therefore, if ecosystem's Grass production potential revived, they can use their land on which they grow Grass for crop production.

Similarly, both farmers who are engaged in renting in and renting out of farmland also positively prefer to invest in conservation of their ecosystem in order to rehabilitate their ecosystem's Grass productivity potential. This result can be viewed in two directions. On one hand, farmers who are engaged in farmland renting out will only continue in the business if they can get their Grass need from their ecosystem. Unless they invest on the ecosystem sustainability, they will be enforced to re-allocate the portion of their land for own Grass production otherwise. On the other hand, farmers engaged in farmland renting in also can get farmland if landowners will to be engaged in the rural land transaction, which also depend on the availability of harvestable Grass in the ecosystem. Furthermore, those farmers have no their own land (Rent in variable) to allocate for own Grass production, entirely rely on the ecosystem's Grass provision. The positive effect of dependency ration on the farmers' utility is also in line with the same argument. This is due to the fact that, farmers with large dependency ratio needs to use their entire farmland for crop production to feed their family. Thus, they will to invest in the ecosystem to get Grass which otherwise compete for farmland.

Table 20. Determinants of farmers' attributes demand heterogeneity: conditional logit

Choice Decision		**Coef. (Std. Err.)**	
Cost		-6.53x10-4 (6.63 x10-5)***	
CatGraz		0.029 (0.003)***	
BamDemo		0.004(4.13 x10-4)***	
GraDemo		-0.044 (0.012)***	
Watserv##		2.129 (0.208)***	
Watserv #		0.670 (0.188)***	
(GraDemo) X (HHRhist)		0.041 (0.009)***	
(GraDemo) X (HHLanho)		0.004 (0.001)***	
(GraDemo) X (HHFLanTR(RIn))		0.024 (0.009)***	
(GraDemo) X (HHFLanTR(Rout))		0.031 (0.009)***	
(GraDemo) X (DpenRet)		0.009 (0.005)*	
(Watserv##)X (HHeduL)		0.112 (0.061)*	
(Watserv##)X (HHRhist)		1.193 (0.236)***	
(Watserv##)X (HHFLanTR(TRBoth))		0.468 (0.190)**	
(Watserv#) X (HHeduL)		0.165 (0.054)***	
(Watserv#) X (HHRhist)		1.192 (0.191)***	
(Watserv#) X (HHLanho)		0.092 (0.021)***	
(Watserv#) X (HHFLanTRIn)		0.632 (0.175)***	
(Watserv#) X (HHR&wr)		0.153 (0.074)**	
Log likelihood	-801.115	Number of observation	4392
LR chi2(19)	1442.07***	Pseudo R2	0.4737

 # and ## indicate availability of water throughout the year at far and near distance respectively.
Rin, Rout and TRBoth represents rent in, rent out and both transaction participation, respectively
, ** and * represent 0.10, 0.05 and 0.01 levels of statistical significance*
Source: own survey, 2014

The model revealed positive effect of education on farmers and farm families on the demand of water access from their ecosystem. This result shows as the educated farmers are more sensitive to the effect of water availability reduction in the ecosystem (due to climate change and/or mismanagement). On the other hand, the effect of education on the farmers' preference for their willingness to invest in the conservation of the ecosystem in order to improve their water access could also be attributed and argued as the spill over effect of education.

The other two factors (i.e. residence history and land holding) shows that farmers who planned to permanently live in the area are willing to conserve their ecosystem and demand the sustainable existence of water in the ecosystem compared to resettles (new arrival). On the other hand, farmers participating in rural farmland transaction institution of the study are wilful to invest in the conservation of their ecosystem in order to have water access throughout the year (Table 20). The study by Dembela amd Koch (2012), also reported that heterogeneity preference of the community towards ecosystem goods and services improvement scenario associated to socioeconomic background of the individual.

4.3.5. Ecological resource attribute preference analysis of Anbesa forest ecosystem

Similar to the estimation method employed for Tullu Dimtu choice experiment data modelling, from choice experimental data collected at household level, Mixed logit model was fitted using choice decision of the farmers as dependent variable and ecological resource attributes as independent or determinant variables. The result of Mixed logit model indicated all attributes to highly statistically significantly (at less than 1% statistical significance level) determine farmers' ecological resource use and management scenario choice decision. These variables are ecosystem enrichment cost, Bamboo for domestic use, access of wild food, medicinal plant for domestic use, medicinal plant for market and Bamboo for market.

The sign of coefficients of all ecological resource attributes are in line with prior expectation. This means, except ecosystem enrichment cost attribute, all considered ecological resource attributes coefficients have positive sign. This implies that an intervention which leads to improvement of the attributes considered in the model will leads to higher probability of farmers' choice decision of ecosystem management and use scenario with higher or improved ecological resource attributes. The negative sign of the cost attribute exhibits left to right downward sloping demand curve which states that the demand or preference of farmers for attributes improvement decreases with an increases in expenditure or cost requested to get the improvement of attributes. This result agrees with demand theory which states that, as a price of a good increases, the demand of a consumer (or the number of a good that the consumer will purchase) will decrease. On the other hand, the positive sign of coefficients of the other ecological resource attributes indicates that farmers on average have positive demand for the attributes; i.e. they will pay to have the improvement of the attributes considered.

Keeping ecosystem enrichment cost as a normalizing factor, availability of wild food has higher coefficient. This indicates that, it is more determinant factor in governing farmers' ecosystem management and use scenario choice decision. The effect of its improvement on the likelihood of choice decision of farmers is higher than the effect of improvement of other attributes in the model on the choice decision likelihood of farmers. The effect of this variable on the likelihood of choice decision of farmers is followed by the effect of improvement of Bamboo for market, medicinal plant for market, medicinal plant and Bamboo for domestic use on the likelihood of choice decision of farmers. Furthermore, the effect level of medicinal plant for market is higher than its domestic use on the likelihood of choice decision of respondents.

Table 21. Indirect utility function estimate: mixed logit model

Choice		**Coef. (Std. Err.)**		**SD (std. err.)**	
Cost		$-5.83 \times 10^{-4} (8.44 \times 10^{-5})$***		-	
BamDome		$0.004 (4.74 \times 10^{-4})$***		-	
AcctWfd		1.661(0.352)***		3.088 (0.385)***	
MedpDome		0.415 (0.147)***		0.983 (0.199)***	
MedpMkt		0.434 (0.098)***		0.621 (0.124)***	
BamMkt		0.506 (0.115)***		0.888 (0.127)***	
Number of obs	3000	LR chi2(4)	281.24***	Log likelihood	-813.262

, ** and * represent 0.10, 0.05 and 0.01 levels of statistical significance*

Source: own survey, 2014

To be clear and specific, an ecosystem management and use scenario requesting farmers' expenditure having a power of improving access to wild food increases the likelihood of farmers' ecosystem management choice decision scenario by 1.66. On the other hand, even if it requests them expenditure, an intervention which can improve Bamboo for market, medicinal plant for market, medicinal plant and Bamboo for domestic use increases the likelihood of farmers choice decision of an intervention by 0.506, 0.434, 0.415, and 0.004 respectively (Table 21).

This result is intuitively pleasant and indicative. The farmers of the study area complained for extreme deterioration of access of wild food. However, this result justified their need for it looking it to use for security and insurance at a time of food shortage because of different crop due calamities resulted of different factors. Hence, the result from this model coincides with their need which they thoroughly discussed during group discussion sessions.

On the other hand, Bamboo for market got higher weight of importance than its domestic use and medicinal plant for market is more limiting factor of likelihood of farmers' choice decision than its domestic purpose. This result is very interesting. Because of farmers have no any constraints harvesting of Bamboo and medicinal plants for domestic use. However, the use they can make of these ecological sources is only personal or household consumption and local benefit, which is very minimal in comparison to its existence. Hence, improving the marketability of the resources can widen the margin of the benefit they can derive from the availability of these resources. Therefore, they have positive demand and make expenditure for an intervention proposed and implemented in order to improve the marketability of these resources. Furthermore, the preference farmers' have for an intervention of marketability attribute improvement is greater than their preference for the intervention oriented to improve the access for domestic use of these resources even if they derive positive utility and have preference for both interventions.

4.3.6. Farmers' ecological resource attributes preference heterogeneity

As stated under respondent preference heterogeneity analysis of Tullu Dimtu, mixed logit provides two results simultaneously addressing demand level estimation and demand heterogeneity towards the ecological resource attributes considered in the model. According, the result uncovered the exhibition of heterogeneous farmers' preference for four ecological resource attributes with an exception of Bamboo domestic use among five considered ecological resource attributes. That means, farmers have different preference for those attributes whose utility that they render to farmers distributed heterogeneously. The presence of heterogeneity of farmer' demand for the attributes is discovered by looking at the high and statistically significant values of standard deviations of the coefficients of the attributes in the indirect utility function.

All ecological resource attributes exhibiting heterogeneous utility for the farmers have high and statistically significant standard deviations. The standard deviations are higher than their respective coefficients (mean values) of the attributes in the indirect utility function. This indicates that, there are farmers who derive negative utility from a request for an expenditure in order to implement interventions which improves those attributes having higher and statistically significant standard deviations. This can be found by subtracting the values of standard deviations from their respective mean values in the indirect utility function.

For instance, there are farmers who derive negative utility if they are enforced to participate in an intervention which improves the accessibility of wild food and their participation costs them. This is revealed by subtracting the standard deviation of the coefficient of access to wild food in the indirect utility function (i.e. 3.09) from the coefficient (mean) of the attribute itself. Hence, (1.66-3.09) is negative, thus, it indicates the presence of farmers deriving negative utility from an expenditure they have to make in order to participate in the intervention pursuing improvement of the attribute (Table 21). This result was in agreement with the finding of Dikgang and Muchapondwa (2013), that carried out a choice experiment valuation study on dry land ecosystem service of Kgalagadi area in South Africa and reported that the statistically highly significant heterogeneity preference of the community in the study area towards Medicinal plants and Bush meat traditionally hunted (wild life meat) attributes, while Grazing Opportunities and Alfa attributes considered in the study, estimated to have non-random (fixed) effect on the likelihood of respondents choice decision.

Similarly, there are farmers who derive negative utility if they are enforced to make an expenditure in order to support an intervention pursuing the improvement of medicinal plant for domestic use, medicinal plant and Bamboo for market which is uncovered by looking at the resultants of the subtraction of their standard deviation from their respective coefficients in the indirect utility function, hence, (0.42-0.98), (0.43-0.62) and (0.51-0.89) respectively. The only ecological resource attribute which gives positive and fixed or homogeneous utility for all farmers is Bamboo for domestic use.

4.3.7. Farmers' ecological resource attributes valuation

Compensation surplus or part worth of attributes trade of was calculated using wald procedure of STATA from the model (Mixed logit model) fitted before to estimate the mean or average willingness to pay (WTP) or willingness to accept (WTA) of farmers for the attributes. In order to calculate the monetized farmers' values attached to ecological resource attributes, ecosystem enrichment cost attributes was used as normalizing attribute.

All estimated result of attributes monetized farmers' value attached to ecological resource attributes (part worth) is positive. The positive sign of the implicit price coefficients of the attributes indicates farmers willingness to pay (WTP) for the improvement of the attributes. Hence, the result indicated that farmers will to make an expenditure of 6.20 Birr per stick of Bamboo for improvement of an intervention which makes better access to have higher harvest to domestic use, *citrus paribus.* This finding was in agreement with Dikgang and Muchapondwa (2013), a choice experiment application of valuation study, concerning dry land ecosystem service of Kgalagadi area in South Africa and reported the respondents WTP to be 598.80, 112.36 and 1849.41 South African Rand for ecosystem attributes improvement considered in the model (i.e. Medicinal plants, Bush meat traditionally hunted and Tree), respectively under random parameter logit model.

Similarly, farmers will to pay 2847.35 Birr per year for an intervention which improves access of wild food. Interpreting the other implicit prices of the other attributes in the same way, the willingness to pay of farmers for an intervention which improves medicinal plant for domestic use, medicinal plant and Bamboo for market is 711.83 Birr, 743.57 Birr and 867.12 Birr/year, respectively (Table 22).

Table 22. Mean WTP/IP of ecological resource attributes: mixed logit model

Attributes	WTP	95% CI
BamDome	6.195	(4.059, 8.330)
AcctWfd	2847.353	(1621.574, 4073.133)
MedpDome	711.837	(217.625, 1206.050)
MedpMkt	743.567	(384.786, 1102.349)
BamMkt	867.117	(445.380, 1288.853)

Source: own survey, 2014

To clearly state this result, farmers attach significant values with ecological resource attributes. The willingness to pays or implicit prices of the attributes estimated from the model is the values that they attached with the attributes. The average value that farmers attached to unit stick of Bamboo is their willingness to pay to have a harvest of a stick of Bamboo. Hence, it is 6.20 Birr. Similarly, the value that farmers attached to the access to wild food is 2847.35 Birr per annum and the value that they attributed to medicinal plant for domestic use is 711.83 Birr per annum. In the same manner, the average vale that the farmers attached to medicinal plant and Bamboo for market is 743.57 Birr and 867.12 Birr per annum, respectively.

4.3.8. Sources of farmers' ecological resource attributes demand heterogeneity

The preceding model result discussion uncovered the exhibition of farm households' heterogeneous demand for four among ecological resource attributes considered in the study. Hence, investigating sources of this heterogeneity in demand for resource attributes is rewarding to be informed in making a decision on ecosystem or natural resource management plan. To get this information, conditional logit model was fitted on a data set produced by interacting ecological resource attributes with demographic and socio-economic variables. Significant interacted variables with the ecological resource attributes rendering random preference for farm households were found. This indicates the potential of the included demographic and socio-economic variables to explain sources of farmers' ecological resource attributes demand heterogeneity.

Table 23. Summary of variables in the model

Continuous Variables	Mean	Std. Err.
Education level in year (Total sample)	1.632	0.273
Family size	6.304	0.273
Total rain fed land agricultural land holding	2.734	0.222
Total irrigated agricultural land holding	0.2667	0.050
Male age 14-64	1.848	0.114
Categorical/Dummy variables		%
Literacy/Read and write (Yes)		23.20
Participation in production of Cash crops (Yes)		44.80
Land shortage (Yes)		31.20
Soil fertility (Yes)		73.60
Labour market participation (Yes)		21.60
Kocho (Yes)		60
Bamboo Bud (Yes)		45.60
Wild Life meat (Yes)		40
Using medicinal plant (Yes)		66.40
Lack of management (Yes)		40

Source: own survey, 2014

The result of the model indicated mixed effect of education on the demand of the access to wild food. For instance, farm household heads having writing and reading skill have most probability of choosing natural resource management intervention insuring sustainability of wild food availability to access as compared to farm households without having writing and reading skill. Hence , education of household heads to the level of acquiring writing and reading skill have positive effect on their preference to natural resource management intervention insuring sustainability of wild food availability. This result shows the difference of the utility that such intervention will entail for different section of farmers. Thus, the utility the intervention provides to those farmers having different education level is different.

Therefore, farm household's heterogeneous demand for such intervention can out sourced from heterogeneity of the community in relation to education level. In contrast, natural resource management intervention which needs farm households cost contribution to insure sustainability of wild food availability to access entails negative utility for those households having higher education level measured in schooling year. This means, the increase in education level negatively affects farm household's preference for natural resource management intervention requesting them to contribute in order to insure wild food to access.

On the other hand, natural resource management intervention which request farm household's contribution in order to insure wild food availability renders positive utility for households with high family size and shortage of farm land. Moreover, households having soil fertility problem of farm land, an experience of using Bamboo bud as food and households using or have an experience of using medicinal plant also positively demand for natural resource conservation which improves wild food accessibility.

Conversely, those farm households having large size of agricultural land (irrigated and rain fed), high number of male age between 14-64 in the household and those who have an experience of using wild Kocho as food derives negative utility from natural resource management intervention which request farm household's contribution in order to insure access to wild food.

This result shows intuitively interesting meaning. It is rewarding to look at two important indication of the result in order to honour the interesting meaning that this result holds. Firstly, it is clear that those farmers having higher education level did not want to rely their family's livelihood on wild food. Because, the venture is open to all users and each farmers did not have a way to control on the amount they have to harvest. Hence, the benefit they could get from such venture is erratic, depends on the decision of other economic agents and government policies; social security of the area and even the condition of local climate. Thus, it is natural to expect those educated households to follow logic and reasonability in the process of decision making. This is meaningful as more educated person can predict the future and understands the risks associated with common resource utilization.

Table 24. Determinants of farmers' attributes demand heterogeneity: conditional logit

Choice	Coeff. (stand. error)
Cost	$-4.53x10^{-4}(6x87x10^{-5})$***
BamDome	$3.07x10^{-3}(3.98x10^{-4})$***
AcctWfd	-0.326(0.449)
MedpDome	-0.122(0.177)
MedpMkt	0.116(0.078)
BamMkt	-0.007(0.152)
(AcctWfd)X(HHR&wr)	0.407(0.232)*
(AcctWfd)X(HHR&wr)	-0.115(0.039)***
(AcctWfd)X(FamilyS)	0.075(0.037)**
(AcctWfd)X(HHLanho (rain fed))	-0.115(0.038)***
(AcctWfd)X(HHLanho (irrigated))	-0.805(0.242)***
(AcctWfd)X(MMLabor)	-0.234(0.085)***
(AcctWfd)X(Lanshort)	1.347(0.231)***
(AcctWfd)X(SoilFertPM)	0.881(0.225)***
(AcctWfd)X(HHNRuExp (Kocho))	-0.695(0.240)***
(AcctWfd)X(HHNRuExp (Bamboo Bud))	1.119(0.256)***
(AcctWfd)X(HHNRuExp (medicinal plant))	1.205(0.275)***
(MedpDome)X(HHCashCro)	0.409(0.161)**
(MedpDome)X(HHLabMkt)	-0.733(0.197)***
(MedpDome)X(HHNRuExp (medicinal plant))	0.666(0.203)***
(MedpMkt)X(NRLackM)	0.563(0.128)***
(BamMkt)X(HHNRuExp (Kocho))	-0.430(0.154)***
(BamMkt)X(HHNRuExp (Bamboo Bud))	0.825(0.163)***
(BamMkt)X(HHWildMt)	-0.281(0.131)**
(BamMkt)X(HHNRuExp (medicinal plant))	0.626(0.140)***
No.of obs = 3000 Log likelihood =-806.354 chi2(25) =466.73***	Pseudo R^2=0.225

, ** and * represent 0.10, 0.05 and 0.01 levels of statistical significance*

Source: own survey, 2014

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Hence, they want to have more secured and manageable venture in order to secure their family's livelihood. In agreement with such expectation of their characteristics, this result indicted as they derive negative utility from erratic livelihood making enterprise.

Secondly, farm households mainly need wild food during food shortage. Since educated households did not want to deal with the option which helps them to escape food shortage after its occurrence, they did not want to deal on making an investment in order to secure the availability of wild food to access so that they use it during the occurrence of food shortage risk. Because, such food is seen as inferior, which the poorest and low productive farm households use in order to supplement their food shortage. It is reasonable as educated household heads can make their resources more productive since they are expected to have better awareness on how to manage their farm and allocate their resources. Hence, they could minimally encounter food shortage problem and thus look wild food as inferior food. Therefore, instead of investing on natural resource management securing wild food availability, they prefer to invest the same resource on their farm to produce normal or superior food.

Contrasting to the effect of higher level of education, an intervention which costs farm households in order to secure wild food to access provides positive utility for farm households having reading and writing skill as compared to those who have no such skill. This can be explained by how those farmers having such skills would take what professionals said and write about the benefit of sustainability of their ecosystem in relation to their livelihood security. It is clear that professionals provoke as ecosystem sustainability can give a secured livelihood making for rural farm households. Farm household heads who could understand the logic of such argument is those farmers having the skill of reading and writing. Hence, such farm household heads reasonable to have positive demand for an intervention which insures wild food availability to access. Since lower level educated farm household heads derive positive utility from an intervention and argued as they have an understanding of the benefit of sustainable ecosystem, the reason of negative utility of derivation of those farmers having higher education level could be explained tying it with the ability of educated farmers to predict the risk of relying on a venture that they cannot control than relating the reason to their understanding ability of the benefit that they can derive from sustainability of ecosystems. Hence, even if the result show mixed effect of education on the demand of farm household's demand for an intervention insuring sustainability of wild food, it is possible to generally conclude as education can enhance farm household heads understanding on the benefit of natural resource management and give them positive utility. However, the positive utility those educated farm household's derive from the intervention continue until the benefit it renders to the community is reliably secured and got confidence of the educated household heads. Unless, even if educated farm household's heads understand the benefit that sustainably managed ecosystem provides, they could derive negative utility if they are asked to invest in the sector which could not supply them secured and reliable product.

As reported before, the result indicated that those farm households having high number of family member (high family size) have positive demand for an intervention costing them insures availability of wild food to access. This finding is very interesting. Most rural farmers who have large family size have difficulty of feeding their family. Hence, they need additional source of food for their family. The community on which this study is conducted on highly relies on ecosystem to feed their families. When comparison is made and in relative terms, those farm households having high family size needs their ecosystems' wild food provision service than those farm households having smaller family size. Hence, the effect of having large family size on the farm households' preference for natural resource management intervention costing farmers in order to insure access to wild food is positive since they demand wild food provision of the ecosystem and it supplements high food need of family having high number of individuals in the household.

The discussion made on the empirical model result of the effect of family size on the demand of access to wild food can be more clarified with an insight acquired by looking at the effect of farm size on farm household head's demand for natural resource management intervention to insure availability of wild food access to. Following this outcome, it is possible to argue the behaviour of farmers having larger farm size (rain fed and irrigated) to derive negative utility from natural resource management interventions costing them in order to ensure availability of wild food access to. It is clear that farmers who cultivate large farm size will produce larger size of crop, since crop production size is directly related with land holding size in a community practicing extensive crop production system. Thus, those farmers cultivating large land holding and produce large size crop will have sufficient food for their family throughout the year. In order to manage their large size farms, they use their family labour and/or capital on their farm to the maximum possible level. On the other hand, since they have an experience of reliability of crop farming and the confidence the sector provides to be secured source of livelihood than wild food, they more prefer investing on crop production than investing on natural resource management. Thus, farm size has negative effect on the farmer's preference for natural resource management intervention costing farmers opting insurance of sustainability of wild food availability.

The intuitive meaning of observing the effect of family size and land holding size at the same time is very interesting. Those farmers having larger family size have positive demand for natural resource management intervention costing them but pursuing to ensure the sustainability of access to wild food. As argued before, large land holding requires high labour and capital inputs, hence, negatively related with the utility natural resource management intervention ensuring sustainability of wild food availability access to provide to farm households. To relate these variables, those farmers having large family labour would not be affected if they are requested to allocate some labour for natural resource management. On the other hand, large family size requires large food which could be obtained from managed ecosystem and supplement farm land cultivation. At the same time, large land holding requires large working inputs (labour and capital). So, farmers negatively prefer natural resource management intervention requiring them to contribute an input for the management. Hence, this result can be interpreted intuitively and interestingly by looking at the complimentary of the products of the two sectors and their competitive nature for input demand.

The two sectors are complementing each other in providing food for farm households. As a result, positive demand of those farm households having large family size and thus large food need for natural resource management intervention ensuring wild food availability is indicating their need for sustainability of ecosystems food provision service which complements their food crop production. Furthermore, the positive demand of the result also shows the need of farmers to invest on the sector (natural resource) in order to ensure ecosystems' food provision service so that it is able to complement agricultural production. On the other hand, the two sectors are competitive in their input need (labour and capital). Thus, those farmers who have large farm size and then crop production need to have large inputs (labour and capital) for crop production. Such farmers derive negative utility from natural resource management intervention which shares their inputs in order to ensure wild food provision service of ecosystem. Because, they can have sufficient and superior food items (food crops) from their farm if they invest on crop production as much as they can and they do not need ecosystem to supplement food for their family.

From the discussion made so far, negative effect of farm size on the farmer's preference for the intervention of access to wild food improvement can be argued from five directions. Firstly, the two sectors are complementary in providing food for household consumption. As noted under the discussion mad on the effect of family size, it is clear that wild food is mainly used by those farmers who have large family size and who may fail to feed his family. Hence, natural ecosystem is supplementing food provision of crop farming. In order to make the scene more clear, it is important to remember the discussion made on the effect of higher education level in relation to supplementary function of wild food in order to insure household's livelihood. Discovered effect of land holding on farmer's preference for natural resource management intervention costing them revealed the supplementary function of wild food for food crop and strengthened the finding discussed so far.

Secondly, the effect of the two variables discussed also have been seen in relation to shading the light on the nature (superiority or inferiority) of the two sectors products; wild food and food crop. Looking at the three variables effects altogether, similar to the first two variables the third variable indicates as farmers give inferior goods position for wild food. Because, farmers who have larger land holding prefer to invest more of their capital and labour on crop production than investing on natural resource management intervention to get more and sustainable wild food. This is indicated as those farmers having large size of land holding derives negative utility from investing or asked a cost of insuring sustainability of wild food to access.

Thirdly, household could not control wild food. Its property right is not given to individuals. The return to investment of household is not secured to the investing party. Hence, the benefit and return of investing to insure wild food to access could not be reliable and manageable to feed those investing household's family.

Fourthly, the two sectors are competitive in their labour and capital investment. This means, allocation of labour and/or capital to natural resource management would reduce the allocation of those resources in crop farming. Hence, for those farmers constrained with labour and/or capital holding due to large farm size which needs them to invest more of such inputs, farmers have to make allocation tradeoffs. The rational decision they are expected to make is to invest more on more preferred and returning enterprise. As so far discussed, wild food is inferior food as compared to food crop. Furthermore, the return from crop farming is more secured and only harvested by the investing party. As a result those farmers having large farm size want to use or invest more of their labour and capital on their farm. Therefore, a competitive nature of natural resource management intervention competing with crop production on inputs and resources (labour and capital) would partly explain the negative demand that farm households having large land holding derive from intervention of natural resource management costing farmers in order to secure the availability of wild food. On farm investment and shift it to natural resource management.

Finally, it is important to deal with the possible effect of experience of farmer's crop production on large size land where they learned as it is rewarding. Having such experience may encourage them to opt for larger farm land. This may give a precedence of expanding their farm land to natural resource endowed land since crop farming is more rewarding than the natural ecosystem. But, contrasting crop land expansion, natural resource management intervention pursuing insurance of access to wild food inhibits the expansion of farmland expansion. Therefore, natural resource management intervention inhibiting farmland expansion induces opportunity cost to farm households restricting them at their current land holding and enforcing them to abstain what benefit they would get by farmland expansion. This is second and additional cost to farmers, since the first is requested in cash and/or labour in order to be the member of beneficiary group.

The strength of this argument can be uncovered by simultaneously looking at the effect of two more variables in the model. These are number of men age between 14-64 in the household and participation of farmers in the rural labour market. The group discussion held with different groups of farm families in the study area clarified men age between 14 14-64 in the household mainly mange crop farming whilst collection of wild food is entirely the responsibility of females in this age rage in the household. The result showing negative preference of farm households having large number of male age between 14 14-64 for natural resource management intervention costing them and ensuring wild food access indicates the competition of crop production and natural resource management for working labour. Similarly, farmers who engaged in labour market derive negative utility from natural resource management intervention requiring them to contribute management cost and/or inputs. It is important to clearly state as farmers who engaged in rural labour market only hire in labourer and not hire out their labour. Hence, those farmers who hire in labourer derive negative utility from natural resource management intervention asking them to contribute cost of natural resource management and/or input. This further indicates the competition of both sectors for inputs.

In general, it is possible to conclude the argument by summarizing the intuitive and empirical meaning of the effect of family size and land holding size on farmer's preference and demand for natural resource management intervention ensuring access to wild food. To conclude, the effect of these variables on the farmer's preference and demand for natural resource management intervention in general and the pursuit of intervention to ensure access to wild food can be clearly defined through investigating the economics of complementary and competitive enterprises. Hence, the two sectors are complementary in providing food for farm household family. As a result, those farm households having large family size and requiring to have large size of food derives positive utility from natural resource management intervention opting for ensuring sustainability of ecosystems' wild food provision service to access even if it requires them to provide input or management cost of the resource. On the other hand, in using inputs (i.e. land, labour and capita), the two sectors competes each other. Hence, the effect of farm holding of farm households on the farmer's preference for natural resource management intervention ensuring ecosystem wild food provision service to access is negative. Because, it is thoroughly discussed as large farm size requires large size of inputs and the management cost need of ecosystem competes for capital that crop farming make use of it. The strength and evidence supporting this argument was found from empirical result of other variables in the model.

Furthermore, the relationship between factors affecting productivity of crop farming and access to wild food attributes shade a light on further variable justifying the interpretation of the results and respective discussion. For instance, shortage of farm land and deterioration of soil fertility reduce crop productivity. In line with this, farm households who reported their farms' soil fertility deterioration as the problem of households' crop production problem derives positive utility from an intervention which can sustain wild food availability to access regardless of the cost it request them. This is further evidence for complementary relationship of crop production and ecosystem food provision service. Because, farmers positively demand to invest in ecosystem so that the ecosystem will provide them wild food to supplement their crop production which is impotent to provide them sufficient food due to soil fertility deterioration.

Other than demographic, economic holding and economic activities of farm households, their ecological resource use experience also has a potential to govern farmer's ecological resource attributes preference heterogeneity. For instance, those farmers who have an experience of using wild kocho for food derives negative utility from natural resource intervention requesting them cost of management. This result is not in line with prior expectation since experience of farmers on using wild food was expected to positively relate with farmers preference for natural resource improvement intervention. However, this result could be attributed with the characteristics of kocho. It is possible to cultivate on farm. Particularly, now days, it is mainly produced on farm and kocho on farm production gives sole property right for the cultivator. Hence, farmers having this knowledge would prefer to cultivate the enterprise on their own farm rather than contributing their production capital in order to ensure regeneration of wild kocho which is open access to anyone who is interested to harvest it. The effect of farmer's experience of using wild kocho on the demand of farmers for an intervention which improves Bamboo for market can be explained in similar way.

On the other hand, farmers who have an experience of using Bamboo bud for food and those who are using medicinal plants derive positive utility from natural resource improvement intervention which ensures access to wild food even if it requests them to contribute for management cost and/or inputs. This is in line with the prior expectation. Because, those farmers who have such experience have the knowledge on how wild food is important during food crop failure due to different calamities. Furthermore, the effect of farmer's medicinal plant using experience on farmer's demand for medicinal plant for domestic use and Bamboo for market can be interpreted and discussed in the same way.

The importance of empirical results of the other variables in the model is attributed to their ability to indicate the effect of market on ecosystem management intervention demand of farm households. For instance, farmers who participate in cash crop production prefer and derive positive utility from ecosystem management intervention which insures medicinal plant for domestic use regardless of the cost an intervention requests them. Though medicinal plant for market is not as such important in the livelihood of the farm households of the area, there is understanding of farmers to have its market in future. The contribution that intervention of medicinal plant project of Ethiopian institute of biodiversity (EIB) induced in the area is paramount to initiate this farmers understanding. It is working to establish market value chain for the venture and farmers of the area hopefully opt for its full establishment. In agreement with this, those farmers who have experience of cash crop production positively demand an intervention sustaining medicinal plant for domestic use which one day in the future they would cultivate as cash crop. Hence, they demand its existence having a willingness to pay for what an intervention ensuring its availability costs.

On the other hand, those farmers who complained absence of natural resource management in the study area derive positive utility from an intervention which ensures marketability attribute of medicinal plant. This indicates that if marketability of medicinal plant is ensured, farmers will to manage the ecosystem to harvest medicinal plant paying what management intervention costs. This result proves the importance of market power to lead ecosystem management (Tabel 24).

In opposite to this two important factors showing market power as to initiating farmers willingness to participate in ecosysm management intervention, farmers who have an experience of hunting wild life derive negative utility from an intervention ensuring Bamboo for market attribute. This can be argued positioning on the impact that market can have on Bamboo forest. If Bamboo market is well established, there could be farmer's intensive Bamboo harvest and intervention in the forest. This could disturb wild life in the forest and could enforce them to escape the area. Those farmers who have experience of hunting might have seen before as how the intervention of people enforced wild life to escape their home Bamboo forest. Thus, they reasonably indicated their negative preference for market intervention promoting marketability and peoples' intensive intervention in managing Bamboo forest.

Generally, it is possible to see the difficulty of finding ecosystem management option which is *de facto* to satisfy all characteristics and experience of farmers. What is important is to know how farmers behave regarding ecosystem management intervention projects and how management interventions affects farmer's livelihood. Furthermore, such analysis indicates how much could be the impact of interventions on the livelihood of farmers. Therefore, this part of the study thoroughly indicated what characteristics of farmers governed ecological resource attributes demand of individual farmers and what further determines the heterogeneity of demand of ecological resource attributes at community level. This result was in agreement with the study of Kaffashi *et al.* (2012), applied choice experiment valuation method on Shadegan international wetland ecosystem services located in southern part of Iran, and reported, after interaction analysis, that socioeconomic background (i.e. age, Education level, household size and gender) were to be determinants of demand heterogeneity that influence respondents preference.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Anbesa forest and Tullu Dimtu mountain ecosystems in Benishangul Gumuz, Western Ethiopia provide a wide range of valuable services to the surrounding communities. Their livelihood highly depends on the ecosystems functions and ecological resources. Hence, insuring improved livelihood of the communities and economic development of the area at large without sustenance of ecological resource is difficulty achievable.

Applying valuation study on ecological resource attributes using choice experiment renders a lot of information, which can be used in formulation of natural resource conservation planning. This thesis employed choice experiment approach in order to investigate community's ecological resource valuation. The study uncovered interesting results and evaluated users preference using different conservation typologies designed with an assumption of ensuring ecosystem sustainability and enhance its service provision so that it increases community's welfare at large. Such empirical analysis approach is more plausible in its methodological set up since it provides a chance of involvement for all stockholders so that they reflect their choice decision which is invaluable input in investigating determinants of ecological resource preference that can be used in conservation planning and implementation.

Moreover, it avoids blindly application of conservation intervention technologies and paves a way to identify area of interest of local community to be incorporated in the plan intended. For long lasting of conservation interventions and insurance of development, recommended contemporary approach is bottom up and participatory. Thus using choice experiment approach fulfils the recommended technique in presenting the reality of ecological resource utilization scenario of the study area and the trade off made by respondent (farmers) so far to acknowledge their choice decision.

In doing so, a total of 125 households from the Anbesa forest proximate kebles and 122 households from Tullu Dimtu ecosystem dwellers were selected and surveyed based on random sampling procedures. In this study, three data generating tool was used at both study sites (Anbesa forest and Tullu Dimtu ecosystems) and analyzed accordingly.

First, in relation to first objective of this study, PRA tool is employed to differentiate more relevant component of ecological resources in affecting community's livelihood and ecosystems' functioning. Second, to address the second objective of this study, choice experiment was carried out to elicit willingness to pay of households in order to estimate values attached to ecological resource attributes. In this especial tool, the respondents were presented with choice cards comprising different ecological resources attributes and attribute levels for choice decision data generation. Finally, socioeconomic data was gathered from each respondent using structured questioner to have full personal information of the households that is needed in the analysis of determinants of preference heterogeneity, which addresses the third and the final objective of the study on hand.

The result of a data collected using PRA tools (such as likert scale and pair wise comparison) point out that Bamboo harvest level, marketability of Bamboo, availability of medicinal plant, marketability of medicinal plant and availability of wild food were more relevant livelihood base components of ecological resources for community nearby Anbesa forest. With the same fashion Grass for roofing, Bamboo harvest level, availability of water (measured in terms of distance to residential place) and grazing service of Grass (measured in terms of level of cattle) were identified as more relevant components of ecological resources for Tullu Dimitu ecosystem beneficiary households.

Following, mixed logit model was fitted as it has a capability of handling repeated observation data generated with choice experiment card, to analyze the discrete choice outcomes and to know impacts of ecological resource attributes on respondent's choice preference and average marginal willingness to pay of the households for the attributes. Furthermore, mixed logit model estimates respondents' ecological resource attributes preference and preference heterogeneity (as a factor of personal backgrounds) towards the attribute considered in choice scenarios simultaneously.

At both Anbesa forest and Tullu Dimtu ecosystems, the result of choice experimental models revealed positive sign for all ecological resources attributes. This obviously shows as choice decision makers drive positive utility from the improvement of ecological resources. However, preference heterogeneity is identified using mixed logit (MXL) model result for all ecological resource attributes except for Bamboo for domestic use at Anbesa forest ecosystem. In contrast, non-heterogeneity of users' preference was found for ecological resource attributes in the Tullu Dimtu ecosystems except Grass for domestic use and access to water service attribute. Following the identification of household's preference heterogeneity for the attributes, sources of farm household's preference heterogeneity have been investigated by fitting conditional logit model on a data generated by interaction of ecological resource attributes and socio economic variables. The result indicated the importance of considering respondents' socio-economic background disparity and treating it accordingly in any conservation intervention planning.

Furthermore, under Mixed logit model result, the estimate of ecological resource attributes WTP/IP shows that Tullu Dimtu ecosystem respondents (farmers) attached a value to the attributes, which is equal to their marginal willingness to pay (WTP/IP). The average monetized value that they attached to the ecological resource attributes are 48.013, 5.699, 40.853, 4969.132 and 3702.781 ETB for grazing service of the ecosystem per head of cattle, per stick of Bamboo harvest for domestic use, per a load of Grass for domestic use, Water## and Water# (using distance as proxy estimation) respectively. Following the same modelling activity for Tullu Dimtu ecosystem respondent data, the Mixed logit model result famers' marginal willingness to pay at Anbesa forest ecosystem estimated to be 6.195, 2847.353, 711.837, 743.567 and 867.117 ETB to a stick of Bamboo harvest for domestic use, access to wild food, medicinal plant for domestic use, medicinal plant for market and Bamboo for market respectively.

This result confirms the community's valuation of these resources distributed in the both ecosystems. It is indicative result that the societies of the study area fully relay on these resources. Hence, if emphasis is given to improve these resources, it will be warmly accepted and the communities will participation conservation intervention practices improving the ecosystem service considered in this study.

5.2. Recommendation

Given that the ecological resource attributes supplied by Anbesa forest and Tullu Dimtu ecosystems play a great roll in livelihood making to both communities of the area, thus, farmers are willing to pay for the conservation interventions potentially improving and insuring the sustainability of the resources considered. Water resource is extremely vital component of the ecosystem’s resource base without which life cannot sustain. Furthermore, Bamboo is worthwhile resource well known worldwide. But, considerable degradation undergo on the resource in the study area. Likewise, Grass for roofing and grazing are the ecosystem assets supporting rural households in their shelter making and cattle feeding which their economy depends on at large. Medicinal plant availability and marketability attribute receive significant concern from Anbesa forest beneficiary stockholders as a result of promotion effort made so far like training, supplying medicinal plant seedling and establishing medicinal plant production cooperative by Ethiopian institute of biodiversity under medicinal project team.

Based on empirical results of this study, respondents’ response implies that any concerned body either government or non government could generate inputs (labour force or money) from stockholders (farmers of the study area) so as to improve, enhance and manage the attributes of the ecosystems resources understudy. Therefore, taking the finding in to account the following recommendations are forwarded.

1. In order to curve ecological resource degradation induced problems and to scale up utility of the community at the study area (Anbesa forest and Tullu Dimtu ecosystem) a reliable conservation work ensure service sustainability and improving ecological resource need to be implemented. This can be addressed, when the planning provide more focus to the enhancement of the attributes considered in this study like Bamboo for domestic use and for market, medicinal plant for domestic use and for market at the same time linking them with respective market outlet.

2. The value that respondents attached to each attribute implies the willingness of the community to responsible for any externality caused through their economic activity. So, depending on this result encouraging the community of the study area to pay and use for ecological resource should be established to solve the degradation problem that ever increasing in the study area in using for conservation work what the community pays for using of the resource.

3. Since farmers of the study area those who have perceived that the lack of natural resource management imposes the existing degradation preferred a conservation work of medicinal plant for market positively, considering this portion of the community is essential during conservation work. Moreover, it can produce positive result in due course of the conservation practice since they are the portion of the community, even they can persuade their partner to involve in the same work.

4. Access to water service variable receives higher coefficient and value than the other attribute at Tullu Dimtu ecosystem. From this result one can understand the degradation of the water resource is serious in study area. Thus, focusing on water resource conservation work at the Tullu Dimtu renders a lot of utility for the community, enhances the community participation in conservation work and keeps sustainability of the resource up. Moreover, identifying and protecting water points through establishing buffer zones with recommended distance and launching upper stream rehabilitation work along with community participation is more important to achieve sustainability of water resource at the study area.

5. In this study result, education is one of the households background (socioeconomic characteristics) and the educated (read and write) respondent positively preferred ecological resource use and management scenario. Thus, training should be given to the community of the study area on the sustainable use and conservation work of the ecological resource attributes considered in this study.

6. Detail discussion and awareness creation is required to the portion of community, particularly for those farmers who were identified to derive negative utility (i.e participating in rural labour market, using wild life meat and using wild Kocho for food) from investing on insuring sustainable ecological resource use. This is important to convince whatever suspicion they have and encourage them to participate in conservation interventions in order to enrich the ecosystem with species they required it to have. Furthermore, convincing the community is important to implement conservation interventions without any barrier even if they did not provide resource for the implementation of intervention projects.

7. Generally, since the study areas are located in the upper stream of Blue Nile (Abay of Ethiopia) and the ecological resource conservation work benefit go farther beyond the need of local communities (infiltration enhancement and soil loss control to reduce siltation of the grand renascence hydroelectric dam), government should emphasis on participatory conservation works like (improvements of Bamboo through plantation for domestic use) to be undertaken in the upper stream in collaboration with local community of Tullu Dimtu and Anbesa forest ecosystems.

REFERENCES

Adamowicz, W., Swait, J., Boxall, P., Louviere, J. and Williams, M., 1997. Perceptions versus objective measures of environmental quality in combined revealed and stated preference models of environmental valuation. *Journal of environmental economics and management*, *32*(1): 65-84.

Alemu Mekonnen, 2000. Valuation of community forestry in Ethiopia: a contingent valuation study of rural households. *Environment and Development Economics*, *5*(03): 289-308.

Amsalu, A., Stroosnijder, L. and de Graaff, J., 2007. Long-term dynamics in land resource use and the driving forces in the Beressa watershed, highlands of Ethiopia. *Journal of Environmental Management*, *83*(4): 448-459.

Arjunan, M., Holmes, C., Puyravaud, J.P. and Davidar, P., 2006. Do developmental initiatives influence local attitudes toward conservation? A case study from the Kalakad–Mundanthurai Tiger Reserve, India. *Journal of Environmental Management*, *79*(2): 188-197.

Ayalneh Bogale, 2011. Valuing natural forest resources: an application of contingent valuation method on Adaba-Dodola Forest Priority Area, Bale Mountains, Ethiopia. *Journal of Sustainable Forestry*, *30*(6): 518-542.

Barnosky, A.D., Hadly, E.A., Bascompte, J., Berlow, E.L., Brown, J.H., Fortelius, M., Getz, W.M., Harte, J., Hastings, A., Marquet, P.A. and Martinez, N.D., 2012. Approaching a state shift in Earth/'s biosphere. *Nature*, *486*(7401): 52-58.

Befikadu Beyene, L., 2015.Determinants of WTP and WTA in Watershed Management: For Linking Land Tenure, Use and Shared Prosperity in A PES intervention in the Blue Nile Basin, Ethiopia. 42p. Paper presented at World Bank Conference on Land and Poverty. *Washington DC*, 23-27 March, 2015, the World Bank.

Biazin, B. and Sterk, G., 2013. Drought vulnerability drives land-use and land cover changes in the Rift Valley dry lands of Ethiopia. *Agriculture, ecosystems & environment*, *164*: 100-113.

Birol, E., Karousakis, K. and Koundouri, P., 2006. Using economic valuation techniques to inform water resources management: A survey and critical appraisal of available techniques and an application. *Science of the Total Environment*, *365*(1): 105-122.

Birol, E., Koundouri, P. and Kountouris, Y., 2008. Using economic valuation techniques to inform water resources management in the southern European, Mediterranean and developing countries: pp.135-155. In Coping with Water Deficiency. A survey and critical appraisal of available techniques. Springer Netherlands.

Boettcher, P.J., Tixier-Boichard, M., Toro, M.A., Simianer, H., Eding, H., Gandini, G., Joost, S., Garcia, D., Colli, L.I.C.I.A. and Ajmone-Marsan, P.A.O.L.O., 2010. Objectives, criteria and methods for using molecular genetic data in priority setting for conservation of animal genetic resources. *Animal Genetics*, *41*: .64-77.

Bourassa, S.C., Hoesli, M. and Sun, J., 2006. A simple alternative house price index method. *Journal of Housing Economics*, *15*(1): 80-97.

Boxall, P.C., Adamowicz, W.L., Swait, J., Williams, M. and Louviere, J., 1996. A comparison of stated preference methods for environmental valuation. *Ecological economics*, *18*(3): 243-253.

Boyd, J. and Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, *63*(2): 616-626.

Braat, L.C. and de Groot, R., 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, *1*(1): 4-15.

Brander, L.M., Florax, R.J. and Vermaat, J.E., 2006. The empirics of wetland valuation: a comprehensive summary and a meta-analysis of the literature. *Environmental and Resource Economics*, *33*(2): 223-250.

Brander, L.M., Van Beukering, P. and Cesar, H.S., 2007. The recreational value of coral reefs: a meta-analysis. *Ecological Economics*, *63*(1): 209-218.

Brouwer, R., Dekker, T., Rolfe, J. and Windle, J., 2010. Choice certainty and consistency in repeated choice experiments. *Environmental and Resource Economics*, *46*(1): 93-109.

Celine.N.. and Caroline.Van Den B., 2009. Demand for piped and non-piped water supply services: Evidence from southwest Sri Lanka. *Environmental and Resource Economics*, *42*(4): 535-549.

Champ, P.A. and Bishop, R.C., 2001. Donation payment mechanisms and contingent valuation: an empirical study of hypothetical bias. *Envi. and R. Economics*, *19*(4): 383-402.

Christie, M., Fazey, I., Cooper, R., Hyde, T. and Kenter, J.O., 2012. An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. *Ecological economics*, *83*: 67-78.

Christie, M., Hanley, N., Warren, J., Murphy, K., Wright, R. and Hyde, T., 2006. Valuing the diversity of biodiversity. *Ecological economics*, *58*(2): 304-317.

Cochran, W. G., 1977. Sampling techniques (3 rd ed). John Wiley & Sons, New York. 442p.

Coyles, S. and Gokey, T.C., 2002. Customer retention is not enough. *The McKinsey Quarterly*, *2*(2): 81-89.

Currano, E.D., Jacobs, B.F., Pan, A.D. and Tabor, N.J., 2011. Inferring ecological disturbance in the fossil record: a case study from the late Oligocene of Ethiopia. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *309*(3): 242-252.

Dambala Gelo, and Koch, S.F., 2012. Does one size fit all? Heterogeneity in the valuation of community forestry programs. *Ecological Economics*, *74*: 85-94.

De Groot, R.S., Alkemade, R., Braat, L., Hein, L. and Willemen, L., 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity*, *7*(3): 260-272.

Dessie, G. and Kleman, J., 2007. Pattern and magnitude of deforestation in the South Central Rift Valley Region of Ethiopia. *Mountain research and development*, *27*(2): 162-168.

Dikgang, J. and Muchapondwa, E., 2013. The economic valuation of dryland ecosystem services in the South African Kgalagadi by the local communities. *Environment for Development Discussion Paper Resources for the Future (RFF)*. 13-15.

Ethiopia, C.S.A., 2008. Summary and statistical report of the 2007 population and housing census. *Federal democratic republic of Ethiopia population census commission, Addis Ababa, Ethiopia*. 133p.

FAO, 2010. Global Forest Resources Assessment. Agriculture Organisation, Rome, Italy. 378p.

FAO, I. and Isric, I., 2009. JRC: Harmonized World Soil Database (version 1.1): 43p. *FAO, Rome, Italy and IIASA, Laxenburg, Austria*.

Font, A.R., 2000. Mass tourism and the demand for protected natural areas: a travel cost approach. *Journal of environmental economics and management*, *39*(1): 97-116.

Gayatri. A. and Edwared. B., 2002. Using Domestic Water Analysis to Value Groundwater Recharge in the HadejiaJamaare Floodplain, Northern Nigeria. *American Journal of Agricultural Economics*, *84*(2): 415-426.

Geoghegan, J., 2002. The value of open spaces in residential land use. *Land use policy*, *19*(1): 91-98.

Gete Zeleke and Hurni, H., 2001. Implications of land use and land cover dynamics for mountain resource degradation in the Northwestern Ethiopian highlands. *Mountain research and development*, *21*(2): 184-191.

Getnet Birhanu 2012. *Valuation of Choke Mountain Range Wetland Ecosystem, East Gojjam, Amhara Region, Ethiopia: Application of Choice Experiment Valuation Method.* An MSc Thesis presented to the School of Graduate Studies of Addis Ababa University. 100p

Girma Kassie, T., Abdulai, A. and Wollny, C., 2012. Estimating the worth of traits of indigenous breeds of cattle in Ethiopia. *intech open access publisher*, 78: 337-360.
Gonzalez, C., Johnson, N. and Qaim, M., 2009. Consumer Acceptance of Second-Generation GM Foods: The Case of Biofortified Cassava in the North-east of Brazil. *Journal of Agricultural Economics*, *60*(3): 604-624.

Hanley, N., Mourato, S. and Wright, R.E., 2001. Choice Modelling Approaches: A Superior Alternative for Environmental Valuatioin?. *Journal of economic surveys*, *15*(3): 435-462.

Hanley, N., R.E. Wright and V. Adamowicz. 1998. Using choice experiments to value the environmental. Environmental and Resource Economics, 11: 413-428.

Hanley, N., R.E. Wright and V. Adamowicz. 1998. Using choice experiments to value the environmental. Environmental and Resource Economics, 11: 413-428.

Hanley, N., Wright, R.E. and Alvarez-Farizo, B., 2006. Estimating the economic value of improvements in river ecology using choice experiments: an application to the water framework directive. *Journal of environmental management*, *78*(2): 183-193.

Harrison, G.W., 2006. Experimental evidence on alternative environmental valuation methods. *Environmental and Resource Economics*, *34*(1): 125-162.

Heal, G., 2000. Valuing ecosystem services. *Ecosystems*, *3*(1): 24-30.

Heary, C.M. and Hennessy, E., 2002. The use of focus group interviews in pediatric health care research. *Journal of Pediatric Psychology*, *27*(1): 47-57.

Hensher, D.A. and Greene, W.H., 2003. The mixed logit model: the state of practice. *Transportation*, *30*(2): 133-176.

Hensher, D.A., Rose, J.M. and Greene, W.H., 2005. Applied choice analysis: a primer. p717. Cambridge University Press.

Hoekstra, A.Y., 2009. Human appropriation of natural capital: A comparison of ecological footprint and water footprint analysis. *Ecological Economics*, *68*(7):196 3-1974.

Howard, K. and Salkeld, G., 2009. Does attribute framing in discrete choice experiments influence willingness to pay? Results from a discrete choice experiment in screening for colorectal cancer. *Value in Health*, *12*(2): 354-363.

Howarth, R., and Farber, S., 2000. Accounting for the value of ecosystem services. *Ecological Economics*, 41:421–429.

Hoyos, D., 2010. The state of the art of environmental valuation with discrete choice experiments. *Ecological economics*, *69*(8), pp.1595-1603.

Hurni, H., Tato, K. and Zeleke, G., 2005. The implications of changes in population, land use, and land management for surface runoff in the upper Nile basin area of Ethiopia. *Mountain Research and Development*, *25*(2): 147-154.

Johnson, R.B., Onwuegbuzie, A.J. and Turner, L.A., 2007. Toward a definition of mixed methods research. *Journal of mixed methods research*, *1*(2), pp.112-133.

Kaffashi, S., Shamsudin, M.N., Radam, A., Yacob, M.R., Rahim, K.A. and Yazid, M., 2012. Economic valuation and conservation: Do people vote for better preservation of Shadegan International Wetland?. *Biological Conservation*, *150*(1). 150-158.

Kallas, Z., Gomez-Limón, J.A. and Hurle, J.B., 2007. Decomposing the value of agricultural multifunctionality: combining contingent valuation and the analytical hierarchy process. *Journal of Agricultural Economics*, *58*(2): 218-241.

Kenessey, Z., 1987. The primary, secondary, tertiary and quaternary sectors of the economy. *Review of Income and Wealth*, *33*(4): 359-385.

Kontogianni, A., Luck, G.W. and Skourtos, M., 2010. Valuing ecosystem services on the basis of service-providing units: A potential approach to address the ‘endpoint problem and improve stated preference methods. *Ecological Economics*, *69*(7): 1479-1487.

Kontoleon, A. and Yabe, M., 2003. Assessing the impacts of alternative ‘opt-out’ formats in choice experiment studies: consumer preferences for genetically modified content and production information in food. *Journal of Agricultural policy and Resources*, *5*(1): 1-43.

Kotchen, M.J. and Reiling, S.D., 2000. Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species. *Ecological Economics*, *32*(1): 93-107.

Krueger, R.A. and Casey, M.A., 2002. Designing and conducting focus group interviews. *Social Analysis, Selected Tools and Techniques*, 1: 4-23.

Kumar, P., 2010. *The Economics of Ecosystems and Biodiversity: ecological and economic foundations*. p410. UNEP/Earthprint.

Lancaster, K.J., 1966. A new approach to consumer theory. *The journal of political economy*, 74: 132-157.

Lang, P., Jeschke, M., Wommelsdorf, T., Backes, T., Lv, C., Zhang, X. and Thomas, F.M., 2015. Wood harvest by pollarding exerts long-term effects on Populus euphratica stands in riparian forests at the Tarim River. *Forest Ecology and Management*, *353*: 87-96.

List, J.A. and Gallet, C.A., 2001. What experimental protocol influence disparities between actual and hypothetical stated values?. *Environmental and Resource Economics*, *20*(3): 241-254.

Long, B.T., 2004. How have college decisions changed over time? An application of the conditional logistic choice model. *Journal of Econometrics*, *121*(1): 271-296.

MA, 2005. Millennium Ecosystem Assessment. Island Press, Washington, DC. 155p.

Markandya, A., Harou, P., Bellù, L.G. and Cistulli, V., 2002. Environmental economics for sustainable growth: A handbook for practitioners. Edward Elgar Publishing Ltd, USA. 567pp.

McFadden, D. and Train, K., 2000. Mixed MNL models for discrete response. *Journal of applied Econometrics, 15*(5): 447-470.

McFadden, D., 1974. The measurement of urban travel demand. *Journal of public economics*, *3*(4): 303-328.

McFadden, D., 2001. Economic choices. *The American Economic Review*, *91*(3): 351-378.

McNeely, J.A., 1993. Economic incentives for conserving biodiversity: lessons for Africa. *Ambio*, 1: 144-150.

Muller, F. and Burkhard, B., 2012. The indicator side of ecosystem services. *Ecosystem Services*, *1*(1): 26-30.

Nega Assefa, 2012. Valuing the Economic Benefit of Irrigation Water: Application of Choice Experiment and Contingent Valuation Methods to Ribb Irrigation and Drainage Project in South Gonder, Ethiopia. An MSc Thesis presented to the School of Graduate Studies of Addis Ababa University. 107p.

Nyssen, J., Poesen, J., Moeyersons, J., Haile, M. and Deckers, J., 2008. Dynamics of soil erosion rates and controlling factors in the Northern Ethiopian Highlands–towards a sediment budget. *Earth surface processes and landforms*, *33*(5): 695-711.

Perman, R. M., James McGilvray, and Michael Common, 2003. Ecological resource and Environmental Economics. p525. UK. Pearson Education Limited.

Randall, A., 1994. A difficulty with the travel cost method. *Land economics,*70(1): 88-96.

Salles, J.M., 2011. Valuing biodiversity and ecosystem services: Why put economic values on Nature?. *Comptes rendus biologies*, *334*(5): 469-482.

Scarpa, A., 2001. Community violence exposure in a young adult sample. Lifetime prevalence and socioemotional effect. Journalof interpersonal violence, 16: 36-53.

Sebsebe Demissew, Nordal, I., Herrmann, C., Friis, I., Awas, T. and Stabbetorp, O., 2005. Diversity and endemism of the western Ethiopian escarpment-comparison with other areas of the. In *Plant Diversity and Complexity Patterns: Local, Regional, and Global Dimensions. Pp.315-330. Proceedings of an International Symposium Held at the Royal Danish Academy* *of Sciences and Letters in Copenhagen, Denmark, 25-28 May, 2003.* Kgl. Danske Videnskabernes Selskab.

Semeneh Bessie, 2015. *Collective Action, Property Rights and Bamboo Deforestation in Benishangul-Gumuz Region, Ethiopia.* A Doctoral dissertation presented to the School of Graduate Studies of Haramaya University. 204p.

Shrestha, R.K., Seidl, A.F. and Moraes, A.S., 2002. Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models. *Ecological economics*, *42*(1): 289-299.

SID. 2010. Market Assessment and Value Chain Analysis in Benishangul Gumuz Regional State, Ethiopia. 95p.

Sinafikih Asrat, Yesuf, M., Carlsson, F. and Wale, E., 2010. Farmers' preferences for crop variety traits: Lessons for on-farm conservation and technology adoption. *Ecological Economics*, *69*(12): 2394-2401.

Sobrevila, C., 2008. The Role of Indigenous Peoples in Biodiversity Conservation: The Natural but Often Forgotten Partners. World Bank, Washington, D.C. 102p.

Soliva, R., Bolliger, J. and Hunziker, M., 2010. Differences in preferences towards potential future landscapes in the Swiss Alps. *Landscape Research*, *35*(6): 671-696.

Sottile, G.D., Meretta, P.E., Tonello, M.S., Bianchi, M.M. and Mancini, M.V., 2015. Disturbance induced changes in species and functional diversity in southern Patagonian forest-steppe ecotone. *Forest Ecology and Management*, *353*: 77-86.

Tadesse Getachew, Zavaleta, E., Shennan, C. and FitzSimmons, M., 2014. Prospects for forest-based ecosystem services in forest-coffee mosaics as forest loss continues in southwestern Ethiopia. *Applied Geography*, *50*: 144-151.

Teddlie, C. and Yu, F., 2007. Mixed methods sampling a typology with examples. *Journal of mixed methods research*, *1*(1), pp.77-100.

Tefera Mengistu, T., 2006. Frontier community valuation for forest patches: The case of Wondo-wosha sub catchment southern nations, nationalities and peoples region, Ethiopia. *Ethiopian Journal of Natural Resources*, *8*(2): 281-93.

Tegegne Sishaw E., 2014. Population dynamics and its impact on land use/ cover in Ethiopia: the case of Manduara Disctrict of Metekel Zone, Benshangul- Gumuz Regional State. Doctoral dissertation presented to the School of Graduate Studies of University of South Africa. 198p.

Thakur, M.P., Reich, P.B., Fisichelli, N.A., Stefanski, A., Cesarz, S., Dobies, T., Rich, R.L., Hobbie, S.E. and Eisenhauer, N., 2014. Nematode community shifts in response to experimental warming and canopy conditions are associated with plant community changes in the temperate-boreal forest ecotone. *Oecologia*, *175*(2): 713-723.

Thurstone, L. L., 1927. A law of comparative judgment. Psychological Review, 34:273-286.

Tsegaw Abebe, Aseffa seyoum and Debela Hunde, F., 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*, 3(3): 060-068.

Tsegaye Diress, Moe, S.R., Vedeld, P. and Aynekulu, E., 2010. Land-use/cover dynamics in Northern Afar rangelands, Ethiopia. *Agriculture, ecosystems & environment*, *139*(1): 174-180.

Turner, R. K., J. Paavola, P., Cooper, S. Farber, V. Jessamy, and S. Georgiou, 2003. Valuing nature. lessons learned and future research directions. *Ecological Economics*, 46: 493-510.

Van Lierop, P., Lindquist, E., Sathyapala, S. and Franceschini, G., 2015. Global forest area disturbance from fire, insect pests, diseases and severe weather events. *Forest Ecology and Management*, *352*: 78-88.

Virtanen, R., Luoto, M., Rämä, T., Mikkola, K., Hjort, J., Grytnes, J.A. and Birks, H.J.B., 2010. Recent vegetation changes at the high-latitude tree line ecotone are controlled by geomorphological disturbance, productivity and diversity. *Global Ecology and Biogeography*, *19*(6): 810-821.

Wattage, P. and Mardle, S., 2008. Total economic value of wetland conservation in Sri Lanka identifying use and non-use values. *Wetlands ecology and management*, *16*(5), pp.359-369.

Weiqi, C., Huasheng, H.O.N.G., Yan, L., Zhang, L., Xiaofeng, H.O.U. and Raymond, M., 2004. Recreation demand and economic value: An application of travel cost method for Xiamen Island. *China Economic Review*, *15*(4): 398-406.

Zander, K.K. and Drucker, A.G., 2008. Conserving what's important: using choice model scenarios to value local cattle breeds in East Africa. *Ecological Economics*, *68*(1): 34-45.

APPENDIX A

I. Selected relevant ecological resource and selection procedure

Table 1. List of natural resource use constraints and problems at Tullu Dimtu

No.	Natural resource use constraints and problems	No.	Natural resource use constraints and problems
1	Low availability of Grass for grazing	6	Low availability of construction material
2	Low availability of Grass for housing	7	Low forest cover due to deforestation
3	Low availability of water in dry season	8	Low availability of fuel wood
4	Low availability of construction Bamboo	9	Deterioration of flowering tree
5	Low availability of Bamboo for grazing		

Source: own survey, 2014

Table 2. Llist of natural resource use constraints and problems at Anbesa forest

No.	Natural resource use constraints and problems	No.	Natural resource use constraints and problems
1	Low availability of medicinal plants	6	Low availability of fuel wood
2	Low marketability of medicinal plant	7	Low marketability of Bamboo
3	Low availability of wild food	8	Low availability bee colony
4	Low availability of Bamboo for construction	9	Absence enough farm land
5	Low availability of Grass for grazing	10	Low productivity of farm land

Source: own survey, 2014

Table 3. Pair wise comparison of natural resource use problems listed at Tullu Dimtu

Problems	1	2	3	4	5	6	7	8	9	Frequency	Rank
1	X	2	3	4	1	1	1	1	1	5+1=6	4
2		X	3	2	2	2	2	2	2	7+1=8	2
3			X	3	3	3	3	3	3	8+1=9	1
4				X	4	4	4	4	4	6+1=7	3
5					X	6	5	5	5	3+1=4	6
6						X	6	6	6	4+1=5	5
7							X	7	7	2+1=3	7
8								X	9	0+1=1	9
9									X	1+1=2	8

Source: own survey, 2014

Table 4. pair wise comparison of natural resource use problems listed at Anbesa forest

Problems	1	2	3	4	5	6	7	8	9	10	Frequency	Rank
1	X	1	3	1	1	1	1	1	1	1	6+1=9	2
2		X	3	2	2	2	2	2	2	2	8+1=8	3
3			X	3	3	3	3	3	3	3	9+1=10	1
4				X	4	4	4	4	4	4	7+1=7	4
5					X	6	7	5	5	10	2+1=3	8
6						x	7	6	6	10	3+1=4	7
7							X	7	7	7	5+1=6	5
8								x	9	10	0+1=1	10
9									X	10	1+1=2	9
10										X	4+1=5	6

Source: own survey, 2014

Table 5. List of natural resource attributes of Tullu Dimtu ecosystem

No.	Natural resources attributes	No.	Natural resources attributes
1	Bamboo for construction	7	Honey production
2	Bamboo for grazing (animal feed)	8	Construction material (poles, timber, furniture)
3	Grass for grazing	9	Fuel wood
4	Grass for house construction	10	Medicinal plants
5	Water for human and livestock drinking	11	Availability of wild life for hunting
6	Wild fruit availability		

Source: own survey, 2014

Table 6. List of natural resource attributes of Anbesa Forest ecosystem

No.	Resource Attributes	No.	Resource Attributes
1	Availability of edible Wild plants	9	Availability of Wild honey
2	Bamboo harvesting level	10	Availability of Bee colony for hiving
3	Availability of Bamboo for grazing	11	Availability of wild life
4	Marketability of Bamboo	12	Availability of Construction material
5	Availability of Grass for construction	13	Availability of fuel wood
6	Availability of Grass for Grazing	14	Availability of medicinal plants
7	Marketability of Grass	15	Marketability of medicinal plants
8	Availability of Water		

Source: own survey, 2014

Table 7. Likert scaling of multi-criterions according to communities concern

No.	Criterions	Likert scales	Their meaning	Remark
1	Need consistency across season	1	Very high variation of need	Very low concern
		2	High variation	low concern
		3	Moderate variation	Moderate concern
		4	Low variation	High concern
		5	Very low variation	Very High concern
2	Attributes availability across seasons	5	Extreme variation in its availability	Very high concern
		4	High variation	High concern
		3	Moderate variation	Moderate concern
		2	Low variation	Low concern
		1	Very low	Very low concern
3	Community's harvesting frequency of the attributes	5	Very high harvesting frequency	Very high concern
		4	High harvesting frequency	High concern
		3	Moderate harvesting frequency	Moderate concern
		2	Low harvesting frequency	Low concern
		1	Very low harvesting frequency	Very low concern
4	Using the attribute for home consumption	5	Mainly consumed in the home	Very high concern of the community
		4	Higher proportion is consumed in the home	High concern
		3	Moderate proportion is consumed in the home	Moderate concern
		2	Low proportion is consumed in the home	Low concern
		1	Very low proportion is consumed in the home	Very low concern
5	Using the attribute for sell	5	Mainly consumed in the home	Very high concern
		4	Higher proportion is consumed in the home	High concern
		3	Moderate proportion is consumed in the home	Moderate concern
		2	Low proportion is consumed in the home	Low concern
		1	Very low proportion is consumed in the home	Very low concern
6	Effect of the attribute deterioration on ecosystem service	5	Extremely determinant	Very high concern
		4	Highly determinant	High concern
		3	Moderately determinant	Moderate concern
		2	Low determinant	Low concern
		1	Least determinant	Very low concern

Source: own survey, 2014

Table 8. Multi-co-linearity test (VIF) of Tullu Dimtu

No	Variable	VIF
1	Education level	1.01
2	Total land holding	1.02
3	Dependency ratio	1.01
4	Reading and writing skill	1.01

Source: own survey, 2014

Table 9. Multi-co-linearity test (contingency coefficient) of Tullu Dimtu
Source: own survey, 2014

Variables	Native	Land market participation	Land rent out participation	Land rent in anticipation
Native	*			
Land market participation	0.142	*		
Land rent out participation	0.015	0.53	*	
Land rent in participation	0.144	0.52	0.13	*

Table 10. Multi-co-linearity test (VIF) of Anbesa forest

Variables	VIF
Education level in year of schooling	1.10
Family size	3.14
Total rain fed land holding	1.08
Total irrigated land holding	1.05
working age family members-Male	1.63

Source: own survey, 2014

Table 11. Multi-co-linearity test (contingency coefficient) of Anbesa forest

Variable number		1	2	3	4	5	6	7	8	9	10
1	Literacy (Read and write)	*									
2	Farm land shortage	0.04	*								
3	Soil fertility as agricultural production problem	0.16	0.19	*							
4	using wild Kocho as source of livelihood making	0.02	0.09	0.15	*						
5	using Bamboo	0.07	0.14	0.18	0.46	*					

	Bud as source of livelihood making										
6	Using medicinal plant	0.19	0.15	0.32	0.13	0.20	*				
7	participation in Cash crop production	0.11	0.11	0.03	0.08	0.05	0.10	*			
8	participation in rural labour market	0.17	0.17	0.05	0.08	0.24	0.09	0.04	*		
9	Lack of management	0.09	0.14	0.19	0.10	0.07	0.50	0.12	0.19	*	
10	Wild Life as a source of meat	0.02	0.07	0.10	0.10	0.02	0.14	0.08	0.19	0.16	*

Source: own survey, 2014

II. Photographs showing the presence of continuous ecological resource degradation in the study area.

Fig. 1. Ecosystem provision service and degradation in the study area.

Source: photograph taken during field observation, 2014

Mixed logit model and willingness to pay

```
Iteration 3:   log likelihood = -824.72617
Iteration 4:   log likelihood = -823.21378
Iteration 5:   log likelihood = -823.18873
Iteration 6:   log likelihood = -823.18872

Mixed logit model                                 Number of obs   =       4392
                                                  LR chi2(3)      =      84.85
Log likelihood = -823.18872                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
      Choice |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Mean         |
        Cost |  -.0007151   .0000737    -9.70   0.000    -.0008595   -.0005707
     BamDome |   .0040756   .0004654     8.76   0.000     .0031635    .0049877
     CatGraz |   .0343347    .003436     9.99   0.000     .0276002    .0410691
     GraDome |    .029214   .0057984     5.04   0.000     .0178494    .0405786
      water2 |   3.553454   .1997947    17.79   0.000     3.161863    3.945044
      water1 |   2.647879   .1728823    15.32   0.000     2.309036    2.986722
-------------+----------------------------------------------------------------
SD           |
     GraDome |   .0400634   .0064904     6.17   0.000     .0273425    .0527843
      water2 |  -.7075299   .1731322    -4.09   0.000    -1.046863   -.3681971
      water1 |   1.100989    .138768     7.93   0.000     .8290085    1.372969
------------------------------------------------------------------------------

        CatGraz     BamDome     GraDome      water2      water1
wtp   48.013433   5.6992925   40.852706   4969.1324   3702.7813
 ll   38.428451    4.266438   23.134598   4137.6964   3013.2252
 ul   57.598415   7.1321471   58.570814   5800.5683   4392.3375
```

Fig. 2. Econometrics result direct output for Tullu Dimtu.

Source: own choice experiment data direct output, 2014

Mixed logit model and willingness to pay

```
Iteration 3:   log likelihood = -847.80836
Iteration 4:   log likelihood = -815.76249
Iteration 5:   log likelihood = -813.30919
Iteration 6:   log likelihood = -813.26295
Iteration 7:   log likelihood = -813.26287

Mixed logit model                                 Number of obs   =       3000
                                                  LR chi2(4)      =     281.24
Log likelihood = -813.26287                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
      choice |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Mean         |
        Cost |  -.0005834   .0000844    -6.91   0.000    -.0007489    -.000418
     BamDome |    .003614   .0004741     7.62   0.000     .0026848    .0045433
     Acctwfd |   1.661216   .3522017     4.72   0.000     .9709134    2.351519
    MedpDome |   .4153034   .1465976     2.83   0.005     .1279774    .7026294
     MedpMkt |   .4338155   .0980942     4.42   0.000     .2415545    .6260765
      BamMkt |   .5058972    .115422     4.38   0.000     .2796742    .7321202
-------------+----------------------------------------------------------------
SD           |
     Acctwfd |   3.087788   .3844894     8.03   0.000     2.334202    3.841373
    MedpDome |   .9826019   .1988629     4.94   0.000     .5928378    1.372366
     MedpMkt |   .6205759   .1238594     5.01   0.000     .3778159    .8633358
      BamMkt |   .8880329   .1269057     7.00   0.000     .6393022    1.136764
------------------------------------------------------------------------------

       BamDome    Acctwfd   MedpDome    MedpMkt     BamMkt
wtp   6.194527  2847.3533  711.83721  743.56726  867.11661
 ll  4.0590357  1621.5737  217.62472  384.78581  445.38018
 ul  8.3300183   4073.133  1206.0497  1102.3487   1288.853
```

Fig. 3. Econometrics result direct output for Anbesa forest.

Source: own choice experiment data direct output, 2014

APPENDIX B

Forma Survey Questionnaire

Questionnaire ID. ____

1. Region ____
2. District____
3. Peasant Association (Kebele) ______________________________
4. Interviewer's name ______________________________________
5. Date of interview____
6. Interviewer's signature ____________________________________

A. **HOUSEHOLD CHARACTERISTICS**

Household characteristics					
1. Sex	1. male		2. female		
2. Marital status	1.maried	2. Single	3.Divorced	4.Widow	
3. Age of house hold head					
4. Level of education house hold head	1.Illiterate	2. read and write	3. schooling year (______________)		
5. Religion	1. Muslim	2. Christen	3. Others (specify) (____________)		
5. The main occupation house hold	1. Farmer	2. Labourer	3. trader	4.Student	5.Unemployed
6. Family size					
7. Residence status	1.Indigenous (before 1977 E.C)		2. Immigrant (if after 1977 E.C)		
8. Age categories in the family (No of individuals)	Under 14 M____ F_____		15-64 M____ F____		Above 64 M____ F_____
9. Job categories in the family	Under 14 M____ F_____		15-64 M____ F____		Above 64 M____ F_____
10. Education categories in the family (No of individuals)	Illiterate Male____ Female___	Read & write M____ F_____	Grade 1-4 M____ F____	Grade 5-8 M____ F_____	Grade 9 & above M____ F_____

Code for Job category
1= Domestic task **4= Gove's employee**
2= Farm activity **5= other (specify)**
3= Trade

B. **Economic holding**

1. Do you have any plot of land generating any benefit?

1. Yes 2. No

2. If yes, would you please tell us your land holding size by categories?

Farm land size	Rain fed Plot size		Irrigated Plot size		Means of obtaining **(Code B2b)**
	Area	Unit **(code B2a)**	Area	Unit **(code B2a)**	
1. Own cultivated					
2. Rented in					
3. Rented out					
4. Fallowed					
5. Other (specify)					
6. Total area					

Code B2a

1. Hectare
2. Timad (quantify plowing days)
3. Other (specify and add equivalence to hectare

Code B2b

1. Allocated
2. Purchased
3. Occupying Forest land (deforesting)
4. Occupying Bamboo land (deforesting)
5. Occupying housing Grass land
6. Occupying grazing Grass land
7. Inherited/Parent's gift
8. Rented in
9. Share cropped in
10. Borrowed
11. Others (specify)

3. What types and number of livestock you have**?**

Livestock type	Number owned	Number Bought in 2005 E.C		Number soled in 2005 E.C		Productivity 1. High 2. Low
		Quantity	Price (Birr)	Quantity	Price (Birr)	
Cow						
Oxen						
Heifer						
Calves						
Bulls						
Goat						
Sheep						
Donkey						
Mule						
Chickens						

Note: use 1. High productivity for cow in reference to milk and birth giving frequency, for heifer in reference to first birth giving age, for bulls &oxen in reference to plowing age, for goat and sheep in reference to birth giving frequency, for donkey and mule based on services thy provides.

4. Would you tell us your gross income from selling animal products in the year 2005 E.c?

Type	Did you sell any **1. Yes 2. No**	Amount sold	Unit code **(Code B4a)**	Price per unit	Total revenue **(Birr)**
Hides/Skins					
Butter/cheese					
Eggs					
Honey					

Code B4a

1. Kilogram
2. Kubaya
3. Sini
4. Liter
5. Unit of commodity sold
6. Other specify

5. What other assets you have?

Asset type	Total number or Units Owned now	Total number bought in 2005 E.C		Total price of the owned assets (Birr)
		Unit	Price of each (Birr)	
Table	Table	Table	Table	Table
Chair (including berchuma)				
Boxes (Cupboard/locker)				
Bed (from wood, iron or hide)				
Ornament (like gold, Birr, etc..)				
Town house/space				
Tape recorder				
Television				
Mill (wofcho)				
Cell phone				
Other specify				

C. **Agricultural production characterization and farm management**

1. What crops you produce and how much it yields in 2005 E.C?

Crops	Do you cultivate in 2005 E.C 1.Yes 2. No	If yes, what is allocated Land size of each?		Amount of Produced Yield		Amount sold		Price received		Revenue (Birr)
		Area	Unit (code C1a)	Out put	Unit (code	Quantity sold	Unit (code C1b)	Price (Birr)	Unit (code C1b)	
Cereals										
Finger millet										
Teff										
Maize										
Sorghum										
Pulse and oil crops										
Noug										
Sesame										
Hot Pepper										
Faba bean										
Field pea										
Horse bean										
Groundnut										
soyabean										
Tuber and vegetable										
Anchote										
Potato										
Sweet potato										
Cabbage										
Fruits										
Banana										
Mango										
Papaya										
Total										

Code C1a

1. Hectare
2. Timad (quantify plowing days)
3. Other (specify)

Code C1b

1. Kilogram
2. Quintal
3. Others (ask its equivalence to KG)

2. What farm management practices you did for each crop you produce and how much cost you spend in each session in 2005 E.C?

Activities	Cost for farm management practices in each season			
	Spring (Birr)	Summer (Birr)	Outmen (Birr)	Winter (Birr)
Land preparation				
Planting				
Weeding				
Chemical application				
Harvesting				

Note: pleas tick for which farm management and in which season they face labor shortage.

3. Have you been encountered labor shortage in your farming activity in 2005 E.C?
   1. Yes   2. No
4. If yes, in which season and for what farm management practices labor shortage encounters you?

Season	**Farm management**			
	Land preparation	Planting	Weeding	Harvesting
Spring				
Summer				
Outmen				
Winter				

Note: pleas tick for which farm management and in which season they face labor shortage.

5. Would you tell us about accessibility of farm inputs you use and related constraints?

Types of farm inputs	Access to farm inputs in time? 1. Yes 2. No	Access to farm inputs the amount needed? 1. Yes 2. No	Reasons for inaccessibility of farm inputs **(code C5a)**	Availability at local market 1. available 2. Not available.	Affordability of the inputs **(code C5b)**	source of farm inputs **(code C5c)**
Fertilizer						
labor						
Herbicide						
Improved seed						

Note: multiple responses are possible for code D6a & D6b

Code C5c
1. from aid
2. from traders
3. from cooperatives
4. from agricultural offices

Code C5b
1. Expensive
2. Feasible/fair price

Code C5a
1. Distance of the input market
2. High price
3. Low capacity to purchase
4. No supply on local market
5. Other specify

6. What inputs you use for each crops you produced in 2005 E.C?

Types Crops	Types of inputs	Input amount and irrespective of costs											
		Chemical fertilizer			Herbicide			Pesticide			Improved seed		
Cereals	Input code **(code C6a)**	Quantity	Unit **(Code C6b)**	Price/unit (Birr)	Quantity	Unit **(Code C6c**	Price /unit (Birr)	Quantity	Unit **(Code C6c)**	Price/unit (Birr)	Quantity	Unit **(Code C6b)**	Price/unit (Birr)
Finger millet													
Teff													
Maize													
Sorghum													
Pulse and oil crops													
Noug													
Sesame													
Ground nut													
pepper													
Faba bean													
Field pea													
Horse bean													

Code C6b
1. Killo gram
2. Quintal
3. Other (specify)

Code C6c
1. Bottle
2. Cup
3. Other (specify)

Code C6a
1. Chemical fertilizer
2. Herbicide
3. Pesticide
4. Improved seed

7. Do you sell your farm products (crop)?

a. Yes b. No

8. In which month(s) you sell your crop products?

month(s) in which Crops are soled	Months											
	1	2	3	4	5	6	7	8	9	10	11	12

9. For what purpose you sell your crop produces?

1. For school expense
2. To pay government tax
3. To buy agricultural inputs
4. For holiday ceremony
5. To repay agricultural input purchased on credit
6. To pay for hired labourer

10. What are major crop production constraints in your area?

1. Shortage of land
2. Shortage of farm inputs
3. High farm input price
4. Diseases
5. Shortage of Rainfall
6. Poor soil fertility
7. Inadequate market service
8. Wild life effect
9. Other

11. How you manage crop production constraints in your area Since 10 Year? (multiple response is possible)

Crop production constraints	Management schemes							
	Farm land expansion to forest land	Using fabricated chemicals	Using indigenous knowledge or medicinal plants	Using water harvesting and irrigation	Using compost or animal manure	Fallowing farm land	Rent in farm land	Share cropping
Land shortage								
Shortage of agricultural inputs								
High farm input prices								
Crop disease								
Shortage of rainfall								
Poor soil fertility								
Inadequate/no marketing services								
Wild life effect								

Note: please tick in the appropriate box of response

12. What is the effect of these techniques on the production of crop?

Management scheme	Effects on productivity
Farm land expansion to forest land	
Using fabricated chemicals	
Using indigenous knowledge or medicinal plants	
Using water harvesting and irrigation	
Using compost or animal manure	
Fallowing farm land	
Rent in farm land	
Share cropping	

Note: use code C12a.

Code C12a
1=improves
2= degrades
3=keep constant

13. What is the effect of these techniques on the natural resources?

Management scheme	Effects on natural resources		
	Grass	Bamboo	Water
Farm land expansion to forest land			
Using fabricated chemicals			
Using indigenous knowledge or medicinal plants			
Using water harvesting and irrigation			
Using compost or animal manure			
Fallowing farm land			
Rent in farm land			
Share cropping			

Note: use codes for effects on natural resources columns 1=improves 2= degrades 3=keep constant

14. Is there any local or traditional institutional arrangement in livestock rearing?
    a. Yes
    b. No
15. If yes, what is/are this/these institutional arrangement scheme(s)?
    a. Keeping cattle for milk
    b. Sharing calf
    c. Keeping cattle for oxen
    d. Kaya (keeping for manure)
16. Have you access to formal institution of livestock rearing like veterinary service?
    a. Yes
    b. No
17. If yes, what are these services provided by the institution of veterinary in supporting livestock rearing?
    a. Medication
    b. Vaccination
    c. Fatting
    d. Breading
    e. Other specify
18. What is the effect of the institutional arrangement schemes on the quality and quantity of the pasture on communal grazing land?
    a. It deteriorates as it increased cattle population
    b. It does not affect
    c. It improves
19. Do you participate in any of these institutional arrangement scheme(s)?
    a. Yes
    b. No
20. If yes, in which institutional arrangement scheme(s) you participate?
    a. Keeping cattle for milk
    b. Sharing calf
    c. Keeping cattle for oxen
    d. Keeping for manure
21. Is there any land market institutions in the area?
    a. Yes
    b. No
22. What is/are these market(s)?
    a. Renting/Abel
    b. Contract
    c. Share cropping
23. What is the effect of land market on the productivity of farm land?
    a. It keeps constant/ the same
    b. It deteriorates
    c. It improves
24. Do you participate in any land market institutions?
    a. Yes
    b. No

25. If yes, in which market institutions you participate?
   a. Renting/Abel in
   b. Contract in
   c. Share cropping in
   d. Invitation of Government to farm farmland
   e. Renting/Abel out
   f. Contract out
   g. Share cropping out
   h. Other specify
26. How do institutional arrangements of land market influence land productivity? (multiple response is possible)
   a. Contributes to farmland expansion
   b. Aggravating erosion
   c. Reduce conservation concern in Absence of sense of ownership
   d. Enforce high population to farm Practice
   e. Other specify
27. What is the effect of the institutional arrangements of land market on the sustainability of each ecosystem services?

Institutional arrangement access for	Effect on ecosystem services		
	Grass	Bamboo	Water
Farm land (Rent, Abel, Investment)			

Note: use codes for effects on natural resources columns 1=improves 2= degrades 3=keep constant

28. What is the property system of grazing land?
   a. Communal
   b. Open
   c. Private
   d. Share
29. Is there any often occurrence of conflict on communal and/or open grazing land Since 10 Year?
   a. Yes
   b. No
30. If yes for No 31, what could be main source of the conflict? (Multiple response is possible)
   a. Conversion of grazing land in to farm land
   b. High population of cattle
   c. High population of immigrants
   d. Declining of pasture by natural damaging force
31. If yes for No 31, how you resolve the conflict? (Multiple response is possible)
   a. With negotiation
   b. With local elders
   c. With court
32. Is there any deterioration of pasture of grazing land (in quality and quantity) since 10 year?
   a. Yes
   b. No
33. If yes, what you think as the reason of this deterioration?
   a. Intensive grazing
   b. High cattle population
   c. Open grazing
   d. Lack of management scheme
   e. Susceptibility of the area

34. What benefit you was earning before 1977 E.c. from Anbesa forest?
   a. Bamboo for construction
   b. Bamboo for selling
   c. Bud of Bamboo for food
   d. Medicinal plant for cattle and humans
   e. Water
   f. Echa (for food)
   g. Wild life meat
   h. Wild honey
   i. Kocho (for food)
   j. Fire wood
   k. Other specify

35. What is the trend of these benefits earned from Anbesa forest since 1983 E.c?
    a. Increased
    b. Decreased
    c. Remain constant (unchanged)
36. Do you think that the availability of natural resource items used for food is being degraded in the Anbesa forest?
    a. Yes
    b. No
    c. I don't know
37. What food items of natural resource are degraded that you had been using earlier?
    a. Bud of Bamboo for food
    b. Wild life meat
    c. Wild honey
    d. Kocho
    e. Echa (for food)
38. Do you frequently encounter food shortage since 10 year?
    a. Yes
    b. No
39. If yes, in which month(s) you encounter food shortage?

Food shortage month(s)	Months											
	1	2	3	4	5	6	7	8	9	10	11	12

Note: Use September as the beginning of months of the year

40. Do you use natural resource to manage food shortage?
    a. Yes
    b. No
41. What natural resources you use to manage food shortage currently (if any)?
    a. Echa
    b. Kocho
    c. Somoo (the bud of bamboo)
    d. wild honey
    e. Wild life meat
    f. Other (specify)
42. If you do not use natural resources to manage food shortage, is this feature was consistent in the past before 10 year?
    a. Yes
    b. No
43. If not, what makes you not to use and from what dates onward the feature (you stopped using natural resource as food shortage management) had been changed?
    a. After livestock health & crop production is improved
    b. After well establishment of labor market
    c. Because of disappearance of food items in the forest
    d. After the expansion of farm land damaging food items
    e. Other (specify)

44. Would you tell us in which dates that these (features) and livelihood advancement took place if you remember?

Livelihood advancement	Dates of occurrence **(Code C44a)**
Crop farming advancement	
Livestock health improvement	
Labor market establishment	
disappearance of food items	

<u>Code C44a</u>
1. Before 1977 E.c
2. Between 1977 E.c—1983 E.c
3. After1983 E.c

45. Before this date, what natural resources you use to manage food shortage?

a. Echa

b. Kocho

c. Somoo (the bud of bamboo)

d. wild honey

e. Wild life meat

f. Other specify

46. What is the effect of using bamboo as feed on its deterioration on size of land on which it grows?

a. It deteriorate

b. It improves

c. It has no effect

47. If it deteriorates, how?

a. Non selective cutting

b. Using the bud to not regenerate

c. Digging effect of livestock leg

d. Other (specify)

48. If it has no an effect, how?

a. The harvest did not require high compaction

b. Due to selective harvesting

c. Using only leaf part

d. Other specify

49. What is the effect of using bamboo as construction material on its deterioration in quality of Bamboo sticks?

a. It deteriorate

b. It has no effect

50. If it deteriorates, how?

a. Non selective cutting

b. Using the bud to not regenerate

c. Digging effect of livestock leg

d. Other specify

51. If it has no an effect, how?

a. The harvest did not require so much

b. Due to selective harvesting

c. Using only leaf part

d. Other (specify)

52. What is the effect of using grass as grazing on its deterioration in the size of land on which it grows?

a. It deteriorate

b. It has no effect

53. If it deteriorates, how?

a. Non selective cutting

b. Intensive to expose its root to sun

c. Frequent contact of human and livestock

to expose its root to sun

54. If it has no an effect, how?

a. It did not affect the root part

b. Low frequency of human contact

c. Simple cut and carry, not expose its root to sun

d. Using only leaf part

55. What is the effect of using grass as grazing on its deterioration in quality of housing?

a. It deteriorate

b. It has no effect

56. If it deteriorates, how?

a. It is non-selective harvesting

b. Intensive to expose its root to sun

c. Frequent contact of human to expose its root to sun

d. Other (specify)

57. If it has no an effect, how?

a. It did not affect the root part
b. Low frequency of human contact
c. Simple cut and carry, not expose its root to sun
d. Using only leaf part
e. Other (specify)

58. Do you know the change occurred on water sources in the ecosystem
    a. Yes
    b. No
59. If yes, what is the reason?
    a. Rainfall pattern
    b. Natural resource base degradation
    c. It is natural process
    d. I do not know the reason
    e. Other (specify)
60. If it is deteriorating, what could be its effect on your livelihood?
    a. It has no an effect
    b. It will affect economic system
    c. It will affect the health of family members
    d. It can cause a death in human and livestock
61. Could natural resource base degradation be the reason of the deterioration in water sources?
    a. Yes
    b. No
    c. I do not know
62. Access to natural resource attributes

No	Natural resource attributes	Distance from home (unit is in time/Km)	Availability 1. Excellent 2. Very good 3. Good 4. poor 1. Very poor
1	Grass		
2	Bamboo		
3	Water		
4	Medicinal plant		
5	Food items		
6	Construction materials		
Other specify			

63. Had you been using medicinal plant to cure human and livestock disease?
    a. Yes
    b.No
64. To which types of human and livestock disease you use medicinal plants?
    a. Head ache
    b. Stomach ache
    c. Rheumatism
    d. Malaria
    e. Diarrhea
    f. Vomiting
    g. Urinating blood problem of livestock
    and livestock
    h. Delaying placenta problem of human
    i. Other specify
65. Currently of which disease curing medicinal plant is degraded from Anbesa forest ecosystem?
    a. Head ache
    b. Stomach each
    c. Rheumatism
    d. Malaria
    e. Diarrhea
    f. Vomiting
    g. Urinating blood problem of livestock
    and livestock
    h. Delaying placenta problem of humans
    i. Other specify

66. What you think as a main cause for these medicinal plants availability degradation?

a. Intensive grazing
b. High cattle population
c. Lack of management scheme
d. Expansion of farmland
e. Natural process
f. Other specify

67. Are you voluntary in participation of conservation practice enhancing Anbesa forest with its natural resource provision service?

a. Yes
b. No

C. choice experiment cards

1. For Tullu Dimtu ecosystem

Choice set 1

Attributes	Alternative 1	Alternative 2
Cattle (Grazing service)	20 Heads	3 Heads
Bamboo for domestic use	350 Sticks	500 Sticks
Grass for domestic use	30 Loads	6 Loads
Cost (fee of use)	600 Birr	2400 Birr
Access to Water service	Only Rainy season	Throughout the year
Pleas tick chosen alternative		

Choice set 2

Attributes	Alternative 1	Alternative 2
Cattle (Grazing service)	40 Heads	20 Heads
Bamboo for domestic use	250 Sticks	500 Sticks
Grass for domestic use	30 Loads	6 Loads
Cost (fee of use)	600 Birr	2400 Birr
Access to Water service	Throughout the year	Only Rainy season
Pleas tick chosen alternative		

Choice set 3

Attributes	Alternative 1	Alternative 2
Cattle (Grazing service)	40 Heads	20 Heads
Bamboo for domestic use	250 Sticks	500 Sticks
Grass for domestic use	15 Loads	30 Loads
Cost (fee of use)	1200 Birr	2400 Birr
Access to Water service	Only Rainy season	Far from residence
Pleas tick chosen alternative		

Choice set 4

Attributes	Alternative 1	Alternative 2
Cattle (Grazing service)	3 Heads	40 Heads
Bamboo for domestic use	250 Sticks	350 Sticks
Grass for domestic use	15 Loads	6 Loads
Cost (fee of use)	600 Birr	2400 Birr
Access to Water service	Far from residence	Only Rainy season
Pleas tick chosen alternative		

2. For Anbesa forest ecosystem

Attributes	Choice Set 1	
	Option 1	Option 2
Access to food Wild	not-available	highly available
Medicinal plant for domestic	non-available	available
Medicinal plant for market	non-marketable	marketable
Bamboo for market	Highly marketable	not-marketable
Bamboo for domestic	250 sticks	350 sticks
Conservation (Cost)	4 Labor per month	4 Labor per month
Choice decision		

Attributes	Choice Set 2	
	Option 1	Option 2
Access to food Wild	highly available	not-available
Medicinal plant for domestic	available	available
Medicinal plant for market	non-marketable	marketable
Bamboo for market	not-marketable	Highly marketable
Bamboo for domestic	250 sticks	500 sticks
Conservation (Cost)	7 Labor per month	4 Labor per month
Choice decision		

Attributes	Choice Set 3	
	Option 1	Option 2
Access to food Wild	highly available	not-available
Medicinal plant for domestic	available	non-available
Medicinal plant for market	marketable	non-marketable
Bamboo for market	not-marketable	Highly marketable
Bamboo for domestic	250 sticks	500 sticks
Conservation (Cost)	4 Labor per month	4 Labor per month
Choice decision		

Attributes	Choice Set 4	
	Option 1	Option 2
Access to food Wild	highly available	not-available
Medicinal plant for domestic	available	non-available
Medicinal plant for market	non-marketable	marketable
Bamboo for market	Highly marketable	not-marketable
Bamboo for domestic	350 sticks	500 sticks
Conservation (Cost)	7 Labor per month	4 Labor per month
Choice decision		